DOSAGE CALCULATIONS

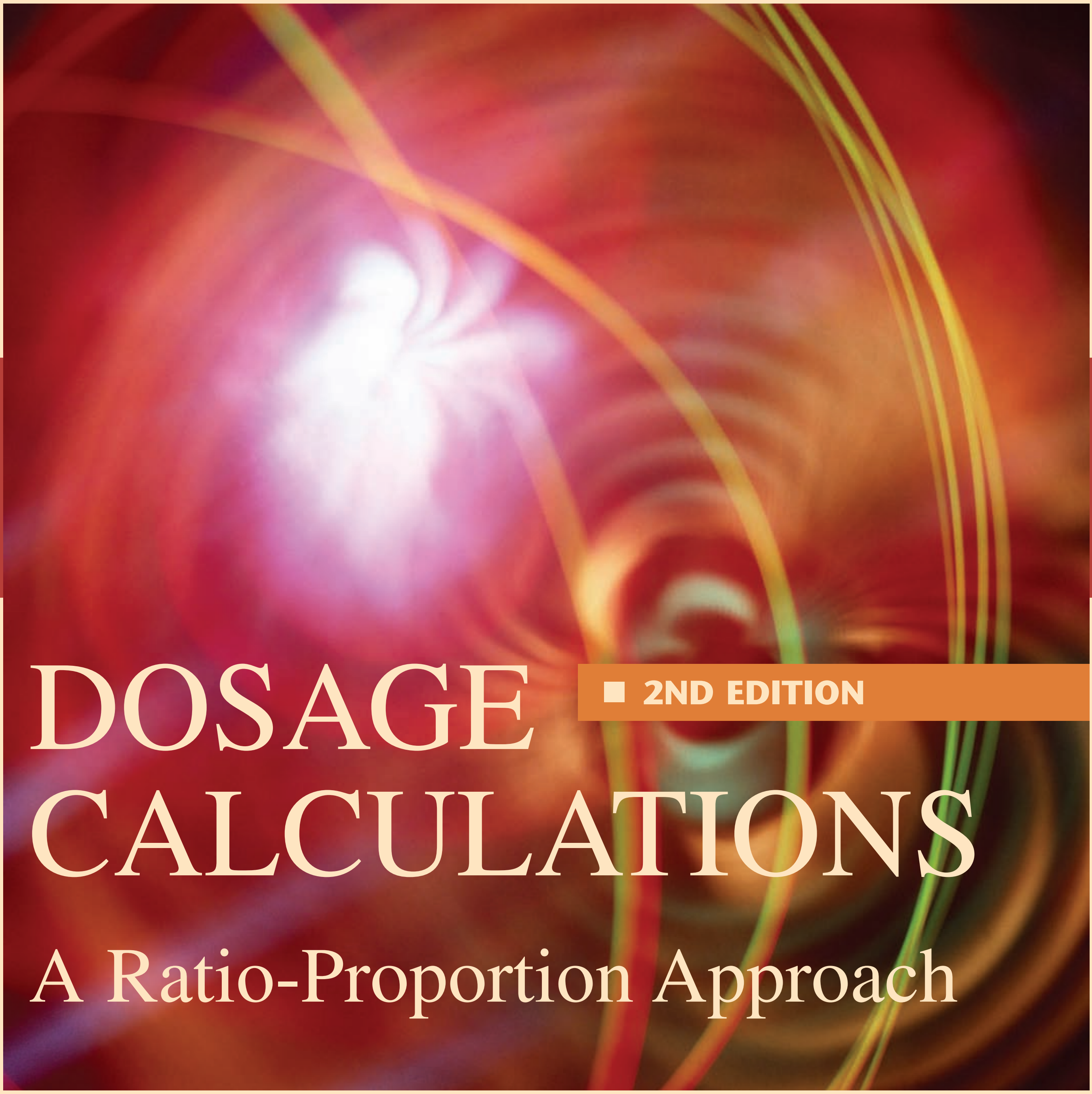
A Ratio-Proportion Approach

2nd Edition

Dedicated to my father,

Eloby Prentis Rish,

who taught me to love learning.



DOSAGE CALCULATIONS

■ 2ND EDITION

A Ratio-Proportion Approach

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Dosage Calculations: A Ratio-Proportion Approach, 2nd Edition

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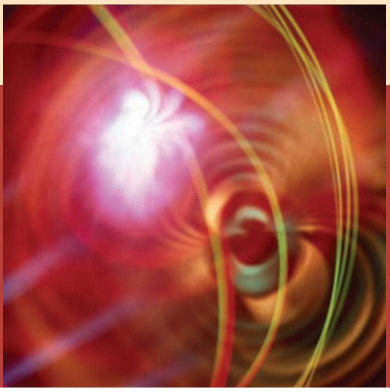


Contents

Preface

Introduction

Dosage Calculations: A Ratio-Proportion Approach, Second Edition, offers a clear and concise method of calculating drug dosages. The text is directed to the student or professional who feels uncomfortable with mathematics and to the faculty member who prefers the ratio-proportion method. Mirroring the popular text *Dosage Calculations* the content has been classroom-tested and reviewed by well more than 750,000 faculty and students, who report that it helped them allay math anxiety and promoted confidence in their ability to perform accurate calculations. As one reviewer noted, "I have looked at others [texts] and I don't feel they can compare."

The only math prerequisite is the ability to do basic arithmetic. For those who need a review, Chapters 1 and 2 offer an overview of basic arithmetic calculations with extensive exercises for practice. The student is encouraged to use a three-step method for calculating dosages:

1. convert measurements to the same system and same size units;
2. consider what dosage is reasonable; and
3. calculate using the ratio-proportion method.

The Second Edition is based upon feedback from users of the previous editions of both Pickar dosage calculations texts as well as users of other dosage calculations texts. The revision also responds to changes in the health care field and includes the introduction of new drugs, the replacement of outdated drugs, and new or refined methods of administering medications. The importance of avoiding medication errors is highlighted by the incorporation of applied critical thinking skills based on patient care situations and by a new chapter on preventing medication errors.

Organization of Content

The text is organized in a natural progression of basic to more complex information. Learners gain self-confidence as they master content in small increments with ample review and reinforcement. Many learners claim that while using this text they did not fear math for the very first time.

The sixteen chapters are divided into four sections.

Section 1 has a mathematics diagnostic evaluation and a mathematics review in Chapters 1 and 2. The *mathematics diagnostic evaluation* allows learners to determine their computational strengths and weaknesses to guide them through the review of the Section 1 chapters. *Chapters 1* and *2* provide a review of basic arithmetic procedures, with numerous examples and practice problems to ensure that students can apply the procedures. *Chapter 2* introduces ratio-proportion calculations with thorough explanations, examples, and practice problems.

Section 2 is made up of Chapters 3–9. This section provides essential information that is the foundation for accurate dosage calculations and safe medication administration, including medicine orders, labels, and equipment. *Chapters 3* and *4* introduce the three systems of measurement (metric, apothecary, and household) and conversion from one system of measurement to another. The metric system of measurement is stressed because of its standardization in the health care field. The apothecary system continues to be included for recognition purposes and the household system is included because of its implications for care at home. International or 24-hour time and Fahrenheit or Celsius temperature conversions are presented in *Chapter 5.*

In *Chapter 6,* users learn to recognize and select appropriate equipment for the administration of medications based on the drug, dosage, and the method of administration. Emphasis is placed on interpreting syringe calibrations to ensure that the dosage to be administered is accurate. All photos and drawings have been enhanced for improved clarity.

Chapter 7 presents the common abbreviations used in health care so that learners can become proficient in interpreting medical orders. Additionally, the content on computerized medication administration records has been updated.

It is essential that learners be able to read medication labels to calculate accurately. This ability is developed by having students interpret the medication labels provided beginning in *Chapter 8.* These labels represent current, commonly prescribed medications and are presented in full color and actual size (except in a few instances where the label is enlarged to improve readability).

A new *Chapter 9* directs the learner's attention to the risks and responsibilities inherent in receiving medication prescriptions, transcribing orders, and administering medications. It provides the rationale for the importance of accurate dosage calculations and the patient's rights to safe medication administration. Throughout the text, care is taken to comply with standards and recommendations for medical notation available at the time of publication by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) and the Institute for Safe Medication Practices. The JCAHO *Official "Do Not Use" List* is emphasized. Learners are directed to stay abreast of these standards as they evolve to ensure patient safety and prevent medication administration errors.

In *Section 3,* the user learns and practices the skill of dosage calculations applied to patients across the life span. *Chapters 10* and *11* guide the learner to apply all the skills mastered to achieve accurate oral and injectable drug dosage calculations. Users learn to think through the problem logically for the right answer and then to apply ratio-proportion to double-check their thinking. When this logical but unique system is applied every time to every problem, experience has shown that decreased math anxiety and increased accuracy result.

Insulin content (types, species, and manufacturers) has been expanded with a description of insulin action time. The 70-30 and 50-50 insulins are also thoroughly explained.

A new *Chapter 12* introduces the concepts of solutions. Users learn the calculations associated with diluting solutions and reconstitution of injectable drugs. This chapter provides a segue to intravenous calculations by fully describing the preparation of solutions. With the expanding role of the nurse and other health care workers in the home setting, clinical calculations for home care, such as nutritional feedings, are also emphasized.

A new *Chapter 13* covers the calculation of pediatric and adult dosages and concentrates on the body weight method. Emphasis is placed on verifying safe dosages and applying concepts across the life span.

Advanced clinical calculations applicable to both adults and children are presented in *Section 4.* Intravenous administration calculations are presented in *Chapters 14* through *16.* New content reflects the greater application of IVs in drug therapy. Shortcut calculation methods are presented and explained fully. More electronic infusion devices are included. Heparin and saline locks, types of IV solutions, IV monitoring, IV administration records, and IV push drugs are included in *Chapter 14.* Pediatric IV calculations are presented in *Chapter 15,* and obstetric, heparin, and critical care IV calculations are covered in a new *Chapter 16.* Ample problems help students master the necessary calculations.

Procedures in the text are introduced using several examples. Key concepts are summarized and highlighted in quick review boxes before each set of review problems to give learners an opportunity to review major concepts prior to working through the problems. Math tips provide memory joggers to assist learners in accurately solving problems. Learning is reinforced by practice problems that conclude each chapter. The importance of calculation accuracy and patient safety are emphasized by patient scenarios that apply critical thinking skills. Medication error scenarios added to chapter practice problems and comprehensive exams further emphasize accuracy, safety, and liability associated with dosage calculation and medication administration.

Information to be memorized is identified in remember boxes, and caution boxes alert learners to critical procedures.

Section Self-Evaluations, found at the end of each section, provide learners with an opportunity to test their mastery of chapter objectives prior to proceeding to the next section. Two posttests at the conclusion of the text serve to evaluate the learner's overall skill in dosage calculations. The first posttest covers essential skills commonly tested by employers, and the second serves as a comprehensive examination. Both are presented in a case study format to simulate actual clinical calculations.

An answer key at the back of the text provides all answers and selected solutions to problems in the Review Sets, Practice Problems, Section Self-Evaluations, and posttests.

Features of the Second Edition

- Content is divided into four main sections to help learners better organize their studies.
- More than 2,050 problems for learners to practice their skills and reinforce their learning reflect current drugs and protocols.
- Critical thinking skills are applied to real-life patient care situations to emphasize the importance of accurate dosage calculations and the avoidance of medication errors.

- Full color is used to make the text user-friendly. Chapter elements such as rules, math tips, cautions, remember boxes, quick reviews, and examples are color-coded for easy recognition and use. Color also highlights review sets and practice problems.
- All syringes and measuring devices are drawn to full size to provide accurate scale renderings to help learners master the measurement and reading of dosages.
- An amber color has been added to selected syringe drawings throughout the text to *simulate a specific amount of medication,* as indicated in the example or problem. Because the color used may not correspond to the actual color of the medications named, *it must not be used as a reference for identifying medications.*
- Photos and drug labels are presented in full color; color is used to highlight and enhance the visual presentation of content to improve readability. Special attention is given to visual clarity with some labels enlarged to ensure legibility.
- The math review has been expanded to bring learners up to the required level of basic math competence.
- Measurable objectives at the beginning of each chapter emphasize the content to be learned.
- SI conventional metric system notation is used (apothecary and household systems of measurement are deemphasized but are still included).
- RULE boxes draw the learner's attention to pertinent instructions.
- REMEMBER boxes highlight information to be memorized.
- QUICK REVIEW boxes summarize critical information throughout the chapters before Review Sets are solved.
- CAUTION boxes alert learners to critical information.
- MATH TIPS serve to point out math short cuts and reminders.
- Content is presented from simple to complex concepts in small increments, followed by Review Sets and chapter Practice Problems for better understanding and to reinforce learning.
- Many problems are included involving the interpretation of syringe scales to ensure that the proper dosage is administered. Once the dosage is calculated, the learner is directed to draw an arrow on a syringe at the proper value. Syringe photos and illustrations have been updated.
- Many more labels of current and commonly prescribed medications are included to help users learn how to select the proper information required to determine correct dosage. There are more than 375 labels included.
- More solved examples are included to demonstrate the ratio-proportion method of calculating dosages.
- Orders and calculations common in home health care settings are included.
- IV equipment and calculations have been expanded.
- Clear instructions are included for calculating IV medications administered in mg per kilogram per minute.
- Clinical situations are simulated using actual medication labels, syringes, physician order forms, and medication administration records.
- Case study format of posttests simulate actual clinical calculations and scenarios.
- Essential skills posttest simulates exams commonly administered by employers for new hires.
- The index facilitates learner and instructor access to content and skills.

New to the Edition

- Abbreviations, examples, and problems strictly adhere to the JCAHO *Official "Do Not Use" List.* Metric measure of dosage volume in mL completely replaces references to cc.
- An entirely new chapter is devoted to preventing medication error and discussing the critical nature of dosage calculations and medication administration.
- Mathematics review is expanded to two chapters.
- Content is expanded to 16 chapters and divided into four sections. New chapters are included for preventing errors, reconstitution, body weight calculations, and advanced pediatric calculations.
- Home health care applications are added.
- Pediatric content is expanded to focus on applications across the life span.
- Examinations include medication error scenarios for learners to analyze and formulate prevention strategies.
- Practice with calculations for IV-push medications prepares users to determine incremental doses.
- Heparin administration protocols are included with practice scenarios and worksheets.

- More critical thinking skill scenarios provide additional practice for analyzing and preventing medication administration errors, including emphasizing JCAHO guidelines for metric notation.

Teaching/Learning Supplement Package

Electronic Classroom Manager

ISBN 1-4180-1564-4

Free to all instructors who adopt *Dosage Calculations: A Ratio-Proportion Approach, Second Edition,* in their courses, this comprehensive resource includes the following:

- **PowerPoint Presentation**—this vital resource for instructors parallels the content found in the book, serving as a foundation on which instructors may customize their own unique presentations.
- **Computerized Test Bank**—more than 200 additional questions not found in the book or in the StudyWare Online are available for further assessment. The software also allows for the creation of test items, tests, and coding for difficulty level.
- **Instructor's Manual**—locate solutions for every question in review sets, practice problems, section evaluations, and posttests throughout the book.

Online Companion

Thomson Delmar Learning offers a series of Online Companions™ through the Delmar Web site: **www.delmarlearning.com.** The Pickar Online Companion enables both students and instructors using *Dosage Calculations: A Ratio-Proportion Approach, Second Edition,* to access a wealth of information designed to enhance the book.

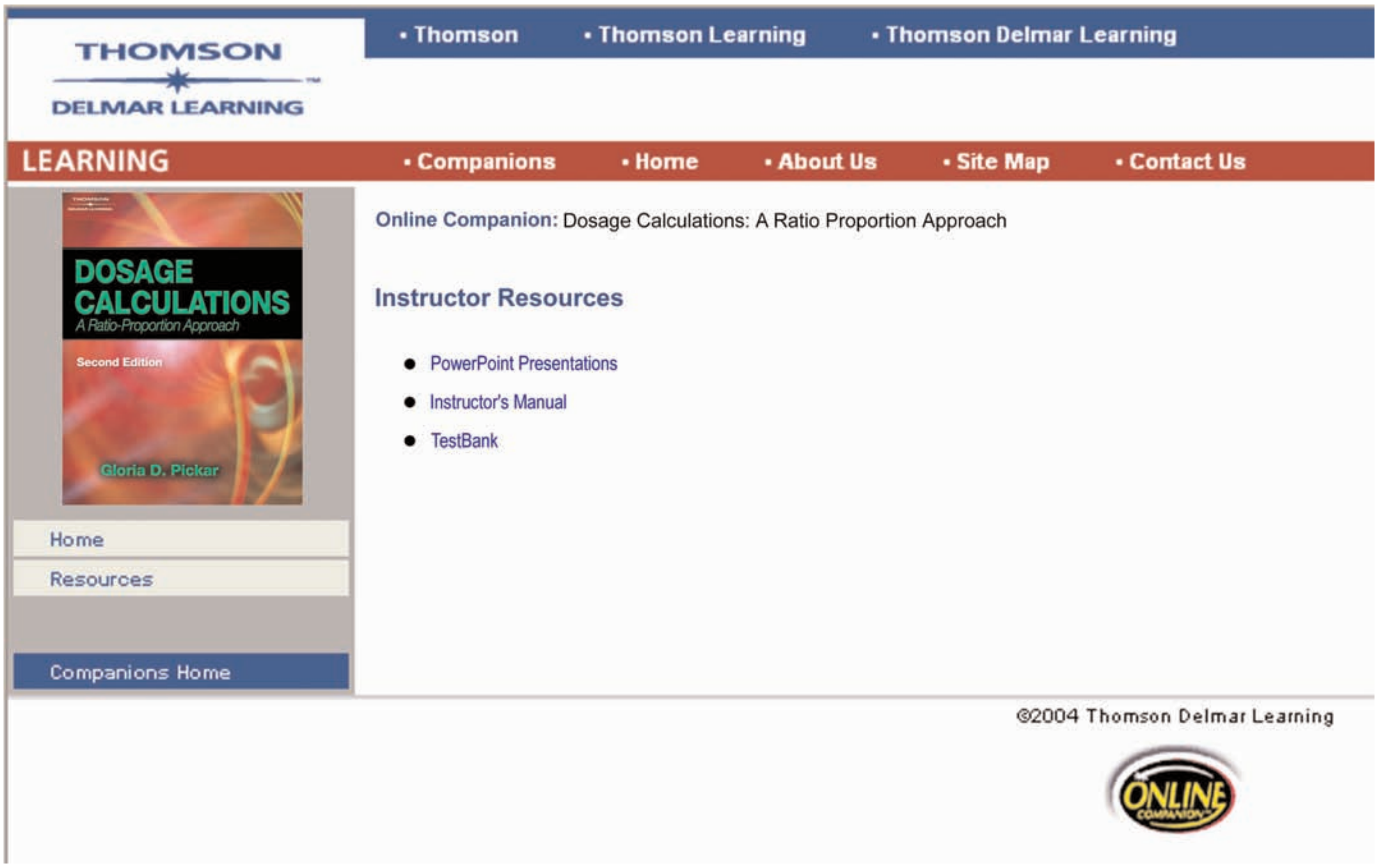
For Students:

- StudyWare Online—contains 500 practice questions tailored to the book's content. Learners can test their knowledge of chapter concepts while applying what they've learned to calculate hundreds of dosages in this electronic practice environment.

For Instructors:

- The PowerPoint presentations, Computerized Test Bank, and Instructor's Manual available on the Electronic Classroom Manager are also available online for added convenience.

To access the site for *Dosage Calculations: A Ratio-Proportion Approach, Second Edition,* simply direct your browser to **www.delmarlearning.com/companions** and select the nursing discipline.



Online Companion: Dosage Calculations: A Ratio Proportion Approach

Instructor Resources

- PowerPoint Presentations
- Instructor's Manual
- TestBank

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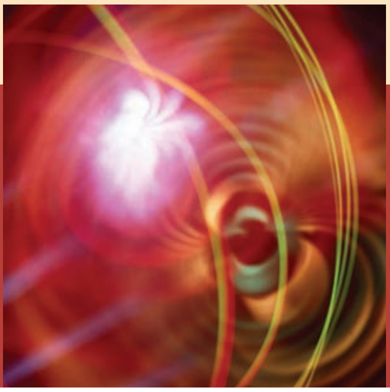

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From the Author

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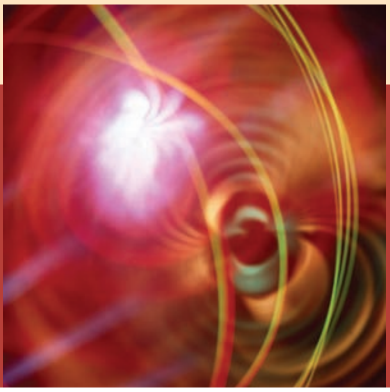
Gloria D. Pickar, EdD, RN



Introduction to the Learner

The accurate calculation of drug dosages is an essential skill in health care. Serious harm to the patient can result from a mathematical error during the calculation and subsequent administration of a drug dosage. It is the responsibility of those administering drugs to precisely and efficiently carry out medical orders.

Learning to calculate drug dosages need not be a difficult or burdensome process. *Dosage Calculations: A Ratio-Proportion Approach, Second Edition,* provides an uncomplicated, easy-to-learn, easy-to-recall three-step method of dosage calculations. Once you master this method, you will be able to consistently compute dosages with accuracy, ease, and confidence.

The text is a self-study guide that is divided into four main sections. The only mathematical prerequisite is the basic ability to add, subtract, multiply, and divide whole numbers. A review of fractions, decimals, percents, ratios, and proportions is included. You are encouraged to work at your own pace and seek assistance from a qualified instructor as needed.

Each procedure in the text is introduced by several examples. Key concepts are summarized and highlighted before the practice problems. This gives you an opportunity to review the concepts before working the problems. Ample review and practice problems are given to reinforce your skill and confidence.

Before calculating the dosage, you are asked to consider the reasonableness of the computation. More often than not, the correct amount can be estimated in your head. Many errors can be avoided if you approach dosage calculation in this logical fashion. The mathematical computation can then be used to double-check your thinking. Answers to all problems and step-by-step solutions to select problems are included at the back of the text.

Many photos and drawings are included to demonstrate key concepts and equipment. Illustrations of drug labels and measuring devices (for example, syringes) are included to give a simulated "hands-on" experience outside of the clinical setting or laboratory. Critical thinking skills emphasize the importance of dosage calculation accuracy, and medication scenarios provide opportunities to analyze and prevent errors.

This text has helped hundreds of thousands of learners just like you to feel at ease about math and to master dosage calculations. I am interested in your feedback. Please write to me to share your reactions and success stories.

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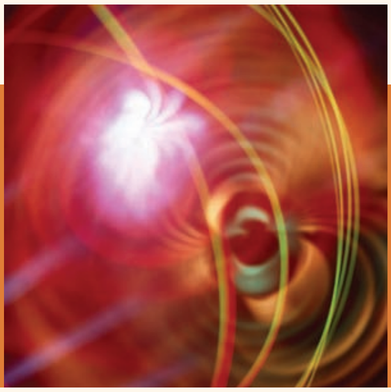
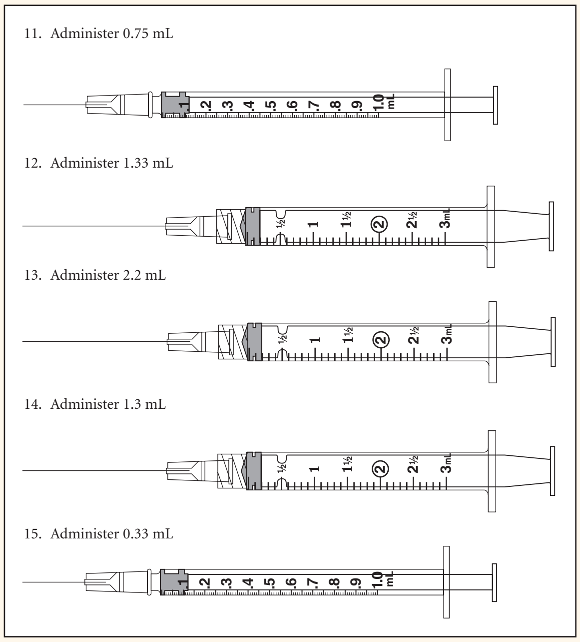


Using This Book

- Content is presented from simple to complex concepts in small increments followed by a quick review and solved examples. Review sets and practice problems provide opportunities to reinforce learning.
- All syringes are drawn to full size to provide accurate scale renderings to help learners master the reading of injectable dosages.



11. Administer 0.75 mL

12. Administer 1.33 mL

13. Administer 2.2 mL

14. Administer 1.3 mL

15. Administer 0.33 mL

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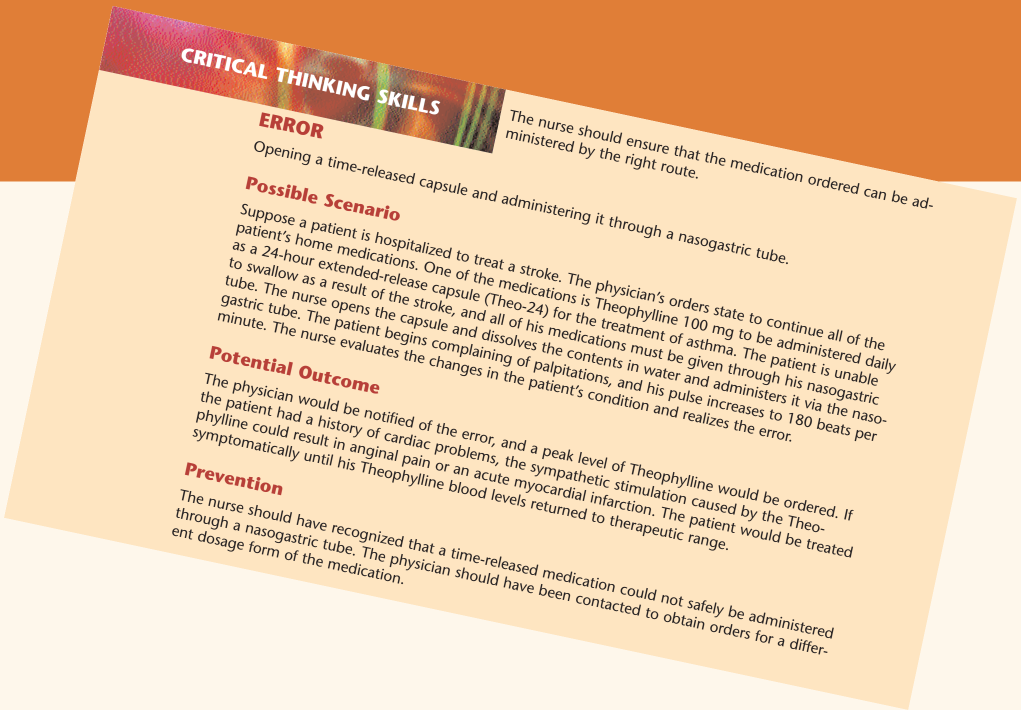
- Photos and drug labels are presented in full color; color is used to highlight and enhance the visual presentation of content and to improve readability. Special attention is given to visual clarity.



CRITICAL THINKING SKILLS

The nurse should ensure that the medication ordered can be administered by the right route.

ERROR

Opening a time-released capsule and administering it through a nasogastric tube.

Possible Scenario

Suppose a patient is hospitalized to treat a stroke. The physician's orders state to continue all of the patient's home medications. One of the medications is Theophylline 100 mg to be administered daily as a 24-hour extended-release capsule (Theo-24) for the treatment of asthma. The patient is unable to swallow as a result of the stroke, and all of his medications must be given through his nasogastric tube. The nurse opens the capsule and dissolves the contents in water and administers it via the nasogastric tube. The patient begins complaining of palpitations, and his pulse increases to 180 beats per minute. The nurse evaluates the changes in the patient's condition and realizes the error.

Potential Outcome

The physician would be notified of the error, and a peak level of Theophylline would be ordered. If the patient had a history of cardiac problems, the sympathetic stimulation caused by the Theophylline could result in anginal pain or an acute myocardial infarction. The patient would be treated symptomatically until his Theophylline blood levels returned to therapeutic range.

Prevention

The nurse should have recognized that a time-released medication could not safely be administered through a nasogastric tube. The physician should have been contacted to obtain orders for a different dosage form of the medication.

- ***Critical Thinking Skills*** are applied to real-life patient care situations to emphasize the importance of accurate dosage calculations and the avoidance of medication errors. As an added benefit, critical thinking scenarios that allow learners to present their own prevention strategies are included in end-of-chapter tests.

MATH TIP

To decrease errors in interpretation of medical notation, a line can be drawn over the lowercase Roman numerals to distinguish them from other letters in a word or phrase. The lowercase i is dotted above, not below, the line.

- ***Math tip*** boxes provide clues to essential computations.

QUICK REVIEW

Use ratio-proportion to convert from one unit of measurement to another.

- Recall the equivalents.
- Set up a proportion of two equivelent ratios. Be sure to label the units.
- Cross-multiply to solve for X. Label the units in the answer to match the unknown X.

- ***Quick review*** boxes summarize critical information.

RULE

To convert Celsius temperature to Fahrenheit, multiply by 1.8 and add 32.
°F = 1.8°C + 32

- ***Rule*** boxes highlight and draw the learners' attention to pertinent instructions.

REMEMBER

The Six Rights of safe and accurate medication administration are:

The *right patient* must receive the *right drug* in the *right amount* by the *right route* at the *right time*, followed by the *right documentation.*

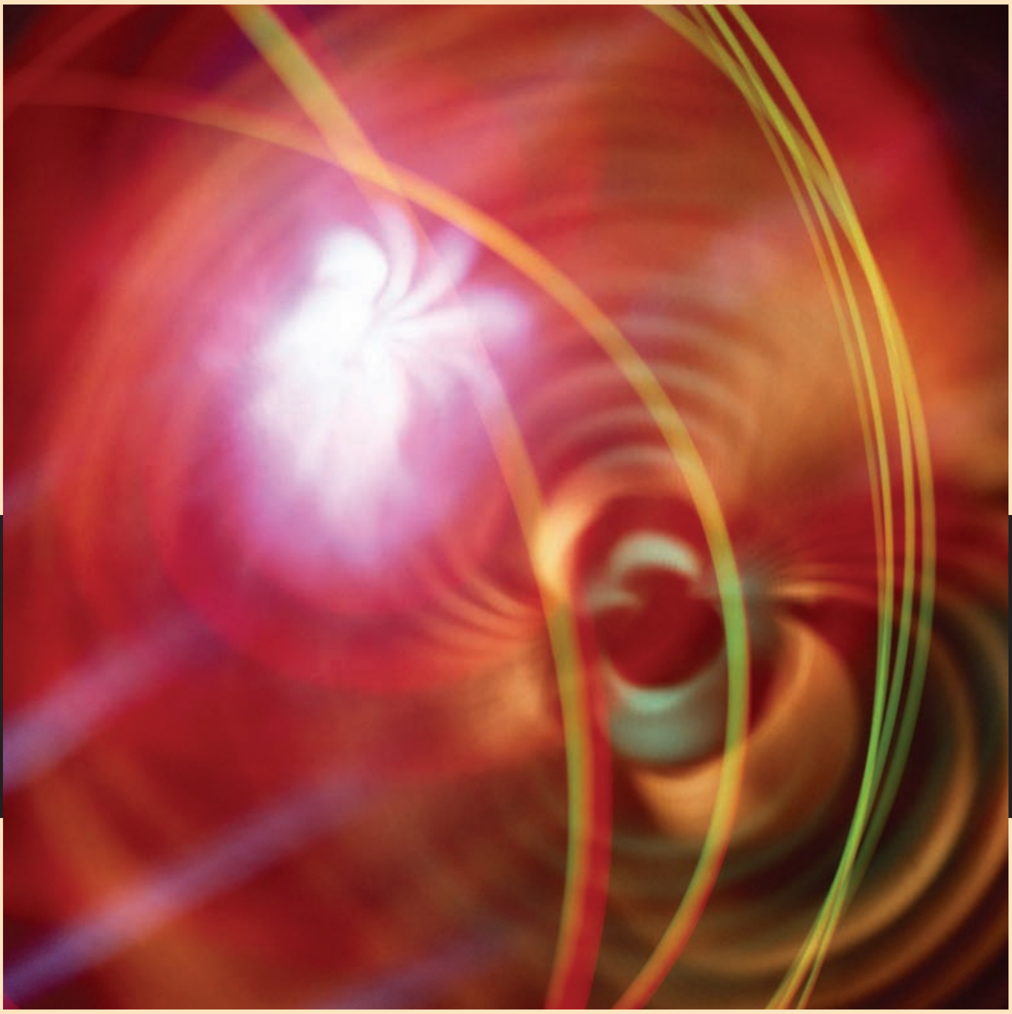
- ***Remember*** boxes highlight information to be memorized.

CAUTION

If any of the seven parts is missing or unclear, the order is considered incomplete and is, therefore, not a legal drug order.

- ***Caution*** boxes alert learners to critical information and safety concerns.

- ***Illustrations*** simulate critical dosage calculation and dose preparation skills.



SECTION

1

Mathematics Review

MATHEMATICS DIAGNOSTIC EVALUATION

As a prerequisite objective, *Dosage Calculations* takes into account that you can add, subtract, multiply, and divide whole numbers. You should have a working knowledge of fractions, decimals, ratios, percents, and basic problem solving as well. This text reviews these important mathematical operations, which support all dosage calculations in health care.

Set aside $1\frac{1}{2}$ hours in a quiet place to complete the fifty items in the following diagnostic evaluation. You will need scratch paper and a pencil to work the problems.

Use your results to determine your computational strengths and weaknesses to guide your review. A minimum score of 86 is recommended as an indicator of readiness for dosage calculations. If you achieve that score, you may proceed to Chapter 3. However, note any problems that you answered incorrectly, and use the related review materials in Chapters 1 and 2 to refresh your skills.

This mathematics diagnostic evaluation and the review that follows are provided to enhance your confidence and proficiency in arithmetic skills, thereby helping you to avoid careless mistakes when you perform dosage calculations.

Good luck!

Directions:

1. Carry answers to three decimal places and round to two places.

   (Examples: 5.175 = 5.18; 5.174 = 5.17)

2. Express fractions in lowest terms.

   (Example: $\frac{6}{10} = \frac{3}{5}$)

Mathematics Diagnostic Evaluation

1. 1,517 + 0.63 =
2. Express the value of 0.7 + 0.035 + 20.006 rounded to two decimal places.
3. 9.5 + 17.06 + 32 + 41.11 + 0.99 =
4. \$19.69 + \$304.03 =
5. 93.2 − 47.09 =
6. 1,005 − 250.5 =
7. Express the value of 17.156 − 0.25 rounded to two decimal places.
8. 509 × 38.3 =
9. \$4.12 × 42 =
10. 17.16 × 23.5 =
11. 972 ÷ 27 =
12. 2.5 ÷ 0.001 =
13. Express the value of $\frac{1}{4} \div \frac{3}{8}$ as a fraction reduced to lowest terms.
14. Express $\frac{1{,}500}{240}$ as a decimal.
15. Express 0.8 as a fraction.
16. Express $\frac{2}{5}$ as a percent.
17. Express 0.004 as a percent.

18. Express 5% as a decimal.
19. Express $33\frac{1}{3}\%$ as a ratio in lowest terms.
20. Express 1:50 as a decimal.
21. $\frac{1}{2} + \frac{3}{4} =$
22. $1\frac{2}{3} + 4\frac{7}{8} =$
23. $1\frac{5}{6} - \frac{2}{9} =$
24. Express the value of $\frac{1}{100} \times 60$ as a fraction.
25. Express the value of $4\frac{1}{4} \times 3\frac{1}{2}$ as a mixed number.
26. Identify the fraction with the greatest value: $\frac{1}{150}, \frac{1}{200}, \frac{1}{100}$.
27. Identify the decimal with the least value: 0.009, 0.19, 0.9.
28. $\frac{6.4}{0.02} =$
29. $\frac{0.02 + 0.16}{0.4 - 0.34} =$
30. Express the value of $\frac{3}{12 + 3} \times 0.25$ as a decimal.
31. 8% of 50 =
32. $\frac{1}{2}\%$ of 18 =
33. 0.9% of 24 =

Find the value of X. Express your answer as a decimal.

34. $\frac{1:1{,}000}{1:100} \times 250 = X$
35. $\frac{300}{150} \times 2 = X$
36. $\frac{2.5}{5} \times 1.5 = X$
37. $\frac{1{,}000{,}000}{250{,}000} \times X = 12$
38. $\frac{0.51}{1.7} \times X = 150$
39. $X = (82.4 - 52)\frac{3}{5}$
40. $\frac{\frac{1}{150}}{\frac{1}{300}} \times 1.2 = X$
41. Express 2:10 as a fraction in lowest terms.
42. Express 2% as a ratio in lowest terms.
43. If five equal medication containers contain 25 tablets total, how many tablets are in each container?
44. A person is receiving 0.5 milligrams of a medication four times a day. What is the total amount of medication in milligrams given each day?
45. If 1 kilogram equals 2.2 pounds, how many kilograms does a 66-pound child weigh?
46. If 1 kilogram equals 2.2 pounds, how many pounds are in 1.5 kilograms? (Express your answer as a decimal.)
47. If 1 centimeter equals $\frac{3}{8}$ inch, how many centimeters are in $2\frac{1}{2}$ inches? (Express your answer as a decimal.)

48. If 2.5 centimeters equal 1 inch, how long in centimeters is a 3-inch wound? ________

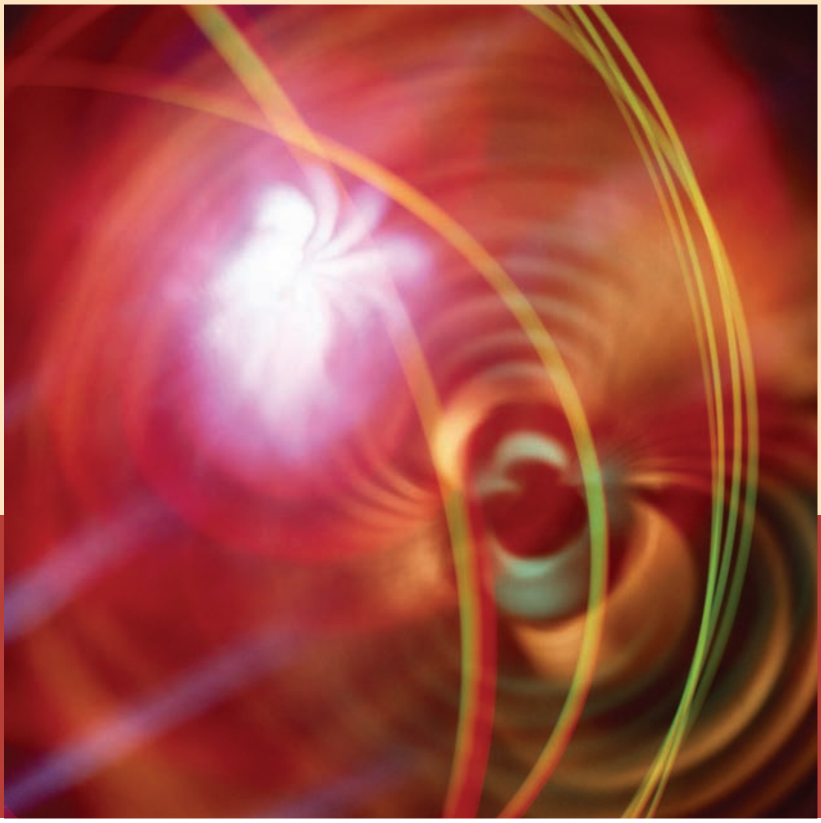
49. This diagnostic test has a total of 50 problems. If you incorrectly answer 5 problems, what percentage will you have answered correctly? ________

50. For every 5 female student nurses in a nursing class, there is 1 male student nurse. What is the ratio of female to male student nurses? ________

After completing these problems, see page 465 to check your answers. Give yourself two points for each correct answer.

Perfect score = 100 My score = ________

Minimum readiness score = 86 (43 correct)



1

Fractions and Decimals

OBJECTIVES

Upon mastery of Chapter 1, you will be able to perform basic mathematical computations that involve fractions and decimals. Specifically, you will be able to:

- Compare the values of fractions and decimals.
- Convert between mixed numbers and improper fractions, and between reduced and equivalent forms of fractions.
- Add, subtract, multiply, and divide fractions and decimals.
- Round a decimal to a given place value.
- Read and write out the value of decimal numbers.

Health care professionals need to understand fractions to be able to interpret and act on medical orders, read prescriptions, and understand patient records and information in health care literature. You will see fractions used in apothecary and household measures in dosage calculations. The method of solving dosage problems in this book relies on expressing relationships in fractional form. Therefore, proficiency with fractions will add to your success with a variety of medical applications.

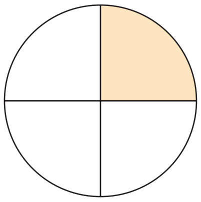
FRACTIONS

A *fraction* indicates a portion of a whole number. There are two types of fractions: *common fractions,* such as $\frac{1}{2}$ (usually referred to simply as fractions) and *decimal fractions,* such as 0.5 (usually referred to simply as decimals).

A fraction is an expression of division, with one number placed over another number ($\frac{1}{4}, \frac{2}{3}, \frac{4}{5}$). The bottom number, or *denominator,* indicates the total number of equal-sized parts into which the whole is divided. The top number, or *numerator,* indicates how many of those parts are considered. The fraction may also be read as the *numerator divided by the denominator.*

EXAMPLE ■

$\frac{1}{4}$ $\frac{\text{numerator}}{\text{denominator}}$



The whole is divided into four equal parts (denominator), and one part (numerator) is considered.

$\frac{1}{4}$ = 1 part of 4 parts, or $\frac{1}{4}$ of the whole.

The fraction $\frac{1}{4}$ may also be read as *1 divided by 4.*

MATH TIP

The *d*enominator begins with *d* and is *d*own below the line in a fraction.

Types of Fractions

There are four types of common fractions: proper, improper, mixed numbers, and complex.

Proper Fractions

Proper fractions are fractions in which the value of the numerator is less than the value of the denominator. The value of the proper fraction is less than 1.

RULE

Whenever the numerator is less than the denominator, the value of the fraction must be less than 1.

EXAMPLE ■

$\frac{5}{8}$ $\frac{\text{numerator}}{\text{denominator}}$ is less than 1

Improper Fractions

Improper fractions are fractions in which the value of the numerator is greater than or equal to the value of the denominator. The value of the improper fraction is greater than or equal to 1.

RULE

Whenever the numerator is greater than the denominator, the value of the fraction must be greater than 1.

EXAMPLE ■

$\frac{8}{5}$ is greater than 1

RULE

Whenever the numerator and denominator are equal, the value of the improper fraction is always equal to 1; a nonzero number divided by itself is equal to 1.

EXAMPLE ■

$\frac{5}{5} = 1$

Mixed Numbers

When a whole number and a proper fraction are combined, the result is referred to as a *mixed number.* The value of the mixed number is always greater than 1.

EXAMPLE ■

$1\frac{5}{8} = 1 + \frac{5}{8}$ $1\frac{5}{8}$ is greater than 1

Complex Fractions

Complex fractions include fractions in which the numerator, the denominator, or both may be a proper fraction, improper fraction, or mixed number. The value may be less than, greater than, or equal to 1.

EXAMPLES ■

$\dfrac{\frac{5}{8}}{\frac{1}{2}}$ is greater than 1 $\dfrac{\frac{5}{8}}{2}$ is less than 1 $\dfrac{1\frac{5}{8}}{\frac{1}{5}}$ is greater than 1 $\dfrac{\frac{1}{2}}{\frac{2}{4}} = 1$

To perform dosage calculations that involve fractions, you must be able to convert among these different types of fractions and reduce them to lowest terms. You must also be able to add, subtract, multiply, and divide. Review these simple rules of working with fractions. Continue to practice until the concepts are crystal clear and automatic.

Equivalent Fractions

The value of a fraction can be expressed in several ways. This is called *finding an equivalent fraction*. In finding an equivalent fraction, both terms of the fraction (numerator and denominator) are either multiplied or divided by the same nonzero number.

MATH TIP

In an equivalent fraction, the form of the fraction is changed, but the value of the fraction remains the same.

EXAMPLES ■

$\frac{2}{4} = \frac{2 \div 2}{4 \div 2} = \frac{1}{2}$ $\frac{1}{3} = \frac{1 \times 3}{3 \times 3} = \frac{3}{9}$

Reducing Fractions to Lowest Terms

When calculating dosages, it is usually easier to work with fractions using the smallest numbers possible. Finding these equivalent fractions is called *reducing the fraction to the lowest terms* or *simplifying the fraction*.

RULE

To reduce a fraction to lowest terms, divide both the numerator and denominator by the largest nonzero whole number that will go evenly into both the numerator and the denominator.

EXAMPLE ■

Reduce $\frac{6}{12}$ to lowest terms.

6 is the largest number that will divide evenly into both 6 (numerator) and 12 (denominator).

$\frac{6}{12} = \frac{6 \div 6}{12 \div 6} = \frac{1}{2}$ in lowest terms

Sometimes this reduction can be done in several steps. Always check a fraction to see if it can be reduced further. For example,

$\frac{5{,}000}{20{,}000} = \frac{5{,}000 \div 1{,}000}{20{,}000 \div 1{,}000} = \frac{5}{20}$ (not in lowest terms)

$\frac{5}{20} = \frac{5 \div 5}{20 \div 5} = \frac{1}{4}$ (in lowest terms)

MATH TIP

If both the numerator and denominator cannot be divided evenly by a nonzero number other than 1, then the fraction is already in lowest terms.

Enlarging Fractions

RULE

To find an equivalent fraction in which both terms are larger, multiply both the numerator and the denominator by the same nonzero number.

EXAMPLE ■

Enlarge $\frac{3}{5}$ to the equivalent fraction in tenths.

$\frac{3}{5} = \frac{3 \times 2}{5 \times 2} = \frac{6}{10}$

Conversion

It is important to be able to convert among different types of fractions. Conversion allows you to perform various calculations with greater ease and permits you to express answers in simplest terms.

Converting Mixed Numbers to Improper Fractions

RULE

To change or convert a mixed number to an improper fraction with the same denominator, multiply the whole number by the denominator and add the numerator. Place that value in the numerator, and use the denominator of the fraction part of the mixed number.

EXAMPLE ■

$2\frac{5}{8} = \frac{(2 \times 8) + 5}{8} = \frac{21}{8}$

MATH TIP

Order of Operations—Follow the rules of math in this order: Multiply, Divide, Add, Subtract. You can remember this by: **M**y **D**ear **A**unt **S**ally.

Converting Improper Fractions to Mixed Numbers

RULE

To change or convert an improper fraction to an equivalent mixed number or whole number, divide the numerator by the denominator. Any remainder becomes the numerator of a proper fraction and is reduced to lowest terms.

EXAMPLES ■

$\frac{8}{5} = 8 \div 5 = 1\frac{3}{5}$

$\frac{10}{4} = 10 \div 4 = 2\frac{2}{4} = 2\frac{1}{2}$

Comparing Fractions

In calculating some drug dosages, it is helpful to know when the value of one fraction is greater or less than another. The relative sizes of fractions can be determined by comparing the numerators when the denominators are the same or comparing the denominators if the numerators are the same.

RULE

If the denominators are both the same, the fraction with the smaller numerator has the lesser value.

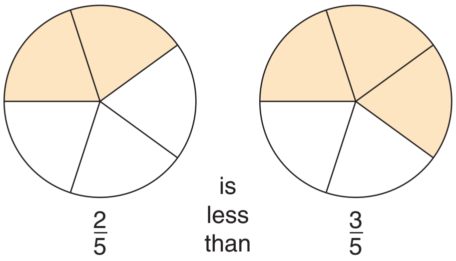
EXAMPLE ■

Compare $\frac{2}{5}$ and $\frac{3}{5}$.

Denominators are both 5

Numerators: 2 is less than 3

$\frac{2}{5}$ has a lesser value



RULE

If the numerators are the same, the fraction with the smaller denominator has the greater value.

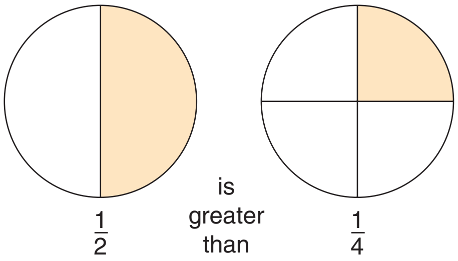
EXAMPLE ■

Compare $\frac{1}{2}$ and $\frac{1}{4}$.

Numerators are both 1

Denominators: 2 is less than 4

$\frac{1}{2}$ has a greater value



Note: A smaller denominator means it has been divided into fewer pieces, so each one is larger.

QUICK REVIEW

- Proper fraction: numerator is less than denominator; value is less than 1. Example: $\frac{1}{2}$
- Improper fraction: numerator is greater than denominator; value is greater than 1. Example: $\frac{4}{3}$.

  Or numerator = denominator; value = 1. Example: $\frac{5}{5}$
- Mixed number: whole number + a fraction; value is greater than 1. Example: $1\frac{1}{2}$
- Complex fraction: numerator and/or denominator are composed of a fraction, decimal, or mixed number; value is less than,

  greater than, or = 1. Example: $\dfrac{\frac{1}{2}}{\frac{1}{50}}$
- Any nonzero number divided by itself = 1. Example: $\frac{3}{3} = 1$
- To reduce a fraction to lowest terms, divide both terms by the largest nonzero whole number that will divide both the numerator and denominator evenly. Value remains the same.

  Example: $\frac{6}{10} = \frac{6 \div 2}{10 \div 2} = \frac{3}{5}$
- To enlarge a fraction, multiply both terms by the same nonzero number. Value remains the same.

  Example: $\frac{1}{12} = \frac{1 \times 2}{12 \times 2} = \frac{2}{24}$
- To convert a mixed number to an improper fraction, multiply the whole number by the denominator and add the numerator; use original denominator in the fractional part.

  Example: $1\frac{1}{3} = \frac{4}{3}$
- To convert an improper fraction to a mixed number, divide the numerator by the denominator. Express any remainder as a proper fraction reduced to lowest terms.

  Example: $\frac{21}{9} = 2\frac{3}{9} = 2\frac{1}{3}$
- When numerators are equal, the fraction with the smaller denominator is greater.

  Example: $\frac{1}{2}$ is greater than $\frac{1}{3}$
- When denominators are equal, the fraction with the larger numerator is greater.

  Example: $\frac{2}{3}$ is greater than $\frac{1}{3}$

Review Set 1

1. Circle the *improper* fraction(s).

   $\frac{2}{3}$ $\quad 1\frac{3}{4}$ $\quad \frac{6}{6}$ $\quad \frac{7}{5}$ $\quad \frac{16}{17}$ $\quad \dfrac{\frac{1}{9}}{\frac{2}{3}}$

2. Circle the *complex* fraction(s).

   $\frac{4}{5}$ $\quad 3\frac{7}{8}$ $\quad \frac{2}{2}$ $\quad \frac{9}{8}$ $\quad \frac{8}{9}$ $\quad \dfrac{\frac{1}{100}}{\frac{1}{150}}$

3. Circle the *proper* fraction(s).

   $\frac{1}{4}$ $\quad \frac{1}{14}$ $\quad \frac{14}{1}$ $\quad \frac{14}{14}$ $\quad \frac{144}{14}$

4. Circle the *mixed* number(s) *reduced to the lowest terms*.

   $3\frac{4}{8}$ $\quad \frac{2}{3}$ $\quad 1\frac{2}{9}$ $\quad \frac{1}{3}$ $\quad 1\frac{1}{4}$ $\quad 5\frac{7}{8}$

5. Circle the pair(s) of *equivalent* fractions.

$\frac{3}{4} = \frac{6}{8}$ $\quad \frac{1}{5} = \frac{2}{10}$ $\quad \frac{3}{9} = \frac{1}{3}$ $\quad \frac{3}{4} = \frac{4}{3}$ $\quad 1\frac{4}{9} = 1\frac{2}{3}$

Change the following mixed numbers to improper fractions.

6. $6\frac{1}{2} =$ ________

7. $1\frac{1}{5} =$ ________

8. $10\frac{2}{3} =$ ________

9. $7\frac{5}{6} =$ ________

10. $102\frac{3}{4} =$ ________

Change the following improper fractions to whole numbers or mixed numbers; reduce to lowest terms.

11. $\frac{24}{12} =$ ________

12. $\frac{8}{8} =$ ________

13. $\frac{30}{9} =$ ________

14. $\frac{100}{75} =$ ________

15. $\frac{44}{16} =$ ________

Enlarge the following fractions to the number of parts indicated.

16. $\frac{3}{4}$ to eighths ________

17. $\frac{1}{4}$ to sixteenths ________

18. $\frac{2}{3}$ to twelfths ________

19. $\frac{2}{5}$ to tenths ________

20. $\frac{2}{3}$ to ninths ________

Circle the correct answer.

21. Which is larger? $\frac{1}{150}, \frac{1}{100}$

22. Which is smaller? $\frac{1}{1000}, \frac{1}{10{,}000}$

23. Which is larger? $\frac{2}{9}, \frac{5}{9}$

24. Which is smaller? $\frac{3}{10}, \frac{5}{10}$

25. A patient is supposed to drink a 10-ounce bottle of magnesium citrate prior to his X-ray study. He has been able to drink 6 ounces. What portion of the bottle remains? (Express your answer as a fraction reduced to lowest terms.) ________________

26. If 1 medicine bottle contains 12 doses, how many bottles of medicine are consumed for 18 doses? (Express your answer as a fraction reduced to lowest terms.) ________________

27. A respiratory therapy class consists of 3 men and 57 women. What fraction of the students in the class are men? (Express your answer as a fraction reduced to lowest terms.) ________________

28. A nursing student answers 18 out of 20 questions correctly on a test. Write a proper fraction (reduced to lowest terms) to represent the portion of the test questions that were answered correctly.

____

29. A typical dose of Children's Tylenol contains 160 milligrams of Tylenol per teaspoonful. Each 80 milligrams is what part of a typical dose? ________________

30. In question 29, how many teaspoons of Tylenol would you need to give 80 milligrams? ________

After completing these problems, see page 465–466 to check your answers.

If you answered question 30 correctly, you can already calculate dosages!

Addition and Subtraction of Fractions

To add or subtract fractions, all the denominators must be the same. You can determine the least common denominator by finding the smallest whole number into which all denominators will divide evenly. Once the least common denominator is determined, convert the fractions to equivalent fractions with the least common denominator. This operation involves *enlarging the fractions,* which we examined in the last section. Let's look at an example of this important operation.

EXAMPLE ■

Find the equivalent fractions with the least common denominator for $\frac{3}{8}$ and $\frac{1}{3}$.

1. Find the smallest whole number into which the denominators 8 and 3 will divide evenly. The least common denominator is 24.
2. Convert the fractions to equivalent fractions with 24 as the denominator.

$$\frac{3}{8} = \frac{3 \times 3}{8 \times 3} = \frac{9}{24} \qquad \frac{1}{3} = \frac{1 \times 8}{3 \times 8} = \frac{8}{24}$$

You have enlarged $\frac{3}{8}$ to $\frac{9}{24}$ and $\frac{1}{3}$ to $\frac{8}{24}$. Now both fractions have the same denominator. Finding the least common denominator is the first step in adding or subtracting fractions.

RULE

To add or subtract fractions:

1. Convert all fractions to equivalent fractions with the least common denominators.
2. Add or subtract the numerators, place that value in the numerator, and use the least common denominator as the denominator.
3. Convert to a mixed number and/or reduce the fraction to lowest terms, if possible.

MATH TIP

To add or subtract fractions, no calculations are performed on the denominators. Once they are all converted to least common denominators, perform the mathematical operation (addition or subtraction) on the *numerators* only, and use the least common denominator as the denominator. Never add or subtract denominators.

Adding Fractions

EXAMPLE 1 ■

$\frac{3}{4} + \frac{1}{4} + \frac{2}{4}$

1. Find the least common denominator. This step is not necessary in this example, because the fractions already have the same denominator.
2. Add the numerators: $\frac{3 + 1 + 2}{4} = \frac{6}{4}$
3. Convert to a mixed number and reduce to lowest terms: $\frac{6}{4} = 1\frac{2}{4} = 1\frac{1}{2}$

EXAMPLE 2 ■

$\frac{1}{3} + \frac{3}{4} + \frac{1}{6}$

1. Find the least common denominator: 12. The number 12 is the least common denominator that 3, 4, and 6 will all equally divide into.

   Convert to equivalent fractions in twelfths. This is the same as enlarging the fractions.

   $$\frac{1}{3} = \frac{1 \times 4}{3 \times 4} = \frac{4}{12}$$

   $$\frac{3}{4} = \frac{3 \times 3}{4 \times 3} = \frac{9}{12}$$

   $$\frac{1}{6} = \frac{1 \times 2}{6 \times 2} = \frac{2}{12}$$

2. Add the numerators, and use the common denominator: $\frac{4 + 9 + 2}{12} = \frac{15}{12}$
3. Convert to a mixed number, and reduce to lowest terms: $\frac{15}{12} = 1\frac{3}{12} = 1\frac{1}{4}$

Subtracting Fractions

EXAMPLE 1 ■

$\frac{15}{18} - \frac{8}{18}$

1. Find the least common denominator. This is not necessary in this example, because the denominators are the same.
2. Subtract the numerators, and use the common denominator: $\frac{15 - 8}{18} = \frac{7}{18}$
3. Reduce to lowest terms. This is not necessary here because no further reduction is possible.

EXAMPLE 2 ■

$1\frac{1}{10} - \frac{3}{5}$

1. Find the least common denominator: 10. The number 10 is the least common denominator that both 10 and 5 will equally divide into.

   Convert to equivalent fractions in tenths:

   $1\frac{1}{10} = \frac{11}{10}$ Note: First convert mixed numbers into improper fractions for computations.

   $$\frac{3}{5} = \frac{3 \times 2}{5 \times 2} = \frac{6}{10}$$

2. Subtract the numerators, and use the common denominator: $\frac{11 - 6}{10} = \frac{5}{10}$
3. Reduce to lowest terms: $\frac{5}{10} = \frac{1}{2}$

   Let's review one more time how to add and subtract fractions.

QUICK REVIEW

To add or subtract fractions:

- Convert to equivalent fractions with least common denominators.
- Add or subtract the numerators; place that value in the numerator. Use the least common denominator as the denominator.
- Convert the answer to a mixed number and/or reduce to lowest terms.

Review Set 2

Add, and reduce the answers to lowest terms.

1. $7\frac{4}{5} + \frac{2}{3} =$ ________
2. $\frac{3}{4} + \frac{2}{3} =$ ________
3. $4\frac{2}{3} + 5\frac{1}{24} + 7\frac{1}{2} =$ ________
4. $\frac{3}{4} + \frac{1}{8} + \frac{1}{6} =$ ________
5. $12\frac{1}{2} + 20\frac{1}{3} =$ ________
6. $\frac{1}{4} + 5\frac{1}{3} =$ ________
7. $\frac{1}{7} + \frac{2}{3} + \frac{11}{21} =$ ________
8. $\frac{4}{9} + \frac{5}{8} + 4\frac{2}{3} =$ ________
9. $34\frac{1}{2} + 8\frac{1}{2} =$ ________
10. $\frac{12}{17} + 5\frac{2}{7} =$ ________
11. $\frac{6}{5} + 1\frac{1}{3} =$ ________
12. $\frac{1}{4} + \frac{5}{33} =$ ________

Subtract, and reduce the answers to lowest terms.

13. $\frac{3}{4} - \frac{1}{4} =$ ________
14. $8\frac{1}{12} - 3\frac{1}{4} =$ ________
15. $\frac{1}{8} - \frac{1}{12} =$ ________
16. $100 - 36\frac{1}{3} =$ ________
17. $355\frac{1}{5} - 55\frac{2}{5} =$ ________
18. $\frac{1}{3} - \frac{1}{6} =$ ________
19. $2\frac{3}{5} - 1\frac{1}{5} =$ ________
20. $14\frac{3}{16} - 7\frac{1}{8} =$ ________
21. $25 - 17\frac{7}{9} =$ ________
22. $4\frac{7}{10} - 3\frac{9}{20} =$ ________
23. $48\frac{6}{11} - 24 =$ ________
24. $1\frac{2}{3} - 1\frac{1}{12} =$ ________

25. A patient weighs 50 pounds on admission and 48 pounds on day 3 of his hospital stay. Write a fraction, reduced to lowest terms, to express the weight he has lost as a fraction of his original weight. ________

26. A patient is on strict recording of fluid intake and output, including measurement of liquid medications. A nursing student gave the patient $\frac{1}{4}$ ounce of medication at 8 AM and $\frac{1}{3}$ ounce of medication at noon. What is the total amount of medication to be recorded on the Intake and Output sheet? ________

27. An infant has grown $\frac{1}{2}$ inch during his first month of life, $\frac{1}{4}$ inch during his second month, and $\frac{3}{8}$ inch during his third month. How much did he grow during his first 3 months? ________

28. The required margins for your term paper are $1\frac{1}{2}$ inches at the top and bottom of a paper that has 11 inches vertical length. How long is the vertical area available for written information? ________

29. The central supply stock clerk finds there are $34\frac{1}{2}$ pints of hydrogen peroxide on the shelf. If the fully stocked shelf held 56 pints of hydrogen peroxide, how many pints were used? ________

30. Your 1-year-old patient weighs $30\frac{1}{8}$ pounds. At birth, she weighed $10\frac{1}{16}$ pounds. How much weight has she gained in one year? ________

After completing these problems, see page 466 to check your answers.

Multiplication of Fractions

To multiply fractions, multiply numerators (for the numerator of the answer) and multiply denominators (for the denominator of the answer).

When possible, *cancellation of terms* simplifies and shortens the process of multiplication of fractions. Cancellation (like reducing to lowest terms) is based on the fact that the division of both the numerator and denominator by the same whole number does not change the value of the resulting number. In fact, it makes the calculation simpler because you are working with smaller numbers.

EXAMPLE ■

$\frac{1}{3} \times \frac{250}{500}$ (numerator and denominator of $\frac{250}{500}$ are both divisible by 250)

$$= \frac{1}{3} \times \frac{\overset{1}{\cancel{250}}}{\underset{2}{\cancel{500}}} = \frac{1}{3} \times \frac{1}{2} = \frac{1}{6}$$

Also, a numerator and a denominator of any of the fractions involved in the multiplication may be cancelled when they can be divided by the same number. This is called *cross-cancellation.*

EXAMPLE ■

$$\frac{1}{8} \times \frac{8}{9} = \frac{1}{\underset{1}{\cancel{8}}} \times \frac{\overset{1}{\cancel{8}}}{9} = \frac{1}{1} \times \frac{1}{9} = \frac{1}{9}$$

RULE

To multiply fractions:

1. Cancel terms, if possible.
2. Multiply numerators for the numerator of the answer, multiply denominators for the denominator of the answer.
3. Reduce the result (*product*) to lowest terms.

EXAMPLE 1 ■

$\frac{3}{4} \times \frac{2}{6}$

1. Cancel terms: Divide 2 and 6 by 2

   $$\frac{3}{4} \times \frac{\overset{1}{\cancel{2}}}{\underset{3}{\cancel{6}}} = \frac{3}{4} \times \frac{1}{3}$$

   Divide 3 and 3 by 3

   $$\frac{\overset{1}{\cancel{3}}}{4} \times \frac{1}{\underset{1}{\cancel{3}}} = \frac{1}{4} \times \frac{1}{1}$$

2. Multiply numerators and denominators:

   $$\frac{1}{4} \times \frac{1}{1} = \frac{1}{4}$$

3. Reduce to lowest terms. This is not necessary here because no further reduction is possible.

EXAMPLE 2

$\frac{15}{30} \times \frac{2}{5}$

1. Cancel terms: Divide 15 and 30 by 15

   $$\frac{\overset{1}{\cancel{15}}}{\underset{2}{\cancel{30}}} \times \frac{2}{5} = \frac{1}{2} \times \frac{2}{5}$$

   Divide 2 and 2 by 2

   $$\frac{1}{\underset{1}{\cancel{2}}} \times \frac{\overset{1}{\cancel{2}}}{5} = \frac{1}{1} \times \frac{1}{5}$$

2. Multiply numerators and denominators:

   $$\frac{1}{1} \times \frac{1}{5} = \frac{1}{5}$$

3. Reduce to lowest terms. This is not necessary here because no further reduction is possible.

MATH TIP

When multiplying a fraction by a nonzero whole number, the same rule applies as for multiplying fractions. First convert the whole number to a fraction with a denominator of 1; the value of the number remains the same.

EXAMPLE 3

$\frac{2}{3} \times 4$

1. No terms to cancel. (You cannot cancel 2 and 4, because both are numerators. To do so would change the value.) Convert the whole number to a fraction.

   $$\frac{2}{3} \times 4 = \frac{2}{3} \times \frac{4}{1}$$

2. Multiply numerators and denominators:

   $$\frac{2}{3} \times \frac{4}{1} = \frac{8}{3}$$

3. Convert to a mixed number.

   $$\frac{8}{3} = 8 \div 3 = 2\frac{2}{3}$$

MATH TIP

To multiply mixed numbers, first convert them to improper fractions, and then multiply.

EXAMPLE 4

$3\frac{1}{2} \times 4\frac{1}{3}$

1. Convert: $3\frac{1}{2} = \frac{7}{2}$

   $4\frac{1}{3} = \frac{13}{3}$

   Therefore, $3\frac{1}{2} \times 4\frac{1}{3} = \frac{7}{2} \times \frac{13}{3}$

2. Cancel: not necessary. No numbers can be cancelled.

3. Multiply: $\frac{7}{2} \times \frac{13}{3} = \frac{91}{6}$
4. Convert to a mixed number: $\frac{91}{6} = 15\frac{1}{6}$

Division of Fractions

The division of fractions uses three terms: *dividend, divisor,* and *quotient.* The *dividend* is the fraction being divided or the first number. The *divisor,* the number to the right of the division sign, is the fraction the dividend is divided by. The *quotient* is the result of the division. To divide fractions, the divisor is inverted, and the operation is changed to multiplication. Once inverted, the calculation is the same as for multiplication of fractions.

EXAMPLE ■

$$\underset{\substack{\uparrow\\ \textbf{Dividend}}}{\frac{1}{4}} \div \underset{\substack{\uparrow\\ \textbf{Divisor}}}{\frac{2}{7}} = \frac{1}{4} \underset{\substack{\uparrow\\ \div\ \textbf{Changed}\\ \textbf{to}\ \times}}{\times} \underset{\substack{\uparrow\\ \textbf{Inverted}\\ \textbf{Divisor}}}{\frac{7}{2}} = \underset{\substack{\uparrow\\ \textbf{Quotient}}}{\frac{7}{8}}$$

RULE

To divide fractions:

1. Invert the terms of the divisor, change ÷ to ×.
2. Cancel terms, if possible.
3. Multiply the resulting fractions.
4. Convert the result (quotient) to a mixed number, and/or reduce to lowest terms.

EXAMPLE 1 ■

$\frac{3}{4} \div \frac{1}{3}$

1. Invert divisor, and change ÷ to ×: $\frac{3}{4} \div \frac{1}{3} = \frac{3}{4} \times \frac{3}{1}$
2. Cancel: not necessary. No numbers can be cancelled.
3. Multiply: $\frac{3}{4} \times \frac{3}{1} = \frac{9}{4}$
4. Convert to mixed number: $\frac{9}{4} = 2\frac{1}{4}$

EXAMPLE 2 ■

$\frac{2}{3} \div 4$

1. Invert divisor, and change ÷ to ×: $\frac{2}{3} \div \frac{4}{1} = \frac{2}{3} \times \frac{1}{4}$
2. Cancel terms: $\frac{\overset{1}{\cancel{2}}}{3} \times \frac{1}{\underset{2}{\cancel{4}}} = \frac{1}{3} \times \frac{1}{2}$
3. Multiply: $\frac{1}{3} \times \frac{1}{2} = \frac{1}{6}$
4. Reduce: not necessary; already reduced to lowest terms.

MATH TIP

To divide mixed numbers, first convert them to improper fractions.

EXAMPLE 3 ■

$1\frac{1}{2} \div \frac{3}{4}$

1. Convert: $\frac{3}{2} \div \frac{3}{4}$
2. Invert divisor, and change ÷ to ×: $\frac{3}{2} \times \frac{4}{3}$
3. Cancel: $\frac{\overset{1}{\cancel{3}}}{\underset{1}{\cancel{2}}} \times \frac{\overset{2}{\cancel{4}}}{\underset{1}{\cancel{3}}} = \frac{1}{1} \times \frac{2}{1}$
4. Multiply: $\frac{1}{1} \times \frac{2}{1} = \frac{2}{1}$
5. Reduce: $\frac{2}{1} = 2$

MATH TIP

Multiplying complex fractions also involves the division of fractions.

In the next example the divisor is the same as the denominator, so you will invert the denominator and multiply. Multiplying complex fractions can be confusing—take your time and study this carefully.

EXAMPLE 4 ■

$$\frac{\frac{1}{150}}{\frac{1}{100}} \times 2$$

1. Convert: Express 2 as a fraction. $\frac{\frac{1}{150}}{\frac{1}{100}} \times \frac{2}{1}$
2. Rewrite complex fraction as division: $\frac{1}{150} \div \frac{1}{100} \times \frac{2}{1}$
3. Invert divisor and change ÷ to ×: $\frac{1}{150} \times \frac{100}{1} \times \frac{2}{1}$
4. Cancel: $\frac{1}{\underset{3}{\cancel{150}}} \times \frac{\overset{2}{\cancel{100}}}{1} \times \frac{2}{1} = \frac{1}{3} \times \frac{2}{1} \times \frac{2}{1}$
5. Multiply: $\frac{1}{3} \times \frac{2}{1} \times \frac{2}{1} = \frac{4}{3}$
6. Convert to mixed number: $\frac{4}{3} = 1\frac{1}{3}$

This example appears difficult at first but when solved logically, one step at a time, it is just like the others.

QUICK REVIEW

- To *multiply* fractions, cancel terms, multiply numerators, and multiply denominators.
- To *divide* fractions, invert the divisor, cancel terms, and multiply.
- Convert results to a mixed number and/or reduce to lowest terms.

Review Set 3

Multiply, and reduce the answers to lowest terms.

1. $\frac{3}{10} \times \frac{1}{12} =$ ________
2. $\frac{12}{25} \times \frac{3}{5} =$ ________
3. $\frac{5}{8} \times 1\frac{1}{6} =$ ________
4. $\frac{1}{100} \times 3 =$ ________
5. $\frac{\frac{1}{6}}{\frac{1}{4}} \times \frac{3}{\frac{2}{3}} =$ ________
6. $\frac{\frac{1}{150}}{\frac{1}{100}} \times 2\frac{1}{2} =$ ________
7. $\frac{30}{75} \times 2 =$ ________
8. $9\frac{4}{5} \times \frac{2}{3} =$ ________
9. $\frac{3}{4} \times \frac{2}{3} =$ ________
10. $4\frac{2}{3} \times 5\frac{1}{24} =$ ________
11. $\frac{3}{4} \times \frac{1}{8} =$ ________
12. $12\frac{1}{2} \times 20\frac{1}{3} =$ ________

Divide, and reduce the answers to lowest terms.

13. $\frac{3}{4} \div \frac{1}{4} =$ ________
14. $6\frac{1}{12} \div 3\frac{1}{4} =$ ________
15. $\frac{1}{8} \div \frac{7}{12} =$ ________
16. $\frac{1}{33} \div \frac{1}{3} =$ ________
17. $5\frac{1}{4} \div 10\frac{1}{2} =$ ________
18. $\frac{1}{60} \div \frac{1}{2} =$ ________
19. $2\frac{1}{2} \div \frac{3}{4} =$ ________
20. $\frac{\frac{1}{20}}{\frac{1}{3}} =$ ________
21. $\frac{1}{150} \div \frac{1}{50} =$ ________
22. $\frac{7}{8} \div 1\frac{1}{2} =$ ________
23. $\frac{\frac{3}{5}}{\frac{3}{4}} \div \frac{\frac{4}{5}}{1\frac{1}{9}} =$ ________

24. The nurse is maintaining calorie counts (or counting calories) for a patient who is not eating well. The patient ate $\frac{3}{4}$ of an apple. If one large apple contains 80 calories, how many calories were consumed? ________________________________

25. How many seconds are there in 9 $\frac{1}{3}$ minutes? ________________________________

26. A bottle of Children's Tylenol contains 20 teaspoons of liquid. If each dose for a 2-year-old child is $\frac{1}{2}$ teaspoon, how many doses are available in this bottle? ________________________________

27. You need to take $1\frac{1}{2}$ tablets of medication 3 times per day for 7 days. Over the 7 days, how many tablets will you take? ________________________________

28. The nurse aide observes that the patient's water pitcher is still $\frac{1}{3}$ full. If he drank 850 milliliters of water, how many milliliters does the pitcher hold? (Hint: The 850 milliliters does not represent $\frac{1}{3}$ of the pitcher.) ________________________________

29. A pharmacist weighs a tube of antibiotic eye ointment and discovers it weighs $\frac{7}{10}$ of an ounce. How much would 75 tubes weigh? ____________________

30. A patient is taking a liquid antacid from a 16-ounce bottle. If she takes $\frac{1}{2}$ ounce every 4 hours while awake beginning at 7 AM and ending with a final dose at 11 PM, how many full days would this bottle last? (Hint: First, draw yourself a clock.) ____________________

After completing these problems, see pages 466–467 to check your answers.

DECIMALS

Decimal Fractions and Decimal Numbers

Decimal fractions are fractions with a denominator of 10, 100, 1,000, or any multiple or power of 10. At first glance, they appear to be whole numbers because of the way they are written. But the numeric value of a decimal fraction is always less than 1.

EXAMPLES ■

0.1 $= \frac{1}{10}$

0.01 $= \frac{1}{100}$

0.001 $= \frac{1}{1{,}000}$

These incremental multiples of 10 define the decimal system.

Decimal numbers are numeric values that include a whole number, a decimal point, and a decimal fraction.

EXAMPLES ■

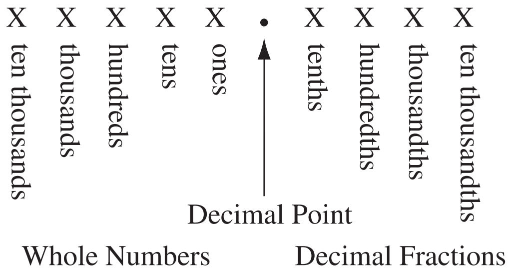
4.67 and 23.956

Generally, decimal fractions and decimal numbers are referred to simply as *decimals,* while common fractions are referred to as *fractions.*

Nurses and other health care professionals must have an understanding of decimals to be competent at dosage calculations. Medication orders and other measurements in health care primarily use metric measure, which is based on the decimal system. Decimals are a special shorthand for designating fractional values. They are simpler to read and faster to use when performing mathematical computations.

MATH TIP

When dealing with decimals, think of the decimal point as the center that separates whole and fractional amounts. The position of the numbers in relation to the decimal point indicates the place value of the numbers.



MATH TIP

The words for all decimal fractions end in *th(s)*.

EXAMPLES ■

0.001 = one thousand*th*

0.02 = two hundred*ths*

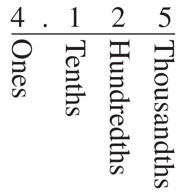
0.7 = seven ten*ths*

RULE

The decimal number is read by stating the whole number first, the decimal point as *and,* and then the decimal fraction by naming the value of the last decimal place.

EXAMPLE ■

Look carefully at the decimal number 4.125. The last decimal place is thousandths. Therefore, the number is read as *four and one hundred twenty-five thousandths*.



EXAMPLES ■

The number 6.2 is read as *six and two tenths*.

The number 10.03 is read as *ten and three hundredths*.

MATH TIP

Given a decimal fraction (whose value is less than 1), the decimal number is read alone, without stating the zero. However, the zero is written to emphasize the decimal point. In fact, since 2004 this is a requirement by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) when writing decimal fractions in medical notation.

EXAMPLE ■

0.125 is read as *one hundred twenty-five thousandths*.

A set of rules governs the decimal system of notation.

RULE

The whole number value is controlled by its position to the left of the decimal point.

EXAMPLES ■

10.1 = ten and one tenth. The whole number is *10*.

1.01 = one and one hundredth. The whole number is *1*.

Notice that the decimal point's position completely changes the numeric value.

RULE

The decimal fraction value is controlled by its position to the right of the decimal point.

EXAMPLES ■

25.1 = twenty-five and one tenth. The decimal fraction is *one tenth*.

25.01 = twenty-five and one hundredth. The decimal fraction is *one hundredth*.

MATH TIP

Each decimal place is counted off as a power of 10 to tell you which denominator is expected.

EXAMPLE 1 ■

437.5 = four hundred thirty-seven and **five tenths** $(437 + \frac{5}{10})$

One decimal place indicates *tenths*.

EXAMPLE 2 ■

43.75 = forty-three and **seventy-five hundredths** $(43 + \frac{75}{100})$

Two decimal places indicate *hundredths*.

EXAMPLE 3 ■

4.375 = four and **three hundred seventy-five thousandths** $(4 + \frac{375}{1{,}000})$

Three decimal places indicate *thousandths*.

RULE

Zeros added after the last digit of a decimal fraction do not change its value.

EXAMPLE ■

0.25 = 0.25**0**

Twenty-five hundredths equals two hundred fifty thousandths.

CAUTION

When writing decimals, eliminate unnecessary zeros at the end of the number to avoid confusion. As of 2004, JCAHO forbids the use of trailing zeros and cautions that in such cases, the decimal point may be missed when an unnecessary zero is written. This is part of JCAHO's *Official "Do Not Use" List* for medical notation, which will be discussed again in Chapters 3 and 9.

Although the last zero does not change the value of the decimal, it is not necessary. The preferred notation is 0.25 rather than 0.250. For example, the required notation is 0.25 rather than 0.250 and 10 not 10.0, which can be misinterpreted as 100 if the decimal point is not clear.

RULE

Zeros added before or after the decimal point of a decimal number *may* change its value.

EXAMPLES ■

0.125 ≠ (is not equal to) 0.**0**125

1.025 ≠ 1**0**.025

However, .6 = **0**.6 and 12. = 12.**0**, but you should use 0.6 (with a leading decimal) and 12 (without a trailing zero).

Comparing Decimals

It is important to be able to compare decimal amounts, noting which has a greater or lesser value.

CAUTION

A common error in comparing decimals is to overlook the decimal place values and misinterpret higher numbers for greater amounts and lower numbers for lesser amounts.

MATH TIP

You can accurately compare decimal amounts by aligning the decimal points and adding zeros, so that the numbers to be compared have the same number of decimal places. Remember that adding zeros at the end of a decimal fraction does not change the original value.

EXAMPLE 1 ■

Compare 0.125, 0.05, and 0.2 to find which decimal fraction is largest.

Align decimal points and add zeros.

$0.125 = \frac{125}{1{,}000}$ or one hundred twenty-five thousandths

$0.05\mathbf{0} = \frac{50}{1{,}000}$ or fifty thousandths

$0.20\mathbf{0} = \frac{200}{1{,}000}$ or two hundred thousandths

Now it is easy to see that 0.2 is the greater amount and 0.05 is the least. But at first glance, you might have been tricked into thinking that 0.2 was the least amount and 0.125 was the greater amount. This kind of error can have dire consequences in dosage calculations and health care.

EXAMPLE 2 ■

Suppose 0.5 microgram of a drug has been ordered. The recommended maximum dosage of the drug is 0.25 microgram, and the minimum recommended dosage is 0.125 microgram. Comparing decimals, you can see that the ordered dosage is not within the allowable range.

0.125 microgram (recommended minimum dosage)

0.25**0** microgram (recommended maximum dosage)

0.5**00** microgram (ordered dosage)

Now you can see that 0.5 microgram is outside the allowable limits of the safe dosage range of 0.125 to 0.25 microgram for this medication. In fact, it is twice the allowable maximum dosage.

CAUTION

It is important to eliminate possible confusion and avoid errors in dosage calculation. To avoid overlooking a decimal point in a decimal fraction and thereby reading the numeric value as a whole number, always place a zero to the left of the decimal point to emphasize that the number has a value less than one. This is another JCAHO requirement: use a leading zero to be sure the decimal point is not missed. The JCAHO *Official "Do Not Use" List* prohibits writing a decimal fraction that is less than 1 without a leading zero. This important concept will be emphasized again in Chapters 3 and 9.

EXAMPLE ■

0.425, **0**.01, or **0**.005

Conversion between Fractions and Decimals

For dosage calculations, you may need to convert decimals to fractions and vice versa.

RULE

To convert a fraction to a decimal, divide the numerator by the denominator.

MATH TIP

Make sure the numerator is inside the division sign and the denominator is outside. You will avoid reversing the numerator and the denominator in division, if you will write down the number you read first and put the division sign around that number, with the second number written outside the division sign. This will work regardless of whether is is written as a fraction or as a division problem (such as $\frac{1}{2}$ or 1 ÷ 2).

EXAMPLE 1 ■

Convert $\frac{1}{4}$ to a decimal.

$$\frac{1}{4} = \begin{array}{r} .25 \\ 4\overline{)1.00} \\ \underline{8} \\ 20 \\ \underline{\underline{20}} \end{array} = 0.25$$

EXAMPLE 2 ■

Convert $\frac{2}{5}$ to a decimal.

$$\frac{2}{5} = \begin{array}{r} .4 \\ 5\overline{)2.0} \\ \underline{\underline{20}} \end{array} = 0.4$$

RULE

To convert a decimal to a fraction:

1. Express the decimal number as a whole number in the numerator of the fraction.
2. Express the denominator of the fraction as the number 1 followed by as many zeros as there are places to the right of the decimal point.
3. Reduce the resulting fraction to lowest terms.

EXAMPLE 1 ■

Convert 0.125 to a fraction.

1. Numerator: 125
2. Denominator: 1 followed by 3 zeros = 1,000
3. Reduce: $\frac{125}{1{,}000} = \frac{1}{8}$

EXAMPLE 2 ■

Convert 0.65 to a fraction.

1. Numerator: 65
2. Denominator: 1 followed by 2 zeros = 100
3. Reduce: $\frac{65}{100} = \frac{13}{20}$

MATH TIP

State the complete name of the decimal, and write the fraction that has the same name, such as 0.65 = "sixty-five hundredths" = $\frac{65}{100}$.

QUICK REVIEW

- In a decimal number, whole number values are to the left of the decimal point, and fractional values are to the right.
- Zeros added to a decimal fraction before the decimal point of a decimal number less than 1 or at the end of the decimal fraction do not change the value. Example: .5 = **0**.5 = 0.5**0**. However, using the leading zero is the only acceptable notation (such as, 0.5).
- In a decimal number, zeros added before or after the decimal point *may* change the value.

  Example: 1.5 ≠ 1.**05** and 1.5 ≠ 1**0**.5.
- To avoid overlooking the decimal point in a decimal fraction, *always* place a zero to the left of the decimal point.

  Example:
  .5 ← Avoid writing a decimal fraction this way; it could be mistaken for the whole number *5*.

  Example:
  0.5 ← This is the required method of writing a decimal fraction with a value less than 1.
- The number of places in a decimal fraction indicates the power of 10.

  Examples:
  0.5 = five tenths
  0.05 = five hundredths
  0.005 = five thousandths
- Compare decimals by aligning decimal points and adding zeros.

  Example:
  Compare 0.5, 0.05, and 0.005.
  0.500 = five hundred thousandths (greatest)
  0.050 = fifty thousandths
  0.005 = five thousandths (least)
- To convert a fraction to a decimal, divide the numerator by the denominator.
- To convert a decimal to a fraction, express the decimal number as a whole number in the numerator and the denominator as the correct power of 10. Reduce the fraction to lowest terms.

  Example:

$$0.04 = \frac{4 \text{ (numerator is a whole number)}}{100 \text{ (denominator is 1 followed by two zeros)}} = \frac{\overset{1}{\cancel{4}}}{\underset{25}{\cancel{100}}} = \frac{1}{25}$$

Review Set 4

Complete the following table of equivalent fractions and decimals. Reduce fractions to lowest terms.

	Fraction	Decimal	The decimal number is read as:
1.	$\frac{1}{5}$	________	____________________
2.	________	________	eighty-five hundredths
3.	________	1.05	____________________
4.	________	0.006	____________________
5.	$10\frac{3}{200}$	________	____________________
6.	________	1.9	____________________
7.	________	________	five and one tenth
8.	$\frac{4}{5}$	________	____________________
9.	________	250.5	____________________
10.	$33\frac{3}{100}$	________	____________________
11.	________	0.95	____________________
12.	$2\frac{3}{4}$	________	____________________
13.	________	________	seven and five thousandths
14.	$\frac{21}{250}$	________	____________________
15.	________	12.125	____________________
16.	________	20.09	____________________
17.	________	________	twenty-two and twenty-two thousandths
18.	________	0.15	____________________
19.	$1{,}000\frac{1}{200}$	________	____________________
20.	________	________	four thousand eighty-five and seventy-five thousandths

21. Change 0.017 to a four-place decimal. ____

22. Change 0.2500 to a two-place decimal. ____

23. Convert $\frac{75}{100}$ to a decimal. ____

24. Convert 0.045 to a fraction reduced to lowest terms. ____________________________

Circle the correct answer.

25. Which is largest? 0.012 0.120 0.021

26. Which is smallest? 0.635 0.6 0.063

27. True or false? $0.375 = 0.0375$

28. True or false? 2.2 grams = 2.02 grams

29. True or false? 6.5 ounces = 6.500 ounces

30. For a certain medication, the safe dosage should be greater than or equal to 0.5 gram but less than or equal to 2 grams. Circle each dosage that falls within this range.

0.8 gram 0.25 gram 2.5 grams 1.25 grams

After completing these problems, see page 467 to check your answers.

Addition and Subtraction of Decimals

The addition and subtraction of decimals is similar to addition and subtraction of whole numbers. There are two simple but essential rules that are different. Health care professionals must use these two rules to perform accurate dosage calculations for some medications.

RULE

To add and subtract decimals, line up the decimal points.

CAUTION

In final answers, eliminate unnecessary zeros at the end of a decimal to avoid confusion.

EXAMPLE 1 ■

$$1.25 + 1.75 = \begin{array}{r} 1.25 \\ +\ 1.75 \\ \hline 3.00 \end{array} = 3$$

EXAMPLE 2 ■

$$1.25 - 0.13 = \begin{array}{r} 1.25 \\ -\ 0.13 \\ \hline 1.12 \end{array}$$

EXAMPLE 3 ■

$$3.54 + 1.26 = \begin{array}{r} 3.54 \\ +\ 1.26 \\ \hline 4.80 \end{array} = 4.8$$

EXAMPLE 4 ■

$$2.54 - 1.04 = \begin{array}{r} 2.54 \\ -\ 1.04 \\ \hline 1.50 \end{array} = 1.5$$

RULE

To add and subtract decimals, add zeros at the end of decimal fractions if necessary to make all decimal numbers of equal length.

EXAMPLE 1 ■

$$3.75 - 2.1 = \begin{array}{r} 3.75 \\ -\ 2.1\mathbf{0} \\ \hline 1.65 \end{array}$$

EXAMPLE 2 ■

Add 0.9, 0.65, 0.27, 4.712

$$\begin{array}{r} 0.9\mathbf{00} \\ 0.65\mathbf{0} \\ 0.27\mathbf{0} \\ +\ 4.712 \\ \hline 6.532 \end{array}$$

EXAMPLE 3 ■

$$5.25 - 3.6 = \begin{array}{r} 5.25 \\ -\ 3.6\mathbf{0} \\ \hline 1.65 \end{array}$$

EXAMPLE 4 ■

$$66.96 + 32 = \begin{array}{r} 66.96 \\ +\ 32.\mathbf{00} \\ \hline 98.96 \end{array}$$

QUICK REVIEW

- To add or subtract decimals, align the decimal points and add zeros, making all decimals of equal length. Eliminate unnecessary zeros in the final answer.

EXAMPLES ■

$$1.5 + 0.05 = \begin{array}{r} 1.5\mathbf{0} \\ +\ 0.05 \\ \hline 1.55 \end{array}$$

$$7.8 + 1.12 = \begin{array}{r} 7.8\mathbf{0} \\ +\ 1.12 \\ \hline 8.92 \end{array}$$

$$0.725 - 0.5 = \begin{array}{r} 0.725 \\ -\ 0.5\mathbf{00} \\ \hline 0.225 \end{array}$$

$$12.5 - 1.5 = \begin{array}{r} 12.5 \\ -\ 1.5 \\ \hline 11.0 = 11 \end{array}$$

Review Set 5

Find the result of the following problems.

1. 0.16 + 5.375 + 1.05 + 16 = ________
2. 7.517 + 3.2 + 0.16 + 33.3 = ________
3. 13.009 − 0.7 = ________
4. 5.125 + 6.025 + 0.15 = ________
5. 175.1 + 0.099 = ________
6. 25.2 − 0.193 = ________
7. 0.58 − 0.062 = ________
8. $10.10 − $0.62 = ________
9. $19 − $0.09 = ________
10. $5.05 + $0.17 + $17.49 = ________
11. 4 + 1.98 + 0.42 + 0.003 = ________
12. 0.3 − 0.03 = ________
13. 16.3 − 12.15 = ________
14. 2.5 − 0.99 = ________
15. 5 + 2.5 + 0.05 + 0.15 + 2.55 = ________

16. 0.03 + 0.16 + 2.327 = ________

17. 700 − 325.65 = ________

18. 645.32 − 40.9 = ________

19. 18 + 2.35 + 7.006 + 0.093 = ________

20. 13.529 + 10.09 = ________

21. A dietitian calculates the sodium in a patient's breakfast: raisin bran cereal = 0.1 gram, 1 cup 2% milk = 0.125 gram, 6 ounces orange juice = 0.001 gram, 1 corn muffin = 0.35 gram, and butter = 0.121 gram. How many grams of sodium did the patient consume? ________

22. In a 24-hour period, an infant drank 3.6 oz, 4.2 oz, 3.9 oz, 3.15 oz, and 3.7 oz of formula. How many ounces did the infant drink in 24 hours? ________

23. A patient has a hospital bill for $16,709.43. Her insurance company pays $14,651.37. What is her balance due? ________

24. A patient's hemoglobin was 16.8 grams before surgery. During surgery, his hemoglobin dropped 4.5 grams. What is his hemoglobin value after it dropped? ________

25. A home health nurse accounts for her day of work. If she spent 3 hours and 20 minutes at the office, 40 minutes traveling, $3\frac{1}{2}$ hours caring for patients, 24 minutes for lunch, and took a 12-minute break, what is her total number of hours including the break? Express your answer as a decimal. (HINT: First convert each time to hours and minutes.) ________

After completing these problems, see page 467 to check your answers.

Multiplying Decimals

The procedure for multiplication of decimals is similar to that used for whole numbers. The only difference is the decimal point, which must be properly placed in the product or answer. Use the following simple rule.

RULE

To multiply decimals:

1. Multiply the decimals without concern for decimal point placement.
2. Count off the number of decimal places in the decimals multiplied.
3. Move the decimal point in the product to the left of the number of places counted.

EXAMPLE 1 ■

1.5 × 0.5 = 1.5 (1 decimal place)

× 0.5 (1 decimal place)

0.75 (The decimal point is located 2 places to the left, because a total of 2 decimal places are counted.)

EXAMPLE 2 ■

1.72 × 0.9 = 1.72 (2 decimal places)

× 0.9 (1 decimal place)

1.548 (The decimal point is located 3 places to the left, because a total of 3 decimal places are counted.)

EXAMPLE 3 ■

$$\begin{array}{lrl} 5.06 \times 1.3 = & 5.06 & \text{(2 decimal places)} \\ & \times\ 1.3 & \text{(1 decimal place)} \\ \hline & 1518 & \\ & 506 & \\ \hline & 6.\underset{\curvearrowleft}{578} & \text{(The decimal point is located 3 places to the left, because a total of 3 decimal places are counted.)} \end{array}$$

EXAMPLE 4 ■

$$\begin{array}{lrl} 1.8 \times 0.05 = & 1.8 & \text{(1 decimal place)} \\ & \times\ 0.05 & \text{(2 decimal places)} \\ \hline & 0.\underset{\curvearrowleft}{090} & \text{(The decimal point is located 3 places to the left. Notice that a zero has to be inserted between the decimal point and the 9 to allow for enough decimal places.)} \\ & 0.090 & = 0.09 \text{ (Eliminate unnecessary zero.)} \end{array}$$

RULE

When multiplying a decimal by a power of 10, move the decimal point as many places to the right as there are zeros in the multiplier.

EXAMPLE 1 ■

1.25×10

The multiplier 10 has 1 zero; move the decimal point 1 place to the right.

$1.25 \times 10 = 1.\underset{\curvearrowright}{2}.5 = 12.5$

EXAMPLE 2 ■

2.3×100

The multiplier 100 has 2 zeros; move the decimal point 2 places to the right. (Note: Add zeros as necessary to complete the operation.)

$2.3 \times 100 = 2.\underset{\curvearrowright}{30}. = 230$

EXAMPLE 3 ■

$0.001 \times 1{,}000$

The multiplier 1,000 has 3 zeros; move the decimal point 3 places to the right.

$0.001 \times 1{,}000 = 0.\underset{\curvearrowright}{001}. = 1$

Dividing Decimals

When dividing decimals, set up the problem the same as for the division of whole numbers. Follow the same procedure for dividing whole numbers after you apply the following rule.

RULE

To divide decimals:

1. Move the decimal point in the *divisor* (number divided by) and the *dividend* (number divided) the number of places needed to make the *divisor* a *whole number*.
2. Place the decimal point in the *quotient* (answer) above the *new* decimal point place in the *dividend*.

EXAMPLE 1 ■

$$
\underset{\text{(dividend)}}{100.75} \div \underset{\text{(divisor)}}{2.5} =
\begin{array}{r}
40.3 \;\text{(quotient)} \\
2.5.\overline{)100.7.5} \\
\underline{100} \\
07 \\
\underline{00} \\
75 \\
\underline{\underline{75}}
\end{array}
= 40.3
$$

EXAMPLE 2 ■

$$
56.5 \div 0.02 =
\begin{array}{r}
2825. \\
0.02.\overline{)56.50.} \\
\underline{4} \\
16 \\
\underline{16} \\
5 \\
\underline{4} \\
10 \\
\underline{\underline{10}}
\end{array}
= 2825
$$

MATH TIP

Recall that adding a zero at the end of a decimal number does not change its value (56.5 = 56.50). Adding a zero was necessary in the last example to complete the operation.

RULE

When dividing a decimal by a power of 10, move the decimal point to the left as many places as there are zeros in the divisor.

EXAMPLE 1 ■

$0.65 \div 10$

The divisor 10 has 1 zero; move the decimal point 1 place to the left.

$0.65 \div 10 = .0.65 = 0.065$

(Note: Place the zero to the left of the decimal point to avoid confusion and to emphasize that this is a decimal.)

EXAMPLE 2 ■

$7.3 \div 100$

The divisor 100 has 2 zeros; move the decimal point 2 places to the left.

$7.3 \div 100 = \underset{\curvearrowleft}{.07}.3 = 0.073$

(Note: Add zeros as necessary to complete the operation.)

EXAMPLE 3 ■

$0.5 \div 1{,}000$

The divisor 1,000 has 3 zeros; move the decimal point 3 places to the left.

$0.5 \div 1{,}000 = \underset{\curvearrowleft}{.000}.5 = 0.0005$

Rounding Decimals

For many dosage calculations, it will be necessary to compute decimal calculations to *thousandths* (*three* decimal places) and round back to *hundredths* (*two* places) for the final answer. For example, pediatric care and critical care require this degree of accuracy. At other times, you will need to round to *tenths* (*one* place). Let's look closely at this important math skill.

RULE

To round a decimal to hundredths, drop the number in thousandths place, and

1. Do not change the number in hundredths place, if the number in thousandths place was 4 or less.
2. Increase the number in hundredths place by 1, if the number in thousandths place was 5 or more.

When rounding for dosage calculations, unnecessary zeros can be dropped. For example, 5.20 rounded to hundredths place could be written as 5.2, because the 0 is not needed to clarify the number.

EXAMPLES ■

		Tenths	Hundredths	Thousandths	All rounded to hundredths (2 places)	
0	.	1	2	3	= 0.12	
1	.	7	4	4	= 1.74	
5	.	3	2	5	= 5.33	
0	.	6	6	6	= 0.67	
0	.	3	0		= 0.3	(When this is rounded to hundredths, the final zero can be dropped. It is not needed to clarify the number.)

RULE

To round a decimal to tenths, drop the number in hundredths place, and

1. Do not change the number in tenths place, if the number in hundredths place was 4 or less.
2. Increase the number in tenths place by 1, if the number in hundredths place was 5 or more.

EXAMPLES ■

		Tenths	Hundredths	All rounded to tenths (1 place)	
0	.	1	3	= 0.1	
5	.	6	4	= 5.6	
0	.	7	5	= 0.8	
1	.	6	6	= 1.7	
0	.	9	5	= 1.0 = 1	(Zero at the end of a decimal is unnecessary.)

QUICK REVIEW

- To multiply decimals, place the decimal point in the product to the left as many decimal places as there are in the two decimals multiplied.

  Example:
  $0.25 \times 0.2 = 0.050 = 0.05$ (Zeros at the end of the decimal are unnecessary.)

- To divide decimals, move the decimal point in the divisor and dividend the number of decimal places that will make the divisor a whole number and align it in the quotient.

  Example: $24 \div 1.2$

  $$\begin{array}{r} 20. \\ 1\underset{\smile}{.2.}\overline{)\,24\underset{\smile}{.0.}} \end{array}$$

- To multiply or divide decimals by a power of 10, move the decimal point to the right (to multiply) or to the left (to divide) the number of decimal places as there are zeros in the power of 10.

  Examples:
  $5.06 \times 10 = 5\underset{\smile}{.0.}6 = 50.6$

  $2.1 \div 100 = \underset{\smile}{.02.}1 = 0.021$

- When rounding decimals, add 1 to the place value considered if the next decimal place is 5 or greater.

  Examples:
  Rounded to hundredths: $3.054 = 3.05$; $0.566 = 0.57$.

  Rounded to tenths: $3.05 = 3.1$; $0.54 = 0.5$

Review Set 6

Multiply, and round your answers to two decimal places.

1. 1.16 × 5.03 = ________
2. 0.314 × 7 = ________
3. 1.71 × 25 = ________
4. 3.002 × 0.05 = ________
5. 16.1 × 25.04 = ________
6. 75.1 × 1,000.01 = ________
7. 16.03 × 2.05 = ________
8. 55.50 × 0.05 = ________
9. 23.2 × 15.025 = ________
10. 1.14 × 0.014 = ________

Divide, and round your answers to two decimal places.

11. 16 ÷ 0.04 = ________
12. 25.3 ÷ 6.76 = ________
13. 0.02 ÷ 0.004 = ________
14. 45.5 ÷ 15.25 = ________
15. 515 ÷ 0.125 = ________
16. 73 ÷ 13.40 = ________
17. 16.36 ÷ 0.06 = ________
18. 0.375 ÷ 0.25 = ________
19. 100.04 ÷ 0.002 = ________
20. 45 ÷ 0.15 = ________

Multiply or divide by the power of 10 indicated. Draw an arrow to demonstrate movement of the decimal point. Do not round answers.

21. 562.5 × 100 = ________
22. 16 × 10 = ________
23. 25 ÷ 1,000 = ________
24. 32.005 ÷ 1,000 = ________
25. 0.125 ÷ 100 = ________
26. 23.25 × 10 = ________
27. 717.717 ÷ 10 = ________
28. 83.16 × 10 = ________
29. 0.33 × 100 = ________
30. 14.106 × 1,000 = ________

After completing these problems, see page 468 to check your answers.

PRACTICE PROBLEMS—CHAPTER 1

1. Convert 0.35 to a fraction in lowest terms. ________
2. Convert $\frac{3}{8}$ to a decimal. ________

Find the least common denominator for the following pairs of fractions.

3. $\frac{5}{7}; \frac{2}{3}$ ________
4. $\frac{1}{5}; \frac{4}{11}$ ________
5. $\frac{4}{9}; \frac{5}{6}$ ________
6. $\frac{1}{3}; \frac{3}{5}$ ________

Perform the indicated operation, and reduce fractions to lowest terms.

7. $1\frac{2}{3} + \frac{9}{5} =$ ________
8. $4\frac{5}{12} + 3\frac{1}{15} =$ ________
9. $\frac{7}{9} - \frac{5}{18} =$ ________
10. $5\frac{1}{6} - 2\frac{7}{8} =$ ________

11. $\frac{4}{9} \times \frac{7}{12} =$ __________

12. $1\frac{1}{2} \times 6\frac{3}{4} =$ __________

13. $7\frac{1}{5} \div 1\frac{7}{10} =$ __________

14. $\frac{3}{16} + \frac{3}{10} =$ __________

15. $8\frac{4}{11} \div 1\frac{2}{3} =$ __________

16. $\dfrac{9\frac{1}{2}}{1\frac{4}{5}} =$ __________

17. $\dfrac{13\frac{1}{3}}{4\frac{6}{13}} =$ __________

18. $\dfrac{\frac{1}{10}}{\frac{2}{3}} =$ __________

19. $\frac{1}{125} \times \frac{1}{25} =$ __________

20. $\dfrac{\frac{7}{8}}{\frac{1}{3}} \div \dfrac{3\frac{1}{2}}{\frac{1}{3}} =$ __________

21. $\frac{20}{35} \times 3 =$ __________

22. $2\frac{1}{4} \times 7\frac{1}{8} =$ __________

Perform the indicated operation, and round the answer to two decimal places.

23. $11.33 + 29.16 + 19.78 =$ __________

24. $93.712 - 26.97 =$ __________

25. $43.69 - 0.7083 =$ __________

26. $66.4 \times 72.8 =$ __________

27. $360 \times 0.53 =$ __________

28. $268.4 \div 14 =$ __________

29. $10.10 - 0.62 =$ __________

30. $5 + 2.5 + 0.05 + 0.15 =$ __________

31. $1.71 \times 25 =$ __________

32. $45 \div 0.15 =$ __________

33. $2{,}974 \div 0.23 =$ __________

34. $51.21 \div 0.016 =$ __________

35. $0.74 \div 0.37 =$ __________

36. $1.5 + 146.73 + 1.9 + 0.832 =$ __________

Multiply or divide by the power of 10 indicated. Draw an arrow to demonstrate movement of the decimal point. Do not round answers.

37. $9.716 \times 1{,}000 =$ __________

38. $50.25 \div 100 =$ __________

39. $0.25 \times 100 =$ __________

40. $5.75 \times 1{,}000 =$ __________

41. $0.25 \div 10 =$ __________

42. $11.525 \times 10 =$ __________

43. A 1-month-old infant drinks $3\frac{1}{2}$ ounces of formula every four hours. How many ounces will the infant drink in one week on this schedule? __________

44. There are 368 people employed at Riverview Clinic. If $\frac{3}{8}$ of the employees are nurses, $\frac{1}{8}$ are maintenance/cleaners, $\frac{1}{4}$ are technicians, and $\frac{1}{4}$ are all other employees, calculate the number of employees that each fraction represents. __________

45. True or false? A specific gravity of urine of $1\frac{2}{32}$ falls within the normal range of 1.01 to 1.025 for an adult patient. __________

46. Last week a nurse earning $17.43 per hour gross pay worked 40 hours plus 6.25 hours overtime, which is paid at twice the hourly rate. What is the total regular and overtime gross pay for last week? __________

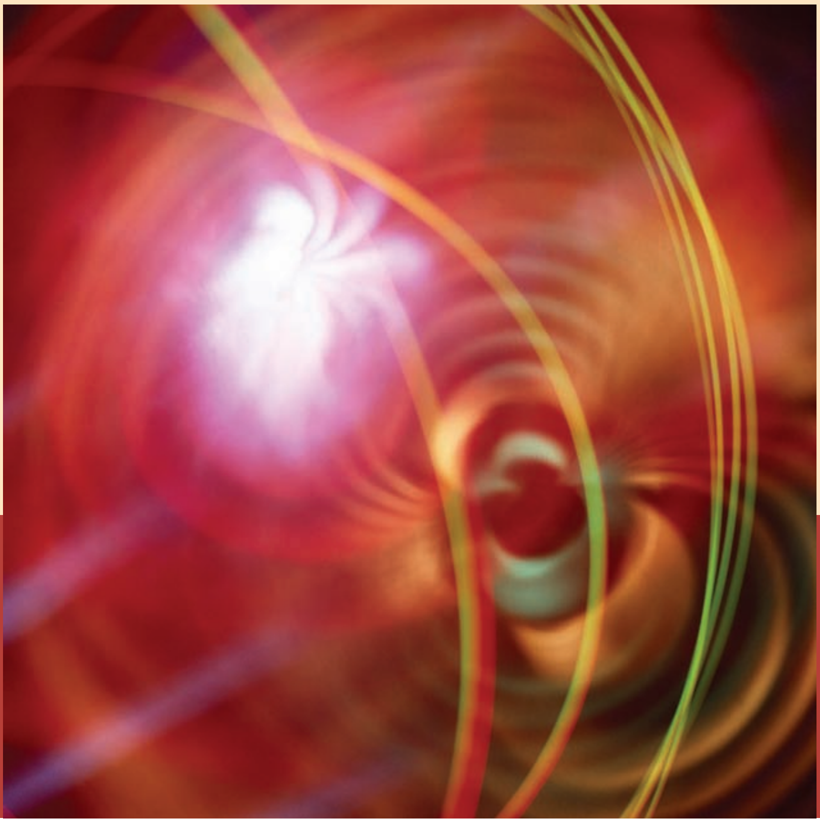
47. The instructional assistant is ordering supplies for the nursing skills laboratory. A single box of 12 urinary catheters costs $98.76. A case of 12 boxes of these catheters costs $975. Calculate the savings per catheter when a case is purchased. ________________

48. If each ounce of a liquid laxative contains 0.065 gram of a drug, how many grams of the drug would be contained in 4.75 ounces? (Round answer to the nearest hundredth.) ________________

49. A patient is to receive 1,200 milliliters of fluid in a 24-hour period. How many milliliters should the patient drink between the hours of 7:00 AM and 7:00 PM if he is to receive $\frac{2}{3}$ of the total amount during that time? ________________

50. A baby weighed 3.7 kilograms at birth. The baby now weighs 6.65 kilograms. How many kilograms did the baby gain? ________________

After completing these problems, see page 468 to check your answers.



2

Ratios, Percents, Simple Equations, and Ratio-Proportion

OBJECTIVES

Upon mastery of Chapter 2, you will be able to perform basic mathematical computations that involve ratios, percents, simple equations, and proportions. Specifically, you will be able to:

- Interpret values expressed in ratios.
- Convert among fractions, decimals, ratios, and percents.
- Compare the size of fractions, decimals, ratios, and percents.
- Determine the value of X in simple equations.
- Set up proportions for solving problems.
- Cross-multiply to find the value of X in a proportion.
- Calculate the percentage of a quantity.

Health care professionals need to understand ratios and percents to be able to accurately interpret, prepare, and administer a variety of medications and treatments. Let's take a look at each of these important ways of expressing ratios and percents and how they are related to fractions and decimals. It is important for you to be able to convert equivalent ratios, percents, decimals, and fractions quickly and accurately.

RATIOS AND PERCENTS

Ratios

Like a fraction, a *ratio* is used to indicate the relationship of one part of a quantity to the whole. The two quantities are written as a fraction or separated by a colon (:). The use of the colon is a traditional way to write the division sign within a ratio.

EXAMPLE ■

On an evening shift, if there are 5 nurses and 35 patients, what is the ratio of nurses to patients? 5 nurses to 35 patients = 5 nurses per 35 patients $= \frac{5}{35} = \frac{1}{7}$. This is the same as a ratio of 5:35 or 1:7.

MATH TIP

The terms of a ratio are the numerator (always to the left of the colon) and the denominator (always to the right of the colon) of a fraction. Like fractions, ratios should be stated in lowest terms.

If you think back to the discussion of fractions and parts of a whole, it is easy to see that a ratio is *actually the same as* a fraction and its equivalent decimal. It is just a different way of *expressing the same quantity*. Recall from Chapter 1 that to convert a fraction to a decimal, you simply divide the numerator by the denominator.

EXAMPLE ■

Adrenalin 1:1,000 for injection = 1 part Adrenalin to 1,000 total parts of solution. It is a fact that 1:1,000 is the same as $\frac{1}{1{,}000}$.

In some drug solutions, such as Adrenalin 1:1,000, the ratio is used to indicate the drug's concentration. This will be covered in more detail later.

Percents

A type of ratio is a percent. *Percent* comes from the Latin phrase *per centum,* translated *per hundred.* This means per hundred parts or hundredth part.

MATH TIP

To remember the value of a given percent, replace the % symbol with "/" for per and "100" for cent. THINK: Percent (%) means */100* or per hundred.

EXAMPLE ■

$3\% = 3 \text{ percent} = 3/100 = \frac{3}{100} = 0.03$

Converting among Ratios, Percents, Fractions, and Decimals

When you understand the relationship of ratios, percents, fractions, and decimals, you can readily convert from one to the other. Let's begin by converting a percent to a fraction.

RULE

To convert a percent to a fraction:

1. Delete the % sign.
2. Write the remaining number as the numerator.
3. Write 100 as the denominator.
4. Reduce the result to lowest terms.

EXAMPLE ■

$$5\% = \frac{5}{100} = \frac{1}{20}$$

It is also easy to express a percent as a ratio.

RULE

To convert a percent to a ratio:

1. Delete the % sign.
2. Write the remaining number as the numerator.
3. Write 100 as the denominator.
4. Reduce the result to lowest terms.
5. Express the fraction as a ratio.

EXAMPLE ■

$$25\% = \frac{25}{100} = \frac{1}{4} = 1{:}4$$

Because the denominator of a percent is always 100, it is easy to find the equivalent decimal. Recall that to divide by 100, you move the decimal point two places to the left, the number of places equal to the number of zeros in the denominator. This is the hundredths place.

RULE

To convert a percent to a decimal:

1. Delete the % sign.
2. Divide the remaining number by 100, which is the same as moving the decimal point two places to the left.

EXAMPLE ■

$$25\% = \frac{25}{100} = 25 \div 100 = \underset{\curvearrowleft}{.25.} = 0.25$$

Conversely, it is easy to change a decimal to a percent.

RULE

To convert a decimal to a percent:

1. Multiply the decimal number by 100 (move the decimal point two places to the right).
2. Add the % sign.

EXAMPLE ■

$0.25 \times 100 = 0.\underset{\curvearrowright}{25}. = 25\%$

MATH TIP

When converting a decimal to a percent, always move the decimal point two places, so the resulting percent is the larger number.

Now you know all the steps to change a ratio to the equivalent percent.

RULE

To convert a ratio to a percent:

1. Convert the ratio to a fraction.
2. Convert the fraction to a decimal.
3. Convert the decimal to a percent.

EXAMPLE ■

Convert 1:1,000 Adrenalin solution to the equivalent concentration expressed as a percent.

1. $1{:}1{,}000 = \frac{1}{1{,}000}$ (ratio converted to fraction)
2. $\frac{1}{1{,}000} = .\underset{\curvearrowleft}{001}. = 0.001$ (fraction converted to decimal)
3. $0.001 = 0.\underset{\curvearrowright}{00}.1 = 0.1\%$ (decimal converted to percent)

Thus, 1:1,000 Adrenalin solution = 0.1% Adrenalin solution.

Review the preceding example again slowly until it is clear. Ask your instructor for assistance, as needed. If you go over this one step at a time, you can master these important calculations. You need never fear fractions, decimals, ratios, and percents again.

Comparing Percents and Ratios

Nurses and other health care professionals frequently administer solutions with the concentration expressed as a percent or ratio. Consider two intravenous solutions (which means given directly into a person's vein) one that is 0.9%; the other 5%. It is important to be clear that 0.9% is *less* than 5%. A 0.9% solution means that there are 0.9 parts of the solid per 100 total parts (0.9 parts is less than one whole part, so it is less than 1%). Compare this to the 5% solution, with 5 parts of the solid (or more than five times 0.9 parts) per 100 total parts. Therefore, the 5% solution is much more concentrated, or stronger, than the 0.9% solution. A misunderstanding of these numbers and the quantities they represent can have dire consequences.

Likewise, you may see a solution concentration expressed as $\frac{1}{3}\%$ and another expressed as 0.45%. Convert these amounts to equivalent decimals to clarify values and compare concentrations.

$$\frac{1}{3}\% = \frac{\frac{1}{3}}{100} = \frac{1}{3} \div \frac{100}{1} = \frac{1}{3} \times \frac{1}{100} = \frac{1}{300} = 0.003\overline{3}$$

$$0.45\% = \frac{0.45}{100} = 0.0045 \text{ (greater value, stronger concentration)}$$

MATH TIP

The line over the last 3 in the decimal fraction 0.0033 indicates that the number 3 repeats itself indefinitely.

Compare solution concentrations expressed as a ratio, such as, 1:1,000 and 1:100.

$$1{:}1{,}000 = \frac{1}{1{,}000} = 0.001$$

$1{:}100 = \frac{1}{100} = 0.01$ or 0.010 (add zero for comparison) 1:100 is a stronger concentration.

QUICK REVIEW

- Fractions, decimals, ratios, and percents are related equivalents.

  Example: $1{:}2 = \frac{1}{2} = 0.5 = 50\%$
- Like fractions, ratios should be reduced to lowest terms.

  Example: $2{:}4 = 1{:}2$
- To express a ratio as a fraction, the number to the left of the colon becomes the numerator, and the number to the right of the colon becomes the denominator. The colon in a ratio is equivalent to the division sign in a fraction.

  Example: $2{:}3 = \frac{2}{3}$
- To change a ratio to a decimal, convert the ratio to a fraction, and divide the numerator by the denominator.

  Example: $1{:}4 = \frac{1}{4} = 1 \div 4 = 0.25$
- To change a percent to a fraction, drop the % sign and place the remaining number as the numerator over the denominator 100. Reduce the fraction to lowest terms. THINK: per (/) cent (100).

  Example: $75\% = \frac{75}{100} = \frac{3}{4}$
- To change a percent to a ratio, first convert the percent to a fraction in lowest terms. Then, place the numerator to the left of a colon and the denominator to the right of that colon.

  Example: $35\% = \frac{35}{100} = \frac{7}{20} = 7{:}20$
- To change a percent to a decimal, drop the % sign, and divide by 100.

  Example: $4\% = \underset{\curvearrowleft}{.04.} = 0.04$
- To change a decimal to a percent, multiply by 100, and add the % sign.

  Example: $0.5 = 0\underset{\curvearrowright}{.50.} = 50\%$
- To change a ratio to a percent, first convert the ratio to a fraction. Convert the resulting fraction to a decimal and then to a percent.

  Example: $1{:}2 = \frac{1}{2} = 1 \div 2 = 0.5 = 0\underset{\curvearrowright}{.50.} = 50\%$

Review Set 7

Change the following ratios to fractions that are reduced to lowest terms.

1. 3 : 150 = ________
2. 6 : 10 = ________
3. 0.05 : 0.15 = ________
4. 4 : 7 = ________
5. 6 : 8 = ________

Change the following ratios to decimals; round to two decimal places, if needed.

6. 20 : 40 = ________

7. $\frac{1}{1{,}000} : \frac{1}{150} =$ ________

8. 0.12 : 0.88 = ________

9. 0.3 : 4.5 = ________

10. $1\frac{1}{2} : 6\frac{2}{9} =$ ________

Change the following ratios to percents; round to two decimal places, if needed.

11. 12 : 48 = ________

12. 2 : 5 = ________

13. 0.08 : 0.64 = ________

14. 7 : 10 = ________

15. 50 : 100 = ________

Change the following percents to fractions that are reduced to lowest terms.

16. 45% = ________

17. 60% = ________

18. 0.5% = ________

19. 1% = ________

20. $66\frac{2}{3}\% =$ ________

Change the following percents to decimals; round to two decimal places, if needed.

21. 2.94% = ________

22. 4.5% = ________

23. 6.32% = ________

24. 33% = ________

25. 0.9% = ________

Change the following percents to ratios that are reduced to lowest terms.

26. 16% = ________

27. 25% = ________

28. 50% = ________

29. 45% = ________

30. 6% = ________

Which of the following is largest? Circle your answer.

31. 0.9% 0.9 1:9 $\frac{1}{90}$

32. 0.05 $\frac{1}{5}$ 0.025 1:25

33. 0.0125% 0.25% 0.1% 0.02%

34. $\frac{1}{150}$ $\frac{1}{300}$ 0.5 $\frac{2}{3}\%$

35. 1:1,000 0.0001 $\frac{1}{100}$ 0.1%

After completing these problems, see pages 468–469 to check your answers.

SOLVING SIMPLE EQUATIONS FOR X

The dosage calculations you will perform can be set up and solved in different ways. One way is to use a simple equation form. The following examples demonstrate the various forms of this equation. Learn to express your answers in decimal form, because decimals will be used most often in dosage calculations and administration. Round decimals to hundredths or to two places.

MATH TIP

The unknown quantity is represented by X.

EXAMPLE 1 ■

$$\frac{100}{200} \times 1 = X$$

MATH TIP

You can drop the 1, because a number multiplied by 1 is the same number.

$\frac{100}{200} \times 1 = X$ is the same as $\frac{100}{200} = X$.

1. Reduce to lowest terms: $\frac{100}{200} = \frac{\overset{1}{\cancel{100}}}{\underset{2}{\cancel{200}}} = \frac{1}{2} = X$
2. Convert to decimal form: $\frac{1}{2} = 0.5 = X$
3. You have your answer. $X = 0.5$

EXAMPLE 2 ■

$\frac{3}{5} \times 2 = X$

MATH TIP

Dividing a number by 1 does not change its value.

1. Convert: Express 2 as a fraction: $\frac{3}{5} \times \frac{2}{1} = X$
2. Multiply fractions: $\frac{3}{5} \times \frac{2}{1} = \frac{6}{5} = X$
3. Convert to a mixed number: $\frac{6}{5} = 1\frac{1}{5} = X$
4. Convert to decimal form: $1\frac{1}{5} = 1.2 = X$
5. You have your answer. $X = 1.2$

EXAMPLE 3 ■

$$\frac{\frac{1}{6}}{\frac{1}{4}} \times 5 = X$$

1. Convert: Express 5 as a fraction: $\frac{\frac{1}{6}}{\frac{1}{4}} \times \frac{5}{1} = X$
2. Divide fractions: $\frac{1}{6} \div \frac{1}{4} \times \frac{5}{1} = X$
3. Invert the divisor, and multiply: $\frac{1}{6} \times \frac{4}{1} \times \frac{5}{1} = X$
4. Cancel terms: $\frac{1}{\underset{3}{\cancel{6}}} \times \frac{\overset{2}{\cancel{4}}}{1} \times \frac{5}{1} = \frac{1}{3} \times \frac{2}{1} \times \frac{5}{1} = \frac{10}{3} = X$
5. Convert to a mixed number: $\frac{10}{3} = 3\frac{1}{3} = X$
6. Convert to decimal form: $3\frac{1}{3} = 3.33\overline{3} = X$
7. Round to hundredths place: $3.33\overline{3} = 3.33 = X$
8. Easy, when you take it one step at a time. $X = 3.33$

EXAMPLE 4

$$\frac{\frac{1}{10}}{\frac{1}{15}} \times 2.2 = X$$

1. Convert: Express 2.2 in fraction form: $\frac{\frac{1}{10}}{\frac{1}{15}} \times \frac{2.2}{1} = X$
2. Divide fractions: $\frac{1}{10} \div \frac{1}{15} \times \frac{2.2}{1} = X$
3. Invert the divisor, and multiply: $\frac{1}{10} \times \frac{15}{1} \times \frac{2.2}{1} = X$
4. Cancel terms: $\frac{1}{\underset{2}{\cancel{10}}} \times \frac{\overset{3}{\cancel{15}}}{1} \times \frac{2.2}{1} = \frac{1}{\underset{1}{\cancel{2}}} \times \frac{3}{1} \times \frac{\overset{1.1}{\cancel{2.2}}}{1} = \frac{1}{1} \times \frac{3}{1} \times \frac{1.1}{1} = X$
5. Multiply: $\frac{1}{1} \times \frac{3}{1} \times \frac{1.1}{1} = \frac{3.3}{1} = 3.3 = X$
6. That's it! $X = 3.3$

EXAMPLE 5

$$\frac{0.125}{0.25} \times 1.5 = X$$

1. Convert: Express 1.5 in fraction form: $\frac{0.125}{0.25} \times \frac{1.5}{1} = X$
2. Convert: Add a zero to thousandths place for 0.25 for easier comparison: $\frac{0.125}{0.250} \times \frac{1.5}{1} = X$
3. Cancel terms: $\frac{\overset{1}{\cancel{0.125}}}{\underset{2}{\cancel{0.250}}} \times \frac{1.5}{1} = \frac{1}{2} \times \frac{1.5}{1} = X$
4. Multiply: $\frac{1}{2} \times \frac{1.5}{1} = \frac{1.5}{2} = X$
5. Divide: $\frac{1.5}{2} = 0.75 = X$
6. You've got it! $X = 0.75$

MATH TIP

It may be easier to work with whole numbers than decimals. If you had difficulty with Step 3, try multiplying the numerator and denominator by 1,000 to eliminate the decimal fractions.

$$\frac{0.125}{0.250} \times \frac{1{,}000}{1{,}000} = \frac{125}{250} = \frac{1}{2}$$

Example 5 can also be solved by computing with fractions instead of decimals.

Try this: $\frac{0.125}{0.25} \times 1.5 = X$

1. Convert: Express 1.5 in fraction form: $\frac{0.125}{0.25} \times \frac{1.5}{1} = X$
2. Convert: Add zeros for easier comparison, making *both* decimals of equal length:

   $\frac{0.125}{0.250} \times \frac{1.5}{1.0} = X$

3. Cancel terms: $\frac{\overset{1}{\cancel{0.125}}}{\underset{2}{\cancel{0.250}}} \times \frac{\overset{3}{\cancel{1.5}}}{\underset{2}{\cancel{1.0}}} = \frac{1}{2} \times \frac{3}{2} = X$ (It is easier to work with whole numbers.)

4. Multiply: $\frac{1}{2} \times \frac{3}{2} = \frac{3}{4} = X$

5. Convert: $\frac{3}{4} = 0.75 = X$

6. You've got it again! $X = 0.75$

Which way do you find easier?

EXAMPLE 6 ■

$\frac{3}{4} \times 45\% = X$

1. Convert: Express 45% as a fraction reduced to lowest terms: $45\% = \frac{45}{100} = \frac{9}{20}$

2. Multiply fractions: $\frac{3}{4} \times \frac{9}{20} = X$

   $\frac{27}{80} = X$

3. Divide: $\frac{27}{80} = 0.337 = X$

4. Round to hundredths place: $0.34 = X$

5. You have your answer. $X = 0.34$

QUICK REVIEW

- To solve simple equations, perform the mathematical operations indicated to find the value of the unknown X.
- Express the result (value of X) in decimal form.

Review Set 8

Solve the following problems for X. Express answers as decimals rounded to two places.

1. $\frac{75}{125} \times 5 = X$ ________

2. $\frac{\frac{3}{4}}{\frac{1}{2}} \times 2.2 = X$ ________

3. $\frac{150}{300} \times 2.5 = X$ ________

4. $\frac{40\%}{60\%} \times 8 = X$ ________

5. $\frac{0.35}{2.5} \times 4 = X$ ________

6. $\frac{0.15}{0.1} \times 1.2 = X$ ________

7. $\frac{0.4}{2.5} \times 4 = X$ ________

8. $\frac{1{,}200{,}000}{400{,}000} \times 4.2 = X$ ________

9. $\frac{\frac{2}{3}}{\frac{1}{6}} \times 10 = X$ ________

10. $\frac{30}{50} \times 0.8 = X$ ________

11. $\frac{200{,}000}{300{,}000} \times 1.5 = X$ ________

12. $\frac{0.08}{0.1} \times 1.2 = X$ ________

13. $\frac{7.5}{5} \times 3 = X$ ________

14. $\frac{250{,}000}{2{,}000{,}000} \times 7.5 = X$ ________

15. $\frac{600}{150} \times 2.5 = X$ ________

16. $\frac{600{,}000}{750{,}000} \times 0.5 = X$ ________

17. $\frac{75\%}{60\%} \times 1.2 = X$ ________

18. $\frac{0.25}{0.125} \times 5 = X$ ________

19. $\frac{1{,}000{,}000}{250{,}000} \times 5 = X$ ________

20. $\dfrac{\frac{1}{100}}{\frac{1}{150}} \times 1.2 = X$ ________

After completing these problems, see page 469 to check your answers.

RATIO-PROPORTION: CROSS-MULTIPLYING TO SOLVE FOR X

A *proportion* is two ratios that are equal or an equation between two equal ratios.

MATH TIP

A proportion is written as two ratios separated by an equal sign, such as 5:10 = 10:20. The two ratios in a proportion may also be separated by a double colon sign, such as 5:10 :: 10:20.

Some of the calculations you will perform will have the unknown X as a different term in the equation. To determine the value of the unknown X, you must apply the rule for cross-multiplying used in a proportion.

RULE

In a proportion, the product of the means (the two inside numbers) equals the product of the extremes (the two outside numbers). Finding the product of the means and the extremes is called cross-multiplying.

EXAMPLE ■

Extremes
5:10 = 10:20
Means

$5 \times 20 = 10 \times 10$

$100 = 100$

Because ratios are the same as fractions, the same proportion can be expressed like this: $\frac{5}{10} = \frac{10}{20}$. The fractions are *equivalent,* or equal. The numerator of the first fraction and the denominator of the second fraction are the extremes, and the denominator of the first fraction and the numerator of the second fraction are the means.

EXAMPLE ■

Extreme $\frac{5}{10} \times \frac{10}{20}$ Mean
Mean Extreme

Cross-multiply to find the equal products of the means and extremes.

RULE

If two fractions are equivalent, or equal, their cross-products are also equal.

EXAMPLE ■

$$\begin{tikzcd} 5 \arrow[dr, <->] & 10 \arrow[dl, <->] \\ 10 & 20 \end{tikzcd}$$

$5 \times 20 = 10 \times 10$

$100 = 100$

When one of the quantities in a proportion is unknown, a letter, such as *X*, may be substituted for this unknown quantity. You would solve the equation to find the value of X. In addition to cross-multiplying, there is one more rule you need to know to solve for X in a proportion.

RULE

Dividing or multiplying each side (member) of an equation by the same nonzero number produces an equivalent equation.

MATH TIP

Dividing each side of an equation by the same nonzero number is the same as reducing or simplifying the equation. Multiplying each side by the same nonzero number enlarges the equation.

Let's examine how to simplify an equation.

EXAMPLE ■

$25X = 100$ ($25X$ means $25 \times X$)

Simplify the equation to find X. Divide both sides by 25, the number before X. Reduce to lowest terms.

$$\frac{\overset{1}{\cancel{25}}X}{\underset{1}{\cancel{25}}} = \frac{\overset{4}{\cancel{100}}}{\underset{1}{\cancel{25}}}$$

$\frac{1X}{1} = \frac{4}{1}$ (Dividing or multiplying a number by 1 does not change its value. 1X is understood to be simply X.)

$X = 4$

Replace X with 4 in the same equation, and you can prove that the calculations are correct.

$25 \times \mathbf{4} = 100$

Now you are ready to apply the concepts of cross-multiplying and simplifying an equation to solve for X in a proportion.

EXAMPLE 1 ■

$\frac{90}{2} = \frac{45}{X}$

You have a proportion with an unknown quantity X in the denominator of the second fraction. Find the value of X.

1. Cross-multiply: $\frac{90}{2} \times \frac{45}{X}$
2. Multiply terms: $90 \times X = 2 \times 45$

   $90X = 90$ (90X means $90 \times X$)

3. Simplify the equation: Divide both sides of the equation by the number before the unknown X. You are equally reducing the terms on both sides of the equation.

   $$\frac{\overset{1}{\cancel{90}}X}{\underset{1}{\cancel{90}}} = \frac{\overset{1}{\cancel{90}}}{\underset{1}{\cancel{90}}}$$

   $X = 1$

Try another one. The unknown X is a different term.

EXAMPLE 2 ■

$\frac{80}{X} \times 60 = 20$

1. Convert: Express 60 as a fraction.

   $\frac{80}{X} \times \frac{60}{1} = 20$

2. Multiply fractions: $\frac{80}{X} \times \frac{60}{1} = 20$

   $\frac{4{,}800}{X} = 20$

3. Convert: Express 20 as a fraction.

   $\frac{4{,}800}{X} = \frac{20}{1}$

   You now have a proportion.

4. Cross-multiply: $\frac{4{,}800}{X} \times \frac{20}{1}$

   $20X = 4{,}800$

5. Simplify: Divide both sides of the equation by the number before the unknown X.

   $$\frac{\overset{1}{\cancel{20}}X}{\underset{1}{\cancel{20}}} = \frac{\overset{240}{\cancel{4{,}800}}}{\underset{1}{\cancel{20}}}$$

   $X = 240$

EXAMPLE 3 ■

$\frac{X}{160} = \frac{2.5}{80}$

1. Cross-multiply: $\frac{X}{160} \times \frac{2.5}{80}$

   $80 \times X = 2.5 \times 160$

   $80X = 400$

2. Simplify: $\frac{\overset{1}{\cancel{80}}X}{\underset{1}{\cancel{80}}} = \frac{\overset{5}{\cancel{400}}}{\underset{1}{\cancel{80}}}$

   $X = 5$

EXAMPLE 4 ■

$\frac{40}{100} = \frac{X}{2}$

1. Cross-multiply: $\frac{40}{100} \times \frac{X}{2}$
2. Multiply terms: $100 \times X = 40 \times 2$

   $100X = 80$
3. Simplify the equation: $\frac{\overset{1}{\cancel{100}}X}{\underset{1}{\cancel{100}}} = \frac{8\cancel{0}}{10\cancel{0}}$

   $X = 0.8$

Calculations that result in an amount less than 1 should be expressed as a decimal. Most medications are ordered and supplied in metric measure. Metric measure is a decimal-based system.

QUICK REVIEW

- A *proportion* is an equation of two equal ratios. The ratios may be expressed as fractions.
- Example: 1:4 = X:8 or $\frac{1}{4} = \frac{X}{8}$
- In a proportion, the product of the means equals the product of the extremes.

  Extremes
- Example: 1:4 = X:8 Therefore, $4 \times X = 1 \times 8$

  Means
- If two fractions are equal, their cross-products are equal. This operation is referred to as cross-multiplying.
- Example: $\frac{1}{4} \times \frac{X}{8}$ Therefore, $4 \times X = 1 \times 8$ or $4X = 8$
- Dividing each side of an equation by the same number produces an equivalent equation. This operation is referred to as *simplifying the equation.*
- Example: If $4X = 8$, then $\frac{4X}{4} = \frac{8}{4}$, and $X = 2$

Review Set 9

Find the value of X. Express answers as decimals rounded to two places.

1. $\frac{1,000}{2} = \frac{125}{X}$ ________
2. $\frac{500}{2} = \frac{250}{X}$ ________
3. $\frac{500}{1} = \frac{280}{X}$ ________
4. $\frac{0.5}{2} = \frac{250}{X}$ ________
5. $\frac{75}{1.5} = \frac{35}{X}$ ________
6. $\frac{40}{X} \times 12 = 60$ ________
7. $\frac{10}{X} \times 60 = 28$ ________
8. $\frac{2}{2,000} \times X = 0.5$ ________

9. $\frac{15}{500} \times X = 6$ ________

10. $\frac{5}{X} = \frac{10}{21}$ ________

11. $\frac{250}{1} = \frac{750}{X}$ ________

12. $\frac{80}{5} = \frac{10}{X}$ ________

13. $\frac{5}{20} = \frac{X}{40}$ ________

14. $\frac{\frac{1}{100}}{1} = \frac{\frac{1}{150}}{X}$ ________

15. $\frac{2.2}{X} = \frac{8.8}{5}$ ________

16. $\frac{60}{15} = \frac{125}{X}$ ________

17. $\frac{60}{10} = \frac{100}{X}$ ________

18. $\frac{80}{X} \times 60 = 20$ ________

19. $\frac{X}{0.5} = \frac{6}{4}$ ________

20. $\frac{5}{2.2} = \frac{X}{1}$ ________

21. $\frac{\frac{1}{4}}{15} = \frac{X}{60}$ ________

22. $\frac{25\%}{30\%} = \frac{5}{X}$ ________

23. In any group of 100 nurses, you would expect to find 45 nurses who will specialize in a particular field of nursing. In a class of 240 graduating nurses, how many would you expect to specialize? ________

24. Low-fat cheese has 48 calories per ounce. A client who is having his caloric intake measured has eaten $1\frac{1}{2}$ ounces of cheese. How many calories has he eaten? ________

25. If a patient receives 450 milligrams of a medication given evenly over 5.5 hours, how many milligrams did the patient receive per hour? ________

After completing these problems, see page 470 to check your answers.

FINDING THE PERCENTAGE OF A QUANTITY

An important computation that health care professionals use for dosage calculations is to find a given percentage or part of a quantity. *Percentage* is a term that describes a *part* of a whole quantity. A *known percent* determines the part in question. Said another way, the percentage (or part in question) is equal to some known percent multiplied by the whole quantity.

RULE

Percentage (Part) = Percent × Whole Quantity
To find a percentage or part of a whole quantity:

1. Change the percent to a decimal.
2. Multiply the decimal by the whole quantity.

EXAMPLE ■

A patient reports that he drank 75% of his 8-ounce cup of coffee for breakfast. To record the amount he actually drank in his chart, you must determine what amount is 75% of 8 ounces.

MATH TIP

In a mathematical expression, the word of means times and indicates that you should multiply.

To continue with the example:

Percentage (Part) = Percent × Whole Quantity

Let X represent the unknown.

1. Change 75% to a decimal: $75\% = \frac{75}{100} = \underset{\curvearrowleft}{.75.} = 0.75$
2. Multiply 0.75 × 8 ounces: $X = 0.75 \times 8 = 6$ ounces

Therefore, 75% of 8 ounces is 6 ounces.

QUICK REVIEW

- Percentage (Part) = Percent × Whole Quantity

  Example: What is 12% of 48? $X = 12\% \times 48 = 0.12 \times 48 = 5.76$

Review Set 10

Perform the indicated operation; round decimals to hundredths place.

1. What is 0.25% of 520? ________
2. What is 5% of 95? ________
3. What is 40% of 140? ________
4. What is 0.7% of 62? ________
5. What is 3% of 889? ________
6. What is 20% of 75? ________
7. What is 4% of 20? ________
8. What is 7% of 34? ________
9. What is 15% of 250? ________
10. What is 75% of 150? ________
11. A patient has an order for an anti-infective in the amount of 500 milligrams by mouth twice a day for 10 days to treat pneumonia. He received a bottle of 20 pills. How many pills has this patient taken if he has used 40% of the 20 pills? ________
12. The patient is on oral fluid restrictions of 1,200 milliliters for a 24-hour period. For breakfast and lunch he has consumed 60% of the total fluid allowance. How many milliliters has he had? ________
13. A patient's hospital bill for surgery is $17,651.07. Her insurance company pays 80%. How much will the patient owe? ________
14. Table salt (sodium chloride) is 40% sodium by weight. If a box of salt weighs 18 ounces, how much sodium is in the box of salt? ________
15. A patient has an average daily intake of 3,500 calories. At breakfast she eats 20% of the total daily caloric allowance. How many calories did she ingest? ________

After completing these problems, see pages 470–471 to check your answers.

PRACTICE PROBLEMS—CHAPTER 2

Find the equivalent decimal, fraction, percent, and ratio forms. Reduce fractions and ratios to lowest terms; round decimals to hundredths and percents to the nearest whole number.

Decimal	Fraction	Percent	Ratio
1. ________	$\frac{2}{5}$	________	________
2. 0.05	________	________	________

Decimal	Fraction	Percent	Ratio
3. ________	________	17%	________
4. ________	________	________	1:4
5. ________	________	6%	________
6. ________	$\frac{1}{6}$	________	________
7. ________	________	50%	________
8. ________	________	________	1:100
9. 0.09	________	________	________
10. ________	$\frac{3}{8}$	________	________
11. ________	________	________	2:3
12. ________	$\frac{1}{3}$	________	________
13. 0.52	________	________	________
14. ________	________	________	9:20
15. ________	$\frac{6}{7}$	________	________
16. ________	________	________	3:10
17. ________	$\frac{1}{50}$	________	________
18. 0.6	________	________	________
19. 0.04	________	________	________
20. ________	________	10%	________

Convert as indicated.

21. 1:25 to a decimal ________

22. $\frac{10}{400}$ to a ratio ________

23. 0.075 to a percent ________

24. 17:34 to a fraction ________

25. 75% to a ratio ________

Perform the indicated operation. Round decimals to hundredths.

26. What is 35% of 750? ________

27. What is 7% of 52? ________

28. What is 8.2% of 24? ________

Identify the strongest solution in each of the following:

29. 1:40 1:400 1:4 __________

30. 1:10 1:200 1:50 __________

Find the value of X in the following equations. Express your answers as decimals rounded to the nearest hundredth.

31. $\frac{20}{400} = \frac{X}{1,680} =$ __________

32. $\frac{75}{X} = \frac{\frac{1}{300}}{4}$ __________

33. $\frac{X}{5} = \frac{3}{15}$ __________

34. $\frac{500}{250} = \frac{2.2}{X}$ __________

35. $\frac{0.6}{1.2} = \frac{X}{200}$ __________

36. $\frac{3}{9} = \frac{X}{117}$ __________

37. $\frac{\frac{1}{8}}{\frac{1}{3}} \times 2 = X$ __________

38. $\frac{X}{7} = \frac{12}{4}$ __________

39. $\frac{X}{8} = \frac{9}{0.6}$ __________

40. $\frac{0.4}{0.1} \times 22.5 = X$ __________

41. A portion of meat totaling 125 grams contains 20% protein and 5% fat. How many grams each of protein and fat does the meat contain? __________ protein __________ fat

42. The total points for a course in a nursing program is 308. A nursing student needs to achieve 75% of the total points to pass the semester. How many points are required to pass? __________

43. To work off 90 calories, Angie must walk for 27 minutes. How many minutes would she need to walk to work off 200 calories? __________

44. The doctor orders a record of the patient's fluid intake and output. The patient drinks 25% of a bowl of broth. How many milliliters of intake will be recorded if the bowl holds 200 milliliters? __________

45. The recommended daily allowance (RDA) of a particular vitamin is 60 milligrams. If a multivitamin tablet claims to provide 45% of the RDA, how many milligrams of the particular vitamin would a patient receive from the multivitamin tablet? __________

46. A label on a dinner roll wrapper reads, "2.7 grams of fiber per $\frac{3}{4}$ ounce serving." If you eat 1.5 ounces of dinner rolls, how many grams of fiber will you consume? __________

47. A patient received an intravenous medication at a rate of 6.75 milligrams per minute. After 42 minutes, how much medication had she received? __________

48. A person weighed 130 pounds at his last doctor's office visit. At this visit the patient has lost 5% of his weight. How many pounds has the patient lost? __________

49. The cost of a certain medication is expected to decrease by 17% next year. If the cost is $12.56 now, how much would you expect it to cost at this time next year? __________

50. A patient is to be started on 150 milligrams of a medication and then decreased by 10% of the original dose for each dose until he is receiving 75 milligrams. When he takes his 75 milligram dose, how many total doses will he have taken? HINT: Be sure to count his first (150 milligrams) and last (75 milligrams) doses. __________

After completing these problems, see pages 471–472 to check your answers.

SECTION 1 SELF-EVALUATION

Directions:

1. Round decimals to two places, as needed.
2. Express fractions in lowest terms.

Section 1 Mathematics Review for Dosage Calculations

Multiply or divide by the power of 10 indicated. Draw an arrow to demonstrate movement of the decimal point.

1. $30.5 \div 10 =$ ________
2. $40.025 \times 100 =$ ________
3. $63 \div 100 =$ ________
4. $72.327 \times 10 =$ ________

Identify the least common denominator for the following sets of numbers.

5. $\frac{1}{6}, \frac{2}{3}, \frac{3}{4}$ ________
6. $\frac{2}{5}, \frac{3}{10}, \frac{3}{11}$ ________

Complete the operations indicated.

7. $\frac{1}{4} + \frac{2}{3} =$ ________
8. $\frac{6}{7} - \frac{1}{9} =$ ________
9. $1\frac{3}{5} \times \frac{5}{8} =$ ________
10. $\frac{3}{8} \div \frac{3}{4} =$ ________
11. $13.2 + 32.55 + 0.029 =$ ________
12. 20% of 0.09 = ________
13. $80.3 - 21.06 =$ ________
14. $0.3 \times 0.3 =$ ________
15. $1.5 \div 0.125 =$ ________
16. $\frac{1}{150} \div \frac{1}{100} =$ ________
17. $\dfrac{\frac{1}{120}}{\frac{1}{60}} =$ ________
18. $\dfrac{16\%}{\frac{1}{4}} =$ ________

Arrange in order from smallest to largest.

19. $\frac{1}{3}$ $\frac{1}{2}$ $\frac{1}{6}$ $\frac{1}{10}$ $\frac{1}{5}$ ____________________
20. $\frac{3}{4}$ $\frac{7}{8}$ $\frac{5}{6}$ $\frac{2}{3}$ $\frac{9}{10}$ ____________________
21. 0.25 0.125 0.3 0.009 0.1909 ____________________
22. 0.9% $\frac{1}{2}$% 50% 500% 100% ____________________
23. Identify the strongest solution of the following: 1:3, 1:60, 1:6. ____________________
24. Identify the weakest solution of the following: 1:75, 1:600, 1:60. ____________________

Convert as indicated.

25. 1:100 to a decimal ________
26. $\frac{6}{150}$ to a decimal ________
27. 0.009 to a percent ________
28. $33\frac{1}{3}$% to a fraction ________

29. $\frac{5}{9}$ to a ratio __________

30. 0.05 to a fraction __________

31. $\frac{1}{2}\%$ to a ratio __________

32. 2:3 to a fraction __________

33. 3:4 to a percent __________

34. $\frac{2}{5}$ to a percent __________

35. $\frac{1}{6}$ to a decimal __________

Find the value of X in the following equations. Express your answers as decimals; round to the nearest hundredth.

36. $\frac{0.35}{1.3} \times 4.5 = X$ __________

37. $\frac{0.3}{2.6} = \frac{0.15}{X}$ __________

38. $\frac{1{,}500{,}000}{500{,}000} \times X = 7.5$ __________

39. $\frac{\frac{1}{6}}{\frac{1}{4}} \times 1 = X$ __________

40. $\frac{1:100}{1:4} \times 2{,}500 = X$ __________

41. $\frac{0.25}{0.125} \times 2 = X$ __________

42. $\frac{10\%}{\frac{1}{2}\%} \times 1{,}000 = X$ __________

43. $\frac{\frac{1}{100}}{\frac{1}{150}} \times 2.2 = X$ __________

44. $X{:}15 = 150{:}7.5$ __________

45. $\frac{1{,}000{,}000}{600{,}000} \times 5 = X$ __________

46. In a drug study, it was determined that 4% of the participants developed the headache side effect. If there were 600 participants in the study, how many developed headaches? __________

47. You are employed in a health care clinic where each employee must work 25% of 8 major holidays. How many holidays will you expect to work? __________

48. If the value of 1 roll of guaze is \$0.69, what is the value of $3\frac{1}{2}$ rolls? __________

49. To prepare a nutritional formula from frozen concentrate, you mix 3 cans of water to every 1 can of concentrate. How many cans of water will you need to prepare formula from 4 cans of concentrate? __________

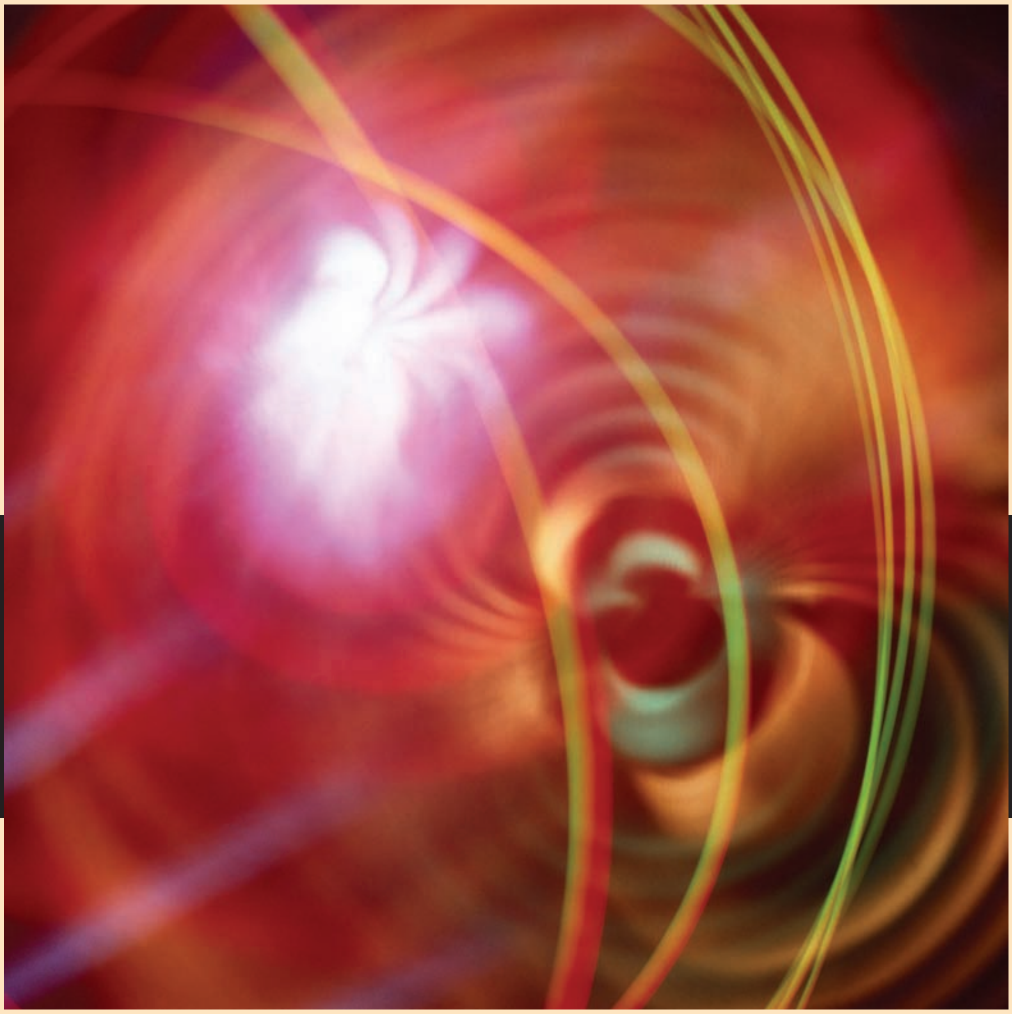
50. If 1 centimeter equals $\frac{3}{8}$ inch, how many centimeters is a laceration that measures 3 inches? __________

After completing these problems, see page 472 to check your answers. Give yourself two points for each correct answer.

Perfect score = 100 My score = __________

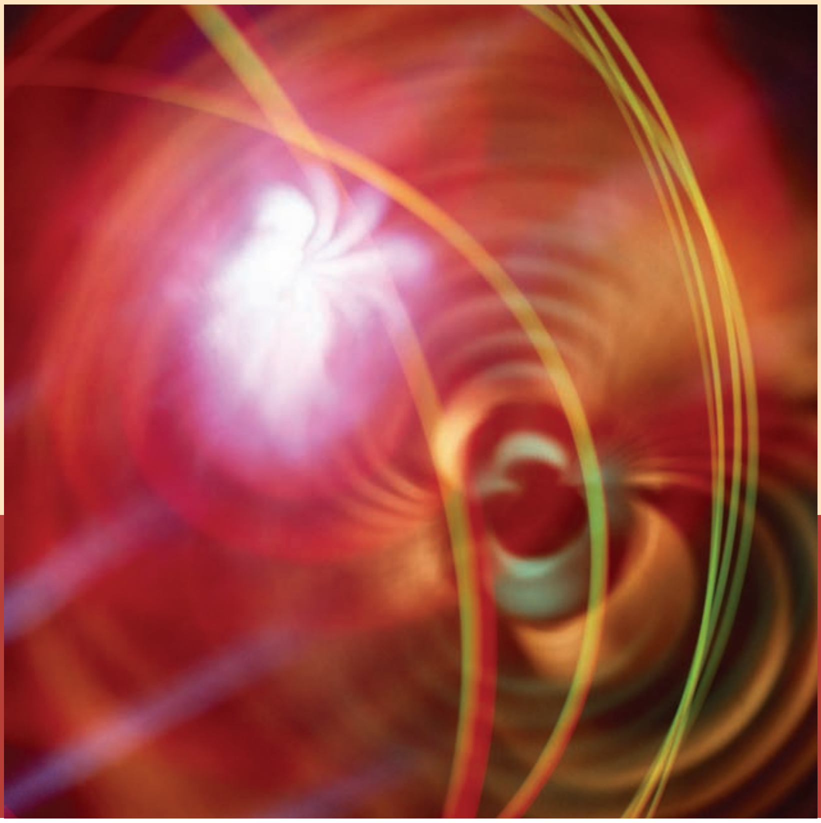
Minimum mastery score = 86 (43 correct)

For more practice, go back to the beginning of this section and repeat the Mathematics Diagnostic Evaluation.



SECTION 2

Measurement Systems, Drug Orders, and Drug Labels



3

Systems of Measurement

OBJECTIVES

Upon mastery of Chapter 3, you will be able to recognize and express the basic systems of measurement used to calculate dosages. To accomplish this you will also be able to:

- Interpret and properly express metric, apothecary, and household notation.
- Recall metric, apothecary, and household equivalents.
- Explain the use of milliequivalent (mEq), international unit, unit, and milliunit in dosage calculation.

To administer the correct amount of the prescribed medication to the patient, you must have a thorough knowledge of the weights and measures used in the prescription and administration of medications. The three systems used by health professionals are the *metric,* the *apothecary,* and the *household* systems.

It is necessary for you to understand each system and how to convert from one system to another. All prescriptions should be written with the metric system, and all U.S. drug labels provide metric measurements. The household system uses measurements found in familiar containers such as *teaspoons, cups,* and *quarts.* It is helpful to understand the relationship between metric and household systems for home health care situations and discharge instructions. You may occasionally see prescriptions and metric notation using the apothecary system, usually written by physicians trained in this system. Until the metric system completely replaces the apothecary and household systems, health care professionals should be familiar with each system.

Three essential parameters of measurement are associated with the prescription and administration of drugs within each system of measurement: weight, volume, and length. *Weight* is the most utilized parameter. It is important as a dosage unit. Most drugs are ordered and supplied by the weight of the drug. Keep in mind that the metric weight units, such as *gram* and *milligram,* are the most accurate and are preferred for health care applications. Occasionally you will also use the apothecary unit of weight referred to as the *grain.*

Think of capacity, or how much a container holds, as you contemplate *volume,* which is the next most important parameter. Volume usually refers to liquids. Volume also adds two additional parameters to dosage calculations: *quantity* and *concentration.* The *milliliter* is the most common metric volume unit for dosage calculations. Much less frequently you will use household and apothecary measures, such as *teaspoon* and *ounce.*

Length is the least utilized parameter for dosage calculations, but linear measurement is still essential to learn for health care situations. A person's height, the circumference of an infant's head, body surface area, and the size of lacerations and tumors are examples of important length measurements. You are probably familiar with the household measurements of *inches* and *feet.* Typically in the health care setting, length is measured in *millimeters* and *centimeters.*

THE METRIC SYSTEM

The metric system was first adopted in 1799 in France. It is the most widely used system of measurement in the world today and is preferred for prescribing and administering medications.

The metric system is a decimal system, which means it is based on powers of 10. The base units (the primary units of measurement) of the metric system are *gram* for weight, *liter* for volume, and *meter* for length. In this system, prefixes are used to show which portion of the base unit is being considered. It is important that you learn the most commonly used prefixes.

REMEMBER

Metric Prefixes

micro = one millionth or 0.000001 or $\frac{1}{1{,}000{,}000}$ of the base unit

milli = one thousandth or 0.001 or $\frac{1}{1{,}000}$ of the base unit

centi = one hundredth or 0.01 or $\frac{1}{100}$ of the base unit

deci = one tenth or 0.1 or $\frac{1}{10}$ of the base unit

kilo = one thousand or 1,000 times the base unit

Figure 3-1 demonstrates the relationship of metric units. Notice that the values of most of the common prefixes used in health care and the ones applied in this text are highlighted: **kilo-, base, milli-,** and **micro-.** These units are three places away from the next place. Often you can either multiply or divide by 1,000 to calculate an equivalent quantity. The only exception is **centi-.** Centi- is easy to remember, though, if you think of the relationship between one cent and one U.S. dollar as a clue to the

FIGURE 3-1 Relationship and value of metric units, with comparison of common metric units used in health care

Prefix	KILO-	Hecto-	Deca-	BASE	DECI-	CENTI-	MILLI-	Decimilli-	Centimilli-	MICRO-
Weight	kilogram			gram			milligram			microgram
Volume				liter	deciliter		milliliter			
Length				meter		centimeter	millimeter			
Value to Base	**1,000**	100	10	**1**	**0.1**	**0.01**	**0.001**	0.0001	0.00001	**0.000001**

relationship of centi- to the base, $\frac{1}{100}$. **Deci-** is one-tenth ($\frac{1}{10}$) of the base. See Chapter 1 to review the rules of multiplying and dividing decimals by a power of 10.

MATH TIP

Try this to remember the order of six of the metric units—kilo-, hecto-, deca-, (BASE), deci-, centi-, and milli-: "**K**ing **H**enry **D**ied from a **D**isease **C**alled **M**umps."

			gram liter meter			
kilo	**h**ecto	**d**eca	BASE	**d**eci	**c**enti	**m**illi
K	**H**	**D**	Δ	**D**	**C**	**M**
"King	Henry	Died	from a	Disease	Called	Mumps."

The international standardization of metric units was adopted throughout much of the world in 1960 with the International System of Units or SI (from the French *Système International*). The abbreviations of this system of metric notation are the most widely accepted. The metric units of measurement and the SI abbreviations most often used for dosage calculations and measurements of health status are given in the following units of weight, volume, and length. Other acceptable abbreviations are given in parentheses. Although these alternate abbreviations are still in use, they are considered confusing. This text uses SI standardized abbreviations throughout. It is recommended that you learn and practice these notations primarily.

REMEMBER

SI METRIC SYSTEM

	Unit	Abbreviation	Equivalents
Weight	**gram** (base unit)	g	1 g = 1,000 mg
	milligram	mg	1 mg = 1,000 mcg = 0.001 g
	microgram	mcg	1 mcg = 0.001 mg = 0.000001 g
	kilogram	kg	1 kg = 1,000 g
Volume	**liter** (base unit)	L	1 L = 1,000 mL
	milliliter	mL	1 mL = 1 cc = 0.001 L
	cubic centimeter	cc	1 cc = 1 mL
Length	**meter** (base unit)	m	1 m = 100 cm = 1,000 mm
	centimeter	cm	1 cm = 0.01 m = 10 mm
	millimeter	mm	1 mm = 0.001 m = 0.1 cm

MATH TIP

A cubic centimeter is the amount of space occupied by one milliliter of liquid.

CAUTION

You may see gram abbreviated as Gm or gm, liter as lowercase l, or milliliter as ml. These abbreviations are considered obsolete and too easily misinterpreted. You should only use the standardized SI abbreviations. Use g for gram, L for liter, and mL for milliliter. Further, the cc abbreviation is provided for recognition purposes only and will not be used. Many health care organizations now prohibit the use of cc and allow only mL, because cc can be mistaken for zeros (00) or units (U).

CAUTION

The SI abbreviations for milligram (mg) and milliliter (mL) appear to be somewhat similar, but in fact mg is a weight unit and mL is a volume unit. Confusing these two units can have dire consequences in dosage calculations. Learn to clearly differentiate them now.

In addition to learning the metric units, their equivalent values, and their abbreviations, it is important to use the following rules of metric notation.

RULES

The following 10 critical rules will help to ensure that you accurately write and interpret metric notation.

1. The unit or abbreviation always follows the amount. Example: *5 g,* NOT *g 5*
2. Do not put a period after the unit abbreviation, as it may be mistaken for the number 1 if poorly written. Example: *mg,* NOT *mg.*
3. Do not add an s to make the unit plural as it may be misread for another unit. Example: *mL,* NOT *mLs*
4. Separate the amount from the unit so the number and unit of measure do not run together, as the unit can be mistaken as zero or zeros, risking a 10-fold to 100-fold overdose. Example: *20 mg,* NOT *20 mg*
5. Place commas for amounts at or above 1,000. Example: *10,000 mcg,* NOT *10000 mcg*
6. Decimals are used to designate fractional amounts. Example: *1.5 mL,* NOT $1\frac{1}{2}$ *mL*
7. Use a leading zero to emphasize the deminal point for fractional amounts less than 1. Without the zero the amount may be interpreted as a whole number resulting in serious overdosing. Example: *0.5 mg,* NOT *.5 mg*
8. Omit unnecessary or trailing zeros that can be misread as part of the amount if the decimal point is not seen. Example: *1.5 mg,* NOT *1.50 mg*
9. Do not use the abbreviation μg for microgram as it might be mistaken for mg, which is 1,000 times the intended amount. Example: *150 mcg,* NOT *150 μg*
10. Do not use the abbreviation cc for mL. Example: *500 mL,* NOT *500 cc*

And always ask the writer to clarify if you are not sure of the abbreviation or notation used. Never guess!

The metric system is the most common and the only standardized system of measurement in health care. Take a few minutes to review these essential points.

QUICK REVIEW

- The metric base units are gram (g), liter (L), and meter (m).
- Subunits are designated by the appropriate prefix and the base unit (such as milligram and standard abbreviations (such as mg).
- There are 10 critical rules for ensuring that units and amounts are accurately interpreted. Review them again now and learn to rigorously adhere to them.
- Never guess as to the meaning of metric notation. When in doubt about the exact amount or the abbreviation used, ask the writer to clarify.

Review Set 11

1. The system of measurement most commonly used for prescribing and administering medications is the __________ system.
2. Liter and milliliter are metric units that measure __________.
3. Gram and milligram are metric units that measure __________.
4. Meter and millimeter are metric units that measure __________.
5. 1 mg is __________ of a g.
6. There are __________ mL in a liter.
7. 10 mL = __________ cc
8. Which is largest—kilogram, gram, or milligram? __________
9. Which is smallest—kilogram, gram, or milligram? __________
10. 1 liter = __________ mL
11. 1,000 mcg = __________ mg
12. 1 kg = __________ g
13. 1 cm = __________ mm

Select the correct metric notation.

14. .3 g, 0.3 Gm, 0.3 g, .3 Gm, 0.30 g __________
15. $1\frac{1}{3}$ ml, 1.33 mL, 1.33 ML, $1\frac{1}{3}$ ML, 1.330 mL __________
16. 5 Kg, 5.0 kg, kg 05, 5 kg, 5 kG __________
17. 1.5 mm, $1\frac{1}{2}$ mm, 1.5 Mm, 1.50 MM, $1\frac{1}{2}$ MM __________
18. mg 10, 10 mG, 10.0 mg, 10 mg, 10 MG __________

Interpret these metric abbreviations.

19. mcg __________
20. mL __________
21. cc __________
22. g __________
23. mm __________
24. kg __________
25. cm __________

After completing these problems, see page 472 to check your answers.

THE APOTHECARY AND HOUSEHOLD SYSTEMS

The Joint Commission on Accreditation of Healthcare Organizations recommends that the metric system be used exclusively for the ordering, measuring, and reporting of medications. However, some apothecary notation—such as lowercase Roman numerals, ounces, and grains—are still in use. Likewise, the household system persists, and nurses and other health care providers need to be familiar with the equivalent measurements that patients or clients use at home.

The historic interconnection between the apothecary and household systems is interesting. The apothecary system was the first system of medication measurement used by pharmacists (apothecaries) and physicians. It originated in Greece and made its way to Europe via Rome and France. The English used it during the late 1600s, and the colonists brought it to America. A modified system of measurement for everyday use evolved; it is now recognized as the household system. Large liquid volumes were based on familiar trading measurements, such as *pints, quarts,* and *gallons,* which originated as apothecary measurements. Vessels to accommodate each measurement were made by craftspersons and widely circulated in colonial America.

Units of weight, such as the *grain, ounce,* and *pound,* also are rooted in the apothecary system. The grain originated as the standard weight of a single grain of wheat, which is approximately 60 milligrams. This one equivalency of weight (1 grain = 60 milligrams) is recognized in drug orders. After more than 100 years as the world's most popular pill, aspirin may still be prescribed in grains.

The Apothecary System

Apothecary notation is unusual. Exercise caution when using this system. The apothecary system utilizes Roman numerals. The ability to interpret Roman numerals is therefore essential. The letters **I, V,** and **X** are the basic symbols of this system that you will use in dosage calculations. In medical notation, lowercase letters are typically used to designate Roman numerals (**i, v,** and **x**).

In addition to Roman numerals, apothecary notation also uses common fractions, special symbols, and units of measure that typically precede numeric values. The common units are *grain* and *ounce.*

CAUTION

In 2004, JCAHO published its *Official "Do Not Use" List* for medical abbreviations and notation. This was followed later that year with another list of abbreviations, acronyms, and symbols recommended not to use (and for **possible** future inclusion on the official list), including apothecary ones. While JCAHO does not prohibit the use of apothecary abbreviations at this time, it does discourage their use because they can be easily misinterpreted. This can be confusing as rules and guidelines are regularly updated to best ensure patient safety; but it is prudent for you to be familiar with notation that you may find in practice. It is important that all health care practitioners are diligent in their efforts to stay current with JCAHO's and their local health care organizations' requirements regarding medical abbreviations and notation, and to rigorously follow those guidelines. You will learn more about medical abbreviations in Chapter 7, and you will find the full "Do Not Use" lists in Chapter 9, as we consider the prevention of medication errors.

The style of apothecary notation includes:

1. The unit or abbreviation typically precedes the amount. Example: gr v
2. Lowercase Roman numerals are often used to express whole numbers: i-x, xv, xx, and xxx.
3. Fractions are used to designate amounts less than 1. Examples: gr $\frac{1}{2}$, gr $\frac{1}{4}$
4. You may see the symbol *ss* used to designate the fraction $\frac{1}{2}$. As this symbol can be easily misinterpreted, it is provided here for recognition purposes only. We will not use this symbol.

MATH TIP

To decrease errors in interpretation of medical notation, a line can be drawn over the lowercase Roman numerals to distinguish them from other letters in a word or phrase. The lowercase i is dotted above, not below, the line.

EXAMPLE ■

3 = iii or $\overline{\text{iii}}$

Learn the following common Roman numerals and their Arabic equivalents. These are the values that you may see.

REMEMBER

Arabic Number	Roman Numeral	Apothecary Notation	Arabic Number	Roman Numeral	Apothecary Notation
1	I	i, $\dot{\bar{\imath}}$	8	VIII	viii, $\overline{\text{viii}}$
2	II	ii, $\overline{\text{ii}}$	9	IX	ix, $\overline{\text{ix}}$
3	III	iii, $\overline{\text{iii}}$	10	X	x, $\overline{\text{x}}$
4	IV	iv, $\overline{\text{iv}}$	15	XV	xv, $\overline{\text{xv}}$
5	V	v, $\overline{\text{v}}$	20	XX	xx, $\overline{\text{xx}}$
6	VI	vi, $\overline{\text{vi}}$			
7	VII	vii, $\overline{\text{vii}}$	30	XXX	xxx, $\overline{\text{xxx}}$

The apothecary units of measurement and essential equivalents for volume are given in the following table. There are no essential equivalents of weight or length to learn for this system.

REMEMBER

APOTHECARY

Unit	Abbreviation	Equivalents
grain	gr	
quart	qt	qt i = pt ii
pint	pt	pt i = oz (℥) 16
ounce or fluid ounce	oz (℥)	qt i = oz (℥) 32
dram	ʒ	
minim	ɱ	

NOTE: The *minim* (ɱ), and *fluid dram* (ʒ), and *fluid ounce* (℥) symbols are given only so that you will be able to recognize them. Some syringes may have the minim scale identified, and the medicine cup continues to show the dram and ounce scales. However, the use of these symbols is discouraged by JCAHO and many health care organizations. We will not use them.

MATH TIP

The ounce (℥) is a larger unit, and its symbol has one more loop than the dram (ʒ), or "more bounce to the ounce."

CAUTION

Notice that the abbreviations for the apothecary grain (**gr**) and the metric gram (**g**) can be confusing. The style indicating the abbreviation or symbol before the quantity in apothecary notation further distinguishes it from the metric system. If you are ever doubtful about the meaning that is intended, be sure to ask the writer for clarification.

QUICK REVIEW

In the apothecary system:

- The common units for dosage calculation are grain (gr) and ounce (oz).
- The quantity is often expressed in lowercase Roman numerals. Amounts greater than 10 may be expressed in Arabic numbers, except 15 (xv), 20 (xx), and 30 (xxx).
- Quantities of less than 1 are expressed as fractions.
- The abbreviation is typically written before the quantity, especially for grains.
- If you are unsure about the exact meaning of any medical notation, do not guess or assume. Ask the writer for clarification.
- Be sure to check with your health care facility regarding the acceptable use of apothecary notation.

Review Set 12

Interpret the following apothecary symbols.

1. ʒ __________
2. ℥ __________
3. ♏ __________
4. qt __________
5. gr __________

Write the following quantities in the apothecary system.

6. one-half ounce __________
7. one-sixth grain __________
8. four ounces __________
9. two pints __________
10. one-and-one-fourth quarts __________
11. ten grains __________
12. eight ounces __________
13. two grains __________
14. sixteen pints __________
15. three grains __________
16. thirty-two ounces __________
17. seven- and- one-half grains __________

Give the equivalent units.

18. qt i = oz __________
19. oz 16 = pt __________
20. qt i = pt __________

After completing these problems, see page 472 to check your answers.

The Household System

Household units are likely to be used by the patient at home where hospital measuring devices are not usually available. You should be familiar with the household system of measurement so that you can explain take-home prescriptions to your patient at the time of discharge. There is no standardized system of notation, but it is preferred to express the quantity in Arabic numbers and common fractions with the abbreviation following the amount. The common household units and abbreviations are given in the following table.

CAUTION

Notice that some units are used in both the apothecary and household systems (e.g., ounce, pint, and quart). And, the ounce household unit is used for both volume (fluid ounce) and weight (ounce). These similarities can be confusing. In apothecary, the amount technically follows the unit with Roman numerals used to designate the amount (e.g., oz ii). In the household system, the unit follows the amount (2 oz). Either notation is acceptable.

REMEMBER

HOUSEHOLD

Unit	Abbreviation	Equivalents
drop	gtt	
teaspoon	t (or tsp)	
tablespoon	T (or tbs)	1 T = 3 t
ounce (fluid)	oz	2 T = 1 oz
cup	cup	1 cup = 8 oz
pint	pt	1 pt = 2 cups
quart	qt	1 qt = 4 cups = 2 pt
ounce (weight)	oz	1 lb = 16 oz
pound	lb	

NOTE: The *drop (gtt)* unit is given only for the purpose of recognition. There are no standard equivalents for drop to learn. The amount of each drop varies according to the diameter of the utensil used for measurement. (See Figure 6-2 Calibrated Dropper and Figure 14-16 Intravenous Drip Chambers.)

MATH TIP

Tablespoon is the larger unit, and the abbreviation is expressed with a capital or “large” T. Teaspoon is the smaller unit, and the abbreviation is expressed with a lowercase or “small” t.

CAUTION

There is wide variation in household measures and common household measuring devices, such as tableware teaspoons. Therefore, using the household system or household measures for dosage measurement can constitute a safety risk. Advise your patients and their families to use the measuring devices packaged with the medication or provided by the pharmacy, rather than using common household measuring devices.

QUICK REVIEW

In the household system:

- The common units used in health care are teaspoon (t), tablespoon (T), ounce (oz), cup, pint (pt), quart (qt), and pound (lb).
- The quantity is typically expressed in Arabic numbers with the unit abbreviation following the amount. Example: 5 t
- Quantities of less than 1 are preferably expressed as common fractions. Example: $\frac{1}{2}$ cup
- When in doubt about the exact amount or the abbreviation used, do not guess or assume. Ask the writer to clarify.

OTHER COMMON DRUG MEASUREMENTS: UNITS AND MILLIEQUIVALENTS

Four other measurements may be used to indicate the quantity of medicine prescribed: international unit, unit, milliunit, and milliequivalent (mEq). The quantity is expressed in Arabic numbers with the symbol following. The *international unit* represents a unit of potency used to measure such things as vitamins and chemicals. The *unit* is a standardized amount needed to produce a desired effect. Medications such as penicillin, heparin, and insulin have their own meaning and numeric value related to the type of unit. One thousandth ($\frac{1}{1,000}$) of a unit is a *milliunit*. The equivalent of 1 unit is 1,000 milliunits. Pitocin is a drug measured in milliunits. The *milliequivalent* (mEq) is one thousandth ($\frac{1}{1,000}$) of an equivalent weight of a chemical. The mEq is the unit used when referring to the concentration of serum electrolytes, such as calcium, magnesium, potassium, and sodium.

CAUTION

The obsolete abbreviations "U" and "IU" are included on the Official "Do Not Use" List published by JCAHO. The written words "unit" and "international unit" should be used instead. See Chapter 9 for the full list.

It is not necessary to learn conversions for the international unit, unit, or milliequivalent, because medications prescribed in these measurements are also prepared and administered in the same system.

EXAMPLE 1 ■

Heparin 800 units is ordered, and *heparin 1,000 units per 1 mL* is the stock drug.

EXAMPLE 2 ■

Potassium chloride 10 mEq is ordered, and *potassium chloride 20 mEq per 15 mL* is the stock drug.

EXAMPLE 3 ■

Syntocinon 2 milliunits (0.002 international units) intravenous per minute is ordered and *Syntocinon 10 international units per 1 mL* to be added to 1,000 mL intravenous solution is available.

QUICK REVIEW

- The international unit, unit, milliunit, and milliequivalent (mEq) are special measured quantities expressed in Arabic numbers.
- No conversion is necessary for unit, international unit, and mEq, because the ordered dosage and supply dosage are in the same system.
- 1 unit = 1,000 milliunits

Review Set 13

Interpret the following notations.

1. 20 gtt __________
2. 10 lb __________
3. 10 mEq __________
4. 4 t __________
5. 10 T __________

Express the following using correct notation.

6. 4 drops __________
7. 30 milliequivalents __________
8. 5 tablespoons __________
9. one and one-half teaspoons __________
10. 10 teaspoons __________
11. The household system of measurement is commonly used in hospital dosage calculations. (True) (False)
12. The drop is a standardized unit of measure. (True) (False)
13. Fluid ounce is equivalent to the ounce that measures weight. (True) (False)
14. Drugs such as heparin and insulin are commonly measured in __________.
15. 1 T = __________ t
16. 1 oz = __________ T
17. 16 oz = __________ lb
18. 2 T = __________ oz
19. 8 oz = __________ cup
20. The unit used to measure the concentration of serum electrolytes, such as calcium, magnesium, potassium, and sodium is the __________ and is abbreviated __________.

After completing these problems, see page 473 to check your answers.

CRITICAL THINKING SKILLS

The importance of the placement of the decimal point cannot be overemphasized. Let's look at some examples of potential medication errors related to placement of the decimal point.

ERROR 1

Not placing a zero before a decimal point on medication orders.

Possible Scenario

An emergency room physician wrote an order for the bronchodilator terbutaline for a patient with asthma. The order was written as follows:

Terbutaline .5 mg subcutaneously now, repeat dose in 30 minutes if no improvement

Suppose the nurse, not noticing the faint decimal point, administered 5 mg of terbutaline subcutaneously instead of 0.5 mg. The patient would receive ten times the dose intended by the physician.

Potential Outcome

Within minutes of receiving the injection the patient would likely complain of headache and develop tachycardia, nausea, and vomiting. The patient's hospital stay would be lengthened because of the need to recover from the overdose.

Prevention

This type of medication error is avoided by remembering the rule to place a 0 in front of a decimal to avoid confusion regarding the dosage: 0.5 mg. Further, remember to question orders that are unclear or seem impractical.

CRITICAL THINKING SKILLS

Many medication errors occur by confusing mg and mL. Remember that mg is the weight of the medication, and mL is the volume of the medication preparation.

ERROR 2

Confusing mg and mL.

Possible Scenario

Suppose a physician ordered Prelone (prednisolone, a steroid) 15 mg by mouth twice a day for a patient with cancer. Prelone syrup is supplied in a concentration of 15 mg in 5 mL. The pharmacist supplied a bottle of Prelone containing a total volume of 240 mL with 15 mg of Prelone in every 5 mL. The nurse, in a rush to give her medications on time, misread the order as 15 mL and gave the patient 15 mL of Prelone instead of 5 mL. Therefore, the patient received 45 mg of Prelone, or three times the correct dosage.

Potential Outcome

The patient could develop a number of complications related to a high dosage of steroids: gastrointestinal bleeding, headaches, seizures, and hypertension, to name a few.

Prevention

The mg is the weight of a medication, and mL is the volume you prepare. Do not allow yourself to get rushed or distracted so that you would confuse milligrams with milliliters. When you know you are distracted or stressed, have another nurse double-check the calculation of the dose.

PRACTICE PROBLEMS—CHAPTER 3

Give the metric prefix for the following parts of the base units.

1. 0.001 ________
2. 0.000001 ________
3. 0.01 ________
4. 1,000 ________

Identify the equivalent unit with a value of 1 that is indicated by the following amounts (such as 1 unit = 1,000 milliunits).

5. 0.001 gram ________
6. 1,000 grams ________
7. 0.001 milligram ________
8. 0.01 meter ________

Identify the metric base unit for the following.

9. length ____________________
10. weight ____________________
11. volume ____________________

Interpret the following notations.

12. gtt ____________________
13. ℥ ____________________
14. oz ____________________
15. gr ____________________
16. mg ____________________
17. mcg ____________________
18. ʒ ____________________
19. mEq ____________________
20. t ____________________
21. qt ____________________
22. mL ____________________
23. cc ____________________
24. pt ____________________
25. T ____________________
26. mm ____________________
27. g ____________________
28. cm ____________________
29. L ____________________
30. m ____________________
31. kg ____________________
32. ɱ ____________________

Express the following amounts in proper notation.

33. one-half grain ____________________
34. two teaspoons ____________________
35. one-third ounce ____________________
36. five million units ____________________
37. one-half liter ____________________
38. one-fourth grain ____________________
39. one two-hundredths of a grain ____________________
40. five hundredths of a milligram ____________________

Express the following numeric amounts in words.

41. $8\frac{1}{4}$ oz ____________________

42. 375 g ____________________

43. gr $\frac{1}{125}$

44. 2.6 mL

45. 20 mEq

46. 0.4 L

47. gr iv $\frac{1}{2}$

48. 0.17 mg

49. Describe the strategy that would prevent the medication error.

Possible Scenario
Suppose a physician ordered oral Coumadin (an anticoagulant) for a patient with a history of phlebitis. The physician wrote an order for 1 mg, but while writing the order placed a decimal point after the 1 and added a 0:

Coumadin 1.0 mg orally once per day

Coumadin 1.0 mg was transcribed on the medication record as Coumadin 10 mg. The patient received ten times the correct dosage.

Potential Outcome
The patient would likely begin hemorrhaging. An antidote, such as vitamin K, would be necessary to reverse the effects of the overdose. However, it is important to remember that not all drugs have antidotes.

Prevention

50. Describe the strategy that would prevent a medication error or the need to notify the prescribing practitioner.

Possible Scenario
Suppose a physician ordered oral codeine (a potent narcotic analgesic) for an adult patient recovering from extensive nasal surgery. The physician wrote the following order for 1 grain (equivalent to about 60 mg), but while writing the order placed the 1 before the abbreviation gr. The gr smeared and the abbreviation gr is unclear. Is it *grains* or *grams*?

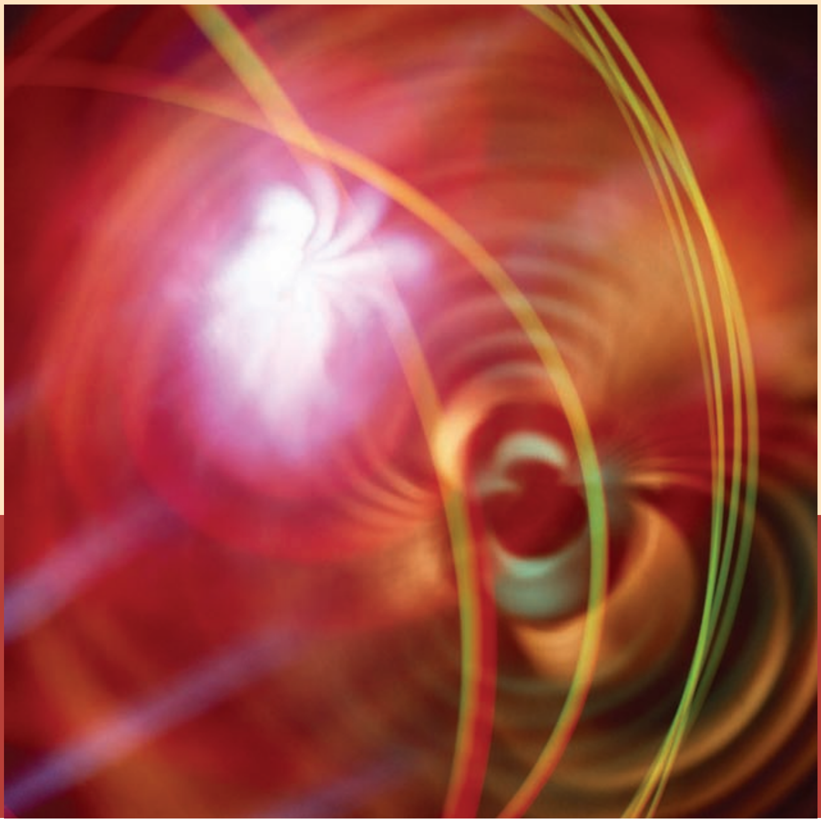
Codeine 1 gr orally every four hours as needed for pain

Codeine 1 gram was transcribed on the medication record. Because 1 gram is equivalent to 1,000 mg or about 15 grains, this erroneous dosage is about 15 times more than the intended amount.

Potential Outcome
Even though the nurse was in a rush to help ease the patient's pain, she realized that the available codeine pills would not be dispensable in this amount. She would have to give the patient 15 tablets to equal the 1 gram amount. The nurse saw the questionable order and called the physician for clarification. The nurse correctly concluded it was unlikely that the physician would have ordered such an excessive number of pills or dosage.

Prevention

After completing these problems, see page 473 to check your answers.



4

Conversions: Metric, Apothecary, and Household Systems

OBJECTIVES

Upon mastery of Chapter 4, you will be able to complete step 1 (conversion) in the three-step process of dosage calculations. To accomplish this, you will also be able to:

- Recall from memory the metric, apothecary, and household approximate equivalents.
- Convert among units of measurement within the same system.
- Convert units of measurement from one system to another.

Medications are usually prescribed or ordered in a unit of weight measurement such as grams or milligrams. The nurse must interpret this order and administer the correct number of tablets, capsules, teaspoons, milliliters, or some other unit of volume or capacity measurement to deliver the prescribed amount of medication.

EXAMPLE 1 ■

A prescription notation may read:

Aldactone 100 mg to be given orally

The nurse has on hand a 100 tablet bottle of *Aldactone labeled 50 mg in each tablet.* To administer the correct amount of the drug, the nurse must convert the prescribed weight of 100 mg to the correct number of tablets. In this case, the nurse gives the patient two of the 50 mg tablets, which equals *100 mg of Aldactone.*

To give the prescribed dosage, the nurse must be able to calculate the order in weight to the correct amount of tablets of the drug on hand or in stock. THINK: If one tablet equals 50 mg, then two tablets equal 100 mg.

7.5
A07774-1
Store below 77°F (25°C).
Pharmacist: Dispense in a tight, light-resistant, child-resistant container.
100 Tablets
NDC 0025-1041-31
Rx only
Aldactone®
(spironolactone USP)
50 mg
SEARLE
Usual Adult Dosage: Two tablets daily or as recommended in attached literature.
G.D. Searle & Co.
Chicago IL 60680 USA
FOR POSITION ONLY
UPC @100%
3 0025-1041-31 *

EXAMPLE 2 ■

A prescription notation may read:

Versed 2.5 mg by intravenous injection

5 mg/mL 5 mL Vial
VERSED®
(midazolam HCl)
midazolam 5 mg/mL (as the hydrochloride)
For I.M. or I.V. Use.
Mfd by: Roche Pharma, Inc.
Manati, PR 00674
C IV
1191
EXPIRES
FACSIMILE

The nurse has on hand a vial of *Versed* labeled *5 mg/mL*. To administer the correct amount of the drug, the nurse must be able to fill the injection syringe with the correct number of milliliters. As the nurse, how many milliliters would you give? THINK: If 5 mg = 1 mL, then 2.5 mg = 0.5 mL. Therefore, 0.5 mL should be administered.

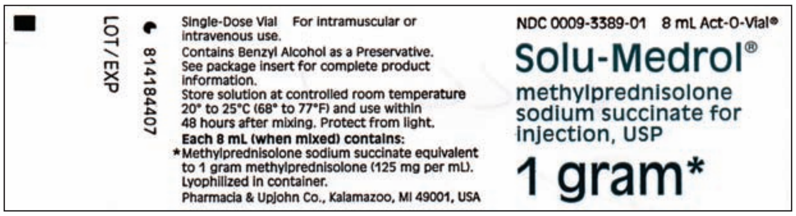
Sometimes a drug order may be written in a unit of measurement that is different from the supply of drugs the nurse has on hand. Let's look at two examples of this situation.

EXAMPLE 1 ■

Medication order: *Solu-Medrol 500 mg by intramuscular injection*

Supply on hand: Solu-Medrol injection 1 g

The drug order is written in milligrams, but the drug is supplied in grams.



LOT/EXP
814184407
Single-Dose Vial For intramuscular or intravenous use.
Contains Benzyl Alcohol as a Preservative.
See package insert for complete product information.
Store solution at controlled room temperature 20° to 25°C (68° to 77°F) and use within 48 hours after mixing. Protect from light.
Each 8 mL (when mixed) contains:
*Methylprednisolone sodium succinate equivalent to 1 gram methylprednisolone (125 mg per mL).
Lyophilized in container.
Pharmacia & Upjohn Co., Kalamazoo, MI 49001, USA
NDC 0009-3389-01 8 mL Act-O-Vial®
Solu-Medrol®
methylprednisolone sodium succinate for injection, USP
1 gram*

EXAMPLE 2 ■

Medication order: *Codeine gr* $\frac{1}{2}$ *orally*

Supply on hand: Codeine 30 mg tablets

The drug order is written in grains (apothecary measurement), but the drug is supplied in milligrams (metric measurement).

See Package Insert for Complete Prescribing Information.
Store at Controlled Room Temperature 15°-30°C (59°-86°F).
PROTECT FROM MOISTURE.
Dispense in a well-closed container as defined in the USP/NF.
TABLETS IDENTIFIED 54 783
(Side One) (Side Two)
DO NOT USE UNLESS TABLETS CARRY THIS IDENTIFICATION
NDC 0054-4156-25
100 Tablets
30 mg
C II
CODEINE
Sulfate
Tablets USP
Each tablet contains Codeine Sulfate 30 mg
℞ only.
Roxane Laboratories, Inc.
Columbus, Ohio 43216
EXP. LOT
S
4151001
039
© RLI, 1999
N 3 0054-4156-25 7

In such cases, the prescribed quantities must be converted into the units as supplied. The nurse or health care professional can then calculate the correct dosage to prepare and administer to the patient. Thus, conversion is the first step in the calculation of dosages.

CONVERTING USING RATIO-PROPORTION

After learning the systems of measurement common for dosage calculations and their equivalents (Chapter 3), the next step is to learn how to use them. First, you must be able to convert, or change, from one unit to another within the same measurement system and between systems of measurement. A method of performing conversions is to set up a proportion of two ratios expressed as fractions. Refer to Chapter 2 to review ratio-proportion, if needed.

RULE

In a proportion, the ratio for a known equivalent equals the ratio for an unknown equivalent. To use ratio-proportion to convert from one unit to another, you need to follow these three steps.

1. Recall the equivalents.
2. Set up a proportion of two equivalent ratios.
3. Cross-multiply to solve for an unknown quantity, X.

Each ratio in a proportion must have the same relationship and follow the same sequence. A proportion compares like things to like things. Be sure the units in the numerators match and the units in the denominators match. Label the units in each ratio.

Let's start by conversion of units within the same measurement system and with household units already familiar to you.

EXAMPLE 1 ■

How many cups are equivalent to 3 quarts?

1. What is the known equivalent that applies to this problem? You know it is 1 qt = 4 cups.
2. Now you are ready to set up a proportion of two equivalent ratios. The first ratio of the proportion contains the *known equivalent,* that is 1 quart : 4 cups. The second ratio contains the *desired unit of measure* and the *unknown equivalent* expressed as X, that is 3 quarts : X cups. Express the ratios as fractions. The proportion now looks like this.

$$\frac{1\text{ qt}}{4\text{ cups}} = \frac{3\text{ qt}}{\text{X cups}}$$

CAUTION

Notice that the ratios follow the same sequence. **THIS IS ESSENTIAL.** The proportion is set up so that like units are across from each other. The units in the numerators match (qt) and the units in the denominators match (cups).

3. Cross-multiply to solve the proportion for X. Refer to Chapter 2 to review this skill, if needed.

$$\frac{1\text{ qt}}{4\text{ cups}} \times \frac{3\text{ qt}}{\text{X cups}} \qquad \text{Cross-multiply}$$

$$1 \times \text{X} = 4 \times 3$$

$$1\text{X} = 12$$

$\frac{1X}{1} = \frac{12}{1}$ Simplify: Divide both sides of the equation by the number before the unknown X

$X = 12$ cups Label the units to match the unknown X

You know the answer is in cups, because cups is the unknown equivalent. Therefore, 3 qt = 12 cups.

MATH TIP

Multiplying or dividing a number by 1 does not change its value. It is the same number.

Therefore in the previous example, it is not necessary to simplify, because 1X = X. You can shorten the calculation. Look again at the math.

$\frac{1\text{ qt}}{4\text{ cups}} \times \frac{3\text{ qt}}{X\text{ cups}}$ Cross-multiply

$X = 4 \times 3$

$X = 12$ cups

In the next example the unknown X is in the numerator. It does not matter, as long as the sequence is the same (numerator units match and denominator units match). Remember, a proportion must compare like things to like things. In the first example, the unknown was cups. In the second example the unknown is quarts.

EXAMPLE 2 ■

How many quarts are in 8 cups?

To solve this you also use the ratio-proportion rule.

- Recall the known equivalent (1 qt = 4 cups).
- Set up a proportion of two equivalent ratios.
- Cross-multiply to solve for X.

$\frac{1\text{ qt}}{4\text{ cups}} = \frac{X\text{ qt}}{8\text{ cups}}$

$\frac{1\text{ qt}}{4\text{ cups}} \times \frac{X\text{ qt}}{8\text{ cups}}$ Cross-multiply

$4X = 8$

$\frac{4X}{4} = \frac{8}{4}$ Simplify: Divide both sides of the equation by the number before the unknown X

$X = 2$ qt Label the units to match the unknown X

EXAMPLE 3 ■

How many inches are in 2 feet?

To convert 2 feet to the equivalent number of inches,

- Recall the known equivalent (1 ft = 12 in).
- Set up a proportion of two equivalent ratios.
- Cross-multiply to solve for X.

$\frac{1\text{ ft}}{12\text{ in}} = \frac{2\text{ ft}}{X\text{ in}}$

$\frac{1\text{ ft}}{12\text{ in}} \times \frac{2\text{ ft}}{X\text{ in}}$ Cross-multiply

$X = 2 \times 12$ Remember 1X = X

$X = 24\text{ in}$ Label the units to match the unknown X

EXAMPLE 4 ■

How many feet are in 36 inches? Notice again that the unknown is now in the numerator. Use ratio-proportion, and be sure to match up the units in the numerators and the denominators.

$\frac{1\text{ ft}}{12\text{ in}} = \frac{X\text{ ft}}{36\text{ in}}$

$\frac{1\text{ ft}}{12\text{ in}} \times \frac{X\text{ ft}}{36\text{ in}}$ Cross-multiply

$12X = 36$ Simplify: Divide both sides of the equation by the number before the unknown X

$\frac{12X}{12} = \frac{36}{12}$

$X = 3\text{ ft}$ Label the units to match the unknown X

QUICK REVIEW

Use ratio-proportion to convert from one unit of measurement to another.

- Recall the equivalents.
- Set up a proportion of two equivelent ratios. Be sure to label the units.
- Cross-multiply to solve for X. Label the units in the answer to match the unknown X.

Review Set 14

Use the following common household equivalents to answer these items. Express amounts that are less than 1 as common fractions.

1 gallon = 4 quarts 1 foot = 12 inches

1 quart = 2 pints = 4 cups 1 yard = 3 feet

1. True or False? The first step to convert between units of measurement is to recall the equivalents. __________
2. True or False? It is correct to match the units of the numerators and denominators in a proportion of 2 equivalent ratios. __________
3. 12 cups = __________ quarts
4. 36 inches = __________ feet
5. 14 quarts = __________ gallons
6. 32 cups = __________ pints
7. 6 feet = __________ inches
8. $\frac{1}{2}$ yard = __________ feet
9. 8 inches = __________ foot
10. $3\frac{1}{4}$ gallons = __________ cups
11. 3 inches = __________ foot
12. 10 yards = __________ feet
13. 10 feet = __________ yards
14. $3\frac{1}{2}$ quarts = __________ cups
15. 3 cups = __________ quart
16. 1 inch = __________ foot
17. 2 feet = __________ yard
18. 1 cup = __________ quart
19. $2\frac{1}{2}$ gallons = __________ cups
20. 126 inches = __________ yards

21. A fruit punch recipe requires 2 quarts of orange juice, $\frac{1}{2}$ gallon of soda water, and 4 cups of cranberry juice. How many 1 cup servings will this make? ________

22. If you have 16 pints, you have the equivalent of how many quarts? ________

23. Milk costs \$1.56 per $\frac{1}{2}$ gallon at Store A; at Store B, milk costs \$0.94 per quart. How much do you save by buying 1 gallon of milk at Store A? ________

Using the prices in question 23, calculate the cost of 1 cup of milk bought at Store A and at Store B.

24. Store A cost = ________ 25. Store B cost = ________

After completing these problems, see page 473-474 to check your answers.

CONVERTING WITHIN THE METRIC SYSTEM

As you recall, most metric conversions are simply derived by multiplying or dividing by 1,000. Recall from Chapter 1 that multiplying by 1,000 is the same as moving the decimal point three places to the right.

To convert 2 grams to the equivalent number of milligrams, use the ratio-proportion rule to solve for X.

$$\frac{1\text{ g}}{1{,}000\text{ mg}} = \frac{2\text{ g}}{\text{X mg}}$$

$$\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{2\text{ g}}{\text{X mg}}$$ Cross-multiply

$\text{X} = 1{,}000 \times 2$

$\text{X} = 2{,}000\text{ mg}$ Label the units to match the unknown X.

Thus, you know that a medicine container labeled 2 grams per tablet is the same as 2,000 milligrams per tablet.

MATH TIP

Notice that to multiply 2 by 1,000, you are moving the decimal three places to the right. This is a shortcut. Sometimes to complete this operaton, you add zeros to hold the places equal to the number of zeros in the equivalent. In this case 1 g = 1,000 mg, so you add three zeros: $2 \times 1{,}000 = 2.\underbrace{000.} = 2{,}000$

Let's look at more examples.

EXAMPLE 1 ■

Convert: 0.3 g to mg

Equivalent: 1 g = 1,000 mg

$$\frac{1\text{ g}}{1{,}000\text{ mg}} = \frac{0.3\text{ g}}{\text{X mg}}$$

$$\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{0.3\text{ g}}{\text{X mg}}$$ Cross-multiply

$\text{X} = 1{,}000 \times 0.3$ $0.\underbrace{300.}$ Move the decimal 3 places to the right. Add zeros to complete the operation.

$\text{X} = 300\text{ mg}$ Label the units to match the unknown X

EXAMPLE 2 ■

Convert: 2.5 g to mg

Equivalent: 1 g = 1,000 mg

$\frac{1\text{ g}}{1{,}000\text{ mg}} = \frac{2.5\text{ g}}{\text{X mg}}$

$\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{2.5\text{ g}}{\text{X mg}}$ Cross-multiply

X = 1,000 × 2.5 $2\underset{\curvearrowright}{.500}.$ Move the decimal 3 places to the right. Add zeros to complete the operation.

X = 2,500 mg Label the units to match the unknown X

EXAMPLE 3 ■

Convert: 0.15 kg to g

Equivalent: 1 kg = 1,000 g

$\frac{1\text{ kg}}{1{,}000\text{ g}} = \frac{0.15\text{ kg}}{\text{X g}}$

$\frac{1\text{ kg}}{1{,}000\text{ g}} \times \frac{0.15\text{ kg}}{\text{X g}}$ Cross-multiply

X = 1,000 × 0.15 $0\underset{\curvearrowright}{.150}.$ Move the decimal 3 places to the right. Add a zero to complete the operation.

X = 150 g Label the units to match the unknown X

EXAMPLE 4 ■

Convert: 0.004 L to mL

Equivalent: 1 L = 1,000 mL

$\frac{1\text{ L}}{1{,}000\text{ mL}} = \frac{0.004\text{ L}}{\text{X mL}}$

$\frac{1\text{ L}}{1{,}000\text{ mL}} \times \frac{0.004\text{ L}}{\text{X mL}}$ Cross-multiply

X = 1,000 × 0.004 $0\underset{\curvearrowright}{.004}.$ Move the decimal 3 places to the right. (There are already enough places, so you do not need to add a zero to complete the operation.)

X = 4 mL Label the units to match the unknown X

EXAMPLE 5 ■

An infant's head circumference is 40.5 cm. How many millimeters is that?

Convert: 40.5 cm to mm

Equivalent: 1 cm = 10 mm

Notice the ratio is now 1:10, not 1:1,000. In this example you are multiplying by 10 (not 1,000), so you will move the decimal point one place to the right.

$\frac{1\text{ cm}}{10\text{ mm}} = \frac{40.5\text{ cm}}{\text{X mm}}$

$\frac{1\text{ cm}}{10\text{ mm}} \times \frac{40.5\text{ cm}}{\text{X mm}}$ Cross-multiply

X = 10 × 40.5 $40\underset{\curvearrowright}{.5}.$ Move the decimal 1 place to the right.

X = 405 mm Label the units to match the unknown X

To convert a smaller unit to its equivalent larger unit, use the same ratio-proportion method. Now the unknown X is in the numerator, and you will usually divide by 1,000 or move the decimal three places to the left.

EXAMPLE 1 ■

Convert: 5,000 mL to L

Equivalent: 1 L = 1,000 mL

$$\frac{1\text{ L}}{1{,}000\text{ mL}} = \frac{\text{X L}}{5{,}000\text{ mL}}$$

$$\frac{1\text{ L}}{1{,}000\text{ mL}} \times \frac{\text{X L}}{5{,}000\text{ mL}}$$ Cross-multiply

$$1{,}000\text{X} = 5{,}000$$

$$\frac{1{,}000\text{X}}{1{,}000} = \frac{5{,}000}{1{,}000}$$ Simplify: Divide both sides of the equation by the number before the unknown X. The zeros cancel

$\text{X} = 5\text{ L}$ Label the units to match the unknown X

MATH TIP

Let's look at the shortcut for dividing 5,000 by 1,000. Now you are moving the decimal three places to the left, and then eliminating unnecessary zeros. $5{,}000 \div 1{,}000 = 5\underset{\curvearrowleft}{.000}. = 5$ (Sometimes to complete this operation you add zeros to hold the places equal to the number of zeros in the equivalent—as in the following examples 3 and 4.)

EXAMPLE 2 ■

Convert: 500 mL to L

Equivalent: 1 L = 1,000 mL

$$\frac{1\text{ L}}{1{,}000\text{ mL}} = \frac{\text{X L}}{500\text{ mL}}$$

$$\frac{1\text{ L}}{1{,}000\text{ mL}} \times \frac{\text{X L}}{500\text{ mL}}$$ Cross-multiply

$$1{,}000\text{X} = 500$$

$$\frac{1{,}000\text{X}}{1{,}000} = \frac{500}{1{,}000}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$\text{X} = 0.5$ $0\underset{\curvearrowleft}{.500}.$ Move the decimal 3 places to the left. Eliminate unnecessary zeros. As the amount is less than 1, use a leading zero for emphasis of the decimal point.

$\text{X} = 0.5\text{ L}$ Label the units to match the unknown X

EXAMPLE 3 ■

Convert: 50 mL to L

Equivalent: 1 L = 1,000 mL

$$\frac{1\text{ L}}{1{,}000\text{ mL}} = \frac{\text{X L}}{50\text{ mL}}$$

$$\frac{1\text{ L}}{1{,}000\text{ mL}} \times \frac{\text{X L}}{50\text{ mL}}$$ Cross-multiply

$$1{,}000\text{X} = 50$$

$$\frac{1{,}000\text{X}}{1{,}000} = \frac{50}{1{,}000}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$X = 0.05$ 0.050. Move the decimal 3 places to the left after adding a zero to complete the operation. Then eliminate unnecessary zero. Use a leading zero for emphasis.

$X = 0.05 \text{ L}$ Label the units to match the unknown X

EXAMPLE 4 ■

Convert: 5 mL to L

Equivalent: 1 L = 1,000 mL

$$\frac{1 \text{ L}}{1{,}000 \text{ mL}} = \frac{\text{X L}}{5 \text{ mL}}$$

$$\frac{1 \text{ L}}{1{,}000 \text{ mL}} \times \frac{\text{X L}}{5 \text{ mL}}$$ Cross-multiply

$$1{,}000\text{X} = 5$$

$$\frac{1{,}000\text{X}}{1{,}000} = \frac{5}{1{,}000}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$X = 0.005$ 0.005. Move the decimal 3 places to the left after adding zeros to complete the operation. Use a leading zero for emphasis.

$X = 0.005 \text{ L}$ Label the units to match the unknown X

EXAMPLE 5 ■

A patient's wound measures 31 millimeters. How many centimeters is that?

Convert: 31 mm to cm

Equivalent: 1 cm = 10 mm

Notice the ratio is now 1:10, not 1:1,000. In this example you are dividing by 10 (not 1,000), so you will move the decimal point one place to the left.

$$\frac{1 \text{ cm}}{10 \text{ mm}} = \frac{\text{X cm}}{31 \text{ mm}}$$

$$\frac{1 \text{ cm}}{10 \text{ mm}} \times \frac{\text{X cm}}{31 \text{ mm}}$$ Cross-multiply

$$10\text{X} = 31$$

$$\frac{10\text{X}}{10} = \frac{31}{10}$$

$X = 3.1$ 3.1. Move the decimal 1 place to the left.

$X = 3.1 \text{ cm}$ Label the units to match the unknown X

MATH TIP

Remember this diagram when converting dosages within the metric system.

Move decimal point three places to the left for each step.

$\longleftarrow$

kg g mg mcg

$\longrightarrow$

Move decimal point three places to the right for each step.

EXAMPLES ■

1 mcg = 0.001 mg (moved decimal point to the left 3 places)

2 g = 2,000 mg (moved decimal point to the right 3 places)

2 g = 2,000,000 mcg (moved decimal point to the right 6 places, as the conversion required two steps)

In time you will probably do these calculations in your head with little difficulty. If you feel you do not understand the concept of conversions within the metric system, review the decimal section in Chapter 1 and the metric section in Chapter 3 again. Get help from your instructor before proceeding further.

QUICK REVIEW

To use the ratio and proportion method to convert between units in the metric system:

1. Recall the metric equivalents.
2. Set up a proportion of two equivalent ratios.
3. Cross-multiply to solve for an unknown quantity, X.

MOVE the decimal point to the right to convert from a larger unit to a smaller unit.

Example: 3L = X mL
Equivalent: 1L = 1,000 mL

$$\frac{1\text{ L}}{1{,}000\text{ mL}} \times \frac{3\text{ L}}{X\text{ mL}}$$

X = 3,000 mL 3.000. Move the decimal 3 places to the right.

MOVE the decimal point to the left to convert from a smaller unit to a larger unit.
Example: 400 mg = X g
Equivalent: 1 g = 1,000 mg

$$\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{X\text{ g}}{400\text{ mg}}$$

1,000X = 400

$$\frac{1{,}000X}{1{,}000} = \frac{400}{1{,}000}$$

X = 0.4 g 0.400. Move the decimal 3 places to the left.

Review Set 15

Convert each of the following to the equivalent unit indicated.

1. 500 mL = ________ L
2. 0.015 g = ________ mg
3. 8 mg = ________ g
4. 10 mg = ________ g
5. 60 mg = ________ g
6. 300 mg = ________ g
7. 0.2 mg = ________ g
8. 1.2 g = ________ mg
9. 0.0025 kg = ________ g
10. 0.065 g = ________ mg
11. 0.005 L = ________ mL
12. 1.5 L = ________ mL
13. 2 mL = ________ L
14. 250 mL = ________ L
15. 2 kg = ________ g
16. 56.08 mL = ________ L
17. 5,000 mL = ________ L
18. 1 L = ________ mL
19. 1 g = ________ mg
20. 1 mL = ________ L

21. 23 mcg = __________ mg
22. 1.05 g = __________ kg
23. 18 mcg = __________ mg
24. 0.4 mg = __________ mcg
25. 25 g = __________ kg
26. 50 cm = __________ m
27. 10 L = __________ mL
28. 450 mL = __________ L
29. 5 mL = __________ L
30. 30 mg = __________ mcg

After completing these problems, see page 474 to check your answers.

Approximate Equivalents

Fortunately, the use of the apothecary and household systems is becoming less and less frequent. But until they are obsolete, the nurse must be familiar with conversions between the metric, apothecary, and household systems of measurement.

Approximate equivalents are used for conversions from one system to another. Exact equivalents are not practical and, therefore, rarely used by health care workers. For example, the exact equivalent of 1 gram as measured in grains is: 1 gram = 15.432 grains. This is rounded to give the approximate equivalent of 1 g = gr 15 (xv). The exact equivalent of one grain is 64.8 milligrams. This is rounded to give the approximate equivalent of gr i = 60 mg. This is the conversion most frequently used; however, there will be a few instances in calculations of some common oral medications (such as acetaminophen, aspirin, and iron) where gr i = 65 mg will be more convenient. This points out the true meaning of approximate equivalents.

Approximate equivalents that are used for dosage calculations are listed in the following Remember box. Learn the equivalents so that you can change from one system to another quickly and accurately. Commit the equivalents to memory. Review them often. When you learn these essential equivalents in addition to the other equivalents you learned in Chapter 3, you are on your way to mastering the skill of dosage calculations.

REMEMBER

Approximate Equivalents

1 g = gr xv
gr i = 60 mg or gr i = 65 mg (in select instances)
1 t = 5 mL
1 T = 3 t = 15 mL = oz $\frac{1}{2}$
oz i = 30 mL = 6 t
1 L = qt i = oz 32 = pt ii = 4 cups
pt i = 500 mL = oz 16 = 2 cups
1 cup = 250 mL = oz viii
1 kg = 2.2 lb
1 in = 2.5 cm

Look at the "Conversion Clock" (Figure 4-1) for an easy-to-remember method for converting between common metric and apothecary weight measures. It is based on the approximate equivalent of gr i = 60 mg, with 15 mg increments around the clock (similar to the 15 minute, 30 minute, 45 minute, and 60 minute increments equivalent to $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and 1 hour).

Figures 4-2 and 4-3 are visual aids that associate most of the base equivalents. You may find these diagrams easier to remember than the tables.

Look at the first triangle of weight equivalents (Figure 4-2). Beginning at the top of the triangle, use your finger to trace the arrow from g (gram) down to gr (grain). The arrow indicates that 1 g = gr xv.

FIGURE 4-1 Metric–Apothecary approximate equivalent "Conversion Clock"

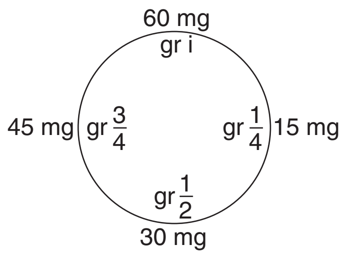


FIGURE 4-2 Weight equivalents

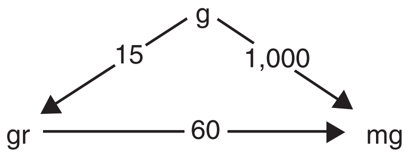
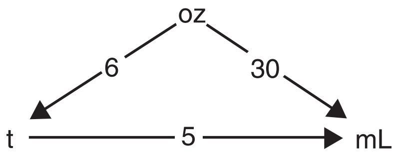


FIGURE 4-3 Volume equivalents



On the other side, trace down from g (gram) to mg (milligram). This arrow indicates that 1 g = 1,000 mg. Likewise, the bottom arrow goes from gr to mg to remind you that gr i = 60 mg. In summary, the triangle simply says:

1 g = gr xv, 1 g = 1,000 mg, and gr i = 60 mg

Look at the second triangle of volume equivalents (Figure 4-3). Beginning at the top of the triangle, use your finger to trace the arrow from oz (ounce) down to t (teaspoon). The arrow indicates that oz i = 6 t. On the other side, trace down from oz (ounce) to mL (milliliter). This arrow reminds you that oz i = 30 mL. Likewise, the bottom arrow goes from t (teaspoon) to mL (milliliter). This arrow reminds you that 1 t = 5 mL. In summary this triangle simply says:

oz i = 6 t, oz i = 30 mL, and 1 t = 5 mL

CONVERTING BETWEEN SYSTEMS OF MEASUREMENT

Now let's convert between systems of measurement using approximate equivalents.

EXAMPLE 1 ■

Convert 0.5 g to gr

Approximate equivalent: 1 g = gr xv = gr 15 (Let's use Arabic numbers for calculations.)

$$\frac{1 \text{ g}}{\text{gr } 15} \quad \times \quad \frac{0.5 \text{ g}}{\text{gr X}}$$

$X = 15 \times 0.5$

$X = \text{gr } 7.5$

$\text{gr } 7.5 = \text{gr vii } \frac{1}{2}$

CAUTION

As is customary, the capital letter X is consistently used in this text to denote the unknown quantity in an equation and proportion. It is important that you do not confuse the unknown X with the value of gr x, which designates 10 grains.

EXAMPLE 2 ■

Convert: oz ii to mL

Approximate equivalent: oz i = oz 1 = 30 mL

$$\frac{\text{oz } 1}{30 \text{ mL}} \times \frac{\text{oz } 2}{\text{X mL}}$$

X = 30 × 2

X = 60 mL

EXAMPLE 3 ■

Convert: gr $\frac{1}{300}$ to mg

Approximate equivalent: gr i = gr 1 = 60 mg

$$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{300}}{\text{X mg}}$$

$$X = \frac{60}{1} \times \frac{1}{300} = \frac{60}{300} = \frac{1}{5} = 0.2$$

X = 0.2 mg

The answer must be a decimal fraction, because the unit of measure is the metric system.

EXAMPLE 4 ■

A child weighs 40 kilograms. The mother wants to know her child's weight in pounds.

Convert 40 kg to lb

Approximate equivalent: 1 kg = 2.2 lb

$$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{40 \text{ kg}}{\text{X lb}}$$

X = 2.2 × 40

X = 88 lb

Use the same method to convert from a smaller to a larger unit of measure. Notice that the unknown is in the numerator. Remember to keep like units across from each other.

EXAMPLE 1 ■

Convert 120 mg to gr

Approximate equivalent: gr i = gr 1 = 60 mg

$$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr X}}{120 \text{ mg}}$$

$$60 \text{ X} = 120$$

$$\frac{60 \text{ X}}{60} = \frac{120}{60}$$

X = gr 2 = gr ii

EXAMPLE 2 ■

Convert 45 mL to t

Approximate equivalent: 1 t = 5 mL

$$\frac{1 \text{ t}}{5 \text{ mL}} \times \frac{\text{X t}}{45 \text{ mL}}$$

$$5X = 45$$

$$\frac{5X}{5} = \frac{45}{5}$$

X = 9 t

EXAMPLE 3 ■

Convert 66 lb to kg

Approximate equivalent: 1 kg = 2.2 lb

$$\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{66\text{ lb}}$$

$$2.2\text{ X} = 66$$

$$\frac{2.2\text{ X}}{2.2} = \frac{66}{2.2}$$

$$\text{X} = 30\text{ kg}$$

EXAMPLE 4 ■

Convert 40 cm to in (inches)

Approximate equivalent: 1 in = 2.5 cm

$$\frac{1\text{ in}}{2.5\text{ cm}} \times \frac{X\text{ in}}{40\text{ cm}}$$

$$2.5\text{ X} = 40$$

$$\frac{2.5\text{ X}}{2.5} = \frac{40}{2.5}$$

$$\text{X} = 16\text{ in}$$

Try this: Convert your weight in pounds to kilograms rounded to hundredths or two decimal places.

MATH TIP

A clue to remember the approximate equivalent 1 kg = 2.2 lb is to realize that there are about 2 pounds for every kilogram, so the number of kilograms you weigh is about half the number of pounds you weigh. (This could almost make getting on a metric scale pleasant.)

QUICK REVIEW

To use the ratio-proportion method to convert from one unit to another or between systems of measurement:

- Recall the equivalent.
- Set up a proportion: Ratio for known equivalent equals ratio for unknown equivalent.
- Label the units and match the units in the numerators and denominators.
- Cross-multiply to find the value of the unknown X equivalent.
- Label the units in the answer to match the unknown X.

Review Set 16

Convert each of the following amounts to the unit indicated. Indicate the approximate equivalent(s) used in the conversion.

		Approximate Equivalent			Approximate Equivalent
1. gr $\frac{1}{2}$ =	________ mg	________	3. 3 g =	________ kg	________
2. gr $\frac{3}{4}$ =	________ mg	________	4. gr $\frac{1}{150}$	________ mg	________

Approximate Equivalent

5. gr vii $\frac{1}{2}$ = ______ g ______

6. 15 mg = gr ______ ______

7. 13 t = ______ mL ______

8. 15 mL = oz ______ ______

9. oz ii $\frac{1}{2}$ = ______ mL ______

10. 750 mL = pt ______ ______

11. 20 mL = ______ t ______

12. 4 T = ______ mL ______

13. 9 kg = ______ lb ______

14. qt iv = pt ______ ______

15. 3 L = oz ______ ______

16. 55 kg = ______ lb ______

17. 12 in = ______ cm ______

18. qt ii = ______ L ______

19. 3 t = ______ mL ______

20. 99 lb = ______ kg ______

21. gr v = ______ mg ______

22. 0.6 mg = gr ______ ______

Approximate Equivalent

23. pt i = ______ mL ______

24. gr x = ______ mg ______

25. 300 mg = gr ______ ______

26. 30 cm = ______ in ______

27. 90 mg = gr ______ ______

28. 60 mL = oz ______ ______

29. gr $\frac{1}{6}$= ______ mg ______

30. 65 mg = gr ______ ______

31. 32 in = ______ cm ______

32. 350 mm = ______ in ______

33. 7.5 cm = ______ in ______

34. 2 in = ______ mm ______

35. 40 kg = ______ lb ______

36. 7.16 kg = ______ g ______

37. 110 lb = ______ kg ______

38. 3.5 kg = ______ lb ______

39. 63 lb = ______ kg ______

40. A newborn infant is $21\frac{1}{2}$ inches long. Her length is ______ cm.

41. The label for a granular medicine recommends mixing it with at least 120 mL of water or juice. At the time of discharge, the nurse should advise the patient to mix the medicine with ______ ounce(s) or ______ cup(s) of water or juice.

42. A patient starts an exercise program and walks 0.75 kilometer on the first day. Each day he increases his distance by 500 meters. How many total kilometers does he walk in 7 days? ______ kilometers

43. Calculate the total fluid intake in mL for 24 hours.

Breakfast	8 ounces milk
	6 ounces orange juice
	4 ounces water with medication
Lunch	8 ounces iced tea
Snack	10 ounces coffee
	4 ounces gelatin dessert
Dinner	8 ounces water
	6 ounces tomato juice
	6 ounces beef broth
Snack	5 ounces pudding
	12 ounces diet soda
	4 ounces water with medication

Total = ______ mL

44. A child who weighs 55 lb is to receive 0.05 mg of a drug per kg of body weight per dose. How much of the drug should the child receive for each dose? __________ mg

45. A child is taking 12 mL of a medication 4 times per day. If the full bottle contains 16 ounces of the medication, how many days will the bottle last? __________ day(s)

46. The doctor prescribes 10 mL of Betadine concentrate in 500 mL of warm water as a soak for a finger infection. Using measures commonly found in the home, how would you instruct the patient to prepare the solution? ____

47. The patient is to receive 10 mL of a drug. How many teaspoonsful should the patient take? __________ t

48. An infant is taking a ready-to-feed formula. The formula comes in quart containers. If the infant usually takes 4 ounces of formula every 3 hours during the day and night, how many quarts of formula should the mother buy for a 3 day supply? __________ qt

49. An infant's head circumference is 40 cm. The parents ask for the equivalent in inches. You tell the parents their infant's head circumference is __________ in.

50. The patient tells you he was weighed in the doctor's office and was told he is 206 pounds. What is his weight in kilograms? __________ kg

After completing these problems, see pages 475–476 to check your answers.

CRITICAL THINKING SKILLS

ERROR

Incorrectly interpreting grains as milligrams.

Possible Scenario

A physician ordered a single dose of *15 grains of aspirin* for a patient complaining of a severe headache. Aspirin was available in *500 mg aspirin tablets.* While preparing the medication, the nurse was distracted by a visitor who fell by the nurses' station. The nurse returned to read the order as *1.5 grams* and calculated the dose this way:

If: 1 g = 1,000 mg and 0.5 g = 0.5 × 1,000 = 500 mg
then: 1.5 g = 1,000 mg + 500 mg = 1,500 mg, so the patient was given 3 tablets.

You know that 15 grains is equivalent to 1 g or 1,000 mg. By misreading the dose, the nurse gave 500 mg more than ordered, overdosing the patient.

Potential Outcome

The patient received $1\frac{1}{2}$ times, or 150%, of the dosage ordered. This larger dose, 1,500 mg, could cause nausea, heartburn, and gastrointestinal upset. In aspirin-sensitive patients it could result in gastrointestinal bleeding.

Prevention

This type of medication error is avoided by carefully checking the drug order at least three times: before preparing a medication, once the dose is prepared, and prior to giving the patient the medication. Also, the nurse should recognize that the ordered dose is in apothecary measurement, while the supply dosage is in metric measurement, and carefully convert between systems.

SUMMARY

At this point, you should be quite familiar with the equivalents for converting within the metric, apothecary, and household systems, and from one system to another. From memory, you should be able to recall quickly and accurately the equivalents for conversions. If you are having difficulty understanding the concept of converting from one unit of measurement to another, review this chapter and seek additional help from your instructor.

Work the practice problems for Chapter 4. Concentrate on accuracy. One error can be a serious mistake when calculating the dosages of medicines or performing critical measurements of health status.

PRACTICE PROBLEMS—CHAPTER 4

Give the following equivalents without consulting conversion tables.

1. 0.5 g = ________ mg
2. 0.01 g = ________ mg
3. 7.5 mL = ________ L
4. qt iii = ________ L
5. 4 mg = ________ g
6. 500 mL = ________ L
7. 250 mL = pt ________
8. 300 g = ________ kg
9. 28 in = ________ cm
10. 68 kg = ________ lb
11. gr iii = ________ mg
12. oz iii $\frac{1}{2}$ = ________ mL
13. gr $\frac{1}{200}$ = ________ mg
14. gr $\frac{1}{4}$ = ________ mg
15. gr $\frac{1}{10}$ = ________ mg
16. gr i $\frac{1}{2}$ = ________ mg
17. $70\frac{1}{2}$ lb = ________ kg
18. 3,634 g = ________ lb
19. 8 mL = ________ L
20. gr xxx = ________ g
21. 237.5 cm = ________ in
22. 0.5 g = gr ________
23. 0.6 mg = gr ________
24. gr x = ________ g
25. 150 lb = ________ kg
26. 60 mg = gr ________
27. gr xv = ________ g
28. 2 cups = ________ mL
29. 6 t = ________ T
30. 90 mL = oz ________
31. 1 ft = ________ cm
32. 2 T = ________ mL
33. 2.2 lb = ________ kg
34. 5 mL = ________ t
35. 1,000 mL = ________ L
36. 1.5 g = ________ mg
37. oz i $\frac{1}{2}$ = ________ mL
38. 1,500 mL = qt ________
39. 10 mg = gr ________
40. 25 mg = ________ g
41. 4.3 kg = ________ g
42. 60 mg = ________ g
43. 0.015 g = ________ mg
44. 45 mL = ________ T
45. gr 12 = ________ g

46. As a camp nurse for 9- to 12-year-old children, you are administering $2\frac{1}{2}$ teaspoons of oral liquid Children's Tylenol to 6 feverish campers every 4 hours for oral temperatures above 100ºF. You have on hand a 4-ounce bottle of liquid Children's Tylenol. How many complete or full doses are available from this bottle? __________ full doses

47. At this same camp, the standard dosage of Pepto-Bismol for 9- to 12-year-olds is 1 tablespoon. How many full doses are available in a 120 mL bottle? __________ full doses

48. Calculate the total fluid intake in mL of this clear liquid lunch:

apple juice	4 ounces
chicken broth	8 ounces
gelatin dessert	6 ounces
hot tea	10 ounces
TOTAL =	__________ mL

49. An ampule contains 10 mg of morphine. The doctor orders **morphine gr $\frac{1}{6}$ intramuscularly every 4 hours as needed for pain**. What percentage of the solution in the ampule should the patient receive? __________

50. Describe the strategy you would implement to prevent this medication error.

Possible Scenario

An attending physician ordered **Claforan 2 g intravenously immediately** for a patient with a leg abscess. The supply dosage available is *1,000 mg per 10 mL*. The nurse was in a rush to give the medication and calculated the dose this way:

If: $1 \text{ g} = 1{,}000 \text{ mg}$

then: $2 \text{ g} = 1{,}000 \div 2 = 500 \text{ mg per } 5 \text{ mL}$

Then the nurse administered 5 mL of the available Claforan.

Potential Outcome

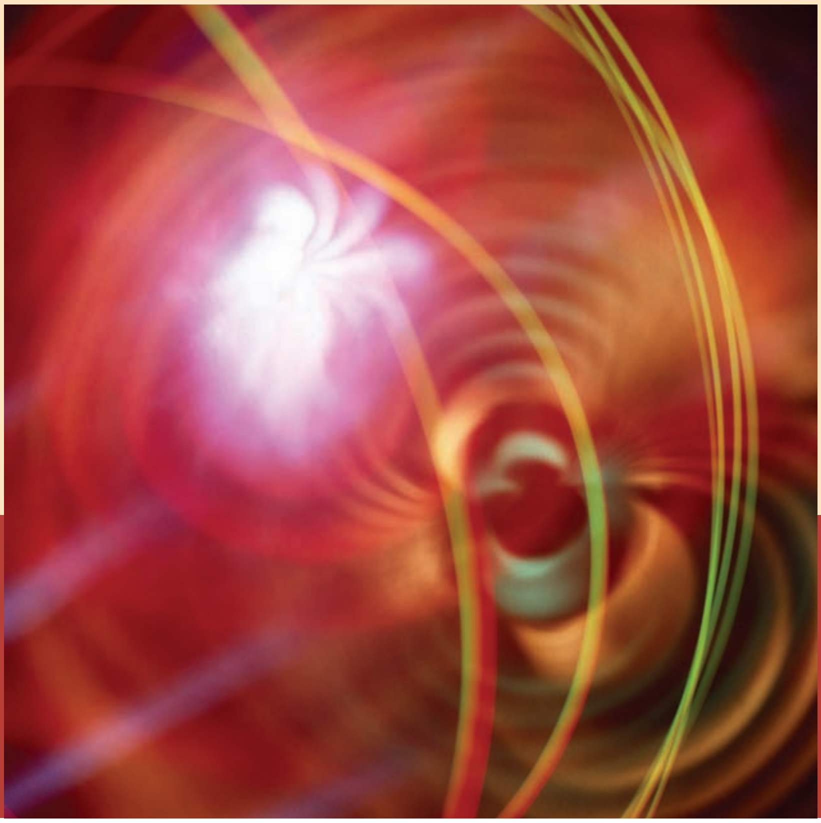
The patient received only $\frac{1}{4}$ or 25% of the dosage ordered. The patient should have received 2,000 mg or 20 mL of Claforan. The leg abscess could progress to osteomyelitis (a severe bone infection) because of underdosage.

Prevention

____

____

After completing these problems, see pages 476–477 to check your answers.



5

Conversions for Other Clinical Applications: Time and Temperature

OBJECTIVES

Upon mastery of Chapter 5, you will be able to:

- Convert between traditional and international time.
- Convert between Celsius and Fahrenheit temperature.

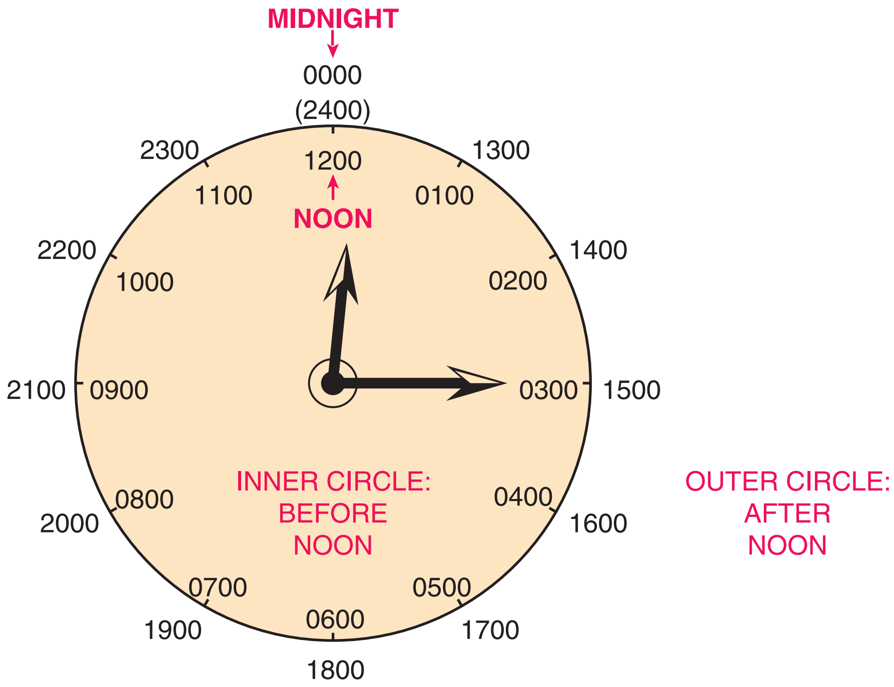
This chapter focuses on two other conversions applied in health care. *Time* is an essential part of the drug order. *Temperature* is an important measurement of health status.

CONVERTING BETWEEN TRADITIONAL AND INTERNATIONAL TIME

It is becoming increasingly popular in health care settings to keep time with a more straight-forward system using the 24-hour clock. In use around the world and in the U.S. military for many years, this system is known as *international time* or *military time.*

Look at the 24-hour clock (Figure 5-1). Each time designation is comprised of a unique four-digit number. Notice there is an inner and outer circle of numbers that identify the hours from 0100 to 2400. The inside numbers correlate to traditional AM time (midnight to 11:59 AM); time periods

FIGURE 5-1 24-hour clock depicting 0015 (12:15 AM) and 1215 (12:15 PM)



that are ante meridian or before noon. The outside numbers correlate to traditional PM time (noon to 11:59 PM); time periods that are post meridian or after noon.

Hours on the 24-hour clock after 0059 minutes (zero-zero fifty-nine) are stated in hundreds. The word *zero* precedes single-digit hours.

EXAMPLE 1 ■
0400 is stated as *zero four hundred*.

EXAMPLE 2 ■
1600 is stated as *sixteen hundred*.

Between each hour, the time is read simply as the hour and the number of minutes, preceded by zero as needed.

EXAMPLE 1 ■
0421 is stated as *zero four twenty-one*.

EXAMPLE 2 ■
1659 is stated as *sixteen fifty-nine*.

The minutes between 2400 (midnight) and 0100 (1:00 AM) are written as 0001, 0002, 0003 . . . 0058, 0059. Each zero is stated before stating the number of minutes.

EXAMPLE 1 ■
0009 is stated as *zero-zero-zero nine*.

EXAMPLE 2 ■
0014 is stated as *zero-zero fourteen*.

Midnight can be written two different ways in international time:

- 2400 and read as *twenty-four hundred*, or
- 0000 (used by the military) and read as *zero hundred*.

Use of the 24-hour clock decreases the possibility for error in administering medications and documenting time, because no two times are expressed by the same number. There is less chance for misinterpreting time using the 24-hour clock.

EXAMPLE 1 ■
13 minutes after 1 AM is written *0113*.

EXAMPLE 2 ■
13 minutes after 1 pm is written *1313*.

FIGURE 5-2 Comparison of traditional and international time

AM	Int'l. Time	PM	Int'l. Time
12:00 midnight	2400	12:00 noon	1200
1:00	0100	1:00	1300
2:00	0200	2:00	1400
3:00	0300	3:00	1500
4:00	0400	4:00	1600
5:00	0500	5:00	1700
6:00	0600	6:00	1800
7:00	0700	7:00	1900
8:00	0800	8:00	2000
9:00	0900	9:00	2100
10:00	1000	10:00	2200
11:00	1100	11:00	2300

The same cannot be said for traditional time. The AM or PM notations are the only things that differentiate traditional times.

EXAMPLE 1 ■

13 minutes after 1 AM is written *1:13 AM*

EXAMPLE 2 ■

13 minutes after 1 PM is written *1:13 PM*

Careless notation in a medical order or in patient records can create misinterpretation about when a therapy is due or actually occurred. Figure 5-2 shows the comparison of traditional and international time. Notice that international time is less ambiguous.

RULES

1. Traditional time and international time are the same hours starting with 1:00 AM (0100) through 12:59 PM (1259).
2. Minutes after 12:00 AM (midnight) and before 1:00 AM are 0001 through 0059 in international time.
3. Hours starting with 1:00 PM through 12:00 AM (midnight) are 12:00 hours greater in international time (1300 through 2400).
4. International time is designated by a unique four-digit number.
5. The hour(s) and minute(s) are separated by a colon in traditional time, but no colon is used in international time.

MATH TIP

Between the hours of 1:00 PM (1300) and 12:00 AM (2400), add 1200 to traditional time to find equivalent international time; subtract 1200 from international time to convert to equivalent traditional time.

Let's apply these rules to convert between the two time systems.

EXAMPLE 1 ■

3:00 PM = 3:00 + 12:00 = 1500

EXAMPLE 2 ■

2212 = 2212 − 1200 = 10:12 PM

EXAMPLE 3 ■

12:45 AM = 0045

EXAMPLE 4 ■

0004 = 12:04 AM

EXAMPLE 5 ■

0130 = 1:30 AM

EXAMPLE 6 ■

11:00 AM = 1100

QUICK REVIEW

- International time is designated by 0001 through 1259 for 12:01 AM through 12:59 PM, and 1300 through 2400 for 1:00 PM through 12:00 midnight.
- The hours from 1:00 PM through 12:00 midnight are 12:00 hours greater in international time (1300 through 2400).

Review Set 17

Convert international time to traditional AM/PM time.

1. 0032 = ________
2. 0730 = ________
3. 1640 = ________
4. 2121 = ________
5. 2359 = ________
6. 1215 = ________
7. 0220 = ________
8. 1010 = ________
9. 1315 = ________
10. 1825 = ________

Convert traditional to international time.

11. 1:30 PM = ________
12. 12:04 AM = ________
13. 9:45 PM = ________
14. 12:00 noon = ________
15. 11:15 PM = ________
16. 3:45 AM = ________
17. 12:00 midnight = ________
18. 3:30 PM = ________
19. 6:20 AM = ________
20. 5:45 PM = ________

Fill in the blanks by writing out the words as indicated.

21. 24-hour time 0623 is stated ____.
22. 24-hour time 0041 is stated ____.
23. 24-hour time 1903 is stated ____.
24. 24-hour time 2311 is stated ____.
25. 24-hour time 0300 is stated ____.

After completing these problems, see page 477 to check your answers.

CONVERTING BETWEEN CELSIUS AND FAHRENHEIT TEMPERATURE

Another important conversion in health care involves Celsius and Fahrenheit temperatures. Simple formulas are used for converting between the two temperature scales. It is easier to remember the formulas when you understand how they were developed.

The Fahrenheit (F) scale establishes the freezing point of pure water at 32° and the boiling point of pure water at 212°. The Celsius (C) scale establishes the freezing point of pure water at 0º and the boiling point of pure water at 100°.

Look at Figure 5-3. Note that there is 180° difference between the boiling and freezing points on the Fahrenheit thermometer, and 100° between the boiling and freezing points on the Celsius ther-

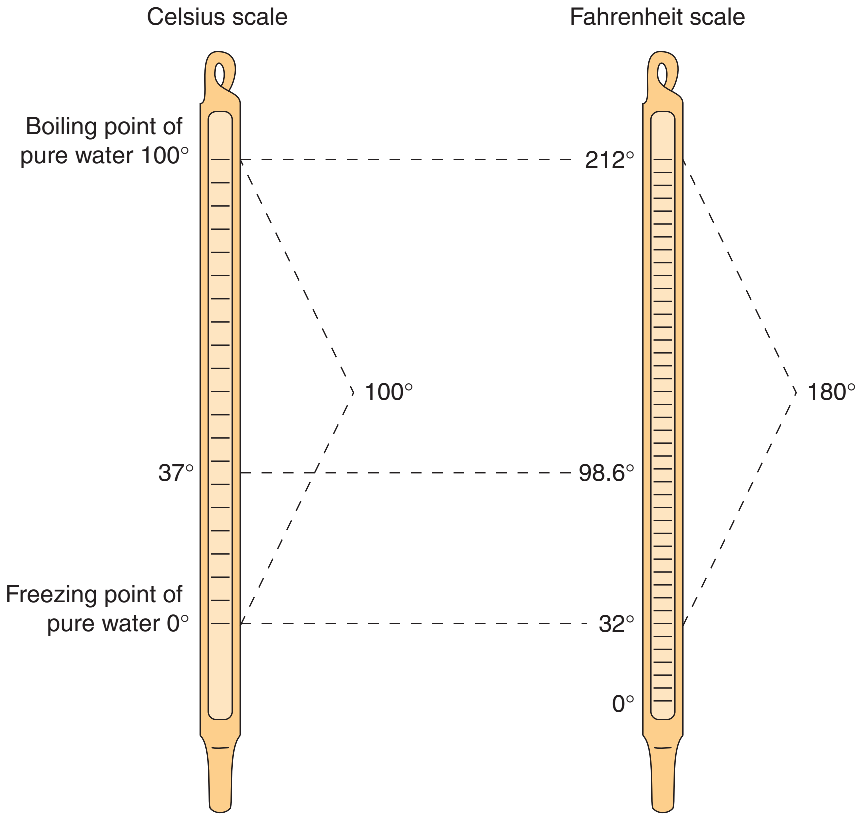


FIGURE 5-3 Comparison of Celsius and Fahrenheit temperature scales

NOTE: Glass thermometers pictured in Figure 5-3 are for demonstration purposes. Electronic digital temperature devices are more commonly used in health care settings. Most electronic devices can instantly convert between the two scales, freeing the health care provider from doing the actual calculations. However, the health care provider's ability to understand the difference between Celsius and Fahrenheit remains important.

mometer. The ratio of the difference between the Fahrenheit and Celsius scales can be expressed as 180:100 or $\frac{180}{100}$. When reduced, this ratio is equivalent to 1:8. You will use this constant in temperature conversions.

To convert between Fahrenheit and Celsius temperature, formulas have been developed based on the differences between the freezing and boiling points on each scale.

RULE

To convert a given Fahrenheit temperature to Celsius, first subtract 32 and then divide the result by 1.8.

$$°C = \frac{°F - 32}{1.8}$$

EXAMPLE ■

Convert 98.6°F to °C

$$°C = \frac{98.6 - 32}{1.8}$$

$$°C = \frac{66.6}{1.8}$$

$$°C = 37°$$

RULE

To convert Celsius temperature to Fahrenheit, multiply by 1.8 and add 32.

$°F = 1.8°C + 32$

EXAMPLE ■

Convert 35°C to °F

$°F = 1.8 \times 35 + 32$

$°F = 63 + 32$

$°F = 95°$

QUICK REVIEW

Use these formulas to convert between Fahrenheit and Celsius temperatures:

- $°C = \frac{°F - 32}{1.8}$
- $°F = 1.8°C + 32$

Review Set 18

Convert these temperatures as indicated. Round your answers to tenths.

1. 0°F = __________ °C
2. 85°C = __________ °F
3. 100°C = __________ °F
4. 32°C = __________ °F
5. 72°F = __________ °C
6. 99°F = __________ °C
7. 103.6°F = __________ °C
8. 40°C = __________ °F
9. 80°C = __________ °F
10. 36.4°C = __________ °F
11. 100°F = __________ °C
12. 19°C = __________ °F
13. 4°C = __________ °F
14. 94.2°F = __________ °C
15. 102.8°F = __________ °C

For each of the following statements, convert the given temperature in °F or °C to its corresponding equivalent in °C or °F.

16. An infant has a body temperature of 95.5°F. __________ °C
17. Store the vaccine serum at 7°C. __________ °F
18. Do not expose medication to temperatures greater than 88°F. __________ °C
19. Normal body temperature is 37°C. __________ °F
20. If Mr. Rose's temperature is greater than 103.5°F, call MD. __________ °C

After completing these problems, see page 477 to check your answers.

CRITICAL THINKING SKILLS

ERROR

Incorrect interpretation of order because of a misunderstanding of traditional time.

Possible Scenario

A physician ordered a mild sedative for an anxious patient who is scheduled for a sigmoidoscopy in the morning. The order read *Valium 5 mg orally at 6:00 × 1 dose*. The evening nurse interpreted that single-dose order to be scheduled for 6 o'clock PM along with the enema and other preparations to be given to the patient. The doctor meant for the Valium to be given at 6 o'clock AM to help the patient relax prior to the actual test.

Potential Outcome

Valium would help the patient relax during the enema and make the patient sleepy. But it is not desirable for the patient to be drowsy or sedated during the evening preparations. Because of the omission of the AM designation, the patient would not benefit from this mild sedative at the intended time, just before the test. The patient would have likely experienced unnecessary anxiety both before and during the test.

Prevention

This scenario emphasizes the benefit of the 24-hour clock. If international time had been in use at this facility, the order would have been written as *Valium 5 mg orally at 0600 × 1 dose* clearly indicating the exact time of administration. Be careful to verify AM and PM times if your facility uses traditional time.

PRACTICE PROBLEMS—CHAPTER 5

Give the following time equivalents as indicated.

AM/PM Clock	24-Hour Clock	AM/PM Clock	24-Hour Clock
1. __________	0257	11. 7:31 PM	__________
2. 3:10 AM	__________	12. 12:00 midnight	__________
3. 4:22 PM	__________	13. 6:45 AM	__________
4. __________	2001	14. __________	0915
5. __________	1102	15. __________	2107
6. 12:33 AM	__________	16. __________	1823
7. 2:16 AM	__________	17. __________	0540
8. __________	1642	18. 11:55 AM	__________
9. __________	2356	19. 10:12 PM	__________
10. 4:20 AM	__________	20. 9:06 PM	__________

Find the length of each time interval for questions 21 through 30.

21. 0200 to 0600	__________	23. 1500 to 2330	__________
22. 1100 to 1800	__________	24. 0935 to 2150	__________

25. 0003 to 1453 __________

26. 2316 to 0328 __________

27. 8:22 AM to 1:10 PM __________

28. 4:35 PM to 8:16 PM __________

29. 1:00 AM to 7:30 AM __________

30. 10:05 AM Friday to 2:43 AM Saturday __________

31. The 24-hour clock is imprecise and not suited to health care. (True) (False)

32. Indicate whether these international times would be AM or PM when converted to traditional time.

    a. 1030 __________

    b. 1920 __________

    c. 0158 __________

    d. 1230 __________

Give the following temperature equivalents as indicated.

33. 99.6°F __________ °C

34. 36.5°C __________ °F

35. 39.2°C __________ °F

36. 100.2°F __________ °C

37. 98°F __________ °C

38. 37.4°C __________ °F

39. 0°C __________ °F

40. 104°F __________ °C

41. 97.8°F __________ °C

42. 35.4°C __________ °F

43. 103.5°F __________ °C

44. 25°C __________ °F

45. 100°C __________ °F

46. 42°F __________ °C

47. 18°F __________ °C

48. Four temperature readings in °C for Mrs. Baskin are 37.6, 35.5, 38.1, and 37.6. Find her average (or mean) °C temperature and convert it to °F. __________ °C __________ °F

49. The freezing and boiling points of pure water on the Fahrenheit and Celsius temperature scales were used to develop the conversion formulas. (True) (False)

50. Describe the strategy you would implement to prevent this conversion error.

Possible Scenario

A nurse takes a child's temperature and finds that it is 38.2°C. The child's mother asks what that equates to in Fahrenheit temperature. The nurse does a quick calculation in her head and multiplies 38° by 2 and adds 32, as she recalls the conversion constant is 1.8 and 2 is close enough. The nurse tells the mother, "Well, about 108°." The mother replies, "I hope not," and smiles.

Potential Outcome

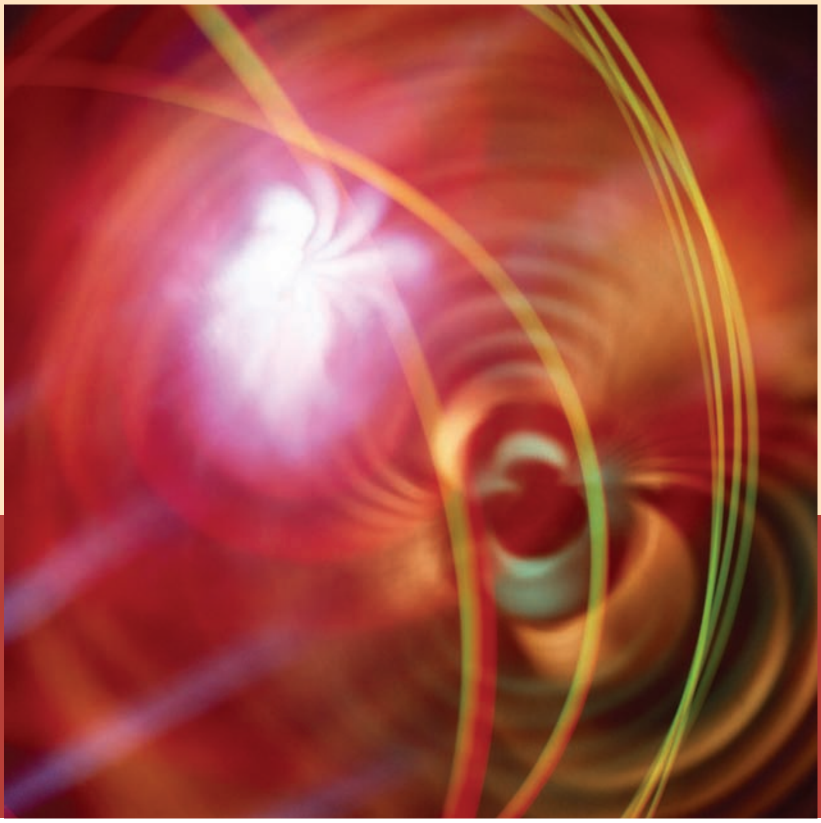
The nurse immediately recognizes that she made an error and feels embarrassed. The mother could have become alarmed and experienced undue anxiety and a loss of confidence in the nurse. The correct temperature measurement is 100.8°F. Fever-reducing medical orders often vary the dosage depending on the severity of the elevated temperature. An incorrect conversion could result in over- or under-medication of the child.

Prevention

____

____

After completing these problems, see page 478 to check your answers.



6

Equipment Used in Dosage Measurement

OBJECTIVES

Upon mastery of Chapter 6, you will be able to correctly measure the prescribed dosages that you calculate. To accomplish this, you will also be able to:

- Recognize and select the appropriate equipment for the medication, dosage, and method of administration ordered.
- Read and interpret the calibrations of each utensil presented.

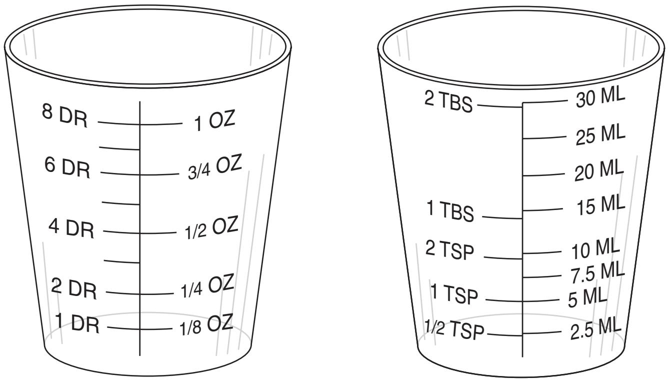
Now that you are familiar with the systems of measurement used in the calculation of dosages, let's take a look at the common measuring utensils. In this chapter you will learn to recognize and read the calibrations of devices used in both oral and parenteral (other than gastrointestinal) administration. The oral utensils include the medicine cup, pediatric oral devices, and calibrated droppers. The parenteral devices include the 3 mL syringe, prefilled syringe, a variety of insulin syringes, 1 mL syringe, and special safety and intravenous syringes.

ORAL ADMINISTRATION

Medicine Cup

Figure 6-1 shows the 30 milliliter or 1-ounce medicine cup that is used to measure most liquids for oral administration. Two views are presented to show all of the scales. Notice that the approximate equivalents of the metric, apothecary, and household systems of measurement are indicated on the cup. The

FIGURE 6-1 Medicine cup with approximate equivalent measures



medicine cup can serve as a great study aid to help you learn the volume equivalents of the three systems of measurement. Look at the calibrations for milliliters, teaspoons, tablespoons, ounces, and drams. You can see that 30 milliliters equal 1 ounce, 5 milliliters equal 1 teaspoon, and so forth. For volumes less than 2.5 mL, a smaller, more accurate device should be used (see Figures 6-2, 6-3, and 6-4).

Calibrated Dropper

Figure 6-2 shows the calibrated dropper, which is used to administer some small quantities. A dropper is used when giving medicine to children, the elderly, and when adding small amounts of liquid to water or juice. Eye and ear medications are also dispensed from a medicine dropper or squeeze drop bottle.

The amount of the drop varies according to the diameter of the hole at the tip of the dropper. For this reason, a properly calibrated dropper usually accompanies the medicine (Figure 6-3). It is calibrated according to the way that drug is prescribed. The calibrations are usually given in milliliters, cubic centimeters, or drops.

FIGURE 6-2 Calibrated dropper

FIGURE 6-3 Furosemide Oral Solution label (Used with permission of Roxane Laboratories, Inc.)

PHARMACIST/
NURSE/PATIENT:
Please note diagram to the right. ←
Fill the dropper to the level of the prescribed dose.
Discard opened bottle after 90 days.
PROTECT FROM LIGHT.

Furosemide
Oral Solution
10 mg per mL

NDC 0054-3294-46
60 mL

FUROSEMIDE
Oral Solution

10 mg per mL

Each mL contains:
Furosemide 10 mg
SUGAR FREE
℞ only

See Package Insert For Complete Prescribing Information.
PROTECT FROM LIGHT

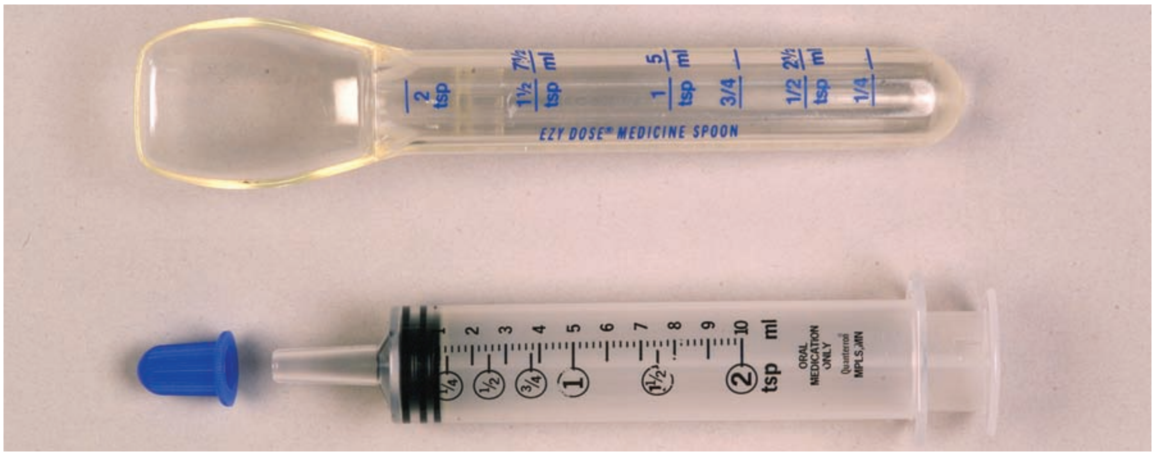
Roxane
Laboratories, Inc.
Columbus, Ohio 43216

4117540//02
© RLI, 2001

Dispense only in this bottle and only with the calibrated dropper provided. Store at Controlled Room Temperature 15°-30°C (59°-86°F).

EXP. LOT

FIGURE 6-4 Devices for administering oral medications to children



CAUTION

To be safe, never exchange packaged droppers between medications, because drop size varies from one dropper to another.

Pediatric Oral Devices

Various types of calibrated equipment are available to administer oral medications to children. Two devices intended only for oral use are shown in Figure 6-4. Parents and child caregivers should be taught to always use calibrated devices when administering medications to children. Household spoons vary in size and are not reliable for accurate dosing.

CAUTION

To be safe, do not use syringes intended for injections in the administration of oral medications. Confusion about the route of administration may occur.

You can distinguish oral from parenteral syringes in two ways. Syringes intended for oral use typically do not have a luerlock hub. They also usually have a cap on the tip that must be removed before administering the medication. Syringes intended for parenteral use have a luerlock hub that allows a needle to be secured tightly (see Figure 6-6).

PARENTERAL ADMINISTRATION

The term *parenteral* is used to designate routes of administration other than gastrointestinal. However, in this text, parenteral always means injection routes.

3 mL Syringe

Figure 6-5 shows a 3 mL syringe assembled with needle unit. The parts of the syringe are identified in Figure 6-6. Notice that the black rubber tip of the suction plunger is visible. The nurse pulls back on the plunger to withdraw the medicine from the storage container. The calibrations are read from the top black ring, NOT the raised middle section and NOT the bottom ring. Look closely at the metric scale in

FIGURE 6-5 3 mL syringe with needle unit measuring 1.5 mL

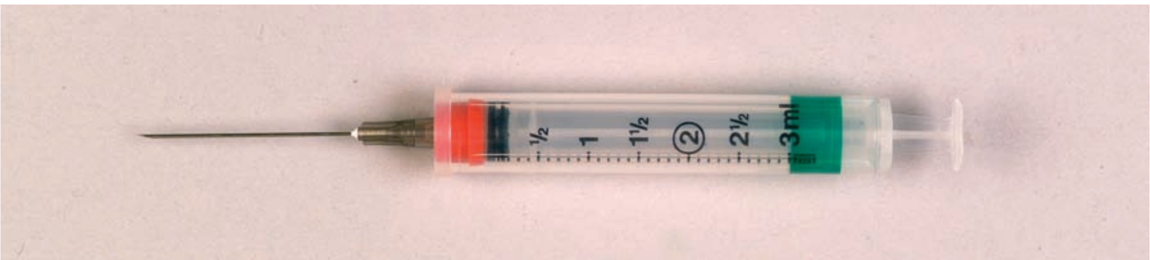


FIGURE 6-6 3 mL syringe with needle unit measuring 2 mL

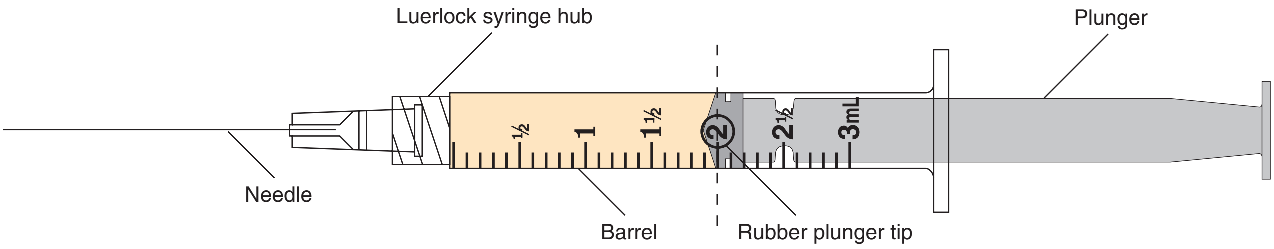


Figure 6-5, which is calibrated in milliliters (mL) for each tenth (0.1) of a milliliter. Each $\frac{1}{2}$ (or 0.5) milliliter is marked up to the maximum volume of 3 milliliters.

Standardized to the syringe calibrations, standard drug dosages of 1 mL or greater can be rounded to the nearest tenth (0.1) of a mL and measured on the mL scale. Refer to Chapter 1 to review the rules of decimal rounding. For example, 1.45 mL is rounded to 1.5 mL. Notice that the colored liquid in Figure 6-5 identifies 1.5 mL.

Prefilled, Single-Dose Syringe

Figure 6-7 is an example of a prefilled, single-dose syringe. Such syringes contain the usual single dose of a medication and are to be used only once. The syringe is discarded after the single use.

If you are to give less than the full single dose of a drug provided in a prefilled, single-dose syringe, you should discard the extra amount before injecting the patient.

EXAMPLE ■

The drug order prescribes 7.5 mg of Valium to be administered to a patient. You have a prefilled, single-dose syringe of Valium containing 10 mg per 2 mL of solution (as in Figure 6-7). You would discard 2.5 mg (0.5 mL) of the drug solution; then 7.5 mg would remain in the syringe. You will learn more about calculating drug dosages beginning in Chapter 10.

FIGURE 6-7 Prefilled, single-dose syringe (Courtesy of Roche Laboratories, Inc.)

Insulin Syringe

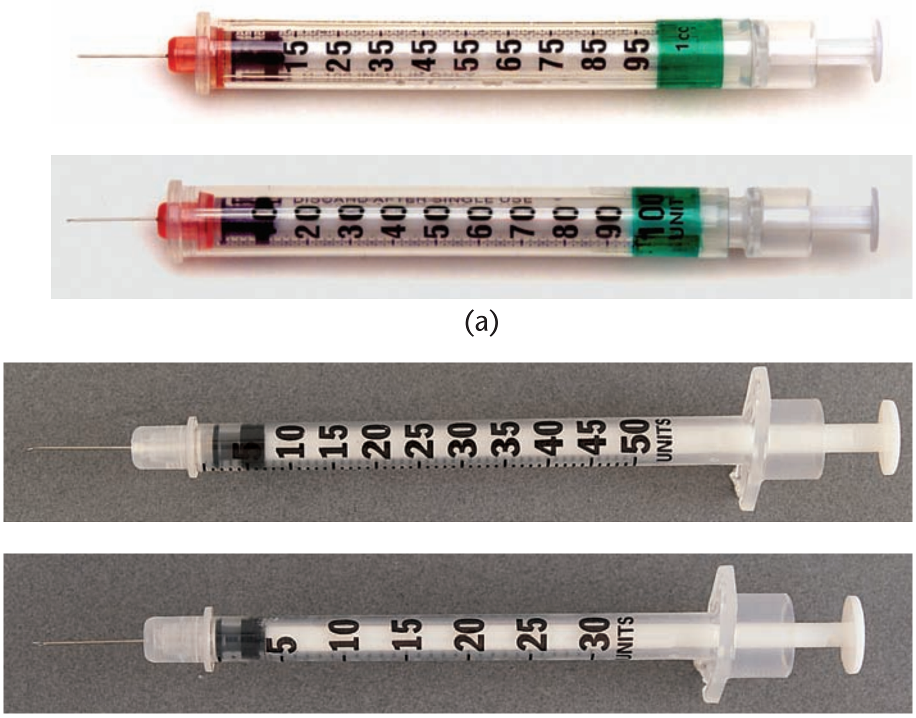
Figure 6-8(a) shows both sides of a standard U-100 insulin syringe. This syringe is to be used for the measurement and administration of U-100 insulin *only*. It must not be used to measure other medications that are measured in units.

CAUTION

U-100 insulin should be measured only in a U-100 insulin syringe.

Notice that Figure 6-8(a) pictures one side of the insulin syringe calibrated in odd-number two-unit increments and the other side calibrated in even-number two-unit increments. The plunger in Figure 6-9(a) simulates the measurement of 70 units of U-100 insulin. It is important to note that for U-100 insulin, 100 units equal 1 mL.

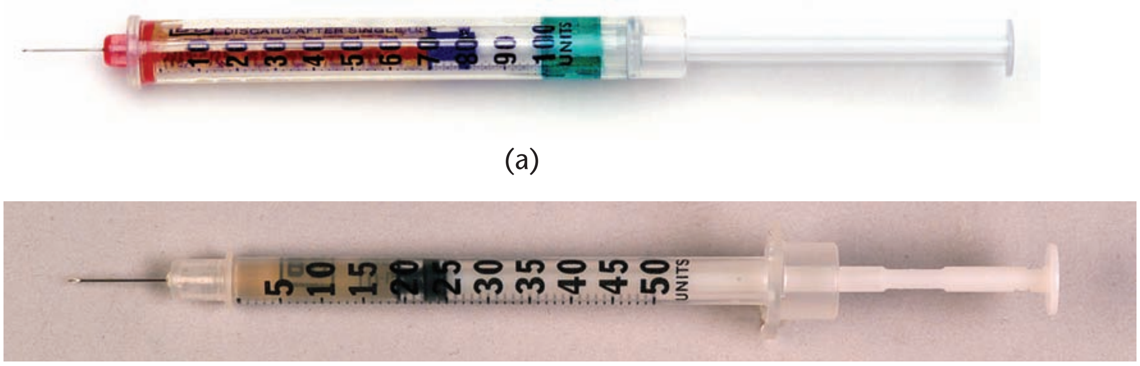
FIGURE 6-8 Insulin syringes (a) front and reverse of a standard U-100 insulin syringe; (b) Lo-Dose U-100 insulin syringes, 50 and 30 units



(a)

(b)

FIGURE 6-9 (a) Standard U-100 insulin syringe measuring 70 units of U-100 insulin; (b) Lo-Dose U-100 insulin syringe measuring 19 units of U-100 insulin



(a)

(b)

Figure 6-8(b) shows two Lo-Dose U-100 insulin syringes. The enlarged scale is easier to read and is calibrated for each 1 unit up to 50 units per 0.5 mL or 30 units per 0.3 mL. Every 5 units are labeled. The 30-unit syringe is commonly used for pediatric administration of insulin. The plunger in Figure 6-9(b) simulates the measurement of 19 units of U-100 insulin.

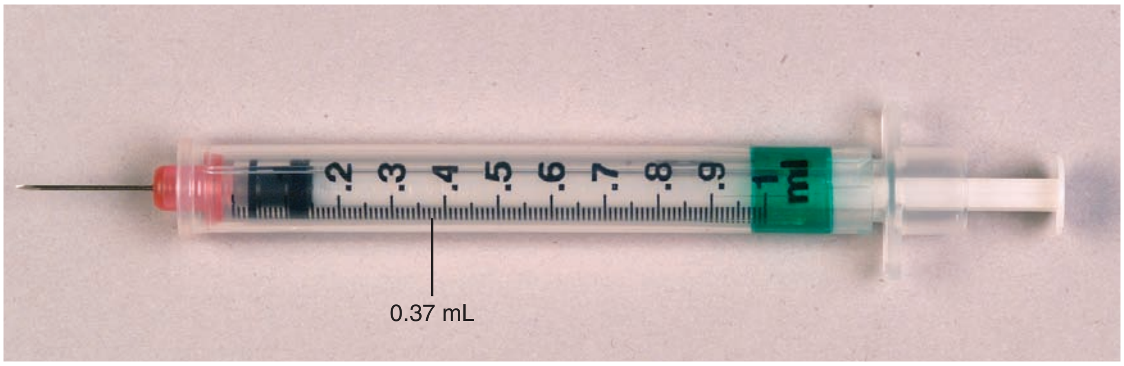
1 mL Syringe

Figure 6-10 shows the 1 mL syringe. This syringe is also referred to as the *tuberculin* or *TB syringe*. It is used when a small dose of a drug must be measured, such as an allergen extract, vaccine, or child's medication. Notice that the 1 mL syringe is calibrated in hundredths (0.01) of a milliliter, with each one tenth (0.1) milliliter labeled on the metric scale. Pediatric and critical care doses of less than 1 mL can be rounded to hundredths and measured in the 1 mL syringe. It is preferable to measure all amounts less than 0.5 mL in a 1 mL syringe.

EXAMPLE ■

The amount 0.366 mL is rounded to 0.37 and measured in the 1 mL syringe.

FIGURE 6-10 1 mL syringe



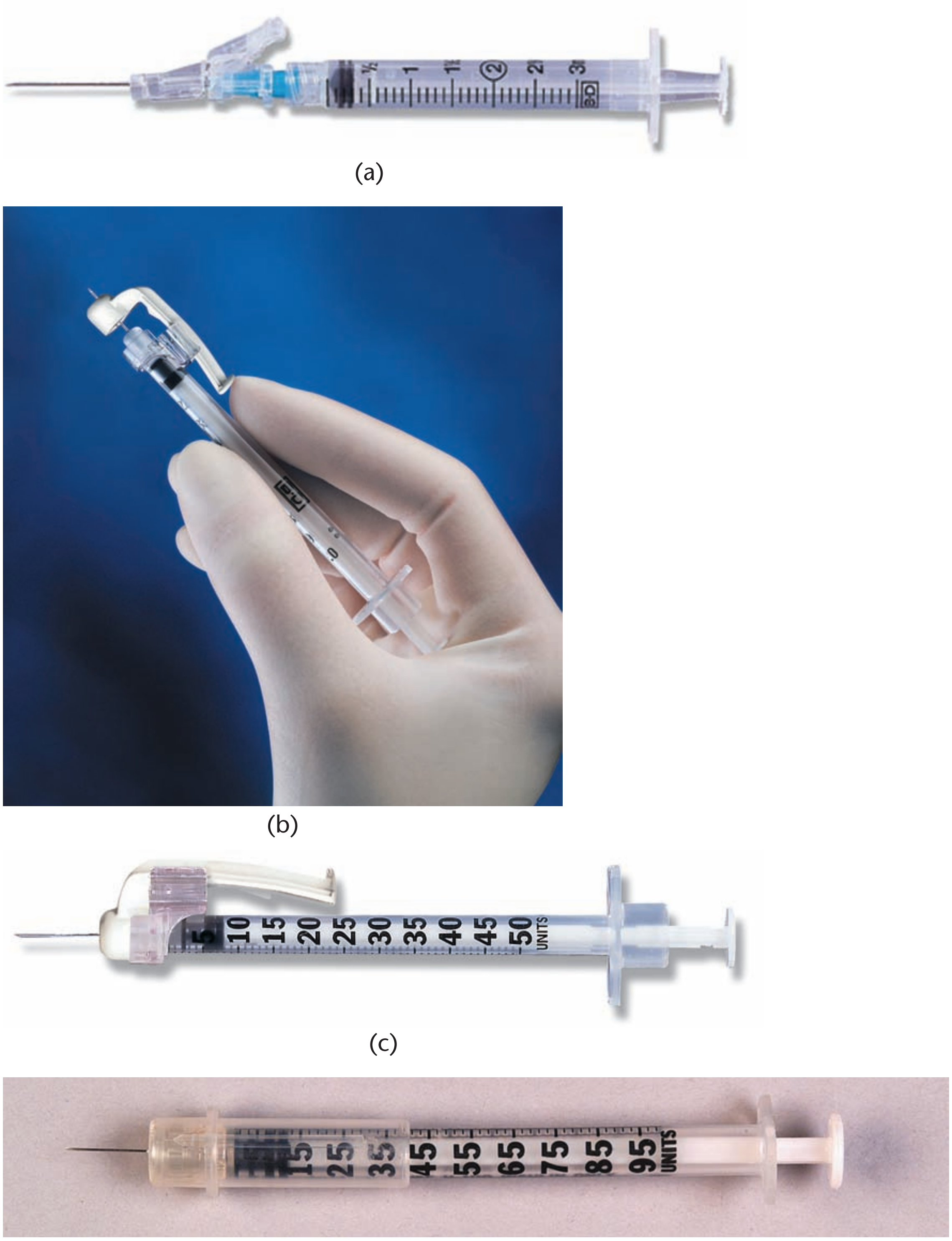
Safety Syringe

Figure 6-11 shows safety 3 mL, 1 mL, and insulin syringes. Notice that the needle is protected by a shield to prevent accidental needlestick injury to the nurse after administering an injectable medication.

Intravenous Syringe

Figures 6-12 and 6-13 show large syringes commonly used to prepare medications for intravenous administration. The volume and calibration of these syringes vary. To be safe, examine the calibrations of the syringes, and select the one best suited for the volume to be administered.

FIGURE 6-11 Safety syringes (Courtesy of BD) (a) 3 mL; (b) 1 mL; (c) Lo-Dose U-100 insulin; (d) Standard U-100 Insulin



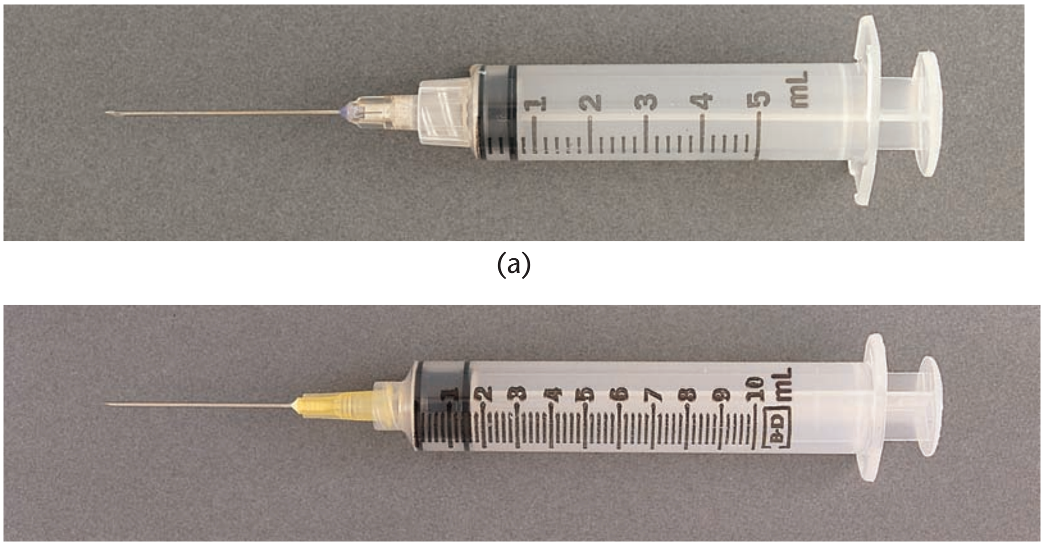
(a)

(b)

(c)

(d)

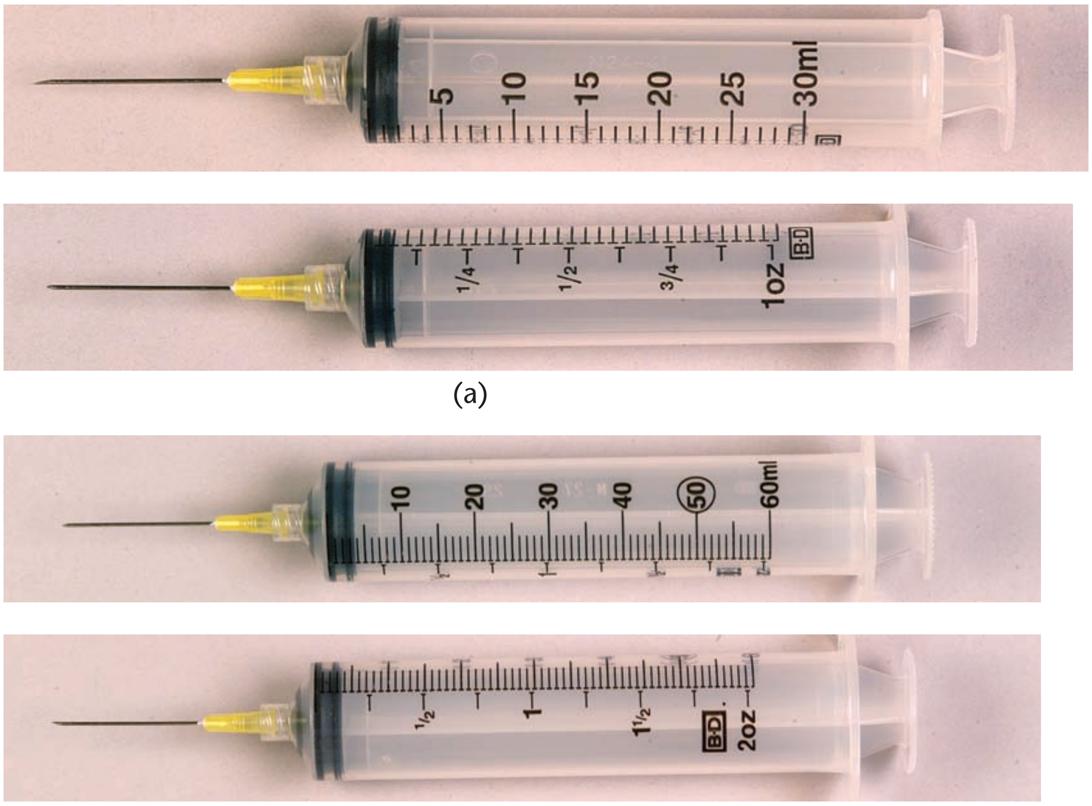
FIGURE 6-12 Intravenous syringes (a) 5 mL; (b) 10 mL



(a)

(b)

FIGURE 6-13 Intravenous syringes (a) front and reverse of a 30 mL or 1 oz syringe; (b) front and reverse of a 60 mL or 2 oz syringe



(a)

(b)

Needleless Syringe

Figure 6-14 pictures a needleless syringe system designed to prevent accidental needlesticks during intravenous administration.

FIGURE 6-14 Example of a needleless syringe system (Courtesy of BD)

QUICK REVIEW

- The medicine cup has a 1 ounce or 30 milliliter capacity for oral liquids. It is also calibrated to measure teaspoons, tablespoons, and drams. Amounts less than 2.5 milliliters should be measured in a smaller device, such as an oral syringe.
- The calibrated dropper measures small amounts of oral liquids. The size of the drop varies according to the diameter of the tip of the dropper.
- The standard 3 mL syringe is used to measure most injectable drugs. It is calibrated in tenths of a mL.
- The prefilled, single-dose syringe cartridge is to be used once and then discarded.
- The Standard U-100 insulin syringe is used to measure U-100 insulin only. It is calibrated for a total of 100 units per 1 mL.
- The Lo-Dose U-100 insulin syringe is used for measuring small amounts of U-100 insulin. It is calibrated for a total of 50 units per 0.5 mL or 30 units per 0.3 mL. The smaller syringe is commonly used for administering small amounts of insulin.
- The 1 mL syringe is used to measure small or critical amounts of injectable drugs. It is calibrated in hundredths of a mL.
- Syringes intended for injections should never be used to measure or administer oral medications.

Review Set 19

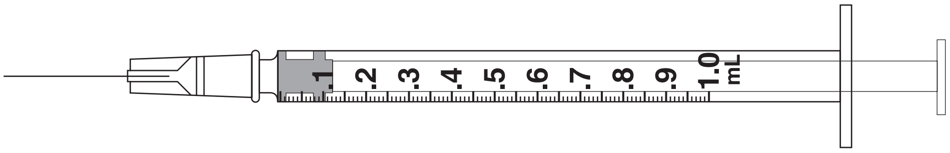
1. In which syringe should 0.25 mL of a drug solution be measured? ____________________
2. a. Can 1.25 mL be measured in the regular 3 mL syringe?
   ____
   b. How? ____________________
3. Should insulin be measured in a 1 mL syringe? ____________________
4. Fifty (50) units of U-100 insulin equals how many milliliters? ____________________
5. a. The gtt is considered a consistent quantity for comparisons between different droppers. (True) (False)
   b. Why? ____________________
6. Can you measure 3 mL in a medicine cup? ____________________
7. How would you measure 3 mL of oral liquid to be administered to a child? ____________________
   ____
8. The medicine cup indicates that each teaspoon is the equivalent of __________ mL.
9. Describe your action if you are to administer less than the full amount of a drug supplied in a prefilled, single-dose syringe. ____________________
   ____
10. What is the primary purpose of the safety and needleless syringes? ____________________
    ____

Note to Learner

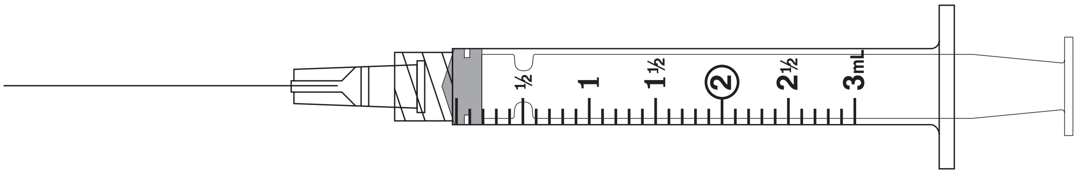
The drawings on subsequent pages of the syringes represent actual sizes.

Draw an arrow to point to the calibration that corresponds to the dose to be administered.

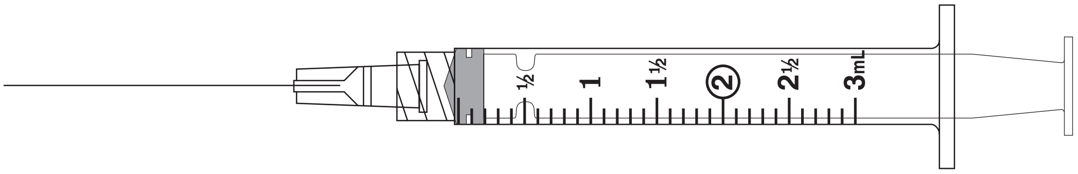
11. Administer 0.75 mL



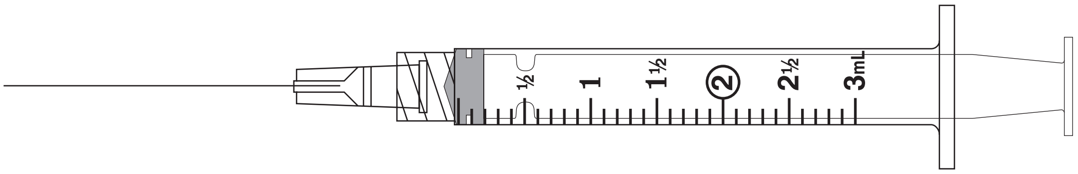
12. Administer 1.33 mL



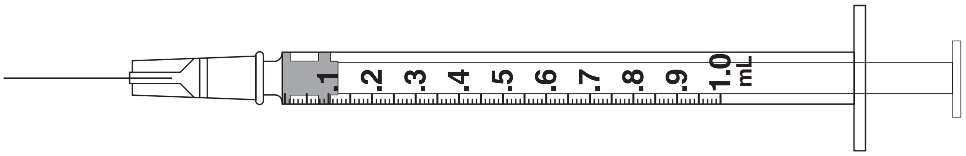
13. Administer 2.2 mL



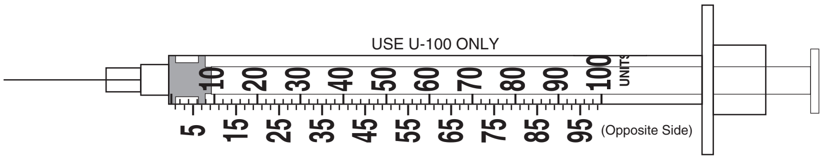
14. Administer 1.3 mL



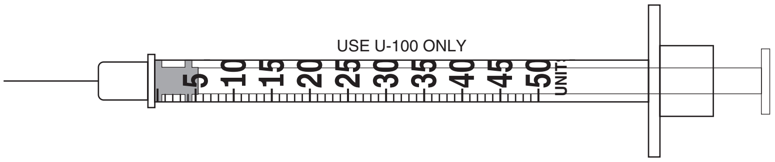
15. Administer 0.33 mL



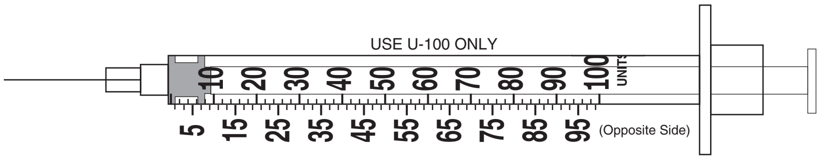
16. Administer 65 units of U-100 insulin



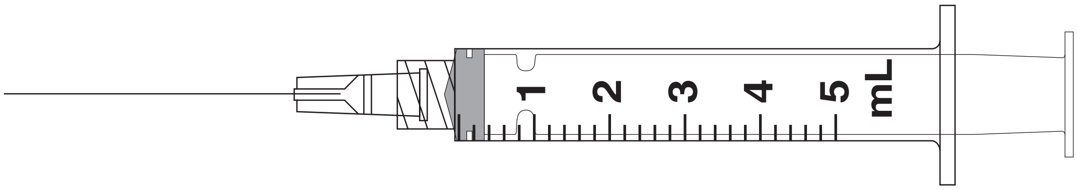
17. Administer 27 units of U-100 insulin



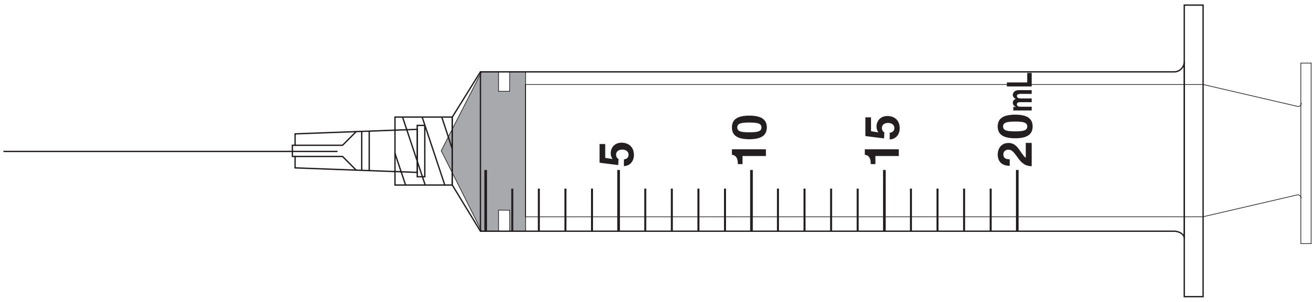
18. Administer 75 units of U-100 insulin



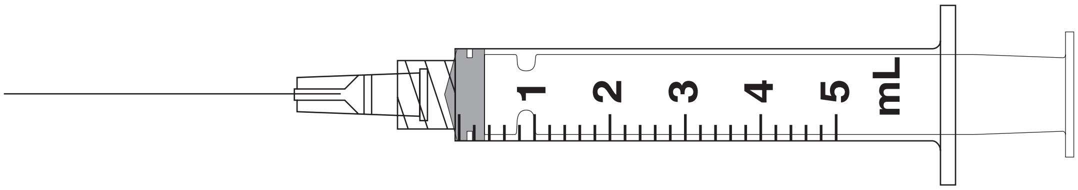
19. Administer 4.4 mL



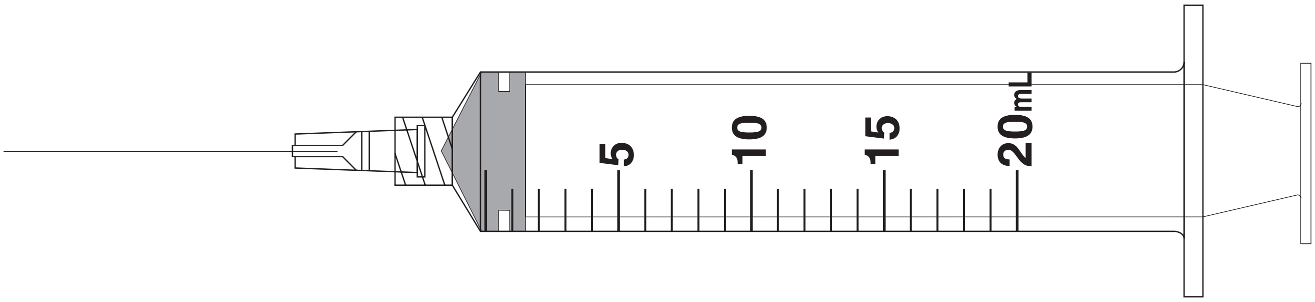
20. Administer 16 mL



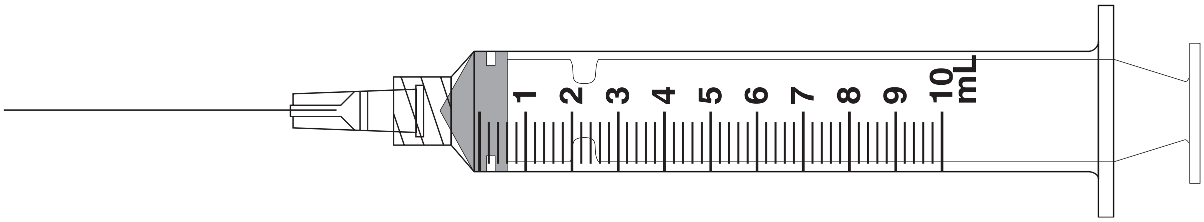
21. On the 5 mL syringe, each calibration is equal to _________. (Express the answer as a decimal.)



22. On the 20 mL syringe, each calibration is equal to _________.



23. On the 10 mL syringe, each calibration is equal to _________. (Express the answer as a decimal.)



After completing these problems, see pages 478-479 to check your answers.

CRITICAL THINKING SKILLS

Select correct equipment to prepare medications. In the following situation, the correct dosage was not given because an incorrect measuring device was used.

ERROR

Using an inaccurate measuring device for oral medications.

Possible Scenario

Suppose a pediatrician ordered *Amoxil suspension (250 mg per 5 mL), 1 teaspoon, every 8 hours*, to be given to a child. The child should receive the medication for 10 days for otitis media, an ear infection. The pharmacy dispensed the medication in a bottle containing 150 mL, or a 10-day supply. The nurse did not clarify for the mother how to measure and administer the medication. The child returned to the clinic in 10 days for routine follow-up. The nurse asked whether the child had taken all the prescribed Amoxil. The child's mother stated, "No, we have almost half of the bottle left." When the nurse asked how the medication had been given, the mother showed the bright pink plastic teaspoon she had obtained from the local ice cream parlor. The nurse measured the spoon's capacity and found it to be less than 3 mL. (Remember, 1 tsp $=$ 5 mL.) The child would have received only $\frac{3}{5}$, or 60%, of the correct dose.

Potential Outcome

The child did not receive a therapeutic dosage of the medication and was actually underdosed. The child could develop a super infection, which could lead to a more severe illness such as meningitis.

Prevention

Teach family members (and patients, as appropriate) to use calibrated measuring spoons or specially designed oral syringes to measure the correct dosage of medication. The volumes of serving spoons may vary considerably, as this situation illustrates.

PRACTICE PROBLEMS—CHAPTER 6

1. In the U-100 insulin syringe, 100 units = ________ mL.
2. The 1 mL syringe is calibrated in ________ of a mL.
3. Can you measure 1.25 mL in a single tuberculin syringe? ________ Explain. ____________

   ____

   ____
4. How would you measure 1.33 mL in a 3 mL syringe? ______________________
5. The medicine cup has a ________ mL or ________ oz capacity.
6. To administer exactly 0.52 mL to a child, select a ________ syringe.
7. Seventy-five (75) units of U-100 insulin equals ________ mL.
8. All droppers are calibrated to deliver standardized drops of equal amounts regardless of the dropper used. (True) (False)
9. The prefilled syringe is a multiple-dose system. (True) (False)
10. Insulin should be measured in an insulin syringe *only*. (True) (False)

11. The purpose of needleless syringes is ____.

12. Medications are measured in syringes by aligning the calibrations with the __________ of the black rubber tip of the plunger (top ring, raised middle, or bottom ring).

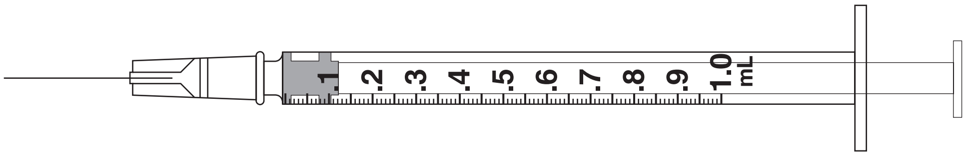
13. The medicine cup calibrations indicate that 2 teaspoons are approximately __________ milliliters.

14. Safety syringes are designed to protect the patient. (True) (False)

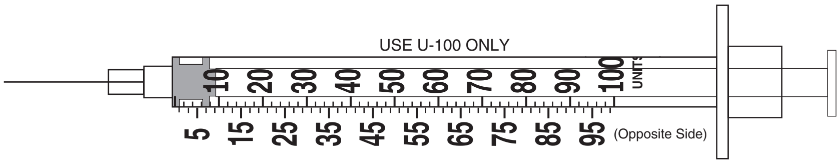
15. The __________ syringe(s) is(are) intended to measure parenteral doses of medications (standard 3 mL, 1 mL, or insulin).

Draw an arrow to indicate the calibration that corresponds to the dose to be administered.

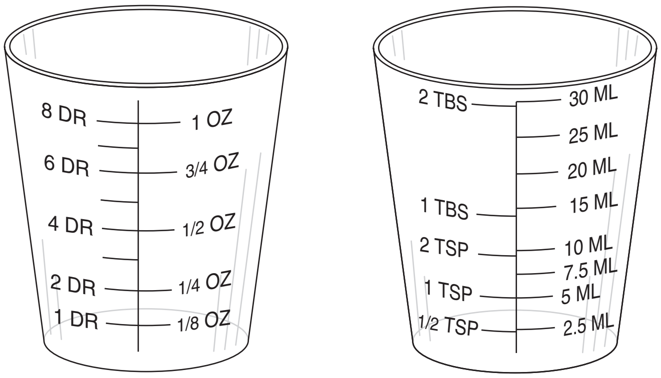
16. Administer 0.45 mL



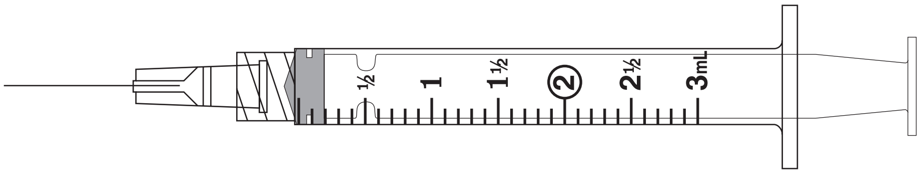
17. Administer 80 units of U-100 insulin



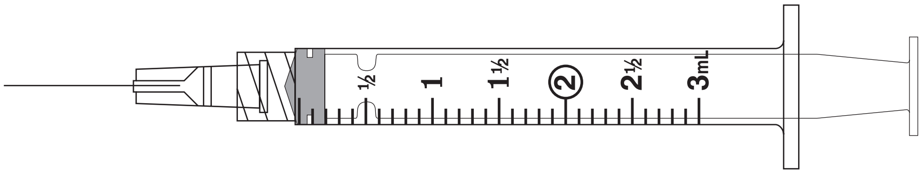
18. Administer $\frac{1}{2}$ ounce



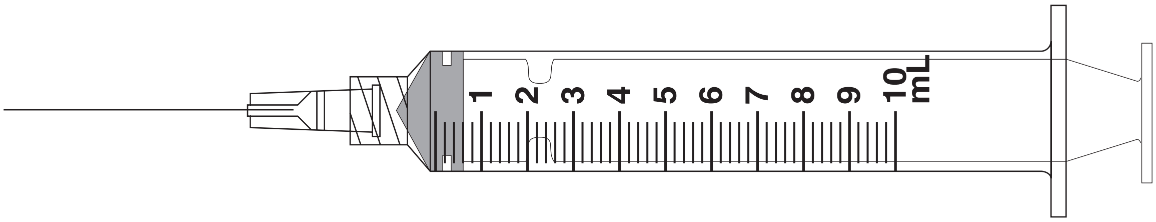
19. Administer 2.4 mL



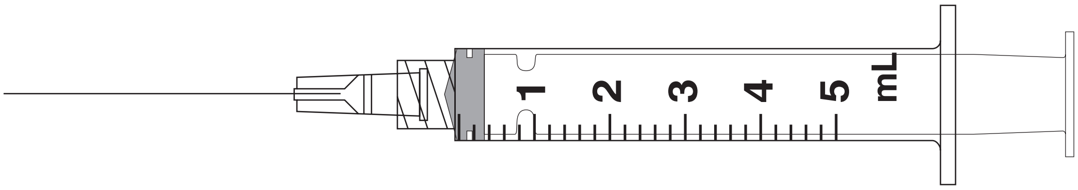
20. Administer 1.1 mL



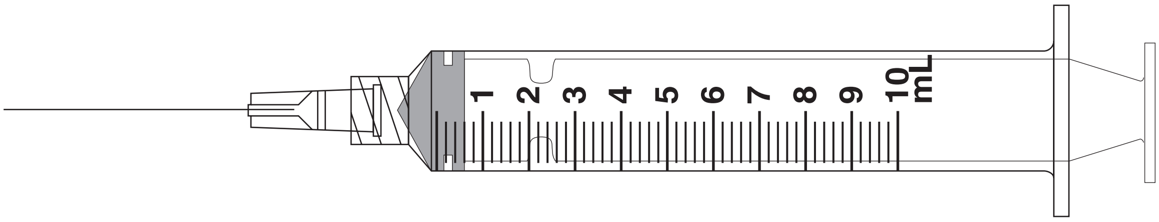
21. Administer 6.2 mL



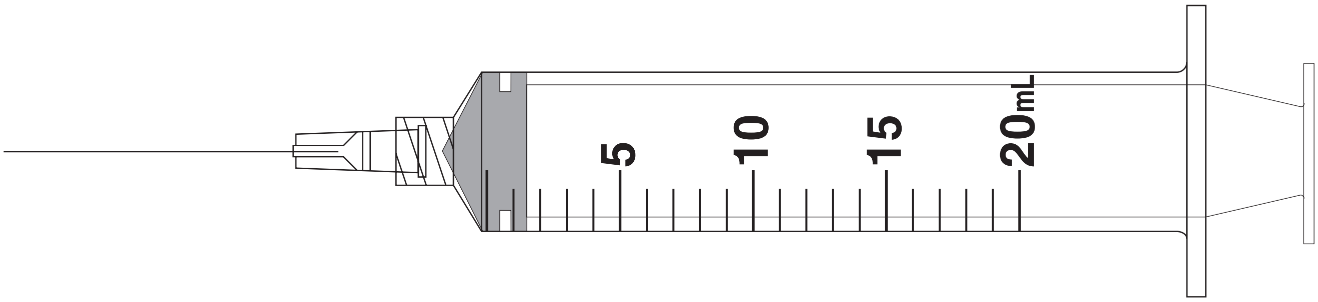
22. Administer 3.6 mL



23. Administer 4.8 mL



24. Administer 12 mL



25. Describe the strategy that would prevent this medication error.

Possible Scenario
Suppose a patient with cancer has oral Compazine liquid ordered for nausea. Because the patient has had difficulty taking the medication, the nurse decided to draw up the medication in a syringe without a needle to facilitate giving the medication. The nurse found this to be quite helpful and prepared several doses in syringes without the needles. A nurse from another unit covered for the nurse during lunch, and when the patient complained of nausea, the nurse assumed that the Compazine prepared in an injection syringe was to be given via injection. The nurse attached a needle and injected the oral medication.

Potential Outcome
The medication would be absorbed systemically, and the patient could develop an abscess at the site of injection.

Prevention

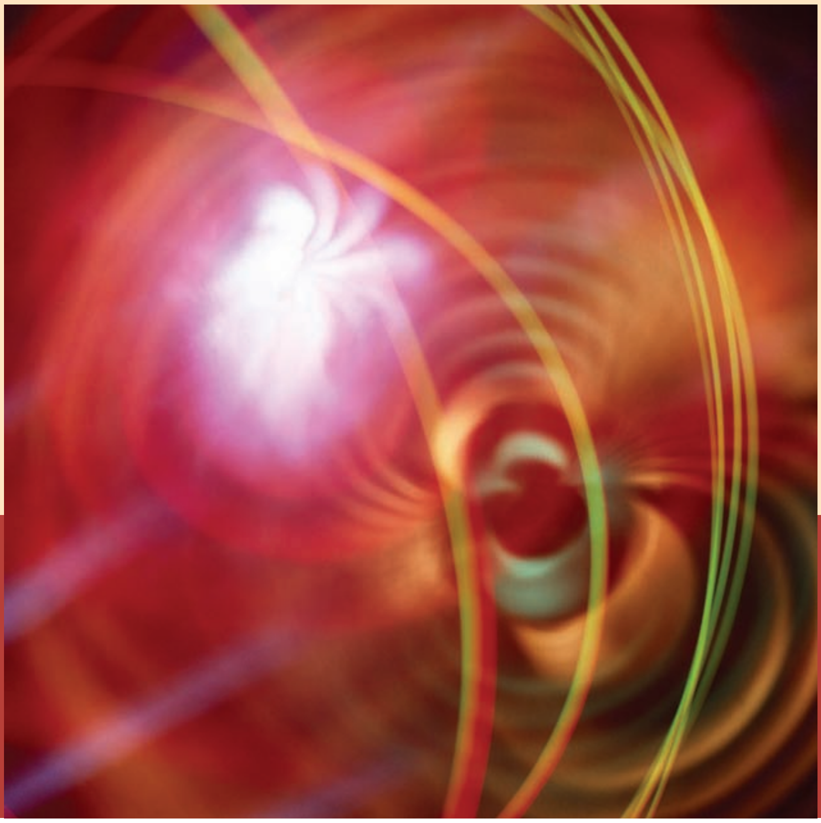
26. Describe the strategy that would prevent this medication administration error.

Possible Scenario
A child with ear infections is to receive Ceclor oral liquid as an anti-infective. The medication is received in oral syringes for administration. The nurse fails to remove the cap on the tip of the syringe and attempts to administer the medication.

Potential Outcome
The nurse would exert enough pressure on the syringe plunger that the protective cap could pop off in the child's mouth and possibly cause the child to choke.

Prevention

After completing these problems, see pages 479-481 to check your answers.



7

Interpreting Drug Orders

OBJECTIVES

Upon mastery of Chapter 7, you will be able to interpret the drug order. To accomplish this you will also be able to:

- Read and write correct medical notation.
- Write the standard medical abbreviation from a list of common terminology.
- Classify the notation that specifies the dosage, route, and frequency of the medication to be administered.
- Interpret physician and other prescribing practitioner orders and medication administration records.

The prescription or medication order conveys the therapeutic drug plan for the patient. It is the responsibility of the nurse to:

- Interpret the order.
- Prepare the exact dosage of the prescribed drug.
- Identify the patient.
- Administer the proper dosage by the prescribed route, at the prescribed time intervals.

- Record the administration of the prescribed drug.
- Monitor the patient's response for desired (therapeutic) and adverse effects.

Before you can prepare the correct dosage of the prescribed drug, you must learn to interpret or read the written drug order. For brevity and speed, the health care professions have adopted certain standards and common abbreviations for use in notation. You should learn to recognize and interpret the abbreviations from memory. As you practice reading drug orders, you will find that this skill becomes second nature to you.

An example of a typical written drug order is:

9/4/XX 0730 Amoxil 500 mg p.o. q.i.d. (p.c. and bedtime)
J. Physician, M.D.

This order means the patient should receive 500 milligrams of an antibiotic named Amoxil (or amoxicillin) orally four times a day (after meals and at bedtime). You can see that the medical notation shortens the written-out order considerably.

MEDICAL ABBREVIATIONS

The following table lists common medical abbreviations used in writing drug orders. The abbreviations are grouped according to those that refer to the route (or method) of administration, the frequency (time interval), and other general terms. Commit these to memory, along with the other abbreviations related to systems of measurement presented in Chapter 3.

REMEMBER

Common Medical Abbreviations

Abbreviation	Interpretation	Abbreviation	Interpretation
Route:		**Frequency:**	
IM	intramuscular	h	hour
IV	intravenous	q.h	every hour
IV PB	intravenous piggyback	q.2h	every two hours
Subcut	subcutaneous	q.3h	every three hours
SL	sublingual, under the tongue	q.4h	every four hours
ID	intradermal	q.6h	every six hours
GT	gastrostomy tube	q.8h	every eight hours
NG	nasogastric tube	q.12h	every twelve hours
NJ	nasojejunal tube	**General:**	
p.o.	by mouth, orally	$\bar{a}$	before
p.r.	per rectum, rectally	$\bar{p}$	after
Frequency:		$\bar{c}$	with
a.c.	before meals	$\bar{s}$	without
p.c.	after meals	q	every
ad. lib.	as desired, freely	qs	quantity sufficient
p.r.n.	when necessary	aq	water
stat	immediately, at once	NPO	nothing by mouth
b.i.d.	twice a day	gtt	drop
t.i.d.	three times a day	tab	tablet
q.i.d.	four times a day	cap	capsule
min	minute	et	and
		noct	night

THE DRUG ORDER

The drug order consists of seven parts:

1. Name of the *patient*.
2. Name of the *drug* to be administered.
3. *Dosage* of the drug.
4. *Route* by which the drug is to be administered.
5. *Frequency,* time, and special instructions related to administration.
6. *Date and time* when the order was written.
7. *Signature and licensure* of the person writing the order.

CAUTION

If any of the seven parts is missing or unclear, the order is considered incomplete and is, therefore, not a legal drug order.

Parts one through five of the drug order are known as the original Five Rights of safe medication administration. They are essential and each one must be faithfully checked every time a medication is prepared and administered. Following safe administration of the medication, the nurse or health care practitioner must accurately document the drug administration. Combined with the original Five Rights, the patient is entitled to *Six Rights* of safe and accurate medication administration and documentation with each and every dose.

REMEMBER

The Six Rights of safe and accurate medication administration are:

The *right patient* must receive the *right drug* in the *right amount* by the *right route* at the *right time,* followed by the *right documentation.*

Each drug order should follow a specific sequence. The name of the drug is written first, followed by the dosage, route, and frequency. When correctly written, the brand (or trade) name of the drug begins with a capital or uppercase letter. The generic name begins with a lowercase letter.

EXAMPLE ■

Procan SR 500 mg p.o. q.6h

1. **Procan SR** is the brand name of the drug.
2. **500 mg** is the dosage.
3. **p.o.** is the route.
4. **q.6h** is the frequency.

This order means: *Give 500 milligrams of Procan SR orally every 6 hours.*

CAUTION

If the nurse has difficulty understanding and interpreting the drug order, the nurse must clarify the order with the writer. Usually this person is the physician or another authorized practitioner, such as an advanced registered nurse practitioner.

Let's practice reading and interpreting drug orders.

EXAMPLE 1 ■

Dilantin 100 mg p.o. t.i.d.

This order means: *Give 100 milligrams of Dilantin orally 3 times a day.*

EXAMPLE 2 ■

procaine penicillin G 400,000 units IM q.6h

This order means: *Give 400,000 units of procaine penicillin G intramuscularly every 6 hours.*

EXAMPLE 3 ■

Demerol 75 mg IM q.4h p.r.n., pain

This order means: *Give 75 milligrams of Demerol intramuscularly every 4 hours when necessary for pain.*

CAUTION

The p.r.n. frequency designates the minimum time allowed between doses. There is no maximum time other than automatic stops as defined by hospital or agency policy.

EXAMPLE 4 ■

Humulin R Regular U-100 insulin 5 units subcut stat

This order means: *Give 5 units of Humulin R Regular U-100 insulin subcutaneously immediately.*

EXAMPLE 5 ■

Ancef 1 g IV PB q.6h

This order means: *Give 1 gram of Ancef by intravenous piggyback every 6 hours.*

The administration times are designated by hospital policy. For example, t.i.d. administration times may be 0900 or 9 AM, 1300 or 1 PM, and 1700 or 5 PM.

QUICK REVIEW

- The *right patient* must receive the *right drug* in the *right amount* by the *right route* at the *right time* followed by the *right documentation.*
- Understanding drug orders requires interpreting common medical abbreviations.
- The drug order must contain (in this sequence): drug name, dosage, route, and frequency.
- All parts of the drug order must be stated clearly for accurate, exact interpretation.
- If you are ever in doubt as to the meaning of any part of a drug order, ask the writer to clarify before proceeding.

Review Set 20

Interpret the following medication (drug) orders:

1. naproxen 250 mg p.o. b.i.d. ____

   ____

2. Humulin N NPH U-100 insulin 30 units subcut daily 30 min ā breakfast ____________________

   ____

3. Ceclor 500 mg p.o. stat, then 250 mg q.8h ______________________

4. Synthroid 25 mcg p.o. daily ______________________

5. Ativan 10 mg IM q.4h p.r.n., agitation ______________________

6. furosemide 20 mg IV stat (slowly) ______________________

7. Gelusil 10 mL p.o. at bedtime ______________________

8. atropine sulfate ophthalmic 1% 2 gtt right eye q.15 min × 4 ______________________

9. morphine sulfate gr $\frac{1}{4}$ IM q.3 h p.r.n., pain ______________________

10. Lanoxin 0.25 mg p.o. daily ______________________

11. tetracycline 250 mg p.o. q.i.d. ______________________

12. nitroglycerin gr $\frac{1}{400}$ SL stat ______________________

13. Cortisporin otic suspension 2 gtt each ear t.i.d. et at bedtime ______________________

14. Compare and contrast *t.i.d.* and *q.8h* administration times. Include sample administration times for each in your explanation. ______________________

15. Describe your action if no method of administration is written. ______________________

16. Do q.i.d. and q.4h have the same meaning? __________ Explain. ______________________

17. Who determines the medication administration times? ______________________

18. Name the seven parts of a written medication prescription. ______________________

19. Which parts of the written medication prescription/order are included in the original Five Rights of medication administration? ______________________

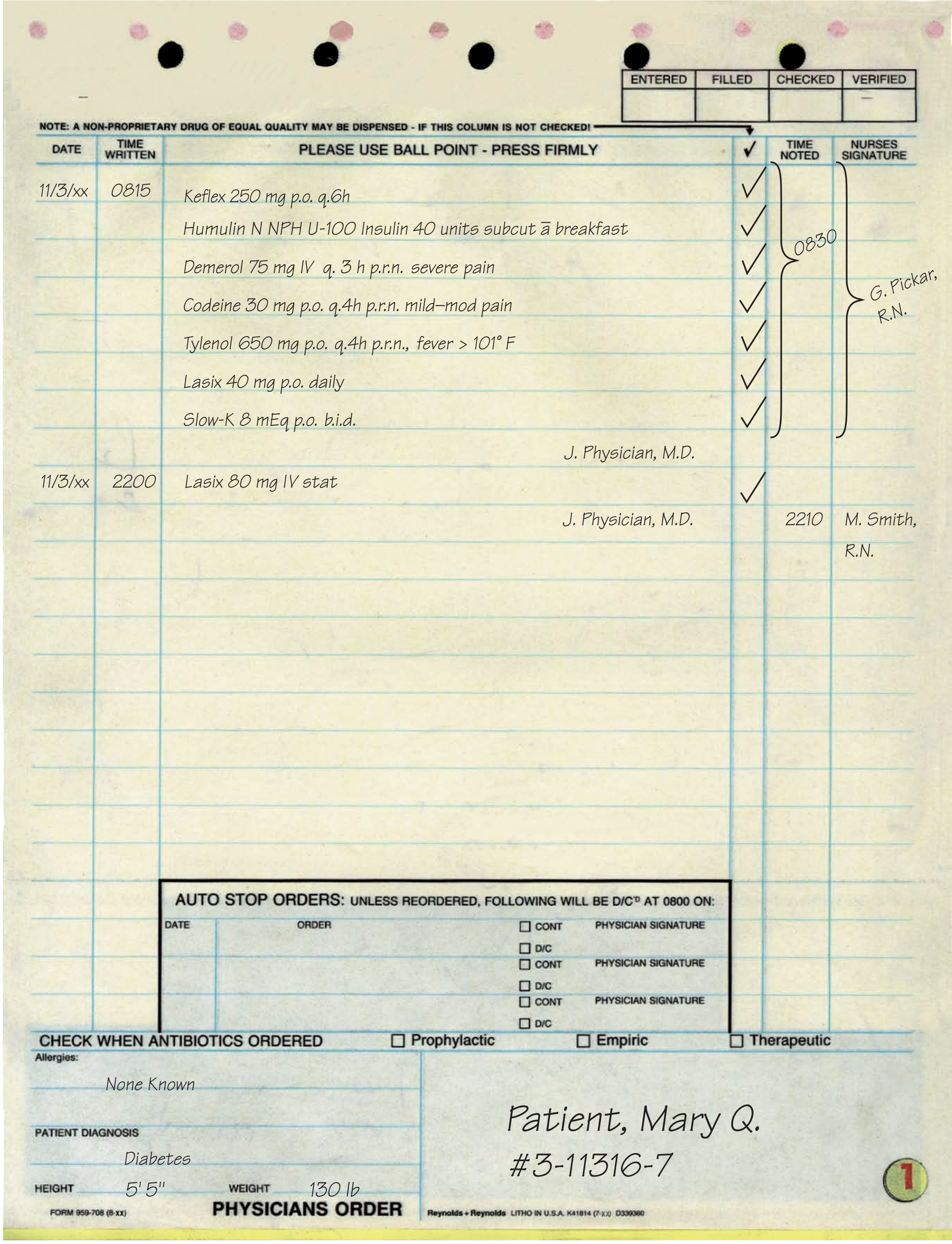
20. State the Six Rights of safe and accurate medication administration. ______________________

After completing these problems, see page 481 to check your answers.

Medication Order and Administration Forms

Hospitals have a special form for recording drug orders. Figure 7-1 shows a sample physician's order form. Find and name each of the seven parts of the drug orders listed. Notice that the nurse or other health care professional must verify and initial each order, ensuring that each of the seven parts is accurate. In some places, the pharmacist may be responsible for verifying the order as part of the computerized record.

FIGURE 7-1 Physician's Order form



ENTERED	FILLED	CHECKED	VERIFIED
			—

NOTE: A NON-PROPRIETARY DRUG OF EQUAL QUALITY MAY BE DISPENSED - IF THIS COLUMN IS NOT CHECKED!

DATE	TIME WRITTEN	PLEASE USE BALL POINT - PRESS FIRMLY	✓	TIME NOTED	NURSES SIGNATURE
11/3/xx	0815	Keflex 250 mg p.o. q.6h	✓	0830	G. Pickar, R.N.
		Humulin N NPH U-100 Insulin 40 units subcut ā breakfast	✓		
		Demerol 75 mg IV q. 3 h p.r.n. severe pain	✓		
		Codeine 30 mg p.o. q.4h p.r.n. mild–mod pain	✓		
		Tylenol 650 mg p.o. q.4h p.r.n., fever > 101° F	✓		
		Lasix 40 mg p.o. daily	✓		
		Slow-K 8 mEq p.o. b.i.d.	✓		
		J. Physician, M.D.			
11/3/xx	2200	Lasix 80 mg IV stat	✓		
		J. Physician, M.D.		2210	M. Smith, R.N.

AUTO STOP ORDERS: UNLESS REORDERED, FOLLOWING WILL BE D/C^{D} AT 0800 ON:

DATE	ORDER		
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE

CHECK WHEN ANTIBIOTICS ORDERED ☐ Prophylactic ☐ Empiric ☐ Therapeutic

Allergies: None Known

PATIENT DIAGNOSIS Diabetes

HEIGHT 5' 5" WEIGHT 130 lb

FORM 959-708 (8-xx) **PHYSICIANS ORDER**

Patient, Mary Q.
#3-11316-7

1

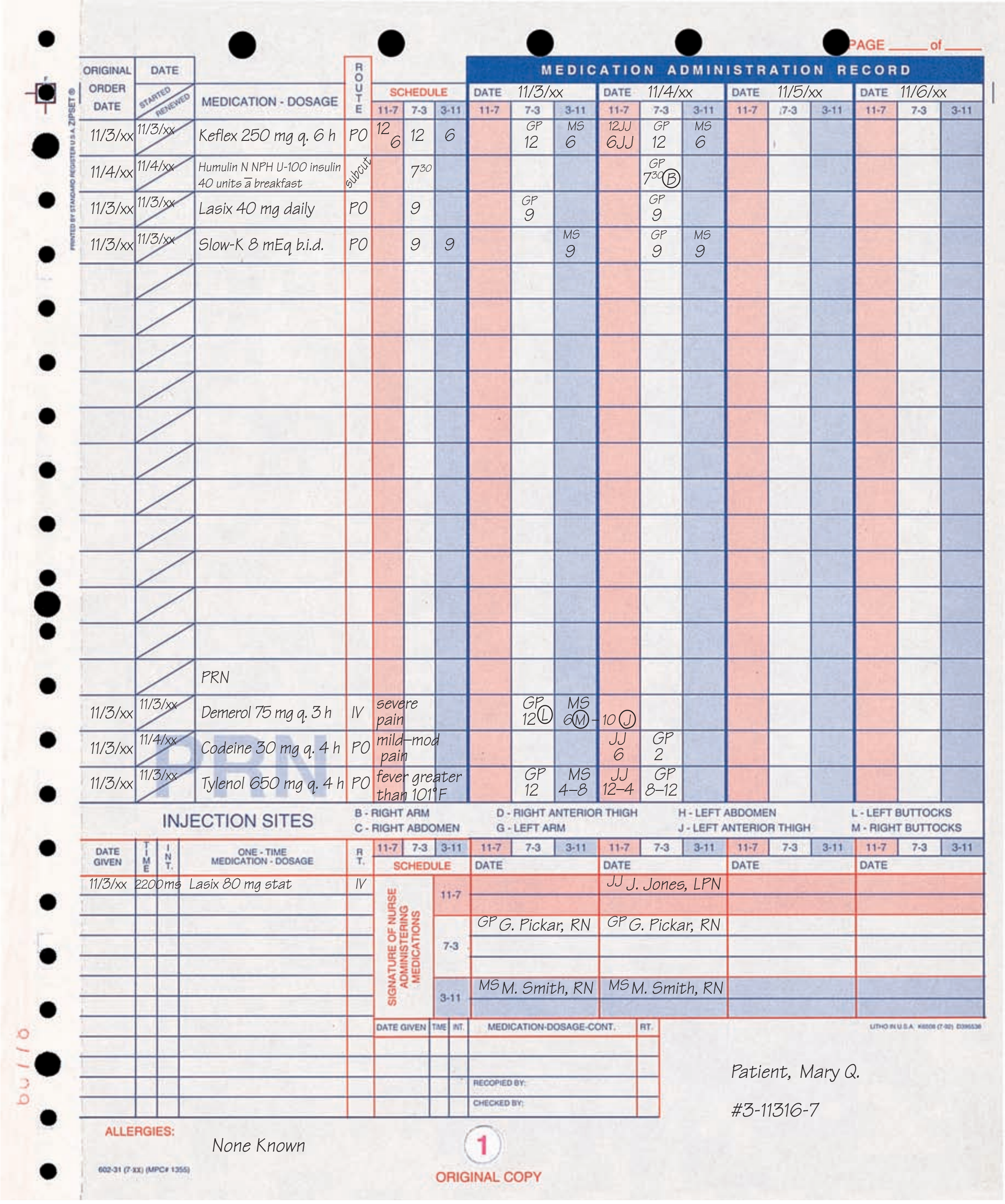
Reynolds + Reynolds LITHO IN U.S.A. K41814 (7-xx) D339360

The drug orders from the physician's order form are transcribed to a medication administration record (MAR), Figure 7-2. The nurse or other health care professional uses this record as a guide to:

- Check the drug order.
- Prepare the correct dosage.
- Record the drug administered.

These three check points help to ensure accurate medication administration.

FIGURE 7-2 Medication Administration Record



PAGE _____ of _____

MEDICATION ADMINISTRATION RECORD

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ORIGINAL ORDER DATE	DATE STARTED / RENEWED	MEDICATION - DOSAGE	ROUTE	SCHEDULE			DATE 11/3/xx			DATE 11/4/xx			DATE 11/5/xx			DATE 11/6/xx		
				11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11
11/3/xx	11/3/xx	Keflex 250 mg q. 6 h	PO	12 6	12	6		GP 12	MS 6	12JJ 6JJ	GP 12	MS 6						
11/4/xx	11/4/xx	Humulin N NPH U-100 insulin 40 units $\bar{a}$ breakfast	subcut		7^{30}						GP 7^{30}Ⓑ							
11/3/xx	11/3/xx	Lasix 40 mg daily	PO		9			GP 9			GP 9							
11/3/xx	11/3/xx	Slow-K 8 mEq b.i.d.	PO		9	9			MS 9		GP 9	MS 9						
		PRN																
11/3/xx	11/3/xx	Demerol 75 mg q. 3 h	IV	severe pain				GP 12Ⓛ	MS 6Ⓜ–	10Ⓙ								
11/3/xx	11/4/xx	Codeine 30 mg q. 4 h	PO	mild–mod pain						JJ 6	GP 2							
11/3/xx	11/3/xx	Tylenol 650 mg q. 4 h	PO	fever greater than 101°F				GP 12	MS 4–8	JJ 12–4	GP 8–12							

PRN

INJECTION SITES
B - RIGHT ARM
C - RIGHT ABDOMEN
D - RIGHT ANTERIOR THIGH
G - LEFT ARM
H - LEFT ABDOMEN
J - LEFT ANTERIOR THIGH
L - LEFT BUTTOCKS
M - RIGHT BUTTOCKS

DATE GIVEN	TIME	INT.	ONE - TIME MEDICATION - DOSAGE	RT.
11/3/xx	2200	ms	Lasix 80 mg stat	IV

SIGNATURE OF NURSE ADMINISTERING MEDICATIONS	DATE	DATE	DATE	DATE
SCHEDULE	11-7 7-3 3-11	11-7 7-3 3-11	11-7 7-3 3-11	11-7 7-3 3-11
11-7		JJ J. Jones, LPN		
7-3	GP G. Pickar, RN	GP G. Pickar, RN		
3-11	MS M. Smith, RN	MS M. Smith, RN		

DATE GIVEN	TIME	INT.	MEDICATION-DOSAGE-CONT.	RT.
			RECOPIED BY:	
			CHECKED BY:	

LITHO IN U.S.A.

Patient, Mary Q.

#3-11316-7

ALLERGIES: None Known

602-31 (7-XX) (MPC# 1355)

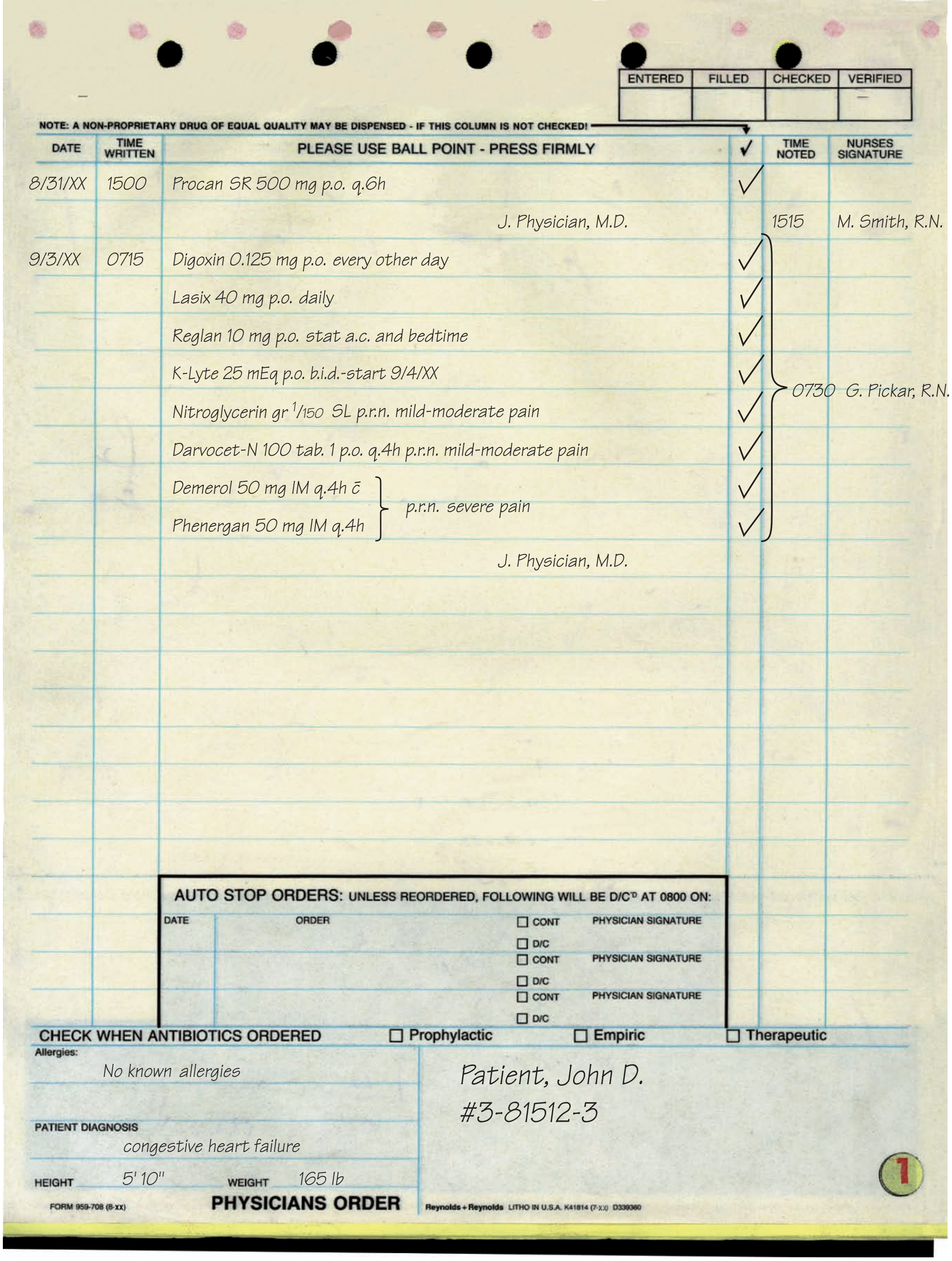
1

ORIGINAL COPY

COMPUTERIZED MEDICATION ADMINISTRATION SYSTEMS

Many health care facilities now use computers for processing drug orders. Drug orders are either electronically transmitted or manually entered into the computer from an order form, such as Figure 7-3. Through the computer, the nurse or other health care professional can transmit the order within seconds

FIGURE 7-3 Physician's Order form



ENTERED	FILLED	CHECKED	VERIFIED
			—

NOTE: A NON-PROPRIETARY DRUG OF EQUAL QUALITY MAY BE DISPENSED - IF THIS COLUMN IS NOT CHECKED!

DATE	TIME WRITTEN	PLEASE USE BALL POINT - PRESS FIRMLY	✓	TIME NOTED	NURSES SIGNATURE
8/31/XX	1500	Procan SR 500 mg p.o. q.6h	✓		
		J. Physician, M.D.		1515	M. Smith, R.N.
9/3/XX	0715	Digoxin 0.125 mg p.o. every other day	✓	0730	G. Pickar, R.N.
		Lasix 40 mg p.o. daily	✓		
		Reglan 10 mg p.o. stat a.c. and bedtime	✓		
		K-Lyte 25 mEq p.o. b.i.d.-start 9/4/XX	✓		
		Nitroglycerin gr $^{1}/_{150}$ SL p.r.n. mild-moderate pain	✓		
		Darvocet-N 100 tab. 1 p.o. q.4h p.r.n. mild-moderate pain	✓		
		Demerol 50 mg IM q.4h c̄ } p.r.n. severe pain	✓		
		Phenergan 50 mg IM q.4h	✓		
		J. Physician, M.D.			

AUTO STOP ORDERS: UNLESS REORDERED, FOLLOWING WILL BE D/C'D AT 0800 ON:

DATE	ORDER		
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE

CHECK WHEN ANTIBIOTICS ORDERED ☐ Prophylactic ☐ Empiric ☐ Therapeutic

Allergies: No known allergies

PATIENT DIAGNOSIS congestive heart failure

HEIGHT 5' 10" WEIGHT 165 lb

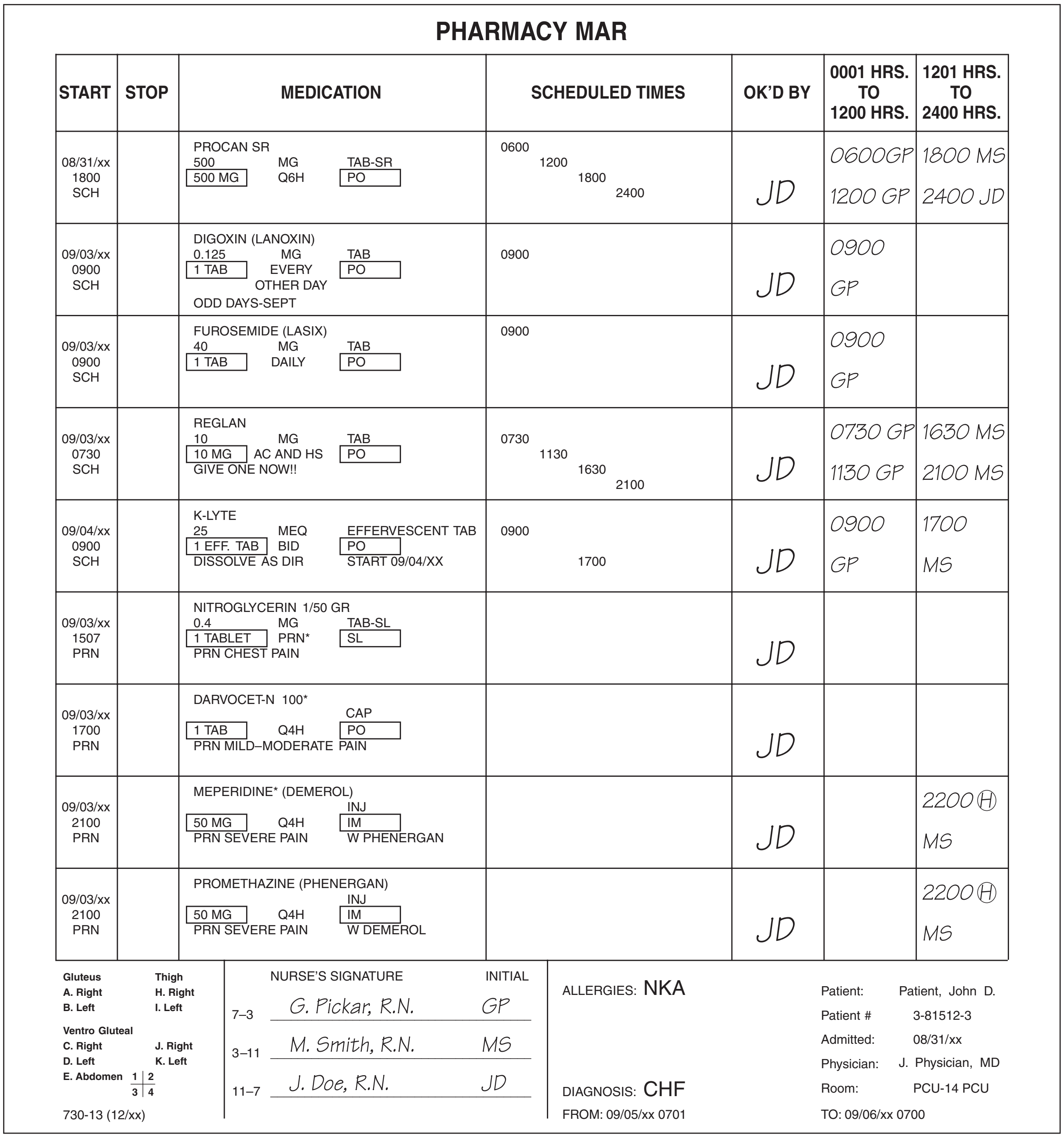
Patient, John D.
#3-81512-3

1

FORM 959-708 (8-xx) **PHYSICIANS ORDER** Reynolds + Reynolds LITHO IN U.S.A. K41814 (7-XX) D339360 to the pharmacy for filling. The computer can keep track of drug stock and usage patterns and even notify the business office to post charges to the patient's account. Most importantly, it can scan for information previously entered, such as drug incompatibilities, drug allergies, safe dosage ranges, doses already given, or recommended administration times. The health care staff can be readily alerted to potential problems or inconsistencies. The corresponding medication administration record may also be printed directly from the computer as in Figure 7-4.

The computerized MAR may be viewed at the computer or from a printed copy as in Figure 7-4. The nurse may be able to look back at the patient's cumulative medication administration record, document administration times and comments at the computer terminal, and then keep a printed copy of the information obtained and entered. The data analysis, storage, and retrieval abilities of computers are making them essential tools for safe and accurate medication administration.

FIGURE 7-4 Computerized Medication Administration Record



PHARMACY MAR

START	STOP	MEDICATION	SCHEDULED TIMES	OK'D BY	0001 HRS. TO 1200 HRS.	1201 HRS. TO 2400 HRS.
08/31/xx 1800 SCH		PROCAN SR 500 MG TAB-SR 500 MG Q6H PO	0600 1200 1800 2400	JD	0600GP 1200 GP	1800 MS 2400 JD
09/03/xx 0900 SCH		DIGOXIN (LANOXIN) 0.125 MG TAB 1 TAB EVERY PO OTHER DAY ODD DAYS-SEPT	0900	JD	0900 GP	
09/03/xx 0900 SCH		FUROSEMIDE (LASIX) 40 MG TAB 1 TAB DAILY PO	0900	JD	0900 GP	
09/03/xx 0730 SCH		REGLAN 10 MG TAB 10 MG AC AND HS PO GIVE ONE NOW!!	0730 1130 1630 2100	JD	0730 GP 1130 GP	1630 MS 2100 MS
09/04/xx 0900 SCH		K-LYTE 25 MEQ EFFERVESCENT TAB 1 EFF. TAB BID PO DISSOLVE AS DIR START 09/04/XX	0900 1700	JD	0900 GP	1700 MS
09/03/xx 1507 PRN		NITROGLYCERIN 1/50 GR 0.4 MG TAB-SL 1 TABLET PRN* SL PRN CHEST PAIN		JD		
09/03/xx 1700 PRN		DARVOCET-N 100* CAP 1 TAB Q4H PO PRN MILD–MODERATE PAIN		JD		
09/03/xx 2100 PRN		MEPERIDINE* (DEMEROL) INJ 50 MG Q4H IM PRN SEVERE PAIN W PHENERGAN		JD		2200 Ⓗ MS
09/03/xx 2100 PRN		PROMETHAZINE (PHENERGAN) INJ 50 MG Q4H IM PRN SEVERE PAIN W DEMEROL		JD		2200 Ⓗ MS

Gluteus	Thigh
A. Right	H. Right
B. Left	I. Left
Ventro Gluteal	
C. Right	J. Right
D. Left	K. Left
E. Abdomen 1 | 2 / 3 | 4	

730-13 (12/xx)

	NURSE'S SIGNATURE	INITIAL
7–3	G. Pickar, R.N.	GP
3–11	M. Smith, R.N.	MS
11–7	J. Doe, R.N.	JD

ALLERGIES: NKA

DIAGNOSIS: CHF

FROM: 09/05/xx 0701

Patient: Patient, John D.
Patient # 3-81512-3
Admitted: 08/31/xx
Physician: J. Physician, MD
Room: PCU-14 PCU
TO: 09/06/xx 0700

QUICK REVIEW

- Drug orders are prescribed on the Physician's Order form.
- The person who administers a drug records it on the medication administration record (MAR). This record may be handwritten or computerized.
- All parts of the drug order must be stated clearly for accurate, exact interpretation. If you are ever in doubt as to the meaning of any part of a drug order, ask the writer to clarify.

Review Set 21

Refer to the Computerized MAR (Figure 7-4) on page 123 to answer questions 1 through 10. Convert the scheduled international time to traditional AM/PM time.

1. Scheduled times for administering Procan SR. ________________________
2. Scheduled times for administering Lanoxin and Lasix. ________________________
3. Scheduled times for administering Reglan. ________________________
4. Scheduled times for administering K-Lyte. ________________________
5. How often can the Demerol be given? ________________________
6. If the Lanoxin was last given on 9/5/xx at 0900, when is the next time and date it will be given? ________________________
7. What is the ordered route of administration for the nitroglycerin? ________________________
8. How many times a day is furosemide ordered? ________________________
9. The equivalent dosage of Lanoxin is ________ mcg.
10. Which drugs are ordered to be administered "as necessary"? ________________________

Refer to the MAR (Figure 7-2) on page 121 to answer questions 11 through 20.

11. What is the route of administration for the insulin? ________________________
12. How many times in a 24-hour period will Lasix be administered? ________________________
13. What is the only medication ordered to be given routinely at noon? ________________________
14. What time of day is the insulin to be administered? ________________________
15. A dosage of 8 mEq of Slow-K is ordered. What does mEq mean? ________________________
16. You work 3 to 11 PM on November 5. Which routine medications will you administer to Mary Q. Patient during your shift? ________________________
17. Mary Q. Patient has a fever of 101.4°F. What medication should you administer? ________________________
18. How many times in a 24-hour period will Slow-K be administered? ________________________
19. What is the equivalent of the scheduled administration time(s) for the Slow-K as converted to international time? ________________________
20. What is the equivalent of the scheduled administration time(s) for the Keflex as converted to international time? ________________________
21. Identify the place on the MAR where the stat IV Lasix was charted. ________________________

After completing these problems, see page 481 to check your answers.

CRITICAL THINKING SKILLS

It is the responsibility of the nurse to clarify any drug order that is incomplete; that is, an order that does not contain the essential seven parts discussed in this chapter. Let's look at an example in which this error occurred.

ERROR

Failing to clarify incomplete orders.

Possible Scenario

Suppose a physician ordered *Pepcid tablet p.o. h.s.* for a patient with an active duodenal ulcer. You will note there is no dosage listed. The nurse thought the medication came in only one dosage strength, added 20 mg to the order, and sent it to the pharmacy. The pharmacist prepared the dosage written on the physician's order sheet. Two days later, during rounds, the physician noted that the patient had not responded well to the Pepcid. When asked about the Pepcid, the nurse explained that the patient had received 20 mg at bedtime. The physician informed the nurse that the patient should have received the 40 mg tablet.

Potential Outcome

Potentially, the delay in correct dosage could result in gastrointestinal bleeding or delayed healing of the ulcer.

Prevention

This medication error could have been avoided simply by the physician writing the strength of the medication. When this was omitted, the nurse should have checked the dosage before sending the order to the pharmacy. When you fill in an incomplete order, you are essentially practicing medicine without a license, which is illegal and potentially dangerous.

PRACTICE PROBLEMS—CHAPTER 7

Interpret the following abbreviations and symbols without consulting another source.

1. b.i.d. __________
2. p.r. __________
3. a.c. __________
4. $\bar{p}$ __________
5. t.i.d. __________
6. q.4h __________
7. p.r.n. __________
8. p.o. __________
9. IV __________
10. q.i.d. __________
11. stat __________
12. ad.lib. __________
13. p.c. __________
14. IM __________
15. $\bar{s}$ __________

Give the abbreviation or symbol for the following terms without consulting another source.

16. night __________
17. drop __________
18. milliliter __________
19. grain __________
20. gram __________
21. four times a day __________

22. with ________
23. subcutaneous ________
24. teaspoon ________
25. twice daily ________
26. every 3 hours ________
27. after meals ________
28. before ________
29. kilogram ________

Interpret the following physician's drug orders without consulting another source.

30. Toradol 60 mg IM stat et q.6h ________
31. procaine penicillin G 300,000 units IM q.i.d. ________
32. Mylanta 5 mL p.o. 1 h a.c., 1 h p.c., h.s., et q.2h p.r.n. at noct, gastric upset ________

____

33. Librium 25 mg p.o. q.6h p.r.n., agitation ________
34. heparin 5,000 units subcut stat ________
35. Demerol 50 mg IM q.3 h p.r.n., pain ________
36. digoxin 0.25 mg p.o. daily ________
37. Neo-Synephrine ophthalmic 10% 2 gtt left eye q.30 min × 2 ________

____

38. Lasix 40 mg IM stat ________
39. Decadron 4 mg IV b.i.d. ________

Refer to the MAR in Figure 7-5 on page 127 to answer questions 40 through 44.

40. Convert the scheduled times for Isosorbide SR to traditional AM/PM time.

________ ________ ________

41. How many units of heparin will the patient receive at 2200? ________
42. What route is ordered for the Humulin R Regular insulin? ________
43. Interpret the order for Cipro. ________
44. If the administration times for the sliding scale insulin are accurate (30 minutes before meals), what times will meals be served? (Use traditional AM/PM time.) ________

Refer to the Computerized Pharmacy MAR in Figure 7-6 on page 128 to answer questions 45 through 49.

45. The physician visited about 5:00 PM on 8/8/xx. What order did the physician write? ________

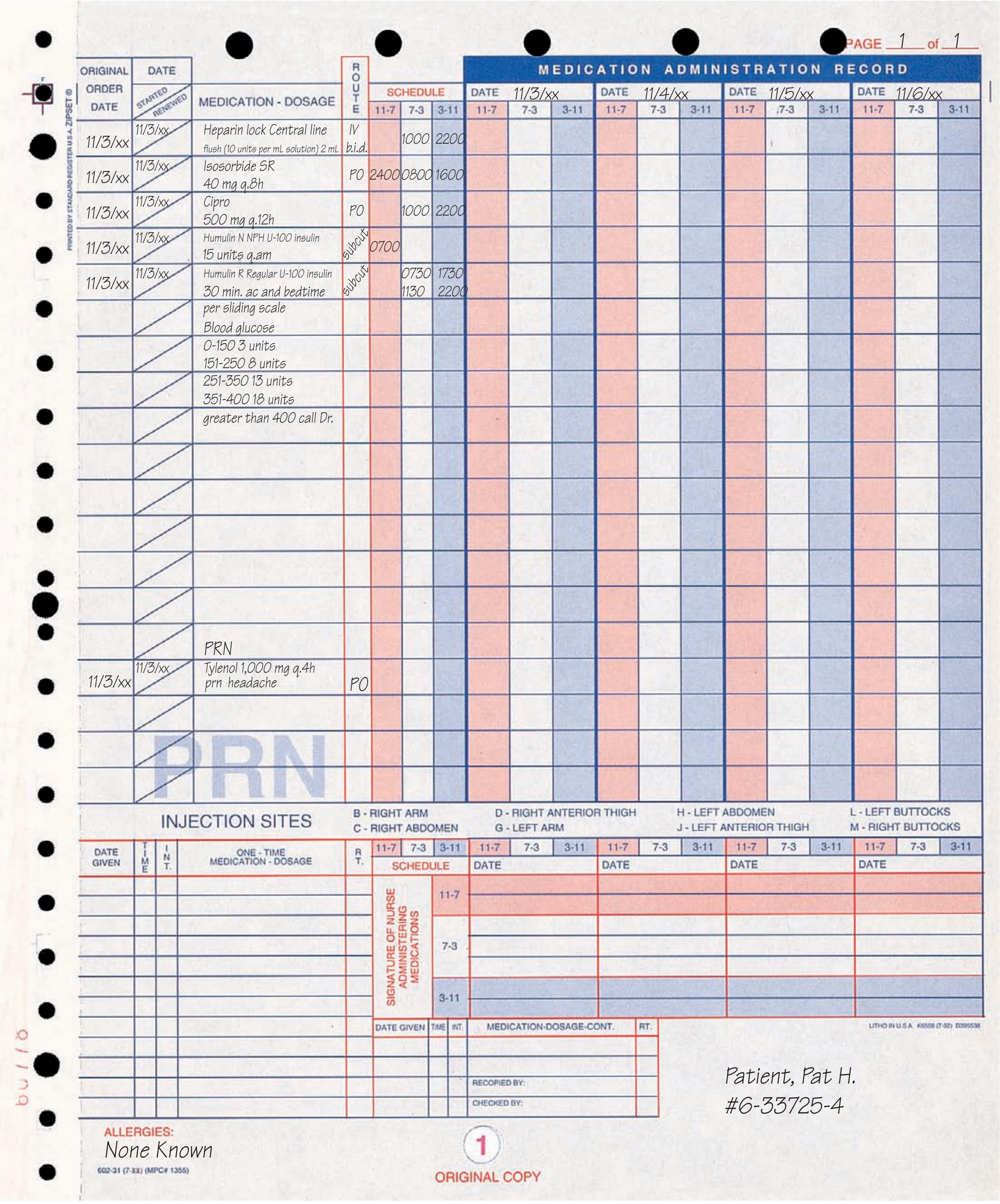
____

46. Using the time as a clue, interpret the symbol "w/" in the Zantac order and give the proper medical abbreviation. ________

____

47. Interpret the order for ranitidine. ________
48. Which of the routine medications is(are) ordered for 6:00 PM? ________
49. How many hours are between the scheduled administration times for Megace? ________

FIGURE 7-5 Medication Administration Record for Chapter 7 practice problems (questions 40–44)



PAGE 1 of 1

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MEDICATION ADMINISTRATION RECORD

ORIGINAL ORDER DATE	DATE STARTED / RENEWED	MEDICATION - DOSAGE	ROUTE	SCHEDULE			DATE 11/3/xx			DATE 11/4/xx			DATE 11/5/xx			DATE 11/6/xx		
				11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11
11/3/xx	11/3/xx	Heparin lock Central line flush (10 units per mL solution) 2 mL	IV b.i.d.		1000	2200												
11/3/xx	11/3/xx	Isosorbide SR 40 mg q.8h	PO	2400	0800	1600												
11/3/xx	11/3/xx	Cipro 500 mg q.12h	PO		1000	2200												
11/3/xx	11/3/xx	Humulin N NPH U-100 insulin 15 units q.am	subcut	0700														
11/3/xx	11/3/xx	Humulin R Regular U-100 insulin 30 min. ac and bedtime	subcut		0730 1130	1730 2200												
		per sliding scale Blood glucose																
		0-150 3 units 151-250 8 units																
		251-350 13 units 351-400 18 units																
		greater than 400 call Dr.																
		PRN																
11/3/xx	11/3/xx	Tylenol 1,000 mg q.4h prn headache	PO															

PRN

INJECTION SITES

B - RIGHT ARM
C - RIGHT ABDOMEN
D - RIGHT ANTERIOR THIGH
G - LEFT ARM
H - LEFT ABDOMEN
J - LEFT ANTERIOR THIGH
L - LEFT BUTTOCKS
M - RIGHT BUTTOCKS

DATE GIVEN	TIME	INT.	ONE - TIME MEDICATION - DOSAGE	RT.

SCHEDULE		11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11
					DATE			DATE			DATE			DATE		
SIGNATURE OF NURSE ADMINISTERING MEDICATIONS	11-7															
	7-3															
	3-11															

LITHO IN U.S.A.

DATE GIVEN	TIME	INT.	MEDICATION-DOSAGE-CONT.	RT.
			RECOPIED BY:	
			CHECKED BY:	

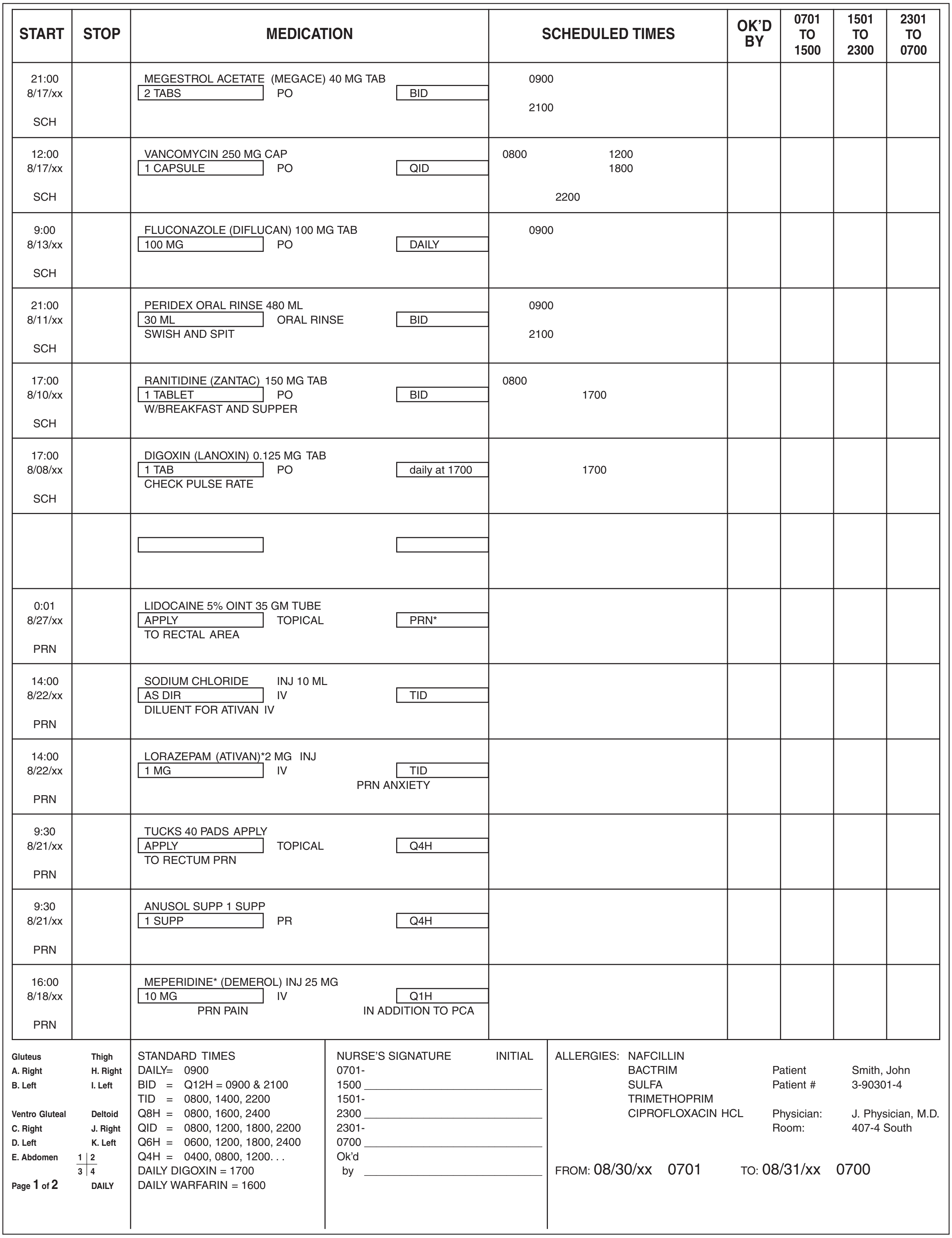
Patient, Pat H.
#6-33725-4

ALLERGIES:
None Known

602-31 (7-XX) (MPC# 1355)

1
ORIGINAL COPY

FIGURE 7-6 Computerized pharmacy MAR for Chapter 7 Practice Problems (questions 45–49)



START	STOP	MEDICATION	SCHEDULED TIMES	OK'D BY	0701 TO 1500	1501 TO 2300	2301 TO 0700
21:00 8/17/xx SCH		MEGESTROL ACETATE (MEGACE) 40 MG TAB 2 TABS PO BID	0900 2100				
12:00 8/17/xx SCH		VANCOMYCIN 250 MG CAP 1 CAPSULE PO QID	0800 1200 1800 2200				
9:00 8/13/xx SCH		FLUCONAZOLE (DIFLUCAN) 100 MG TAB 100 MG PO DAILY	0900				
21:00 8/11/xx SCH		PERIDEX ORAL RINSE 480 ML 30 ML ORAL RINSE BID SWISH AND SPIT	0900 2100				
17:00 8/10/xx SCH		RANITIDINE (ZANTAC) 150 MG TAB 1 TABLET PO BID W/BREAKFAST AND SUPPER	0800 1700				
17:00 8/08/xx SCH		DIGOXIN (LANOXIN) 0.125 MG TAB 1 TAB PO daily at 1700 CHECK PULSE RATE	1700				
0:01 8/27/xx PRN		LIDOCAINE 5% OINT 35 GM TUBE APPLY TOPICAL PRN* TO RECTAL AREA					
14:00 8/22/xx PRN		SODIUM CHLORIDE INJ 10 ML AS DIR IV TID DILUENT FOR ATIVAN IV					
14:00 8/22/xx PRN		LORAZEPAM (ATIVAN)*2 MG INJ 1 MG IV TID PRN ANXIETY					
9:30 8/21/xx PRN		TUCKS 40 PADS APPLY APPLY TOPICAL Q4H TO RECTUM PRN					
9:30 8/21/xx PRN		ANUSOL SUPP 1 SUPP 1 SUPP PR Q4H					
16:00 8/18/xx PRN		MEPERIDINE* (DEMEROL) INJ 25 MG 10 MG IV Q1H PRN PAIN IN ADDITION TO PCA					

Gluteus	Thigh
A. Right	H. Right
B. Left	I. Left
Ventro Gluteal	Deltoid
C. Right	J. Right
D. Left	K. Left
E. Abdomen	1 | 2 3 | 4
Page 1 of 2	DAILY

STANDARD TIMES
DAILY= 0900
BID = Q12H = 0900 & 2100
TID = 0800, 1400, 2200
Q8H = 0800, 1600, 2400
QID = 0800, 1200, 1800, 2200
Q6H = 0600, 1200, 1800, 2400
Q4H = 0400, 0800, 1200. . .
DAILY DIGOXIN = 1700
DAILY WARFARIN = 1600

NURSE'S SIGNATURE INITIAL
0701-1500 ____________________
1501-2300 ____________________
2301-0700 ____________________
Ok'd by ____________________

ALLERGIES: NAFCILLIN
BACTRIM
SULFA
TRIMETHOPRIM
CIPROFLOXACIN HCL

Patient Smith, John
Patient # 3-90301-4
Physician: J. Physician, M.D.
Room: 407-4 South

FROM: 08/30/xx 0701 TO: 08/31/xx 0700

50. Describe the strategy that would prevent this medication error.

Possible Scenario

Suppose a physician wrote an order for *gentamicin 100 mg* to be given IV q.8h to a patient hospitalized with meningitis. The unit secretary transcribed the order as:

gentamicin 100 mg IV q.8h

(12 AM–6 AM–12 PM–6 PM)

The medication nurse checked the order without noticing the discrepancy in the administration times. Suppose the patient received the medication every 6 hours for 3 days before the error was noticed.

Potential Outcome

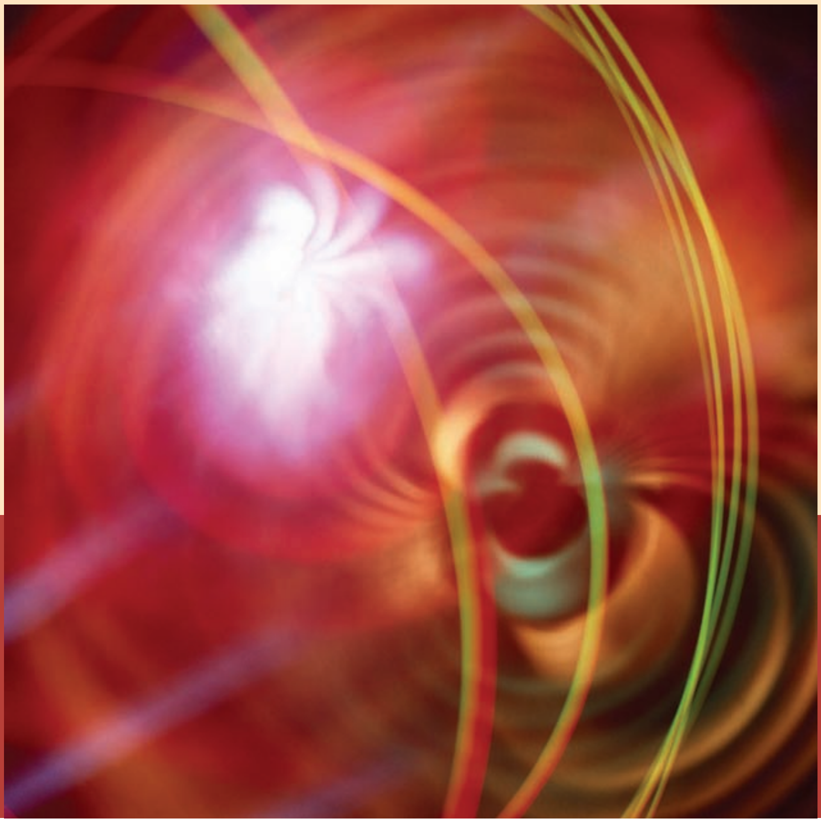
The patient would have received one extra dose each day, which is equivalent to one third more medication daily. Most likely, the physician would be notified of the error, and the medication would be discontinued with serum gentamicin levels drawn. The levels would likely be in the toxic range, and the patient's gentamicin levels would be monitored until the levels returned to normal. This patient would be at risk of developing ototoxicity or nephrotoxicity from the overdose of gentamicin.

Prevention

____

____

After completing these problems, see page 482 to check your answers.



8

Understanding Drug Labels

OBJECTIVES

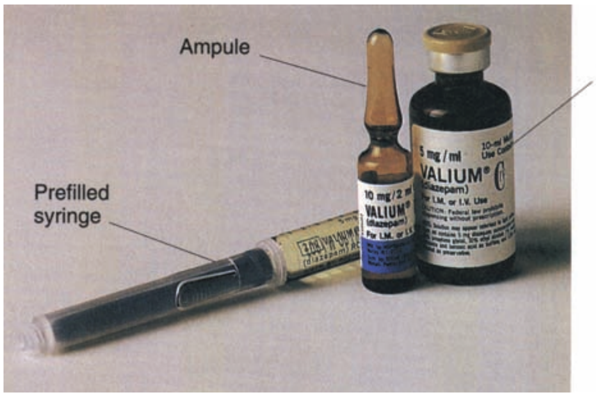
Upon mastery of Chapter 8, you will be able to read and understand the labels of the medications you have available. To accomplish this you will also be able to:

- Find and differentiate the brand and generic names of drugs.
- Determine the dosage strength.
- Determine the form in which the drug is supplied.
- Determine the supply dosage or concentration.
- Identify the total volume of the drug container.
- Differentiate the total volume of the container from the supply dosage.
- Find the directions for mixing or preparing the supply dosage of drugs, as needed.
- Recognize and follow drug alerts.
- Identify the administration route.
- Check the expiration date.
- Identify the lot or control number, National Drug Code, bar code symbols, and controlled substance classifications.
- Recognize the manufacturer's name.
- Differentiate labels for multidose and unit dose containers.
- Identify combination drugs.
- Describe supply dosage expressed as a ratio or percent.

The drug order prescribes how much of a drug the patient is to receive. The nurse must prepare the order from the drugs on hand. The drug label tells how the available drug is supplied. Examine the various preparations, labels, and dosage strengths of Valium injection, Figure 8-1.

Look at the following common drug labels to learn to recognize pertinent information about the drugs supplied.

FIGURE 8-1 Various Valium preparations



BRAND AND GENERIC NAMES

The brand, trade, or proprietary name is the manufacturer's name for a drug. Notice that the brand name is usually the most prominent word on the drug label—large type and boldly visible to promote the product. It is often followed by the registered sign (®) meaning that both the name and formulation are so designated. The generic, or established, nonproprietary name appears directly under the brand name. Sometimes the generic name is also placed inside parentheses. By law, the generic name must be identified on all drug labels.


NDC 63323-280-02 28002
FUROSEMIDE
INJECTION, USP
20 mg/2 mL
(10 mg/mL)
For IM or IV Use Rx only
2 mL Single Dose Vial
Preservative Free
Discard unused portion.
PROTECT FROM LIGHT.
Do not use if discolored.
American Pharmaceutical Partners, Inc.
Los Angeles, CA 90024
401803A
LOT
EXP

Generic drug (furosemide)


NDC 0088-1712-53
Carafate®
Tablets
sucralfate
1 gram
120 Tablets
Aventis

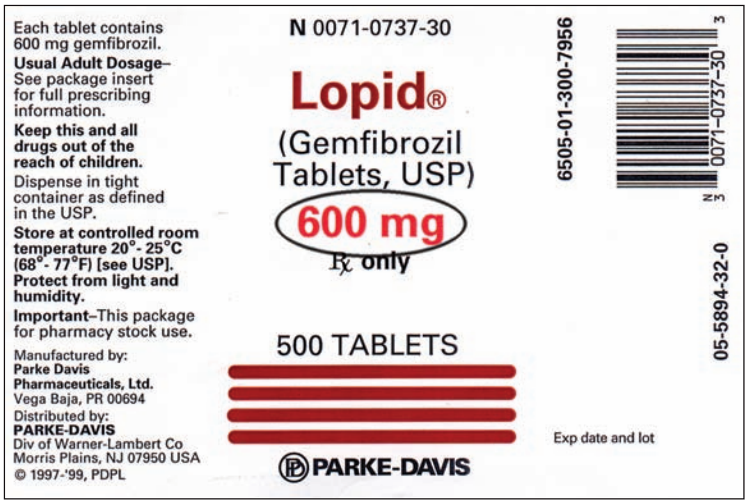
℞ ONLY
Each CARAFATE® Tablet contains 1g sucralfate.
Dosage and Administration: See package insert for dosage information.
WARNING: Keep out of reach of children.
Pharmacist: Dispense in light-resistant, tight container with child-resistant closure.
Important: This package is not child-resistant.
Store at controlled room temperature 59–86°F (15–30°C).
Aventis Pharmaceuticals Inc.
Kansas City, MO 64137
USA ©2000
www.aventispharma-us.com
Exp
3 0088-1712-53 6
50059224

Brand name (Carafate) and generic name (sucralfate)

Generic equivalents of many brand-name drugs are ordered as substitutes by the prescribing practitioner's preference or pharmacy policy. Because only the generic name appears on these labels, nurses need to carefully cross-check all medications. Failure to do so could cause inaccurate drug identification.

DOSAGE STRENGTH

The dosage strength refers to the dosage *weight* or amount of drug provided in a specific unit of measurement. The dosage strength of Lopid tablets is 600 milligrams (the weight and specific unit of measurement) per tablet. Some drugs, such as V-cillin K, have two different but equivalent dosage strengths. V-cillin K has a dosage strength of 250 milligrams (per tablet) or 400,000 units (per tablet). This allows prescribers to order the drug using either unit of measurement.


Each tablet contains 600 mg gemfibrozil.
Usual Adult Dosage–See package insert for full prescribing information.
Keep this and all drugs out of the reach of children.
Dispense in tight container as defined in the USP.
Store at controlled room temperature 20°- 25°C (68°- 77°F) [see USP]. Protect from light and humidity.
Important–This package for pharmacy stock use.
Manufactured by: **Parke Davis Pharmaceuticals, Ltd.** Vega Baja, PR 00694
Distributed by: **PARKE-DAVIS** Div of Warner-Lambert Co Morris Plains, NJ 07950 USA
© 1997-'99, PDPL

600 milligrams

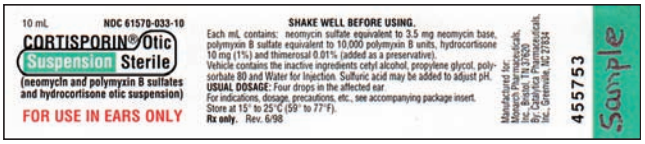

CAUTION—Federal (U.S.A.) law prohibits dispensing without prescription.
Usual Adult Dose—125 to 500 mg (200,000 to 800,000 units) every 6 to 8 hours.
See accompanying literature.
Dispense in a tight container.
Each tablet contains Penicillin V Potassium equivalent to 250 mg (400,000 units) Penicillin V.
Keep Tightly Closed
Store at Controlled Room Temperature 59° to 86°F (15° to 30°C)
Eli Lilly & Co., Indianapolis, IN 46285, U.S.A.
WW 2290 AMX

250 milligrams (400,000 units)

FORM

The form identifies the *structure* and *composition* of the drug. Solid dosage forms for oral use include tablets and capsules. Some powdered or granular medications that are not manufactured in tablet or capsule form can be directly combined with food or beverages and administered. Others must be reconstituted (liquefied) and measured in a precise liquid volume, such as milliliters, drops, or ounces. They may be a crystalloid (clear solution) or a suspension (solid particles in liquid that separate when held in a container).

Fiber granular drug added to beverage/Tablespoon


SHAKE WELL BEFORE USING.
Each mL contains: neomycin sulfate equivalent to 3.5 mg neomycin base, polymyxin B sulfate equivalent to 10,000 polymyxin B units, hydrocortisone 10 mg (1%) and thimerosal 0.01% (added as a preservative).
Vehicle contains the inactive ingredients cetyl alcohol, propylene glycol, polysorbate 80 and Water for Injection. Sulfuric acid may be added to adjust pH.
USUAL DOSAGE: Four drops in the affected ear.
For indications, dosage, precautions, etc., see accompanying package insert.
Store at 15° to 25°C (59° to 77°F).
Rx only. Rev. 6/98
Manufactured for: Monarch Pharmaceuticals, Inc., Bristol, TN 37620
By: Catalytica Pharmaceuticals, Inc., Greenville, NC 27834

Otic Suspension Sterile drops

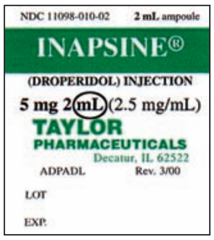

85014902
Dosage: See package insert.
Store between 15°C - 30°C (59°F - 86°F).
Keep this and all drugs out of the reach of children.
Novartis Pharmaceuticals Corporation
East Hanover, New Jersey 07936
Dispense in tight, light-resistant container (USP).

Tablets

Capsules

Injectable medications may be supplied in solution or dry powdered form to be reconstituted. Once reconstituted, they are measured in milliliters or cubic centimeters.

Medications are also supplied in a variety of other forms, such as suppositories, creams, and patches.


NDC 11098-010-02 2 mL ampoule
INAPSINE®
(DROPERIDOL) INJECTION
5 mg 2 mL (2.5 mg/mL)
TAYLOR PHARMACEUTICALS
Decatur, IL 62522
ADPADL Rev. 3/00
LOT
EXP.

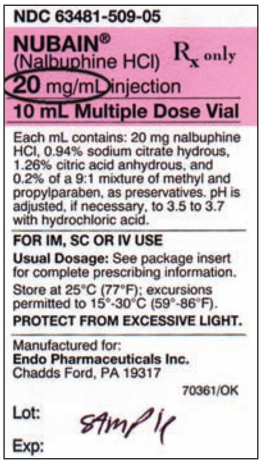
Milliliters

SUPPLY DOSAGE

The supply dosage refers to both *dosage strength* and *form.* It is read "X measured units per some quantity." For solid-form medications, such as tablets, the supply dosage is X measured units per tablet. For liquid medications, the supply dosage is the same as the medication's concentration, such as X measured units per milliliter. Take a minute to read the supply dosage printed on the following labels.


DERIVED FROM PORCINE INTESTINES. Each mL contains heparin sodium 10,000 USP units, sodium chloride 5 mg and benzyl alcohol 0.01 mL in Water for Injection. pH 5.0-7.5; sodium hydroxide and/or hydrochloric acid added, if needed, for pH adjustment.
4 mL MULTIPLE DOSE Vial
NDC 0641-2470-41 ℞ only
HEPARIN
SODIUM INJECTION, USP
10,000 units /1 mL
FOR IV OR SC USE
esi® ELKINS-SINN, INC. Cherry Hill, NJ 08003
Store at controlled room temperature 20° to 25°C (68° to 77°F). [see USP]
USUAL DOSAGE: See package insert.
U2470-41-2
LOT
EXP.

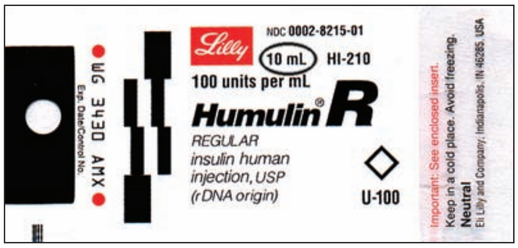
10,000 units per milliliter


NDC 63481-509-05
NUBAIN®
(Nalbuphine HCl) ℞ only
20 mg/mL injection
10 mL Multiple Dose Vial
Each mL contains: 20 mg nalbuphine HCl, 0.94% sodium citrate hydrous, 1.26% citric acid anhydrous, and 0.2% of a 9:1 mixture of methyl and propylparaben, as preservatives. pH is adjusted, if necessary, to 3.5 to 3.7 with hydrochloric acid.
FOR IM, SC OR IV USE
Usual Dosage: See package insert for complete prescribing information.
Store at 25°C (77°F); excursions permitted to 15°-30°C (59°-86°F).
PROTECT FROM EXCESSIVE LIGHT.
Manufactured for:
Endo Pharmaceuticals Inc.
Chadds Ford, PA 19317
70361/OK
Lot: sample
Exp:

20 milligrams per milliliter

TOTAL VOLUME

The total volume refers to the *full quantity* contained in a package, bottle, or vial. For tablets and other solid medications, it is the total number of individual items. For liquids, it is the total fluid volume.


WG 3430 AMX
Exp. Date/Control No.
Lilly NDC 0002-8215-01
10 mL HI-210
100 units per mL
Humulin® R
REGULAR
insulin human
injection, USP
(rDNA origin)
U-100
Important: See enclosed insert.
Keep in a cold place. Avoid freezing.
Neutral
Eli Lilly and Company, Indianapolis, IN 46285, USA

10 milliliters


NDC 0083-0019-76 FSC 1841
6505-01-302-4467
Tegretol®
carbamazepine USP
Suspension
100 mg/5 mL
IMPORTANT: Shake well before using.
Each 5 mL contains 100 mg carbamazepine USP.
450 mL
Dispense in tight, light-resistant container (USP).
Caution: Federal law prohibits dispensing without prescription.
ciba
Keep this and all drugs out of the reach of children.
Dosage: See package insert.
Do not store above 86°F (30°C).
Mfd. by:
Ciba-Geigy Canada, Ltd.
Dorval, Quebec, Canada
Dist. by:
Ciba-Geigy Corporation
Pharmaceuticals Division
Summit, NJ 07901
P550831
893972
N 3 0083-0019-76 1

450 milliliters

ADMINISTRATION ROUTE

The administration route refers to the *site* of the body or *method of drug delivery* into the patient. Examples of routes of administration include oral, enteral (into the gastrointestinal tract through a tube), sublingual, injection (IV, IM, subcut), otic, optic, topical, rectal, vaginal, and others. Unless specified otherwise, tablets, capsules, and caplets are intended for oral use.

Warning–To prevent loss of potency, keep these tablets in the original container. Close tightly immediately after each use.

N 0071-0418-24

Nitrostat®

(Nitroglycerin Tablets,USP)

0.4 mg (1/150 gr)

℞ only

100 SUBLINGUAL TABLETS

PARKE-DAVIS

Usual Dosage–0.3 to 0.6 mg sublingually as needed.

See package insert for full prescribing information.

Keep this and all drugs out of the reach of children.

Dispense in original, unopened container.

Store at Controlled Room Temperature 20°-25°C (68°-77°F) [see USP].

Manufactured by:
Parke Davis Pharmaceuticals, Ltd.
Vega Baja, PR 00694

Distributed by:
PARKE-DAVIS
Div of Warner-Lambert Co
Morris Plains, NJ 07950 USA
© 1999, PDPL

6505-00-687-3663

0418G030

Sublingual

PHARMACIST/ NURSE/PATIENT: Please note diagram to the right. ← Fill the dropper to the level of the prescribed dose. **Discard opened bottle after 90 days. PROTECT FROM LIGHT.**

Furosemide Oral Solution
10 mg per mL

NDC 0054-3294-46

60 mL

FUROSEMIDE
Oral Solution

10 mg per mL

Each mL contains:
Furosemide 10 mg
SUGAR FREE
℞ only

See Package Insert For Complete Prescribing Information.
PROTECT FROM LIGHT

Roxane Laboratories, Inc.
Columbus, Ohio 43216

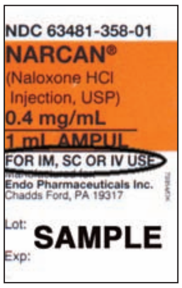
4117540//02

© RLI, 2001

Dispense only in this bottle and only with the calibrated dropper provided. Store at Controlled Room Temperature 15°-30°C (59°-86°F).

EXP. LOT

Oral



NDC 63481-358-01

NARCAN®
(Naloxone HCl
Injection, USP)
0.4 mg/mL
1 mL AMPUL

FOR IM, SC OR IV USE

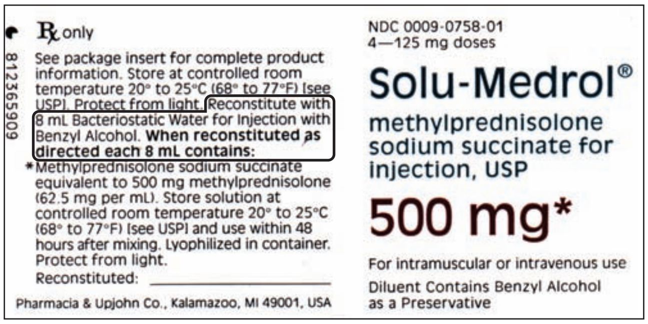
Endo Pharmaceuticals Inc.
Chadds Ford, PA 19317

Lot:
SAMPLE
Exp:

Intramuscular (IM),
Subcutaneous (subcut),
or Intravenous (IV)

DIRECTIONS FOR MIXING OR RECONSTITUTING

Some drugs are dispensed in *powder* form and must be *reconstituted for use.* (Reconstitution is discussed further in Chapters 10 and 12.)



℞ only

812365909

See package insert for complete product information. Store at controlled room temperature 20° to 25°C (68° to 77°F) [see USP]. Protect from light. Reconstitute with 8 mL Bacteriostatic Water for Injection with Benzyl Alcohol. **When reconstituted as directed each 8 mL contains:**
*Methylprednisolone sodium succinate equivalent to 500 mg methylprednisolone (62.5 mg per mL). Store solution at controlled room temperature 20° to 25°C (68° to 77°F) [see USP] and use within 48 hours after mixing. Lyophilized in container. Protect from light.

Reconstituted: ________________

Pharmacia & Upjohn Co., Kalamazoo, MI 49001, USA

NDC 0009-0758-01
4—125 mg doses

Solu-Medrol®

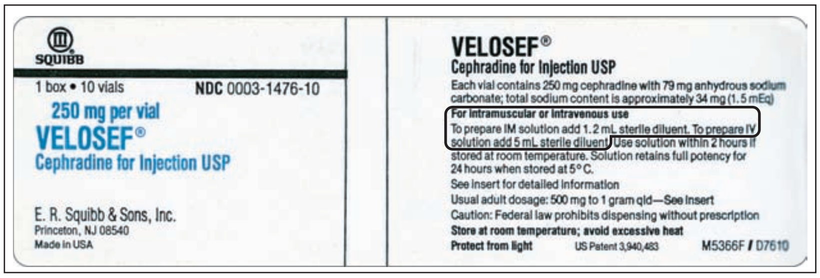
methylprednisolone sodium succinate for injection, USP

500 mg*

For intramuscular or intravenous use

Diluent Contains Benzyl Alcohol as a Preservative

See directions



SQUIBB

1 box • 10 vials **NDC** 0003-1476-10

250 mg per vial

VELOSEF®

Cephradine for Injection USP

E. R. Squibb & Sons, Inc.
Princeton, NJ 08540
Made in USA

VELOSEF®

Cephradine for Injection USP

Each vial contains 250 mg cephradine with 79 mg anhydrous sodium carbonate; total sodium content is approximately 34 mg (1.5 mEq)

For intramuscular or intravenous use

To prepare IM solution add 1.2 mL sterile diluent. To prepare IV solution add 5 mL sterile diluent. Use solution within 2 hours if stored at room temperature. Solution retains full potency for 24 hours when stored at 5° C.

See insert for detailed information

Usual adult dosage: 500 mg to 1 gram qid—See insert

Caution: Federal law prohibits dispensing without prescription

Store at room temperature; avoid excessive heat

Protect from light US Patent 3,940,483 M5366F / D7610

See directions

150 mL CECLOR® CEFACLOR FOR ORAL SUSPENSION, USP

125 mg per 5 mL. Oversize bottle provides extra space for shaking. Store in a refrigerator. May be kept for 14 days without significant loss of potency. Keep Tightly Closed. Discard unused portion after 14 days.

SHAKE WELL BEFORE USING

Control No.

Usual Dose—Pediatric patients, 20 mg per kg a day (40 mg per kg in otitis media) in three divided doses. Adults, 250 mg three times a day. See literature for complete dosage information.

Contains Cefaclor Monohydrate equivalent to 3.75 g anhydrous Cefaclor in a dry pleasantly flavored mixture.

Prior to Mixing, Store at Controlled Room Temperature 59° to 86°F (15° to 30°C)

Directions for Mixing—Add 90 mL of water in two portions to the dry mixture in the bottle. Shake well after each addition.

Each 5 mL (Approx. one teaspoonful) will then contain: Cefaclor Monohydrate equivalent to 125 mg anhydrous Cefaclor.

WV 6465 AMX

Eli Lilly and Company
Indianapolis, IN 46285, USA

Expiration Date

NDC **0002-5057-68**

150 mL (When Mixed) **M-5057**

℞ Lilly

CECLOR®
CEFACLOR FOR
ORAL SUSPENSION, USP

125 mg
per 5 mL

CAUTION—Federal (USA) law prohibits dispensing without prescription.

N 3 0002-5057-68 4

PULL

See directions

LABEL ALERTS

Manufacturers may print warnings on the packaging or special alerts may be added by the pharmacy before dispensing. Look for special storage alerts such as "refrigerate at all times," "keep in a dry place," "replace cap and close tightly before storing," or "protect from light." Reconstituted suspensions may be dispensed already prepared for use, and directions may instruct the health care professional to "shake well before using" as a reminder to remix the components. Read and follow all label instructions carefully.

See alert

See alert

See alerts

NAME OF THE MANUFACTURER

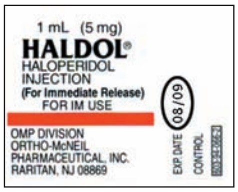
The name of the manufacturer is circled on the following labels.

Pfizer/Roerig

Mylan Pharmaceuticals, Inc.

EXPIRATION DATE

The medication should be used, discarded, or returned to the pharmacy by the expiration date. Further, note the special expiration instructions given on labels for reconstituted medications. Refer to the Solu-Medrol, Velosef, and Ceclor labels on page 135.



08/09

LOT OR CONTROL NUMBERS

Federal law requires all medication packages to be identified with a lot or control number. If a drug is recalled, for reasons such as damage or tampering, the lot number quickly identifies the particular group of medication packages to be removed from shelves. This number has been invaluable for vaccine and over-the-counter medication recalls.

Control number

Lot number

NATIONAL DRUG CODE (NDC)

Federal law requires every prescription medication to have a unique identifying number, much like every U.S. citizen has a unique Social Security number. This number must appear on every manufacturer's label and is printed with the letters "NDC" followed by three discrete groups of numbers (e.g., NDC 0083-0052-30 for Tegretol).

NDC

CONTROLLED SUBSTANCE SCHEDULE

The Controlled Substances Act was passed in May 1971. One of its purposes was to improve the administration and regulation of the production, distribution, and dispensing of controlled substances. Drugs considered controlled substances are classified according to their potential for use and abuse. Drugs are classified into numbered levels or schedules from Schedule I to Schedule V. Drugs that have the highest potential for abuse are Schedule I drugs and those with lowest potential for abuse are Schedule V drugs. The schedule number of controlled substances is indicated on the drug label.

BAR CODE SYMBOLS

Bar code symbols are commonly used in retail sales. Bar code symbols also document drug dosing for recordkeeping and stock reorder, and can automate medication documentation right at the patient's bedside. The horizontal ones look like picket fences and the vertical ones look like ladders.

Bar codes

UNITED STATES PHARMACOPEIA (USP) AND NATIONAL FORMULARY (NF)

These codes are found on many manufacturer-printed medication labels. The USP and NF are the two official national lists of approved drugs. Each manufacturer follows special guidelines that determine when to include these initials on a label. These initials are placed after the generic drug name. Be careful not to mistake these abbreviations for other initials that designate specific characteristics of a drug, such as *SR,* which means *sustained release.*

USP

UNIT- OR SINGLE-DOSE LABELS

Most oral medications administered in the hospital setting are available in unit dosage, such as a single capsule or tablet packaged separately in a typical blister pack. The pharmacy provides a 24-hour supply of each drug for the patient. The only major difference in this form of labeling is that the total volume of the container is usually omitted, because the volume is one tablet or capsule. Likewise, the dosage strength is understood as *per one.* Further, injectable medicines are packaged in single-dose preparations.

Unit dose
single use vial

COMBINATION DRUGS

Some medications are a combination of two or more drugs in one form. Read the labels for Percocet and Augmentin and notice the different substances that are combined in each tablet. Combination drugs are usually prescribed by the number of tablets, capsules, or milliliters to be given rather than by the dosage strength.

Combination drugs

SUPPLY DOSAGE EXPRESSED AS A RATIO OR PERCENT

Occasionally, solutions will be ordered and/or manufactured in a supply dosage expressed as a ratio or percent.

RULE

Ratio solutions express the number of grams of the drug per total milliliters of solution.

EXAMPLE ■

Epinephrine 1:1,000 contains 1 g pure drug per 1,000 mL solution, 1 g:1,000 mL = 1,000 mg:1,000 mL = 1 mg:1 mL.

1:1,000

RULE

Percentage (%) solutions express the number of grams of the drug per 100 milliliters of solution.

EXAMPLE ■

Lidocaine 2% contains 2 g pure drug per 100 mL solution, 2 g per 100 mL = 2,000 mg per 100 mL = 20 mg/mL.

2%

Although these labels look different from many of the other labels, it is important to recognize that the supply dosage can still be determined. Many times the label will have a more commonly identified supply dosage and not just the ratio or percent. Look at the epinephrine and lidocaine labels. On the epinephrine label, the ratio is 1:1,000; the supply dosage also can be identified as 1 mg/mL. On the lidocaine label, the percentage is 2%; the supply dosage also can be identified as 20 mg/mL.

CHECKING LABELS

Recall the Six Rights of medication administration: The *right patient* must receive the *right drug* in the *right amount* by the *right route* at the *right time* followed by the *right documentation.* To be absolutely sure the patient receives the right drug, check the label three times.

CAUTION

Before administering a medication to a patient, check the drug label three times:

1. Against the medication order or MAR.
2. Before preparing the medication.
3. After preparing the medication and before administering it.

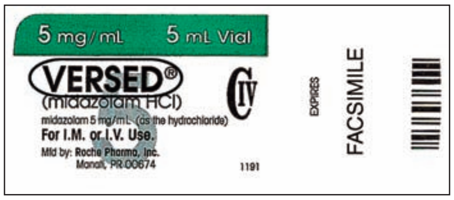
QUICK REVIEW

Read labels carefully to:

- Identify the drug and the manufacturer.
- Differentiate between dosage strength, form, supply dosage, total container volume, and administration route.
- Recognize that the drug's supply dosage similarly refers to a drug's weight per unit of measure or concentration.
- Find the directions for reconstitution, as needed.
- Note expiration date.
- Describe lot or control number.
- Identify supply dosage on labels with ratios and percents.
- Be sure you administer the right drug.

Review Set 22

Use the following labels A through G to find the information requested in questions 1 through 15. Indicate your answer by letter (A through G).



A

B

C

D

Usual Dose—Pediatric patients, 20 mg per kg a day (40 mg per kg in otitis media) in three divided doses. Adults, 250 mg three times a day. See literature for complete dosage information.
Contains Cefaclor Monohydrate equivalent to 3.75 g anhydrous Cefaclor in a dry pleasantly flavored mixture.
Prior to Mixing, Store at Controlled Room Temperature 59° to 86°F (15° to 30°C)
Directions for Mixing—Add 45 mL of water in two portions to the dry mixture in the bottle. Shake well after each addition.
Each 5 mL (Approx. one teaspoonful) will then contain: Cefaclor Monohydrate equivalent to 250 mg anhydrous Cefaclor.

WV 6475 AMX

Eli Lilly and Company
Indianapolis, IN 46285, USA

Expiration Date

75 mL CECLOR® CEFACLOR FOR ORAL SUSPENSION, USP **250 mg per 5 mL.** Oversize bottle provides extra space for shaking. Store in a refrigerator. May be kept for 14 days without significant loss of potency. Keep Tightly Closed. Discard unused portion after 14 days. SHAKE WELL BEFORE USING

Control No.

NDC 0002-5058-18
75 mL (When Mixed) M-5058
℞ Lilly
CECLOR®
CEFACLOR FOR ORAL SUSPENSION USP
250 mg
per 5 mL
CAUTION—Federal (USA) law prohibits dispensing without prescription.

9 0002-5058-18 PULL
N 3

E

NSN 6505-01-425-7431

N 3 0310-0604-30 8

Nolvadex®
TAMOXIFEN CITRATE
20 MG TABLETS

Equivalent to
20 mg tamoxifen

CAUTION: Federal law prohibits dispensing without prescription.

30 TABLETS

ZENECA
Pharmaceuticals
A Business Unit of Zeneca Inc.
Wilmington, Delaware 19850-5437

USUAL DOSAGE: For patients with breast cancer, the recommended daily dose is 20-40 mg. Dosages greater than 20 mg per day should be given in divided doses (morning and evening).

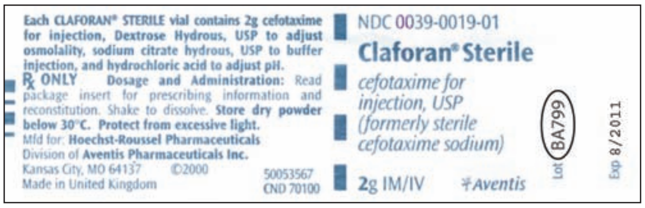
WARNING: As with all medications, keep out of the reach of children. Store at controlled room temperature, 20°-25°C (68°-77°F) [see USP].

US Pat. 4536516

60105-00

LOT 9900444
EXP 4/2011

F



Each CLAFORAN® STERILE vial contains 2g cefotaxime for injection, Dextrose Hydrous, USP to adjust osmolality, sodium citrate hydrous, USP to buffer injection, and hydrochloric acid to adjust pH.
℞ ONLY **Dosage and Administration:** Read package insert for prescribing information and reconstitution. Shake to dissolve. **Store dry powder below 30°C. Protect from excessive light.**
Mfd for: **Hoechst-Roussel Pharmaceuticals**
Division of **Aventis Pharmaceuticals Inc.**
Kansas City, MO 64137 ©2000
Made in United Kingdom
50053567
CND 70100

NDC 0039-0019-01
Claforan® Sterile
cefotaxime for injection, USP (formerly sterile cefotaxime sodium)
2g IM/IV
Aventis

Lot BA799
Exp 8/2011

G

1. The total volume of the liquid container is circled. ________
2. The dosage strength is circled. ________
3. The form of the drug is circled. ________
4. The brand name of the drug is circled. ________
5. The generic name of the drug is circled. ________
6. The expiration date is circled. ________
7. The lot number is circled. ________
8. Look at label E and determine how much of the supply drug you will administer to the patient per dose for the order **Ceclor 250 mg p.o. q.8h p.r.n.** ________
9. Look at label A and determine the route of administration. ________
10. Indicate which labels have an imprinted bar code symbol. ________
11. Look at label C. What does the word *Filmtab* mean on this label? ________
12. Look at label B, and determine the supply dosage. ________
13. Look at label F, and determine how much of the supply drug you will administer to the patient per dose for the order **Tamoxifen 40 mg p.o. q.12h.** ________
14. Which drug label(s) represent controlled substance(s)? ________
15. Evaluate the potential for abuse of the controlled substance drug(s) identified in question 14.

____

Refer to the following label to identify the specific drug information described in questions 16 through 21.

READ ACCOMPANYING PROFESSIONAL INFORMATION.

RECOMMENDED STORAGE IN DRY FORM.

Store below 86°F (30°C)

Sterile solution may be kept in refrigerator for one (1) week without significant loss of potency.

CAUTION: Federal law prohibits dispensing without prescription.

6505-00-958-3305

NDC 0049-0520-83

Buffered

Pfizerpen®

(penicillin G potassium)

For Injection

FIVE MILLION UNITS

Pfizer Roerig

Division of Pfizer Inc, NY, NY 10017

USUAL DOSAGE

Average single intramuscular injection: 200,000-400,000 units.

Intravenous: Additional information about the use of this product intravenously can be found in the package insert.

mL diluent added	Units per mL of solution
18.2 mL	250,000
8.2 mL	500,000
3.2 mL	1,000,000

Buffered with sodium citrate and citric acid to optimum pH.

PATIENT: ________

ROOM NO: ________

DATE DILUTED: ________

05-4243-00-3
MADE IN USA

16. Generic name ________________

17. Brand name ________________

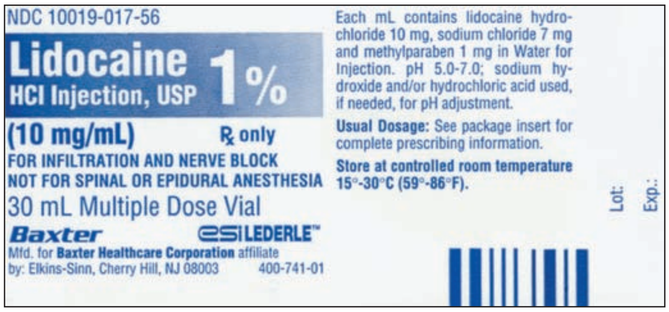
18. Dosage strength ________________

19. Route of administration ________________

20. National Drug Code ________________

21. Manufacturer ________________

Refer to the following label to answer questions 22 through 24.



NDC 10019-017-56

Lidocaine 1%

HCl Injection, USP

(10 mg/mL) **℞ only**

FOR INFILTRATION AND NERVE BLOCK

NOT FOR SPINAL OR EPIDURAL ANESTHESIA

30 mL Multiple Dose Vial

Baxter ESI LEDERLE™

Mfd. for **Baxter Healthcare Corporation** affiliate
by: Elkins-Sinn, Cherry Hill, NJ 08003 400-741-01

Each mL contains lidocaine hydrochloride 10 mg, sodium chloride 7 mg and methylparaben 1 mg in Water for Injection. pH 5.0-7.0; sodium hydroxide and/or hydrochloric acid used, if needed, for pH adjustment.

Usual Dosage: See package insert for complete prescribing information.

Store at controlled room temperature 15°-30°C (59°-86°F).

Lot:

Exp.:

22. The supply dosage of the drug is ________ %.

23. The supply dosage of the drug is ________ g per ________ mL.

24. The supply dosage of the drug is ________ mg per mL.

After completing these problems, see page 482 to check your answers.

CRITICAL THINKING SKILLS

Reading the labels of medications is critical. Make sure that the drug you want is what you have on hand before you prepare it. Let's look at an example of a medication error related to reading the label incorrectly.

ERROR

Not checking the label for correct dosage.

Possible Scenario

A nurse flushed a triple central venous catheter (an IV with three ports). According to hospital policy, the nurse was to flush each port with 10 mL of normal saline followed by 2 mL of heparin flush solution in the concentration of 100 units/mL. The nurse mistakenly picked up a vial of heparin containing heparin 10,000 units/mL. Without checking the label, she prepared the solution for all three ports. The patient received 60,000 units of heparin instead of 600 units.

Potential Outcome

The patient in this case would be at great risk for hemorrhage, leading to shock and death. Protamine sulfate would likely be ordered to counteract the action of the heparin, but a successful outcome is questionable.

Prevention

There is no substitute for checking the label before administering a medication. The nurse in this case having drawn three different syringes of medication for the three ports, had three opportunities to catch the error.

PRACTICE PROBLEMS—CHAPTER 8

Look at labels A through G, and identify the information requested.

Label A:

1. The supply dosage of the drug in milliequivalents is ______________________.
2. The National Drug Code is ______________________.
3. The supply dosage of the drug in milligrams is ______________________.

NDC 63323-006-50 0650

SODIUM BICARBONATE

INJECTION, USP, 8.4%

84 mg/mL

50 mEq/50 mL

(1mEq/mL)

For IV Use Only

50 mL Rx only

Single Dose Vial

Sterile, Nonpyrogenic

Preservative Free

Discard unused portion.

Each mL contains: Sodium bicarbonate 84 mg; Water for Injection q.s. Carbon dioxide is added for pH adjustment.

50 mEq/50 mL

2 mOsmol/mL (calc.)

Usual Dosage: See Insert.

DO NOT USE IF PRECIPITATE IS PRESENT.

Use only if seal is intact.

Store at controlled room temperature 15°-30°C (59°-86°F).

A

Label B:

4. The generic name of the drug is ______________________________.

5. The reconstitution instruction to mix a supply dosage of 100 mg per 5 mL for oral suspension is ______________________________.

6. The manufacturer of the drug is ______________________________.


EXP.:
LOT:

℞ only
See package insert for dosage and complete product information.

Warning: Not for injection

Store unconstituted product at controlled room temperature 20° to 25°C (68° to 77°F) [see USP]. Store constituted suspension in a refrigerator 2° to 8°C (36° to 46°F). Shake well before using. Keep container tightly closed. The mixture may be used for 14 days. Discard unused portion after 14 days.

Directions for mixing: Shake bottle to loosen granules. Add approximately 1/2 the total amount of distilled water required for constitution (total water = 29 mL). Shake vigorously to wet the granules. Add remaining water and shake vigorously.

Each 5 mL of suspension contains cefpodoxime proxetil equivalent to 100 mg cefpodoxime.

U.S. Patent Nos. 4,486,425; 4,409,215

Licensed from Sankyo Company, Ltd., Japan
Manufactured by
Pharmacia & Upjohn S.A.-N.V., Puurs - Belgium
for
Pharmacia & Upjohn Company
Kalamazoo, MI 49001, USA

817 150 101
505358

NDC 0009-3615-03
50 mL (when mixed)

Vantin® For Oral Suspension
cefpodoxime proxetil
for oral suspension

100 mg per 5 mL

Equivalent to 100 mg per 5 mL cefpodoxime when constituted

Pharmacia
&Upjohn

B

Label C:

7. The total volume of the medication container is ______________________________.

8. The supply dosage is ______________________________.

9. How much will you administer to the patient per dose for the order **Methotrexate 25 mg IV stat?** ______________________________.


Lot:
Exp. Date:

NDC 10019-940-78
Methotrexate
Injection, USP
PRESERVATIVE FREE ℞ only
250 mg (25 mg/mL)
Sterile Isotonic Liquid
10 mL Single Dose Vial
Mfd. for **Baxter Healthcare Corp.** affiliate
by: Bigmar Pharmaceuticals SA
Barbengo, Switzerland

See package insert for routes of administration.

Usual Dosage: Consult package insert for dosage and full prescribing information.

Each mL contains methotrexate sodium equivalent to 25 mg methotrexate.

Inactive Ingredients: Sodium Chloride 0.490% w/v and Water for Injection. Sodium hydroxide and/or hydrochloric acid may be added to adjust pH to 8.5-8.7 during manufacture.

Store at controlled room temperature 15°-30°C (59°-86°F). PROTECT FROM LIGHT. Retain in carton until time of use. Discard any unused portion.

10-1052A 460-228-00

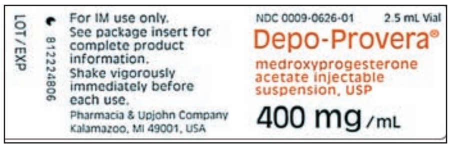
C

Label D:

10. The brand name of the drug is ______________________________.

11. The generic name is ______________________________.

12. The National Drug Code of the drug is ______________________________.


LOT/EXP
812224806

For IM use only.
See package insert for complete product information.
Shake vigorously immediately before each use.
Pharmacia & Upjohn Company
Kalamazoo, MI 49001, USA

NDC 0009-0626-01 2.5 mL Vial
Depo-Provera®
medroxyprogesterone acetate injectable suspension, USP
400 mg /mL

D

Label E:

13. The form of the drug is ______________________________.

14. The total volume of the drug container is ______________________________.

15. The administration route is ______________________________.

FOR INTRAMUSCULAR USE ONLY.
USUAL ADULT DOSE: Intramuscularly: 25 - 100 mg stat; repeat every 4 to 6 hours, as needed.
See accompanying prescribing information.
Each mL contains 50 mg of hydroxyzine hydrochloride, 0.9% benzyl alcohol and sodium hydroxide to adjust to optimum pH.
To avoid discoloration, protect from prolonged exposure to light.
Rx only

10 mL NDC 0049-5460-74
Vistaril®
(hydroxyzine hydrochloride)
Intramuscular Solution
50 mg/mL
Pfizer Roerig
Division of Pfizer Inc, NY, NY 10017

Store below 86°F (30°C).
PROTECT FROM FREEZING.
PATIENT: ______
ROOM NO.: ______
05-1111-32-4
MADE IN USA
9249

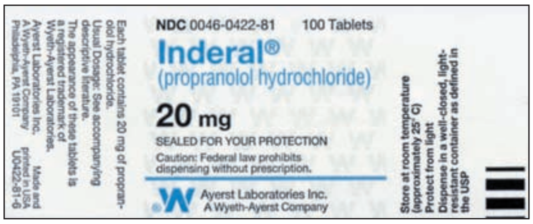
E

Label F:

16. The name of the drug manufacturer is ______________________________.

17. The form of the drug is ______________________________.

18. The appropriate temperature for storage of this drug is ______________________________.



Each tablet contains 20 mg of propranolol hydrochloride.
Usual Dosage: See accompanying descriptive literature.
The appearance of these tablets is a registered trademark of Wyeth-Ayerst Laboratories.
Ayerst Laboratories Inc.
A Wyeth-Ayerst Company
Philadelphia, PA 19101
Made and printed in USA
U0422-81-6

NDC 0046-0422-81 100 Tablets
Inderal®
(propranolol hydrochloride)
20 mg
SEALED FOR YOUR PROTECTION
Caution: Federal law prohibits dispensing without prescription.
Ayerst Laboratories Inc.
A Wyeth-Ayerst Company

Store at room temperature (approximately 25° C)
Protect from light
Dispense in a well-closed, light-resistant container as defined in the USP

F

Label G:

19. The expiration date of the drug is ______________________________.

20. The dosage strength of the drug is ______________________________.

NDC 63323-965-20 96520
POTASSIUM CHLORIDE
For Injection Concentrate, USP
Concentrate Must Be Diluted Before Use
40 mEq (2 mEq/mL)
20 mL
Single Dose Vial
Rx only

Preservative Free
MUST BE DILUTED PRIOR TO IV ADMINISTRATION
Sterile, Nonpyrogenic
Each mL contains:
Potassium chloride 2 mEq (149 mg); Water for Injection q. s. HCl and/or KOH may have been added for pH adjustment.
4000 mOsmol/L (calc.)
Usual Dosage: See Insert.
Store at controlled room temperature 15°-30°C (59°-86°F).
APP AMERICAN PHARMACEUTICAL PARTNERS, INC.
Los Angeles, CA 90024

401701B
LOT
EXP 12/2012

G

Match label H or I with the correct descriptive statement.

21. This label represents a unit- or single-dose drug. __________

22. This label represents a combination drug. __________

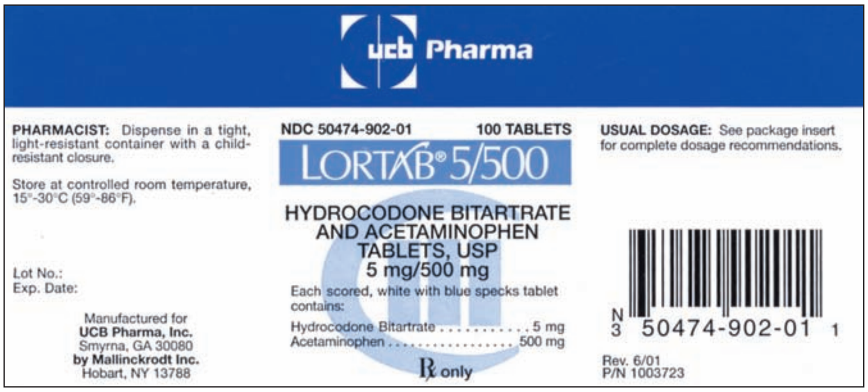
23. This label represents a drug usually ordered by the number of tablets or capsules to be administered rather than the dosage strength. __________

24. The administration route for the drug labeled H is __________.

25. The lot number for the drug labeled I is __________.

26. The controlled substance schedule for the drug labeled H is __________.

H



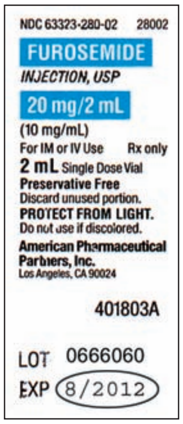
ucb Pharma

PHARMACIST: Dispense in a tight, light-resistant container with a child-resistant closure.
Store at controlled room temperature, 15°-30°C (59°-86°F).
Lot No.:
Exp. Date:
Manufactured for
UCB Pharma, Inc.
Smyrna, GA 30080
by Mallinckrodt Inc.
Hobart, NY 13788

NDC 50474-902-01 100 TABLETS
LORTAB® 5/500
HYDROCODONE BITARTRATE
AND ACETAMINOPHEN
TABLETS, USP
5 mg/500 mg
Each scored, white with blue specks tablet contains:
Hydrocodone Bitartrate .... 5 mg
Acetaminophen .... 500 mg
℞ only

USUAL DOSAGE: See package insert for complete dosage recommendations.
N 3 50474-902-01 1
Rev. 6/01
P/N 1003723

I



NDC 63323-280-02 28002
FUROSEMIDE
INJECTION, USP
20 mg/2 mL
(10 mg/mL)
For IM or IV Use Rx only
2 mL Single Dose Vial
Preservative Free
Discard unused portion.
PROTECT FROM LIGHT.
Do not use if discolored.
American Pharmaceutical Partners, Inc.
Los Angeles, CA 90024
401803A
LOT 0666060
EXP 8/2012

Label J:

27. Expressed as a percentage, the supply dosage of the drug is __________.

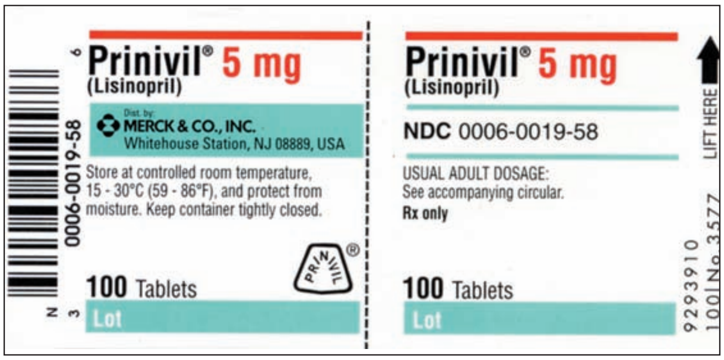
28. The supply dosage is equivalent to __________ g per __________ mL or __________ mg per mL.

J

29. Describe the strategy you would implement to prevent this medication error.

Possible Scenario

Suppose a physician ordered an antibiotic *Principen .5 g p.o. q.6h.* The writing was not clear on the order, and Prinivil (an anti-hypertensive medication) 5 mg was sent up by the pharmacy. However, the order was correctly transcribed to the MAR. In preparing the medication, the nurse did not read the MAR or label carefully and administered Prinivil, the wrong medication.



Potential Outcome

A medication error occurred because the wrong medication was given. The patient's infection treatment would be delayed. Furthermore, the erroneous blood pressure drug could have harmful effects.

Prevention

30. Describe the strategy you would implement to prevent this medication error.

Possible Scenario

Suppose a physician wrote the order *Celebrex 100 mg p.o. q.12h* (anti-inflammatory to treat rheumatoid arthritis pain), but the order was difficult to read. The unit secretary and pharmacy interpreted the order as *Celexa* (antidepressant), a medication with a similar spelling. Celexa was written on the MAR.

Potential Outcome

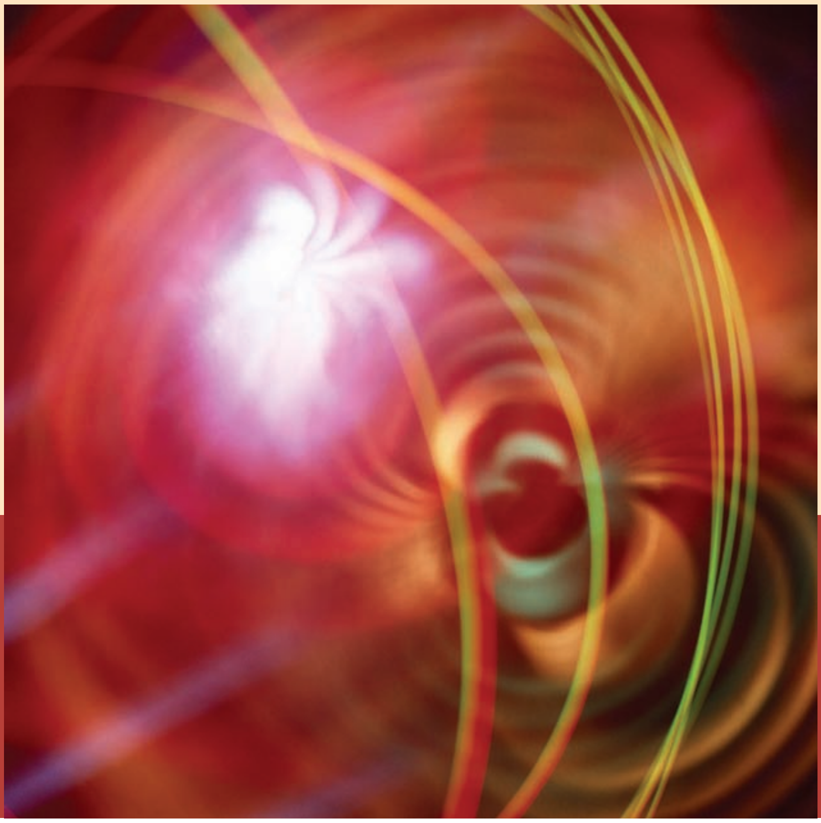
The nurse administered the Celexa for several days, and the patient began complaining of severe knee and hip pain from rheumatoid arthritis. Also, the patient experienced side effects of Celexa, including drowsiness and tremors. A medication error occurred because several health care professionals misinterpreted the order.

Prevention

a) What should have alerted the nurse that something was wrong?

b) What should have been considered to prevent this error?

After completing these problems, see page 482 to check your answers.



9

Preventing Medication Errors

OBJECTIVES

Upon mastery of Chapter 9, you will be able to identify and prevent the common situations that lead to medication administration errors. To accomplish this you will also be able to:

- Describe the consequences and costs of medication errors.
- Cite incidence of hospital injuries and deaths attributable to medication errors.
- Explore evidence and rationale for underreporting of medication errors.
- Name the steps involved in medication administration.
- Identify six common causes of medication errors.
- Identify the role of the nurse in preventing medication errors.
- Describe the role of technology and health care administration in medication error prevention.
- Recognize examples of prescription, transcription, and recording notation errors.
- Correct medical notation errors.
- Describe the recommendations by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) to prevent medication errors.
- Provide a sound rationale for the critical nature of medication administration and the importance of accurate and safe dosage calculations and medication administration.

Medication administration is one of the primary functions of the nurse and other health care practitioners in most health care settings. Unfortunately, medication administration errors are common. Any health care practitioner is potentially at risk for making an error. Several studies addressing the problem indicate there is no relationship between the incidence of medication errors and the characteristics of the nurses who typically make them (i.e., years of practice and education). Statistics indicate that 10% to 18% of all hospital injuries are attributable to medication errors (Mayo & Duncan, 2004). The Institute of Medicine reports that 44,000 to 98,000 people die in U.S. hospitals annually as a result of medication errors that could have been prevented.

The incidence of medication errors by nurses is difficult to accurately determine. Several studies addressing nurses' perception of medication errors support the existence of underreporting by nurses (Mayo & Duncan, 2004; Stetina, Groves, & Pafford, 2005; Wolf & Serembus, 2004). Other research indicates confusion among nurses about what constitutes a drug error. Failure to administer a medication and administering a medication late are the most underreported errors because nurses perceive that the patients will not be harmed in these situations (Mayo & Duncan, 2004; Stetina, Groves, & Pafford, 2005).

The frequency of medication errors made by nurses and the consequences of these errors affect not only the health of the patient but also the overall cost of health care. These medication errors and the reactions that result from them cause increased length of stay, increased cost, patient disability, and death. There are additional indirect consequences as well. These include harm to the nurse involved in regard to his or her personal and professional status, confidence, and practice (Mayo & Duncan, 2004).

The medication delivery process is complex and involves many individuals and departments. This chapter will focus on the critical role of the nurse in this process and the importance of legible medication orders, accurate transcription and interpretation, and safe medication administration.

PRESCRIPTION

The steps involved in safe medication administration begin with the *prescription,* followed by *transcription,* and then *administration.* Only those licensed health care providers who have authority by their state to write prescriptions are permitted to do so; e.g., a medical doctor (MD), an osteopathic doctor (DO), a podiatrist (DPM), a dentist (DDS), a physician's assistant (PA), or an advanced practice nurse (ARNP). Although nurses are not the originator of drug prescriptions, they play an important role in preventing errors in the *prescription* step. Refer back to Chapter 7 to review the seven parts of drug orders: patient's name, date and time of the order, name of the drug, amount of the drug (including the unit of measure), route, frequency or specific administration schedule, and the prescriber's name and licensure. It is important to always remember that the practitioner who administers a drug shares the liability for patient injury, even if the medical order was incorrect. The wise nurse always verifies the safety of the drug order by consulting a reputable drug reference; e.g., the *Hospital Formulary.*

Verbal Orders

In most health care institutions, nurses can receive verbal orders either in person or by phone from licensed physicians or other practitioners who are licensed to prescribe. JCAHO (2006a) recommends that the nurse receiving a verbal or telephone order first **write** it down in the patient's chart or enter it into the computer record; second, **read** it back to the prescriber; and third, **get confirmation** from the individual giving the order that it is correct. For the nurse to only repeat back the order as heard is not sufficient to regularly prevent errors. The nurse should **read back** to ensure that the order is clear to the recipient and in turn confirmed by the individual giving the order. As with written orders, the nurse must also verify that all seven parts of the verbal order have been included and are accurate. If the nurse has any question or concern about the order, it should be clarified during the conversation. Of course, JCAHO advises that in emergency situations, such as a code in the ER, to do a formal read back would not be feasible and would compromise patient safety. In such cases a repeat back is acceptable.

CAUTION

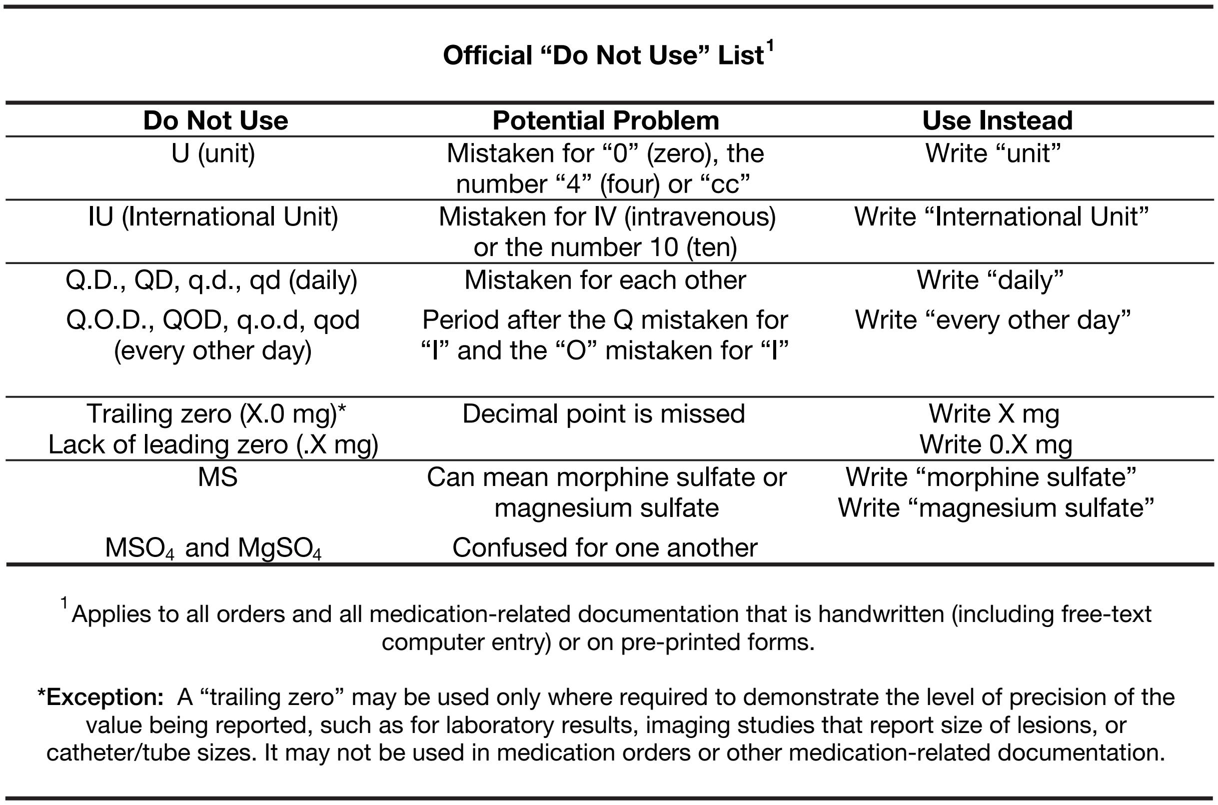
Accepting verbal orders is a major responsibility and a situation that can readily lead to medication errors. Most health care institutions have policies concerning telephone or verbal orders, and the nurse should be informed of his or her responsibility in this regard.

TRANSCRIPTION

One of the main causes of medication errors is incorrect *transcription* of the original prescriber's order. Many studies addressing the causes of medication errors identify one of the main sources to be illegible physician's handwriting (Stetina, Groves, & Pafford, 2005). During the transcription process, the transcriber must ensure that the drug order includes all seven parts. If any of the components are absent or illegible, the nurse must obtain or clarify that information prior to signing off and implementing the order.

Further, JCAHO (2006b) and the Institute for Safe Medication Practices (ISMP; 2005) have published lists of abbreviations, acronyms, and symbols to avoid in prescriptions and patient records because they have been common sources of errors and can be easily misinterpreted. The Commission first published the *Official "Do Not Use" List* (Figure 9-1) in 2004 and recommended that health care organizations should publish their own lists of abbreviations to not use. It suggested that there may be other abbreviations, acronyms, and symbols added to its list in the future (Figure 9-2), and referred health care organizations to the ISMP list of dangerous abbreviations relating to medication use. ISMP recommends that these abbreviations, symbols, and dose designations should be strictly prohibited when communicating medical information (Figure 9-3).

FIGURE 9-1 JCAHO Official "Do Not Use" List of Medical Abbreviations
© Joint Commission on Accreditation of Healthcare Organizations, 2005.
Reprinted with permission.



Official "Do Not Use" List[1]

Do Not Use	Potential Problem	Use Instead
U (unit)	Mistaken for "0" (zero), the number "4" (four) or "cc"	Write "unit"
IU (International Unit)	Mistaken for IV (intravenous) or the number 10 (ten)	Write "International Unit"
Q.D., QD, q.d., qd (daily)	Mistaken for each other	Write "daily"
Q.O.D., QOD, q.o.d, qod (every other day)	Period after the Q mistaken for "I" and the "O" mistaken for "I"	Write "every other day"
Trailing zero (X.0 mg)* Lack of leading zero (.X mg)	Decimal point is missed	Write X mg Write 0.X mg
MS	Can mean morphine sulfate or magnesium sulfate	Write "morphine sulfate" Write "magnesium sulfate"
MSO_4 and $MgSO_4$	Confused for one another	

[1] Applies to all orders and all medication-related documentation that is handwritten (including free-text computer entry) or on pre-printed forms.

***Exception:** A "trailing zero" may be used only where required to demonstrate the level of precision of the value being reported, such as for laboratory results, imaging studies that report size of lesions, or catheter/tube sizes. It may not be used in medication orders or other medication-related documentation.

FIGURE 9-2 JCAHO Additional Abbreviations, Acronyms, and Symbols
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Additional Abbreviations, Acronyms and Symbols
(For possible future inclusion in the Official "Do Not Use" List)

Do Not Use	Potential Problem	Use Instead
> (greater than) < (less than)	Misinterpreted as the number "7" (seven) or the letter "L" Confused for one another	Write "greater than" Write "less than"
Abbreviations for drug names	Misinterpreted due to similar abbreviations for multiple drugs	Write drug names in full
Apothecary units	Unfamiliar to many practitioners Confused with metric units	Use metric units
@	Mistaken for the number "2" (two)	Write "at"
cc	Mistaken for U (units) when poorly written	Write "ml" or "milliliters"
µg	Mistaken for mg (milligrams) resulting in one thousand-fold overdose	Write "mcg" or "micrograms"

CAUTION

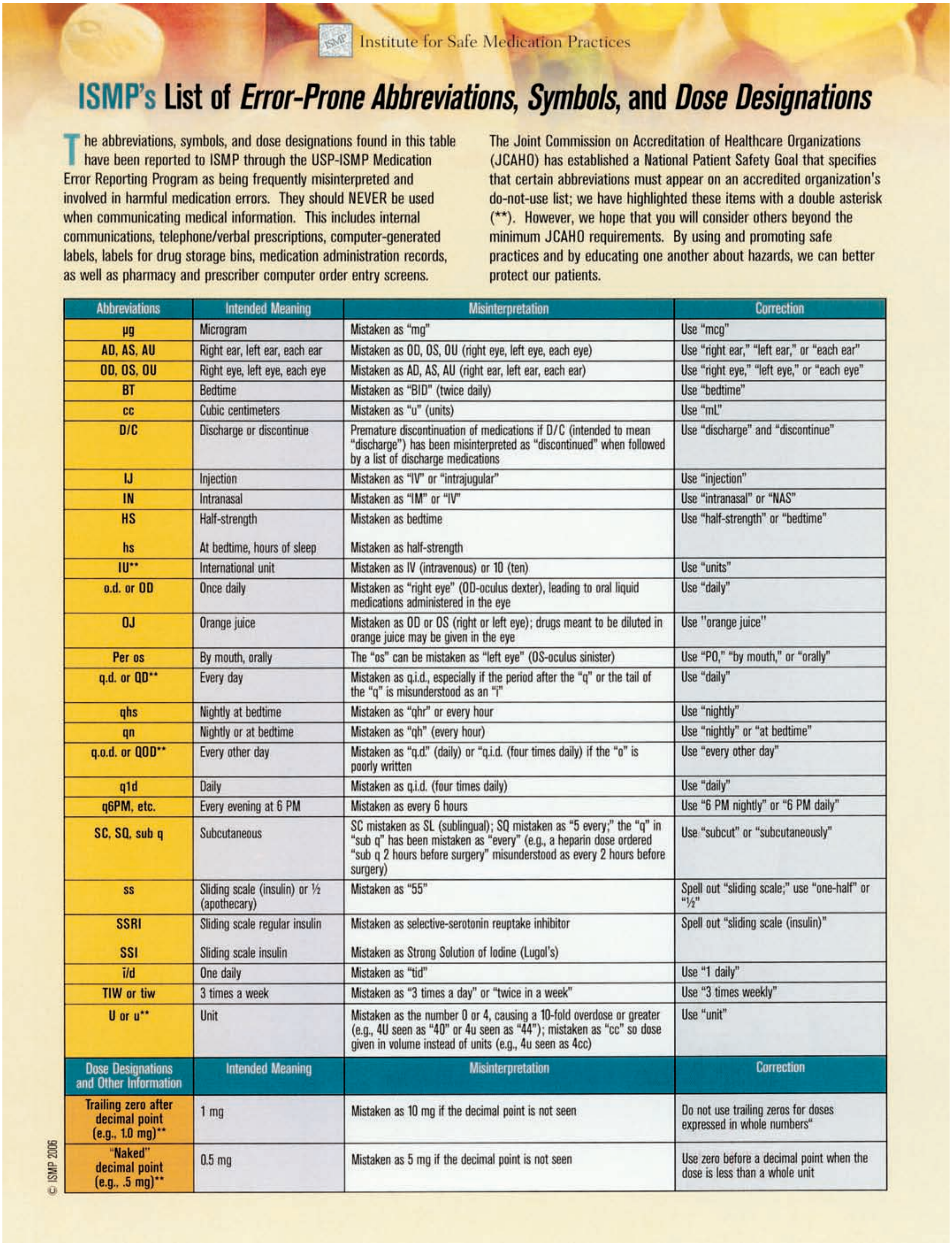
Stay alert to JCAHO, ISMP, and your own health care facility guidelines and restrictions regarding abbreviations and medical notation. Acceptable medical communication is subject to abrupt change.

Many health care institutions are utilizing a computerized physician order entry (CPOE) system to help eliminate transcription sources of error. Physicians choose drug orders from a menu screen (Figure 9-4) and then choose the route and dosage strength offered on the following screen (Figure 9-5). There is an option for editing (Figure 9-6), and then the physician signs the order by entering his or her assigned electronic code. These systems can also be implemented with clinical decision support systems (CDSS). The CDSS may include suggestions or default values for drug dosages, routes, and frequencies. The chance exists that the order may be entered incorrectly, but the computer system does remove the variable of illegible writing (Hopkins, 2005).

SAFE MEDICATION ADMINISTRATION

The five rights of medication administration *(right patient, right drug, right amount, right route, and right time)* have been the cornerstones for safe and effective nursing practice in the area of medication administration. A sixth right, *right documentation,* is often added to the list. These Six Rights were introduced in Chapter 7. Thoroughly and consistently following these rights can ensure that nurses administer medications safely.

FIGURE 9-3 ISMP Error-Prone Abbreviation List
Courtesy of the Institute for Safe Medication Practices



Institute for Safe Medication Practices

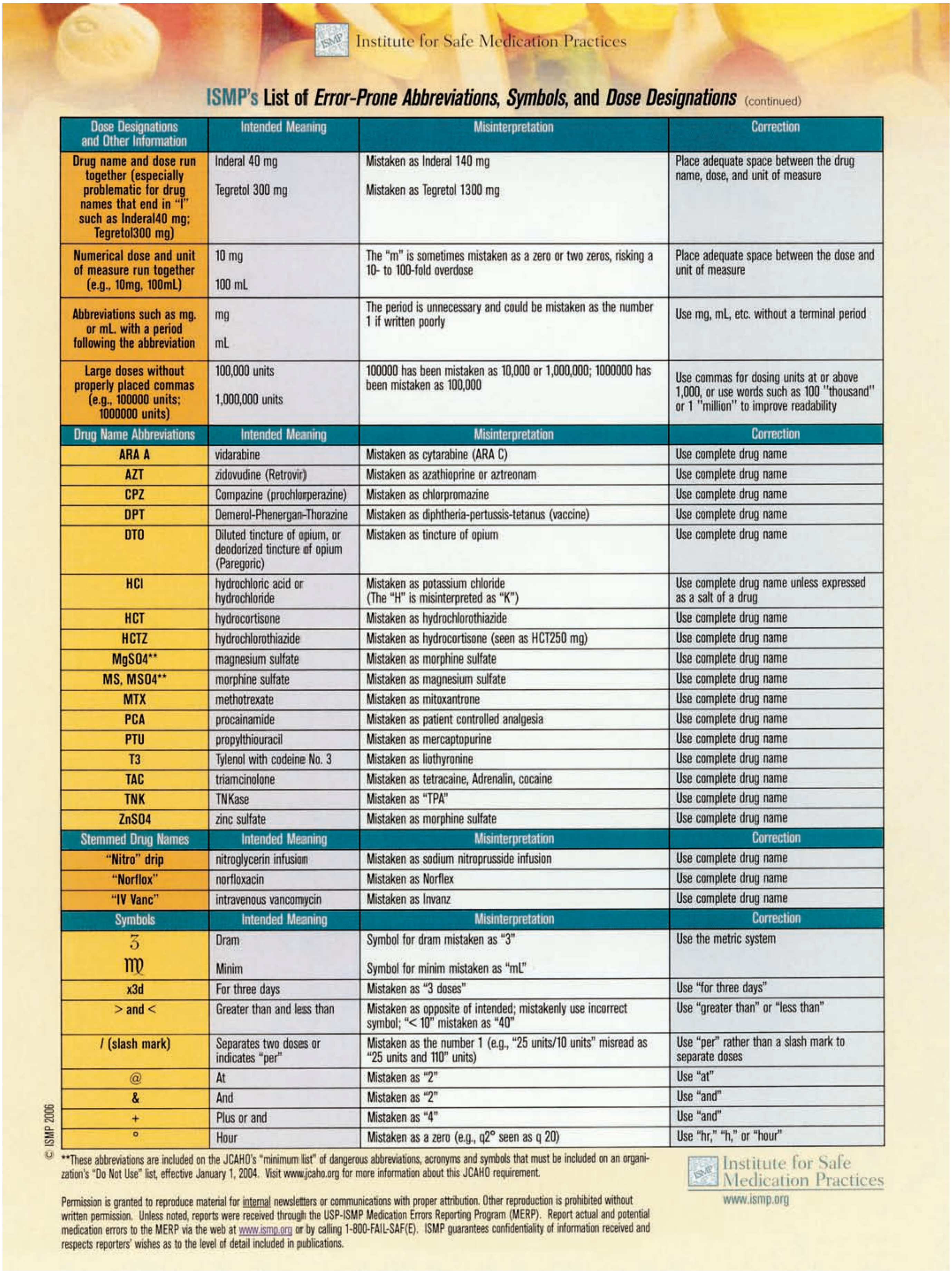
ISMP's List of *Error-Prone Abbreviations, Symbols,* and *Dose Designations*

The abbreviations, symbols, and dose designations found in this table have been reported to ISMP through the USP-ISMP Medication Error Reporting Program as being frequently misinterpreted and involved in harmful medication errors. They should NEVER be used when communicating medical information. This includes internal communications, telephone/verbal prescriptions, computer-generated labels, labels for drug storage bins, medication administration records, as well as pharmacy and prescriber computer order entry screens.

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has established a National Patient Safety Goal that specifies that certain abbreviations must appear on an accredited organization's do-not-use list; we have highlighted these items with a double asterisk (**). However, we hope that you will consider others beyond the minimum JCAHO requirements. By using and promoting safe practices and by educating one another about hazards, we can better protect our patients.

Abbreviations	Intended Meaning	Misinterpretation	Correction
µg	Microgram	Mistaken as "mg"	Use "mcg"
AD, AS, AU	Right ear, left ear, each ear	Mistaken as OD, OS, OU (right eye, left eye, each eye)	Use "right ear," "left ear," or "each ear"
OD, OS, OU	Right eye, left eye, each eye	Mistaken as AD, AS, AU (right ear, left ear, each ear)	Use "right eye," "left eye," or "each eye"
BT	Bedtime	Mistaken as "BID" (twice daily)	Use "bedtime"
cc	Cubic centimeters	Mistaken as "u" (units)	Use "mL"
D/C	Discharge or discontinue	Premature discontinuation of medications if D/C (intended to mean "discharge") has been misinterpreted as "discontinued" when followed by a list of discharge medications	Use "discharge" and "discontinue"
IJ	Injection	Mistaken as "IV" or "intrajugular"	Use "injection"
IN	Intranasal	Mistaken as "IM" or "IV"	Use "intranasal" or "NAS"
HS hs	Half-strength At bedtime, hours of sleep	Mistaken as bedtime Mistaken as half-strength	Use "half-strength" or "bedtime"
IU**	International unit	Mistaken as IV (intravenous) or 10 (ten)	Use "units"
o.d. or OD	Once daily	Mistaken as "right eye" (OD-oculus dexter), leading to oral liquid medications administered in the eye	Use "daily"
OJ	Orange juice	Mistaken as OD or OS (right or left eye); drugs meant to be diluted in orange juice may be given in the eye	Use "orange juice"
Per os	By mouth, orally	The "os" can be mistaken as "left eye" (OS-oculus sinister)	Use "PO," "by mouth," or "orally"
q.d. or QD**	Every day	Mistaken as q.i.d., especially if the period after the "q" or the tail of the "q" is misunderstood as an "i"	Use "daily"
qhs	Nightly at bedtime	Mistaken as "qhr" or every hour	Use "nightly"
qn	Nightly or at bedtime	Mistaken as "qh" (every hour)	Use "nightly" or "at bedtime"
q.o.d. or QOD**	Every other day	Mistaken as "q.d." (daily) or "q.i.d. (four times daily) if the "o" is poorly written	Use "every other day"
q1d	Daily	Mistaken as q.i.d. (four times daily)	Use "daily"
q6PM, etc.	Every evening at 6 PM	Mistaken as every 6 hours	Use "6 PM nightly" or "6 PM daily"
SC, SQ, sub q	Subcutaneous	SC mistaken as SL (sublingual); SQ mistaken as "5 every;" the "q" in "sub q" has been mistaken as "every" (e.g., a heparin dose ordered "sub q 2 hours before surgery" misunderstood as every 2 hours before surgery)	Use "subcut" or "subcutaneously"
ss	Sliding scale (insulin) or ½ (apothecary)	Mistaken as "55"	Spell out "sliding scale;" use "one-half" or "½"
SSRI SSI	Sliding scale regular insulin Sliding scale insulin	Mistaken as selective-serotonin reuptake inhibitor Mistaken as Strong Solution of Iodine (Lugol's)	Spell out "sliding scale (insulin)"
ī/d	One daily	Mistaken as "tid"	Use "1 daily"
TIW or tiw	3 times a week	Mistaken as "3 times a day" or "twice in a week"	Use "3 times weekly"
U or u**	Unit	Mistaken as the number 0 or 4, causing a 10-fold overdose or greater (e.g., 4U seen as "40" or 4u seen as "44"); mistaken as "cc" so dose given in volume instead of units (e.g., 4u seen as 4cc)	Use "unit"
Dose Designations and Other Information	**Intended Meaning**	**Misinterpretation**	**Correction**
Trailing zero after decimal point (e.g., 1.0 mg)**	1 mg	Mistaken as 10 mg if the decimal point is not seen	Do not use trailing zeros for doses expressed in whole numbers"
"Naked" decimal point (e.g., .5 mg)**	0.5 mg	Mistaken as 5 mg if the decimal point is not seen	Use zero before a decimal point when the dose is less than a whole unit

FIGURE 9-3 cont'd



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ISMP's List of *Error-Prone Abbreviations, Symbols,* and *Dose Designations* (continued)

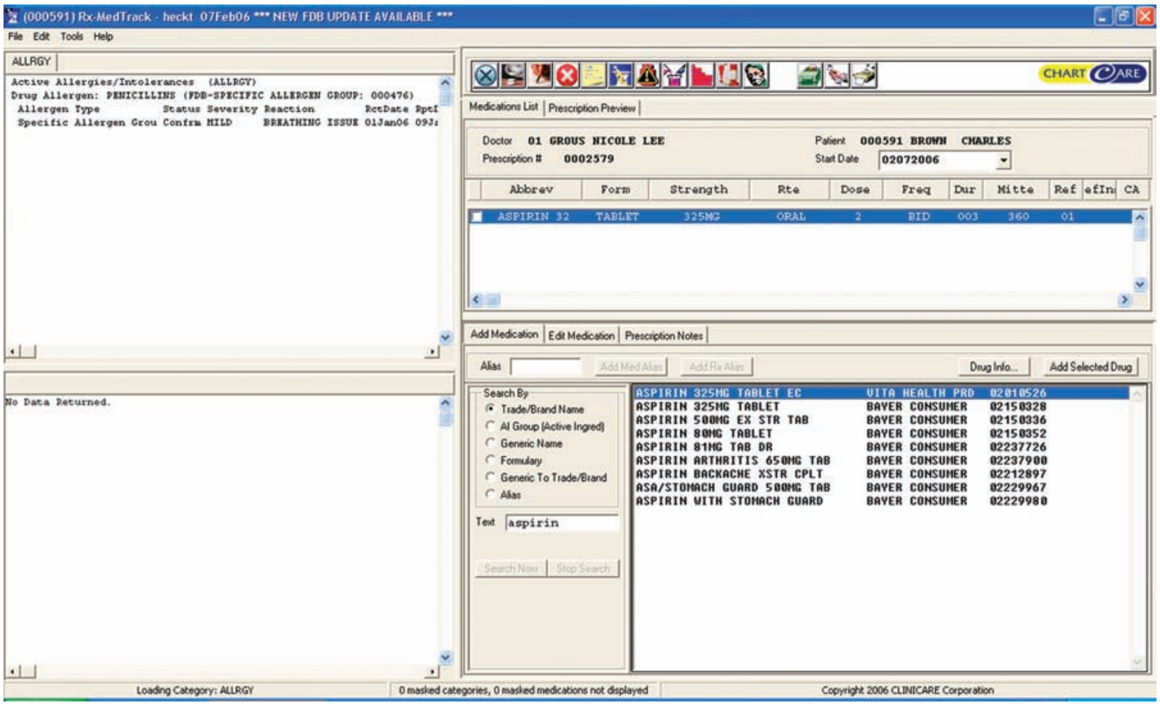
Dose Designations and Other Information	Intended Meaning	Misinterpretation	Correction
Drug name and dose run together (especially problematic for drug names that end in "l" such as Inderal40 mg; Tegretol300 mg)	Inderal 40 mg Tegretol 300 mg	Mistaken as Inderal 140 mg Mistaken as Tegretol 1300 mg	Place adequate space between the drug name, dose, and unit of measure
Numerical dose and unit of measure run together (e.g., 10mg, 100mL)	10 mg 100 mL	The "m" is sometimes mistaken as a zero or two zeros, risking a 10- to 100-fold overdose	Place adequate space between the dose and unit of measure
Abbreviations such as mg. or mL. with a period following the abbreviation	mg mL	The period is unnecessary and could be mistaken as the number 1 if written poorly	Use mg, mL, etc. without a terminal period
Large doses without properly placed commas (e.g., 100000 units; 1000000 units)	100,000 units 1,000,000 units	100000 has been mistaken as 10,000 or 1,000,000; 1000000 has been mistaken as 100,000	Use commas for dosing units at or above 1,000, or use words such as 100 "thousand" or 1 "million" to improve readability
Drug Name Abbreviations	**Intended Meaning**	**Misinterpretation**	**Correction**
ARA A	vidarabine	Mistaken as cytarabine (ARA C)	Use complete drug name
AZT	zidovudine (Retrovir)	Mistaken as azathioprine or aztreonam	Use complete drug name
CPZ	Compazine (prochlorperazine)	Mistaken as chlorpromazine	Use complete drug name
DPT	Demerol-Phenergan-Thorazine	Mistaken as diphtheria-pertussis-tetanus (vaccine)	Use complete drug name
DTO	Diluted tincture of opium, or deodorized tincture of opium (Paregoric)	Mistaken as tincture of opium	Use complete drug name
HCl	hydrochloric acid or hydrochloride	Mistaken as potassium chloride (The "H" is misinterpreted as "K")	Use complete drug name unless expressed as a salt of a drug
HCT	hydrocortisone	Mistaken as hydrochlorothiazide	Use complete drug name
HCTZ	hydrochlorothiazide	Mistaken as hydrocortisone (seen as HCT250 mg)	Use complete drug name
MgSO4**	magnesium sulfate	Mistaken as morphine sulfate	Use complete drug name
MS, MSO4**	morphine sulfate	Mistaken as magnesium sulfate	Use complete drug name
MTX	methotrexate	Mistaken as mitoxantrone	Use complete drug name
PCA	procainamide	Mistaken as patient controlled analgesia	Use complete drug name
PTU	propylthiouracil	Mistaken as mercaptopurine	Use complete drug name
T3	Tylenol with codeine No. 3	Mistaken as liothyronine	Use complete drug name
TAC	triamcinolone	Mistaken as tetracaine, Adrenalin, cocaine	Use complete drug name
TNK	TNKase	Mistaken as "TPA"	Use complete drug name
ZnSO4	zinc sulfate	Mistaken as morphine sulfate	Use complete drug name
Stemmed Drug Names	**Intended Meaning**	**Misinterpretation**	**Correction**
"Nitro" drip	nitroglycerin infusion	Mistaken as sodium nitroprusside infusion	Use complete drug name
"Norflox"	norfloxacin	Mistaken as Norflex	Use complete drug name
"IV Vanc"	intravenous vancomycin	Mistaken as Invanz	Use complete drug name
Symbols	**Intended Meaning**	**Misinterpretation**	**Correction**
ʒ ♍	Dram Minim	Symbol for dram mistaken as "3" Symbol for minim mistaken as "mL"	Use the metric system
x3d	For three days	Mistaken as "3 doses"	Use "for three days"
> and <	Greater than and less than	Mistaken as opposite of intended; mistakenly use incorrect symbol; "< 10" mistaken as "40"	Use "greater than" or "less than"
/ (slash mark)	Separates two doses or indicates "per"	Mistaken as the number 1 (e.g., "25 units/10 units" misread as "25 units and 110" units)	Use "per" rather than a slash mark to separate doses
@	At	Mistaken as "2"	Use "at"
&	And	Mistaken as "2"	Use "and"
+	Plus or and	Mistaken as "4"	Use "and"
°	Hour	Mistaken as a zero (e.g., q2° seen as q 20)	Use "hr," "h," or "hour"

**These abbreviations are included on the JCAHO's "minimum list" of dangerous abbreviations, acronyms and symbols that must be included on an organization's "Do Not Use" list, effective January 1, 2004. Visit www.jcaho.org for more information about this JCAHO requirement.

Unless noted, reports were received through the USP-ISMP Medication Errors Reporting Program (MERP). Report actual and potential medication errors to the MERP via the web at www.ismp.org or by calling 1-800-FAIL-SAF(E). ISMP guarantees confidentiality of information received and respects reporters' wishes as to the level of detail included in publications.

Institute for Safe Medication Practices
www.ismp.org

FIGURE 9-4 A CPOE menu screen allows the user to select a drug (Courtesy of CHARTCARE, Inc.)



```
Active Allergies/Intolerances  (ALLRGY)
Drug Allergen: PENICILLINS (FDB-SPECIFIC ALLERGEN GROUP: 000476)
 Allergen Type        Status Severity Reaction       RctDate RptI
 Specific Allergen Grou Confrm MILD     BREATHING ISSUE 01Jan06 09J:
```

```
No Data Returned.
```

Doctor 01 GROUS NICOLE LEE
Prescription # 0002579
Patient 000591 BROWN CHARLES
Start Date 02072006

	Abbrev	Form	Strength	Rte	Dose	Freq	Dur	Mitte	Ref	efIn:	CA
☐	ASPIRIN 32	TABLET	325MG	ORAL	2	BID	003	360	01		

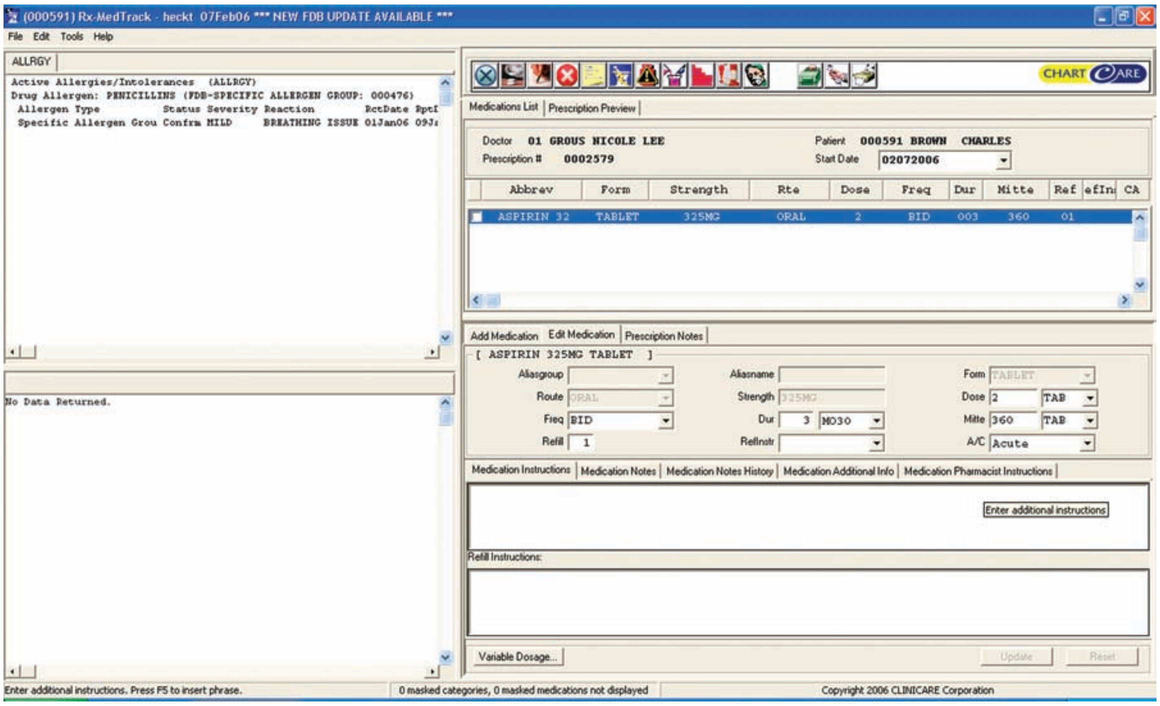
Search By
● Trade/Brand Name
○ AI Group (Active Ingred)
○ Generic Name
○ Formulary
○ Generic To Trade/Brand
○ Alias

Text aspirin

```
ASPIRIN 325MG TABLET EC        VITA HEALTH PRD   02010526
ASPIRIN 325MG TABLET           BAYER CONSUMER    02150328
ASPIRIN 500MG EX STR TAB       BAYER CONSUMER    02150336
ASPIRIN 80MG TABLET            BAYER CONSUMER    02150352
ASPIRIN 81MG TAB DR            BAYER CONSUMER    02237726
ASPIRIN ARTHRITIS 650MG TAB    BAYER CONSUMER    02237900
ASPIRIN BACKACHE XSTR CPLT     BAYER CONSUMER    02212897
ASA/STOMACH GUARD 500MG TAB    BAYER CONSUMER    02229967
ASPIRIN WITH STOMACH GUARD     BAYER CONSUMER    02229980
```

Loading Category: ALLRGY | 0 masked categories, 0 masked medications not displayed | Copyright 2006 CLINICARE Corporation

FIGURE 9-5 A CPOE offers options for route and dose of the drug chosen (Courtesy of CHARTCARE, Inc.)



```
Active Allergies/Intolerances  (ALLRGY)
Drug Allergen: PENICILLINS (FDB-SPECIFIC ALLERGEN GROUP: 000476)
 Allergen Type        Status Severity Reaction       RctDate RptI
 Specific Allergen Grou Confrm MILD     BREATHING ISSUE 01Jan06 09J:
```

```
No Data Returned.
```

Doctor 01 GROUS NICOLE LEE
Prescription # 0002579
Patient 000591 BROWN CHARLES
Start Date 02072006

	Abbrev	Form	Strength	Rte	Dose	Freq	Dur	Mitte	Ref	efIn:	CA
☐	ASPIRIN 32	TABLET	325MG	ORAL	2	BID	003	360	01		

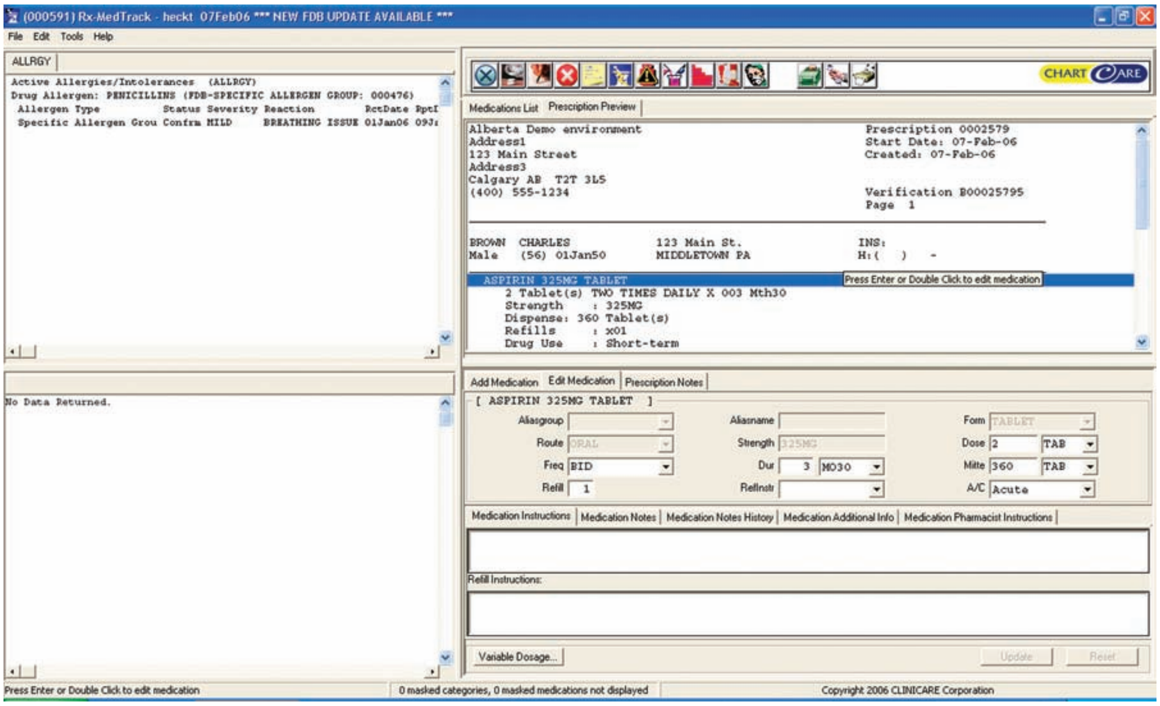
[ASPIRIN 325MG TABLET]

Aliasgroup
Route ORAL
Freq BID
Refill 1
Aliasname
Strength 325MG
Dur 3 MO30
RefInstr
Form TABLET
Dose 2 TAB
Mitte 360 TAB
A/C Acute

Refill Instructions:

Enter additional instructions. Press F5 to insert phrase. | 0 masked categories, 0 masked medications not displayed | Copyright 2006 CLINICARE Corporation

FIGURE 9-6 A CPOE allows the user to edit the medication order (Courtesy of CHARTCARE, Inc.)



```
Active Allergies/Intolerances  (ALLRGY)
Drug Allergen: PENICILLINS (FDB-SPECIFIC ALLERGEN GROUP: 000476)
 Allergen Type          Status Severity Reaction        RctDate RptI
 Specific Allergen Grou Confrm MILD     BREATHING ISSUE 01Jan06 09J:
```

```
No Data Returned.
```

```
Alberta Demo environment                              Prescription 0002579
Address1                                              Start Date: 07-Feb-06
123 Main Street                                       Created: 07-Feb-06
Address3
Calgary AB  T2T 3L5
(400) 555-1234                                        Verification B00025795
                                                      Page  1

BROWN  CHARLES          123 Main St.                 INS:
Male   (56) 01Jan50     MIDDLETOWN PA                H:(   )   -

  ASPIRIN 325MG TABLET                               Press Enter or Double Click to edit medication
     2 Tablet(s) TWO TIMES DAILY X 003 Mth30
     Strength   : 325MG
     Dispense: 360 Tablet(s)
     Refills    : x01
     Drug Use   : Short-term
```

[ASPIRIN 325MG TABLET]

Aliasgroup:
Aliasname:
Form: TABLET
Route: ORAL
Strength: 325MG
Dose: 2 TAB
Freq: BID
Dur: 3 MO30
Mitte: 360 TAB
Refill: 1
RefInstr:
A/C: Acute

Press Enter or Double Click to edit medication | 0 masked categories, 0 masked medications not displayed | Copyright 2006 CLINICARE Corporation

REMEMBER

Nurses should refer to reputable drug reference resources to validate the safety of the medication as ordered and transcribed. Whoever administers a medication is legally responsible for patient safety. Any medication errors that result also fall under the responsibility of the person who administered the drug, regardless of the primary source of the error.

Right Patient

Numerous studies have been published that indicate confusion among nurses in regard to what constitutes a medication error, but the administration of a medication to a patient other than the one for whom it was ordered is a clearly identified error. It is also one that should be easily prevented. Yet the literature supports this as one of the three most common causes of medication errors. The failure of the nurse to accurately identify a patient is the most common cause for the error. JCAHO (2006c) has a Patient Safety Goal to improve the accuracy of patient identification when administering medications. JCAHO requires that patients be identified with at least two unique patient identifiers (neither of which can be the patient's room number), such as name and date of birth, or name and patient ID number. Basic nursing education emphasizes the importance of correctly identifying a patient prior to administering a medication by comparing the two identifiers with the patient's arm band, medication administration record (MAR), or chart; and by asking the patient to state his or her name (as a third identifier). Both steps should be consistently implemented regardless of the nurse's familiarity with the patient or the practice arena.

It is also wise to tell the patient at the time of administration what medication and dosage strength of the drug the nurse is administering. This extra step can often prevent errors, as patients who are familiar with their medications may spot an error or question a drug dosage. This is also an opportunity to engage the patient in medication teaching. However, the nurse should never rely on this practice as the primary means to prevent errors. Instead, this is an extra precaution.

Technological advances in medication administration and documentation have included mechanisms to help prevent errors in this area. Computers installed at the patient's bedside and/or handheld devices that enable the nurse to scan the armband and the bar codes on the medications serve as reinforcement to visual checks by the nurse. Few studies have been published in regard to the effectiveness of these systems in preventing errors. However, an additional mechanism to ensure correct patient identification increases the efficiency in implementing this right in medication administration—that the right patient receives the right drug. The health care industry has invested heavily in technology to help prevent costly medication errors caused by carelessness and distraction.

Right Drug

Nurses can ensure that this right is maintained by checking the medication label at three points during the administration process:

1. On first contact with the drug.
2. Prior to measuring the drug (pouring, counting, or withdrawing the drug).
3. After obtaining the drug, just prior to administration.

Distraction in the workplace has been identified as a variable increasing the occurrence of error in obtaining the right drug (Pape, et al., 2005). Nurses should take measures to ensure that they are not distracted during this phase of medication administration. Optimally, the physical workplace should provide for the nurse to move to an area without distractions. However, if this is not available, the nurse should be conscious of the need to focus solely on the task at hand and avoid the temptation to multitask while dispensing medications.

In February 2004, the U.S. Food and Drug Administration (FDA) issued a regulation that requires all new pharmaceuticals to be bar coded upon launch in the market and all existing pharmaceuticals to be bar coded within two years of the ruling (FDA, 2004). Studies by U.S. Pharmacopeia in 2003 indicated insulin products have the highest rates of error ("Information Technology," 2005). Projections by the FDA indicate that bar coding on prescription drugs will reduce errors by 500,000 instances over the next 20 years with estimated savings of $93 billion in additional health care costs, patient pain, and lost wages (FDA, 2004). This represents a 50% reduction in the medication errors that would otherwise occur without the use of bar coding (FDA, 2004).

Bar codes on drugs are used with a bar-code scanning system and computerized database. At a minimum, the code must contain the drug's National Drug Code. This number uniquely identifies the drug. The process starts as a patient enters the hospital and is given a bar-coded patient identification band. The hospital has bar-code scanners that are linked to the hospital's electronic medical records system. Before a health care worker administers a medication, he or she scans the patient's bar code, which allows the computer to access the patient's medical records. The health care worker then scans each drug prior to administration. This notifies the computer of each medication to be administered. This information is compared to the patient's database to ensure a match. If there is a problem, the health care worker receives an error message and investigates the problem.

Nurses are responsible for being knowledgeable about the actions, indications, and contraindications of the medications they administer. The constant changes that are occurring in health care delivery and the steady influx of new medications being released into the market have challenged the individual nurse's ability to meet this responsibility. A valid and current drug-reference system should be available in every practice setting. The nurse should not hesitate to seek information about any medication that is unfamiliar. The prescribing physician should be contacted for clarification or confirmation for any medication order that appears inappropriate or incorrect.

Automatic Medication Dispensing Machines (AMDM) (Figure 9-7) have been utilized in many health care settings. There are many safety measures in place with the use of this technology, but the possibility still exists that the patient may receive the wrong medication. Nurses who practice in a setting utilizing this technology should continue to implement the three checks described to avoid administering the wrong drug. Review Chapter 8 about reading drug labels to ensure that all of the important information is confirmed.

FIGURE 9-7 The Pyxis MedStation® is an example of an Automatic Medication Dispensing Machine (Photo Courtesy of Cardinal Health)

Right Amount

Illegible physician's handwriting, a transcription error, miscalculation of the amount, or misreading the label can result in errors involving the administration of an incorrect dose of a medication. The need for each nurse to carefully read and clarify drug orders and recheck drug labels has been previously discussed. Two nurses must check some potent medications, such as insulin, which are a common source of errors. Transcription errors involving dosage can be avoided if nurses will consult drug references to confirm the dosage of medications if they are in doubt. The JCAHO *Official "Do Not Use" List* (Figure 9-1) will also help eliminate problems of dosage for those medications ordered daily, every other day, or measured in units.

Teaching effective dosage calculation methods is the main purpose of this text. The need for each nurse to estimate the correct dosage prior to calculating the exact amount is stressed throughout this book. The inclusion of this common-sense approach to calculating dosage is crucial in preventing errors in dosage calculation. Calculating, preparing, and administering the wrong dose of a drug are preventable medication errors. Full attention to accurate dosage calculations will assure that you avoid such liabilities.

Right Route

Errors involving the route of medication administration can occur for several reasons. One of the most common problems has already been addressed, that of illegible physician handwriting. Another common error relates to the nurse's knowledge of medications and their dosage forms. Nurses are typically familiar with medications commonly ordered and administered in their area of practice. But the nurse should consult a drug information source to confirm that the correct route is ordered for an unfamiliar medication, particularly in regard to injection forms. Nurses should also be alert to the need to change or clarify administration forms or routes for the patient receiving medication through a feeding tube; e.g., nasogastric or surgically inserted tubes. Sometimes the patient may not be allowed any oral intake (NPO status) or have a nasogastric tube, but the medications are ordered for oral administration. Often physicians order time-released or enteric-coated medications to be administered via a feeding tube and do not recognize that medications must be crushed or dissolved to be administered. Such situations require the nurse to contact the physician for a change in the medication form, route, or to seek clarification for the drug to be administered safely and correctly. It is the nurse's responsibility to be alert to potential errors of all kinds that may interfere with patient safety and rights.

Right Time

Medication orders should include the frequency that a drug is to be administered or the specific administration schedule. Computerized hospital drug administration systems automatically indicate these times on the medication administration record. The nurse is responsible for checking these records to be sure they are accurate. For example, a physician writes an order for an antibiotic to be given four times a day. The computer system might transcribe these times to 9:00 AM, 1:00 PM, 5:00 PM and 9:00 PM. The nurse should recognize that an antibiotic should be administered at regular intervals so that the four doses would be six hours apart. The right time for the order should have been q.6h or *every six hours.*

JCAHO (2006b) has recognized the frequency of misinterpretation of time and frequency in medication orders. They have taken steps to prevent common errors in regard to the time a drug is to be administered by prohibiting the use of some abbreviations related to dosing frequency. For example the notation to give a drug q.d. has frequently been transcribed as q.i.d. with the period being mistaken for an i, resulting in a daily medication being administered four times a day.

Right Documentation

The last step in medication administration is correct documentation. The policy in most institutions directs nurses to administer a medication prior to documentation. Numerous studies indicate that fatigue and lack of time are factors that contribute to medication errors. Nurses who prioritize their time may find that they give medications correctly, but fail to document it. This omission can result in unintentional overmedication of the patient when the following nurse responds as though the drug was not given. Many of the new AMDMs document drug administration at the time the drug is removed from the machine. This ensures that administration is documented, but the error occurs if the patient does not take the medication. In that situation, the nurse must follow the institution's policy for clarifying or deleting the initial documentation. Often, this is a time-consuming process but if omitted, results in undermedication of the patient.

SUMMARY

In conclusion, medication administration is a critical nursing skill that can lead to costly errors, morbidity, and death. It is the nurse's responsibility to ensure that the right patient receives the right drug, in the right amount, by the right route, at the right time, and with the right documentation. The nurse who administers a medication is legally liable for medication errors whether the primary cause was an unsafe order, incorrect transcription, inaccurate dosage calculation, or administration error.

Review Set 23

1. What are the six patient rights of safe medication administration?

   ____

   ____

2. Correct the error(s) in the following medical order. NPH insulin 20.0 U SC qd

   ____

3. Safe medication administration requires that you check the drug against the order three times: 1) when you first make contact with the drug (e.g., remove it from the medication drawer), 2) when you measure it, and 3) ____________________________
4. Give a rationale for the importance of accurate and safe dosage calculations and medication administration.

   ____

   ____

5. True or False? The nurse who administers a drug based on an incorrect or unsafe medication order shares legal liability for patient injury that results from that drug. ________________
6. What is the preferred method for verifying the safety of the medication order?

   ____

7. What drug products have the highest incidence of medication errors?

   ____

8. What is the purpose of bar coding?

   ____

9. How much financial savings does the FDA project bar coding will contribute over the next 20 years? ________
10. What nursing actions should you implement following the receipt of a verbal or telephone order from a licensed prescribing practitioner to ensure accuracy of the order?

    ____

After completing these problems, see page 483 to check your answers.

CRITICAL THINKING SKILLS

It is important for the nurse to check the label on each medication administered regardless of the medication dispensing mechanism.

ERROR

Failing to check the medication label

Possible Scenario

Suppose a physician orders 40 mg of Lasix for an adult with congestive heart failure. The Lasix is supplied in 20 mg tablets. The nurse plans to administer two tablets and use an AMDM. The nurse chooses the correct medication from the computer screen. The medication drawer, which should contain the medication, opens. The nurse removes two tablets without reading the label, goes to the patient's room, and administers the medication. The medication the nurse removed was Lanoxin 0.25 mg tablets. The pharmacy technician incorrectly stocked the medication drawer.

Potential Outcome

Although the patient has an order for Lanoxin 0.25 mg daily, he had already received his dose for the day. At this point, he has received three times the correct amount. He becomes nauseated, and when the nurse checks his pulse, it is 40 beats per minute. The nurse notifies the doctor of the change in the patient's condition. As the one who administered the incorrect medication, the nurse clearly shares responsibility for the medication error.

Prevention

The nurse should read the label on each medication three times before administering the drug. If the nurse had checked the label as the drug was removed from the medication drawer, the error could have been prevented. And, the nurse had two more opportunities to prevent this error: prior to counting it (the amount should have been 40 mg, not 0.25 mg) and prior to administering it.

CRITICAL THINKING SKILLS

The nurse should ensure that the medication ordered can be administered by the right route.

ERROR

Opening a time-released capsule and administering it through a nasogastric tube.

Possible Scenario

Suppose a patient is hospitalized to treat a stroke. The physician's orders state to continue all of the patient's home medications. One of the medications is Theophylline 100 mg to be administered daily as a 24-hour extended-release capsule (Theo-24) for the treatment of asthma. The patient is unable to swallow as a result of the stroke, and all of his medications must be given through his nasogastric tube. The nurse opens the capsule and dissolves the contents in water and administers it via the nasogastric tube. The patient begins complaining of palpitations, and his pulse increases to 180 beats per minute. The nurse evaluates the changes in the patient's condition and realizes the error.

Potential Outcome

The physician would be notified of the error, and a peak level of Theophylline would be ordered. If the patient had a history of cardiac problems, the sympathetic stimulation caused by the Theophylline could result in anginal pain or an acute myocardial infarction. The patient would be treated symptomatically until his Theophylline blood levels returned to therapeutic range.

Prevention

The nurse should have recognized that a time-released medication could not safely be administered through a nasogastric tube. The physician should have been contacted to obtain orders for a different dosage form of the medication.

PRACTICE PROBLEMS CHAPTER 9

1. How many hospital patients die annually because of preventable medication errors?

   ____

2. True or False? Studies indicate that nurses' education and years of practice are closely correlated to the incidence of medication errors. __________
3. True or False? Ten percent (10%) to 18% of patient injuries are attributable to preventable medication errors. __________
4. True or False? Administering a drug late is a frequently underreported medication error. __________
5. True or False? Illegible prescriber's handwriting is a major contributor of transcription errors.

   ____

6. Fill in the blanks for the following statement. "The right __________ must receive the right __________ in the right __________ by the right __________ at the right __________ followed by the right __________."
7. What are the three steps of medication administration?

   ____

8. The nurse can ensure that the patient receives the right drug by checking the drug label three times. When should the nurse perform these label checks?

9. Which of the following medical notations is preferred? 0.75 mg, .2 cm, q.d.

10. Describe a nursing action to prevent medication errors when receiving verbal drug orders.

11. Cite four direct and/or indirect costs of medication errors.

12. Describe the strategy or strategies you would implement to prevent this potential medication error.

Possible Scenario

Suppose the physician writes the following order:

Dilacor XR 240 mg p.o. q.d.

The order is transcribed as *Dilacor XR 240 mg p.o. q.i.d.* and the medication is scheduled for administration at 0600, 1200, 1800, and 2400 on the medication administration record.

The nurse reviews the order prior to obtaining the medication for administration. The nurse notices the XR following the name of the medication and recognizes that the letters usually indicate a sustained-release form of medication. The nurse consults the *Hospital Formulary* and finds that the drug is a sustained formula and is only to be given once daily. The nurse reviews the original orders and notes that there was a transcription error. The medication administration record is corrected, and the patient receives the correct amount of medication at the correct time.

Potential Outcome

Had the nurse administered the medication at each of the times indicated on the medication administration record, the patient would have received four times the intended dose. The drug's therapeutic effect is a decrease in the cardiac output and decrease in blood pressure. However, the toxic effects caused by overdosing could have resulted in congestive heart failure. The patient's life would have been jeopardized.

Prevention

After completing these questions, see page 483 to check your answers.

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SECTION 2 SELF-EVALUATION

Directions:

1. Round decimals to two places. Round temperatures to one decimal place.
2. Reduce fractions to lowest terms.

Chapter 3: Systems of Measurement

Express the following amounts in proper medical notation.

1. two-thirds grain ________
2. four teaspoons ________
3. one three-hundredths grain ________
4. one-half milliliter ________
5. one-half ounce ________

Interpret the following notations.

6. 4 gtt ________
7. 450 mg ________
8. gr $\frac{1}{100}$ ________
9. gr vii $\frac{1}{2}$ ________
10. 0.25 L ________

Chapters 4 and 5: Conversions

Fill in the missing decimal numbers next to each metric unit as indicated.

11. 7.13 kg = ________ g = ________ mg = ________ mcg
12. ________ kg = ________ g = ________ mg = 925 mcg
13. ________ kg = ________ g = 125 mg = ________ mcg
14. ________ kg = 16.4 g = ________ mg = ________ mcg

Convert each of the following to the equivalent units indicated.

15. gr $\frac{1}{6}$ = ________ mg = ________ g
16. 20 mg = ________ g = gr ________
17. 4 T = ________ t = ________ mL
18. qt ix = ________ L = ________ mL
19. 15 in = ________ cm = ________ mm
20. 56.2 mm = ________ cm = ________ in
21. 198 lb = ________ kg = ________ g
22. 11.59 kg = ________ g = ________ lb
23. A patient is told to take 180 mg of a medication. What is the equivalent dosage in grains? gr ________
24. A patient is being treated for chronic pain with gr $\frac{3}{4}$ of morphine sulphate every 3 hours. How many milligrams will he receive in 24 hours? ________ mg

25. Your patient uses nitroglycerin for chest pain. The prescription is for gr $\frac{1}{300}$ of nitroglycerin. What is the equivalent dosage in milligrams? __________ mg

26. Most adults have about 6,000 mL of circulating blood volume. This is equivalent to __________ L or qt __________ of blood volume.

27. Your patient drinks the following for breakfast: 3 ounces orange juice, 8 ounces coffee with 1 teaspoon cream, and 4 ounces of water. The total intake is __________ mL.

Convert the following times as indicated. Designate AM or PM where needed.

	Traditional Time	International Time
28.	11:35 PM	__________
29.	__________	1844
30.	4:17 AM	__________
31.	__________	0803

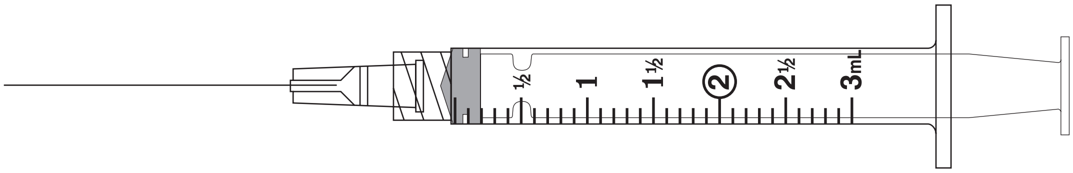
Convert the following temperatures as indicated.

	°C	°F
32.	38°C	__________ °F
33.	__________ °C	101.5°F
34.	37.2°C	__________ °F

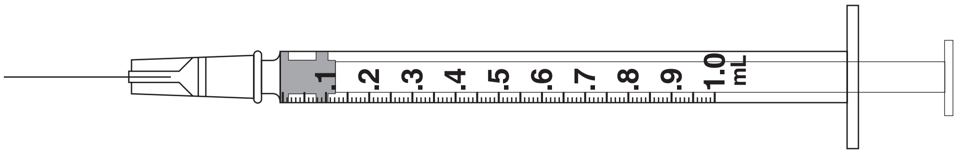
Chapter 6: Equipment Used in Dosage Measurement

Draw an arrow to demonstrate the correct measurement of the doses given.

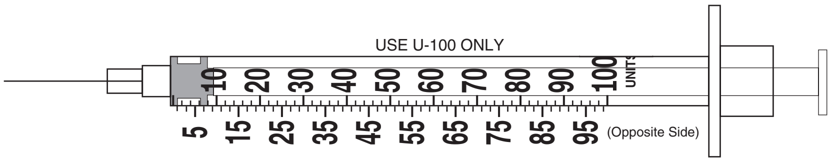
35. 1.5 mL



36. 0.33 mL

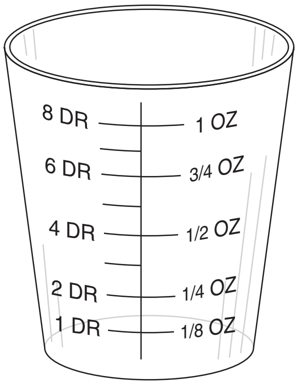


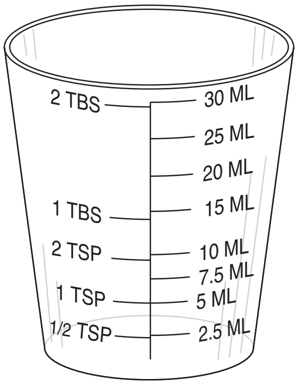
37. 44 units U-100 insulin



38. 37 units U-100 insulin

39. $1\frac{1}{2}$ t





Chapters 7 and 8: Interpreting Drug Orders and Understanding Drug Labels

Use label A to identify the information requested for questions 40 through 43.

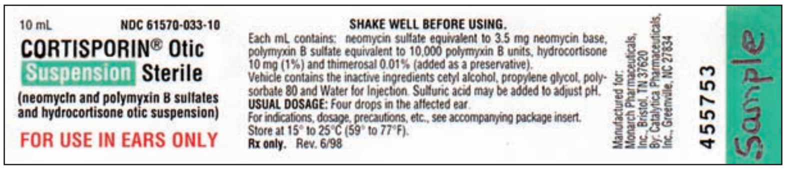
40. The generic name is ______________________________.

41. This drug is an otic solution and is intended for ______________________________.

42. The total volume of this container is ______________________________.

43. Interpret: **Cortisporin Otic Solution 2 gtt each ear q.15 min × 3** ______________________________

____



10 mL NDC 61570-033-10

CORTISPORIN® Otic Suspension Sterile

(neomycin and polymyxin B sulfates and hydrocortisone otic suspension)

FOR USE IN EARS ONLY

SHAKE WELL BEFORE USING.

Each mL contains: neomycin sulfate equivalent to 3.5 mg neomycin base, polymyxin B sulfate equivalent to 10,000 polymyxin B units, hydrocortisone 10 mg (1%) and thimerosal 0.01% (added as a preservative).

Vehicle contains the inactive ingredients cetyl alcohol, propylene glycol, polysorbate 80 and Water for Injection. Sulfuric acid may be added to adjust pH.

USUAL DOSAGE: Four drops in the affected ear.

For indications, dosage, precautions, etc., see accompanying package insert.

Store at 15° to 25°C (59° to 77°F).

Rx only. Rev. 6/98

Manufactured for: Monarch Pharmaceuticals, Inc., Bristol, TN 37620 By: Catalytica Pharmaceuticals, Inc., Greenville, NC 27834

455753

Sample

A

Use label B to identify the information requested for questions 44 through 46.

44. The supply dosage is ____________

45. The National Drug Code is ____________.

46. Interpret: **heparin 3,750 units subcut q.8h** ______________________________

____

NDC 63323-262-01 926201

HEPARIN SODIUM

INJECTION, USP

5,000 USP Units/mL

(Derived from Porcine Intestinal Mucosa)

For IV or SC Use Rx only

1 mL Multiple Dose Vial

Usual Dosage: See insert.

American Pharmaceutical Partners, Inc.

Los Angeles, CA 90024

401810A

LOT

EXP

B

Use label C to identify the information requested for questions 47 through 49.

75 mL (When Mixed) M-5058

Lilly

CECLOR®
CEFACLOR FOR
ORAL SUSPENSION
USP

250 mg
per 5 mL

CAUTION—Federal (U.S.A.)
law prohibits dispensing
without prescription.

Usual Dose—Children, 20 mg per kg a day (40 mg per kg in otitis media) in three divided doses. Adults, 250 mg three times a day. See literature for complete dosage information.
Contains Cefaclor Monohydrate equivalent to 3.75 g anhydrous Cefaclor in a dry pleasantly flavored mixture.
Prior to Mixing, Store at Controlled Room Temperature 59° to 86°F (15° to 30°C)
Directions for Mixing—Add 45 mL of water in two portions to the dry mixture in the bottle. Shake well after each addition.
Each 5 mL (Approx. one teaspoonful) will then contain: Cefaclor Monohydrate equivalent to 250 mg anhydrous Cefaclor.
SHAKE WELL BEFORE USING Oversize bottle provides extra space for shaking. Store in a refrigerator. May be kept for 14 days without significant loss of potency.
Keep Tightly Closed Discard unused portion after 14 days.

PROFESSIONAL PACKAGE
NOT TO BE SOLD

WV 5041 AMX

Mfd. by Eli Lilly Industries, Inc.
Carolina, Puerto Rico 00985, a subsidiary of
Eli Lilly & Co., Indianapolis, IN, U.S.A.
Expiration Date/Control No.

C

47. The trade name is ____.

48. The supply dosage, when reconstituted, is __________.

Chapter 9: Preventing Medication Errors

49. Correct the medical notation of the following order.

    Heparin 5000 U SC qd ____________________________________

50. Complete the following statement that defines the six rights of safe medication administration.

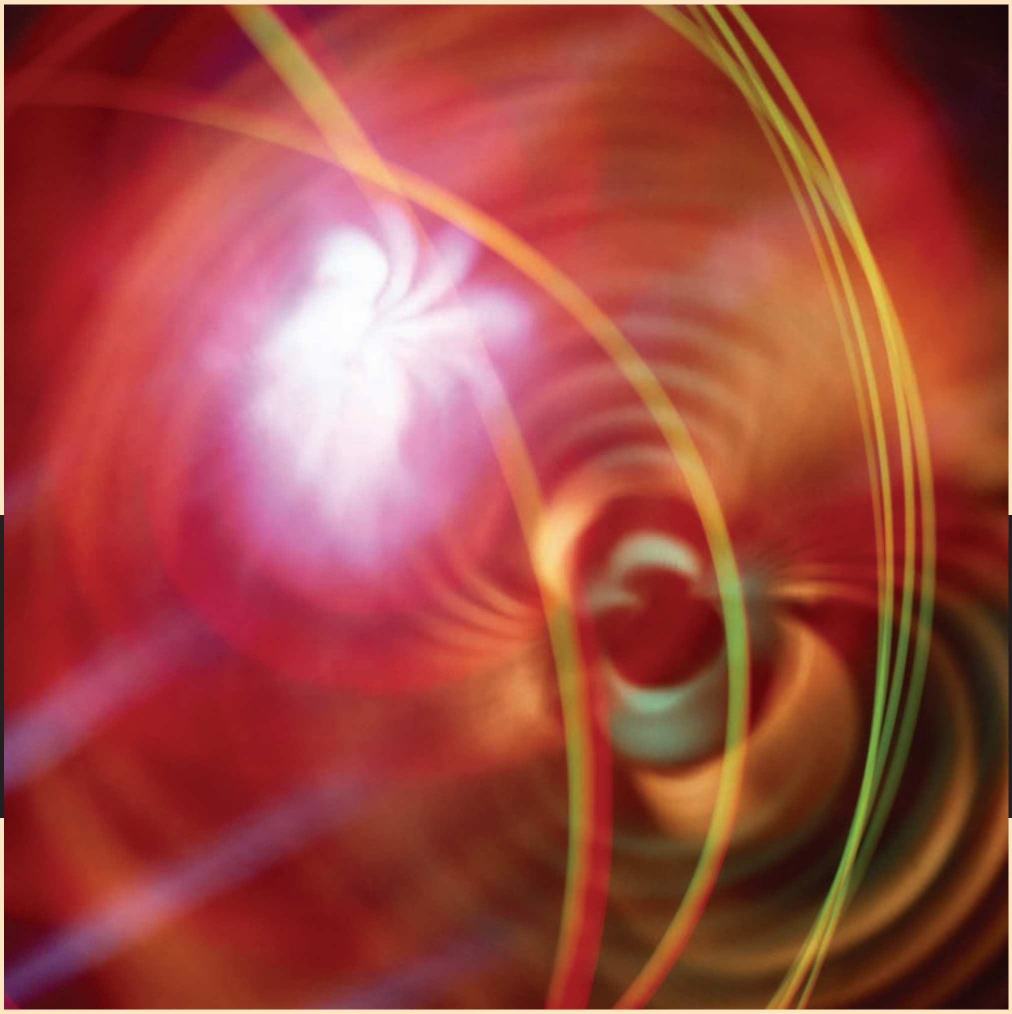
    "The right patient must receive the right . . . ______________________________

    ____."

After completing these problems, see pages 483–484 to check your answers. Give yourself two points for each correct answer.

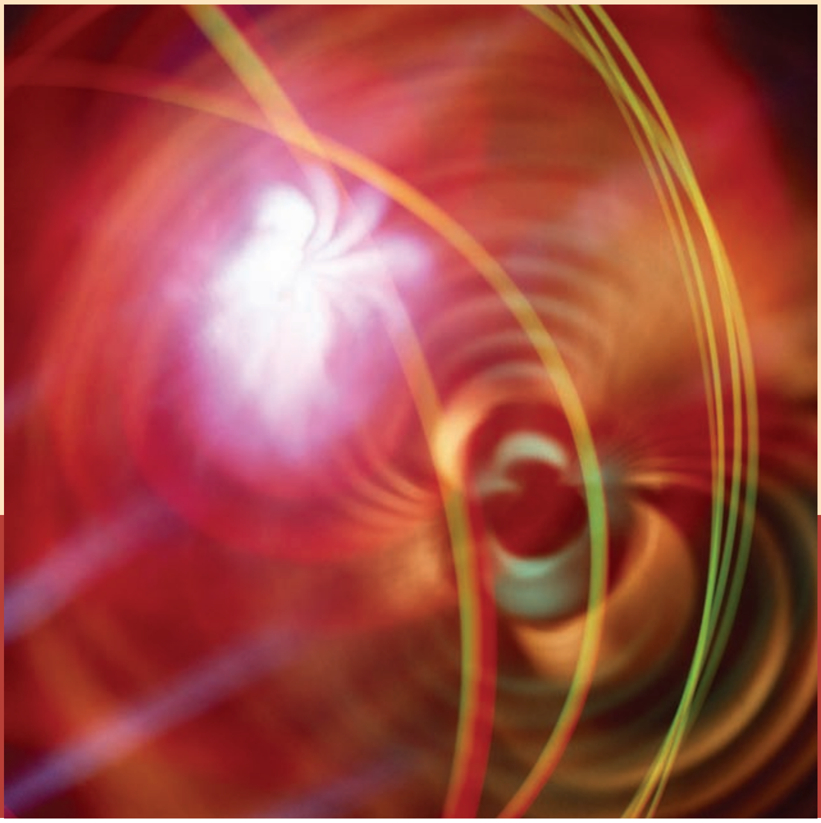
Perfect score = 100 My score = __________

Minimum mastery score = 86 (43 correct)



SECTION 3

Drug Dosage Calculations



10

Oral Dosage of Drugs

OBJECTIVES

Upon mastery of Chapter 10, you will be able to calculate oral dosages of drugs. To accomplish this you will also be able to:

- Convert all units of measurement to the same system and same size units.
- Estimate the reasonable amount of the drug to be administered.
- Use ratio and proportion to calculate drug dosage.
- Calculate the number of tablets or capsules that are contained in prescribed dosages.
- Calculate the volume of liquid per dose when the prescribed dosage is in solution form.

Medications for oral administration are supplied in a variety of forms, such as tablets, capsules, and liquids. They are usually ordered to be administered by mouth, or *p.o.,* which is an abbreviation for the Latin phrase *per os.*

When a liquid form of a drug is unavailable, children and many elderly patients may need to have a tablet crushed or a capsule opened and mixed with a small amount of food or fluid to enable them to swallow the medication. Many of these crushed medications and oral liquids also may be ordered to be given enterally, or into the gastrointestinal tract via a specially placed tube. Such tubes and their associated enteral routes include the *nasogastric* (NG) tube from nares to stomach; the *nasojejunal* (NJ) tube from nares to jejunum; the *gastrostomy tube* (GT) placed directly through the abdomen into the stomach; *jejunum tube* (J-tube) directly into the jejunum of the small intestines; and the *percutaneous endoscopic gastrostomy* (PEG) tube.

It is important to recognize that some solid-form medications are intended to be given whole to achieve a specific effect in the body. For example, enteric-coated medications protect the stomach by dissolving in the duodenum. Sustained-release capsules allow for gradual release of medication over time and should be swallowed whole. Consult a drug reference or the pharmacist if you are in doubt about the safety of crushing tablets or opening capsules.

TABLETS AND CAPSULES

Medications prepared in tablet and capsule form are supplied in the strengths or dosages in which they are commonly prescribed (Figure 10-1). It is desirable to obtain the drug in the same strength as the dosage ordered or in multiples of that dosage. When necessary, scored tablets (those marked for division) can be divided into halves or quarters. Only scored tablets are intended to be divided.

FIGURE 10-1 Biaxin 250 mg and 500 mg tablets

CAUTION

It is safest and most accurate to give the fewest number of whole, undivided tablets possible.

EXAMPLE 1 ■

The doctor's order reads: **Biaxin 500 mg p.o. q.12h.**

Biaxin comes in tablet strengths of 250 milligrams per tablet or filmtab and 500 milligrams per tablet. When both strengths are available, the nurse should select the 500 milligram strength and give one whole tablet for each dose.

EXAMPLE 2 ■

The doctor's order reads: **Klonopin 1.5 mg p.o. t.i.d.**

Klonopin comes in strengths of 0.5 mg, 1 mg, and 2 mg tablets (Figure 10-2). When the three strengths are available, the nurse should select one 1 mg tablet and one 0.5 mg tablet (1 mg + 0.5 mg = 1.5 mg). This provides the ordered dosage of 1.5 mg and is the least number of tablets (two tablets total) for the patient to swallow.

You might want to halve the 2 mg tablet to obtain two 1 mg parts and pair one-half with a 0.5 mg tablet. This would also equal 1.5 mg and give you $1\frac{1}{2}$ tablets. However, cutting any tablet in half may produce slightly unequal halves. Your patient may not get the ordered dose as a result. It is preferable to give whole, undivided tablets, when they are available.

FIGURE 10-2 Klonopin 0.5 mg, 1 mg, and 2 mg tablets

THREE-STEP APPROACH TO DOSAGE CALCULATIONS

Now you are ready to learn to solve dosage problems. The following simple three-step method has been proven to reduce anxiety about calculations and ensure that your results are accurate. Take notice that you will be asked to think or estimate before you attempt to calculate the dosage. Learn and memorize this simple three-step approach, and use it for every dosage calculation every time.

REMEMBER

Three-Step Approach to Dosage Calculations

Step 1	**Convert**	Ensure that all measurements are in the same system of measurement and the same size unit of measurement. If not, use ratio and proportion to convert before proceeding.
Step 2	**Think**	Estimate what is a *reasonable amount* of the drug to administer.
Step 3	**Calculate**	Set up a proportion to calculate the drug dosage. The ratio for the drug you have on hand is equivalent to the ratio for the desired drug.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

Let's carefully examine each of the three steps as essential and consecutive rules of accurate dosage calculation.

RULE

Step 1	**Convert**	Be sure that all measurements are in the same system, and all units are in the same size, converting when necessary.

Many medications are both ordered and supplied in the same system of measurement and the same size unit of measurement. This makes dosage calculation easy, because no conversion is necessary. When this is not the case, then you must convert to the same system or the same size units. Let's look at two examples where conversion is a necessary first step in dosage calculation.

EXAMPLE 1 ■

The drug order reads: Keflex 0.5 g p.o. q.6h.

The supply dosage (what is available on hand) is labeled *Keflex 500 mg per capsule.* This is an example of a medication order written and supplied in the same system (metric), but in different size units (g and mg). A drug order written in grams but supplied in milligrams will have to be converted to the same size unit.

MATH TIP

In most cases, it is more practical to convert to the smaller unit (such as g to mg). This usually eliminates the decimal or fraction, keeping the calculation in whole numbers.

To continue with Example 1, you should convert 0.5 gram to milligrams. Notice that milligrams is the smaller unit and converting eliminates the decimal fraction.

Equivalent: 1 g = 1,000 mg

$\frac{1\text{g}}{1{,}000\text{ mg}} \times \frac{0.5\text{ g}}{\text{X mg}}$ Cross-multiply

$\text{X} = 1{,}000 \times 0.5$ 0.500. Move the decimal three places to the right. Add zeros to complete the operation.

$\text{X} = 500\text{ mg}$ Label the units to match the unknown X.

Now you can see that the order and the supply drug you have on hand are the same amount: *500 mg.*

Order: Keflex 500 mg p.o. q.6h

Supply: Keflex 500 mg per capsule

You would give the patient one Keflex 500 mg capsule by mouth every 6 hours.

MATH TIP

Convert apothecary and household measurements to their metric equivalents. This will be helpful for your calculations even if the conversion is to a larger unit. The metric system is the predominant system of measurement for drugs.

EXAMPLE 2 ■

The drug order reads: phenobarbital gr $\frac{1}{2}$ p.o. q.12h.

The supply dosage (what you have available on hand) is labeled *phenobarbital 15 mg per tablet.* This is an example of the medication ordered in one system but supplied in a different system. The medication order is written in the apothecary system, and the medication is supplied in the metric system. You must recall the approximate equivalents and convert both amounts to the same system. You should convert the apothecary measure to metric.

Approximate equivalent: gr i = 60 mg

Recall that a proportion is a relationship comparing two ratios. Keep the *known* information on the left side of the proportion and the *unknown* on the right. Refer back to Chapter 4 about using ratio-proportion to convert between systems of measurement, as needed.

$$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{2}}{\text{X mg}} \quad \text{Cross-multiply}$$

$$\text{X} = 60 \times \frac{1}{2}$$

$$\text{X} = 30 \text{ mg} \quad \text{Label the units to match the unknown X}$$

$$\text{gr } \frac{1}{2} = 30 \text{ mg}$$

Now the problem looks like this:

Order: phenobarbital 30 mg p.o. q.12h

Supply: phenobarbital 15 mg per tablet

Now you can probably solve this problem in your head. That's what Step 2 is about.

RULE

Step 2 **Think** Carefully consider what is the reasonable amount of the drug that should be administered.

Once you have converted all units to the same system and size, Step 2 asks you to logically conclude what amount should be given. Before you go on to Step 3, you may be able to picture in your mind a reasonable amount of medication to be administered, as was demonstrated in the previous two examples. At least you should be able to estimate, such as more or less than one tablet (or capsule or milliliter). Basically, Step 2 asks you to *stop and think before you go any farther.*

In the last example, you estimate that the patient should receive more than one phenobarbital tablet. In fact, you realize that you would administer two of the 15 mg tablets to fill the order for gr $\frac{1}{2}$ or 30 mg.

RULE

Step 3 **Calculate** Ratio for the dosage you have on hand equals the ratio for the desired dosage.

Always double-check your estimated amount from Step 2 with the ratio and proportion method. When setting up the first ratio to calculate a drug dosage, use the supply dosage or the drug concentration information available on the drug label. This is the drug you *have on hand.* Set up the second ratio using the drug order or the *dosage desired* and the amount or volume you will give the patient. This is unknown or X. Keep the *known* information on the left side of the proportion and the *unknown* on the right.

REMEMBER

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

MATH TIP

When solving dosage problems for drugs supplied in tablets or capsules, the amount on hand is always 1, because the supply dosage is per one tablet or capsule.

Let's use ratio-proportion to double-check our thinking and calculate the dosages for the previous phenobarbital example.

Order: phenobarbital gr $\frac{1}{2}$ p.o. q.12h, converted to phenobarbital 30 mg

Supply: phenobarbital 15 mg per tablet

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{15\text{ mg}}{1\text{ tablet}} \times \frac{30\text{ mg}}{\text{X tablets}}$$

Cross-multiply

$$15\text{X} = 30$$

$$\frac{15\text{X}}{15} = \frac{30}{15}$$

Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 2\text{ tablets}$$

Label the units to match the unknown X

Give two of the phenobarbital 15 mg tablets orally every 12 hours. The calculations verify your estimate from Step 2.

Remember that proportions compare like things. Therefore, you must first convert all units to the same system and to the same size. As pointed out in Chapter 4, the ratio must follow the same sequence. The proportion is set up so that like units are across from each other. The numerators of each represent the weight of the dosage, and denominators represent the amount. It is important to keep like units in order, such as mg as the numerators (on top) and tablets as the denominator (on bottom). And, it is important to keep the known on the left side of the proportion and the unknown (X) on the right. Labeling units also helps you to recognize if you have set up the equation in the proper sequence.

Let's look at two more examples to reinforce this concept.

EXAMPLE 3 ■

Order: Lasix 10 mg p.o. b.i.d.

Supply: Lasix 20 mg per tablet

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{20\text{ mg}}{1\text{ tablet}} \times \frac{10\text{ mg}}{\text{X tablets}}$$

Cross-multiply

$$20\text{X} = 10$$

$$\frac{20\text{X}}{20} = \frac{10}{20}$$

Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = \frac{1}{2}\text{ tablet}$$

Label the units to match the unknown X

Notice that you want to give $\frac{1}{2}$ of the dosage you have on hand which in this case is $\frac{1}{2}$ of one tablet. Therefore, you want to give $\frac{1}{2}$ tablet of Lasix 20 mg tablets orally twice daily.

EXAMPLE 4 ■

Order: Tylenol gr x p.o. q.4h p.r.n., headache

Supply: Tylenol 325 mg per tablet

First convert to the same unit of measure.

Approximate equivalent: gr i = 60 mg

Remember: gr x = gr 10

$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } 10}{\text{X mg}}$ Cross-multiply

$\text{X} = 60 \times 10$

$\text{X} = 600 \text{ mg}$ Label the units to match the unknown X

Then calculate the dosage.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$\frac{325 \text{ mg}}{1 \text{ tablet}} \times \frac{600 \text{ mg}}{\text{X tablets}}$ Cross-multiply

$325 \text{ X} = 600$

$\frac{325\text{X}}{325} = \frac{600}{325}$ Simplify: Divide both sides of the equation by the number before the unknown X

$\text{X} = 1.8 \text{ tablets}$ Label the units to match the unknown X

An amount of 1.8 tablets is not appropriate. Remember that gr i = 60 mg, but in some instances gr i = 65 mg is more relevant. This is true because it is an *approximate* equivalent. In this case, gr i = 65 mg is more accurate.

Order: **Tylenol gr x p.o. q.4h p.r.n., headache**

Supply: Tylenol 325 mg per tablet

Approximate equivalent: gr i = 65 mg

Remember: gr x = gr 10

Convert gr to mg.

$\frac{\text{gr } 1}{65 \text{ mg}} \times \frac{\text{gr } 10}{\text{X mg}}$ Cross-multiply

$\text{X} = 65 \times 10$

$\text{X} = 650 \text{ mg}$ Label the units to match the unknown X

Calculate the amount to give.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$\frac{325 \text{ mg}}{1 \text{ tablet}} \times \frac{650 \text{ mg}}{\text{X tablets}}$ Cross-multiply

$325 \text{ X} = 650$

$\frac{325\text{X}}{325} = \frac{650}{325}$ Simplify: Divide both sides of the equation by the number before the unknown X

$\text{X} = 2 \text{ tablets}$ Label the units to match the unknown X

Notice that you want to give two times the amount of the dosage on hand; that is, you want to give two of the Tylenol 325 mg tablets orally every 4 hours as needed for headache.

Now you are ready to apply all three steps of this logical approach to dosage calculations. The same three steps will be used to solve both oral and parenteral dosage calculation problems. It is most important that you develop the ability to reason for the answer or estimate before you calculate the amount to give.

Note to Learner

Health care professionals can unknowingly make errors if they rely solely on a formula rather than first asking themselves what the answer should be. As a nurse or allied health professional, you are expected to be able to reason sensibly, problem solve, and justify your judgments rationally. With these same skills you gained admission to your educational program and to your profession. While you sharpen your math skills, your ability to think and estimate are your best resources for avoiding errors. Use ratio-proportion as a calculation tool to validate the dose amount you anticipate should be given, rather than the reverse. If your reasoning is sound, you will find the dosages you compute make sense and are accurate. For example, you would question any calculation that directs you to administer 15 tablets of any medication.

CAUTION

The maximum number of tablets or capsules for a single dose is usually three. Recheck your calculation if a single dose requires more.

Let's examine more examples of oral dosages supplied in capsules and tablets to reinforce the three basic steps. Then you will be ready to solve problems on your own.

EXAMPLE 1 ■

The drug order reads: **Lopressor 100 mg p.o. b.i.d.** The medicine container is labeled Lopressor 50 mg per tablet. Calculate one dose.

Step 1 Convert No conversion is necessary. The units are in the same system (metric) and the same size (mg).

Step 2 Think You want to administer 100 milligrams, and you have 50 milligrams in each tablet. You want to give twice the equivalent of each tablet, or you want to administer 2 tablets per dose.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{50 \text{ mg}}{1 \text{ tablet}} = \frac{100 \text{ mg}}{\text{X tablet}}$$ Cross-multiply

$$50X = 100$$

$$\frac{50X}{50} = \frac{100}{50}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$X = 2 \text{ tablets}$$ Label the units to match the unknown X

Give 2 tablets of Lopressor orally twice daily.

Double-check to be sure your calculated dosage matches your *reasonable* dosage from Step 2. If, for example, you had calculated to give more or less than two tablets of Lopressor, you would suspect a calculation error.

EXAMPLE 2 ■

The physician prescribes: **Flagyl 0.75 g p.o. t.i.d.**

The dosage available is Flagyl 500 mg per tablet. How many tablets should the nurse give to the patient per dose?

Step 1 Convert To the same size units. Convert 0.75 g to mg. Remember the math tip: Convert larger unit (g) to the smaller unit (mg), which will eliminate the decimal fraction.

Equivalent: 1 g = 1,000 mg

$$\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{0.75\text{ g}}{\text{X mg}}$$ Cross-multiply

$$\text{X} = 1{,}000 \times 0.75$$ $0.\underset{\frown}{750}.$ Move the decimal three places to the right. Add zero to complete the operation.

$$\text{X} = 750\text{ mg}$$ Label the units to match the unknown X

Now you have the order and supply measured in the same size units.

Order: Flagyl 0.75 g = 750 mg

Supply: Flagyl 500 mg tablets

By now you probably can do conversions like this from memory.

Step 2 Think 750 mg is more than 500 milligrams. You want to give more than 1 tablet, but not as much as 2 tablets. Actually you want to give $1\frac{1}{2}$ tablets. Now calculate to verify your estimate.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{500\text{ mg}}{1\text{ tablet}} \times \frac{750\text{ mg}}{\text{X tablets}}$$ Cross-multiply

$$500\text{X} = 750$$

$$\frac{500\text{X}}{500} = \frac{750}{500}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 1\tfrac{1}{2}\text{ tablets}$$ Label the units to match the unknown X

Give $1\frac{1}{2}$ tablets of Flagyl orally three times daily.

EXAMPLE 3 ■

The drug order reads: codeine sulfate gr $\frac{3}{4}$ p.o. q.4h p.r.n., pain.

The drug supplied is codeine sulfate 30 mg per tablet. Calculate one dose.

Step 1 Convert To equivalent units in the same system of measurement. Convert gr to mg and you will eliminate the fraction. Approximate equivalent: gr i = 60 mg.

$$\frac{\text{gr }1}{60\text{ mg}} \times \frac{\text{gr }\frac{3}{4}}{\text{X mg}}$$ Cross-multiply

$$\text{X} = 60 \times \frac{3}{4}$$

$$\text{X} = 45\text{ mg}$$ Label the units to match the unknown X

Order: codeine gr $\frac{3}{4}$ = 45 mg

Supply: codeine 30 mg tablets

Step 2 Think You estimate that you want to give more than one tablet but less than two tablets.

Step 3 Calculate $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

$\frac{30 \text{ mg}}{1 \text{ tablet}} \times \frac{45 \text{ mg}}{\text{X tablets}}$ Cross-multiply

$30 \text{ X} = 45$

$\frac{30\text{X}}{30} = \frac{45}{30}$ Simplify: Divide both sides of the equation by the number before the unknown X

$\text{X} = 1\frac{1}{2}$ tablets Label the units to match the unknown X

Give $1\frac{1}{2}$ tablets codeine orally every 4 hours as needed for pain.

Now you can see that a dosage problem that may have seemed difficult on first reading is actually simple. Approach every dosage calculation just like this: one step at a time.

EXAMPLE 4 ■

The order is **Synthroid 0.05 mg p.o. daily.**

Synthroid 25 mcg tablets are available. How many tablets will you give?

3 0048-1020-05 5

NDC 0048-1020-05
Code 3P1025

SYNTHROID®
(Levothyroxine Sodium Tablets, USP)

25 mcg (0.025 mg)

1000 TABLETS

Rx only

BASF Pharma knoll

See full prescribing information for dosage and administration.

Dispense in a tight, light-resistant container as described in USP.

Store at 25°C (77°F); excursions permitted to 15°-30°C (59°-86°F). [See USP Controlled Room Temperature].

Knoll Pharmaceutical Company
Mount Olive, NJ 07828
USA

7897-03

Step 1 Convert To same size units. Remember the math tip: Convert larger unit (mg) to smaller unit (mcg) and you will eliminate the decimal fraction.

Approximate equivalent: 1 mg = 1,000 mcg

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{0.05 \text{ mg}}{\text{X mcg}}$ Cross-multiply

$\text{X} = 1{,}000 \times 0.05$ 0.050. Move the decimal three places to the right. Add zero to complete the operation.

$\text{X} = 50$ mcg Label the units to match the unknown X

Order: **Synthroid 0.05 mg = 50 mcg**

Supply: Synthroid 25 mcg tablets

Step 2 Think As soon as you convert the ordered dosage of *Synthroid 0.05 mg* to *Synthroid 50 mcg,* you realize that you want to give more than one tablet for each dose. In fact, you want to give twice the supply dosage, which is the same as two tablets.

Avoid getting confused by the way the original problem is presented. Be sure that you recognize which is the dosage ordered or desired and which is the supply dosage per the amount on hand. A common error is to misread the information and mix up the ratios in Step 3. This demonstrates the importance of thinking (Step 2) before you calculate.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{25 \text{ mcg}}{1 \text{ tablet}} \times \frac{50 \text{ mcg}}{\text{X tablets}}$$ Cross-multiply

$$25\ X = 50$$

$$\frac{25X}{25} = \frac{50}{25}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$X = 2 \text{ tablets}$$ Label the units to match the unknown X

Give 2 tablets of Synthroid orally daily.

EXAMPLE 5 ■

Your client is to receive **Nitrostat gr $\frac{1}{400}$ SL p.r.n. for angina.**

The label on the available Nitrostat bottle tells you that each tablet provides 0.3 mg (gr $\frac{1}{200}$). How much will you give your client?

Step 1 Convert To equivalent units in the same system of measurement. Remember the math tip: Convert apothecary measurement to metric units. Convert the order in grains to milligrams, and you will eliminate the fraction.

Approximate equivalent: gr i = 60 mg. Conversion factor is 60.

$$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{400}}{\text{X mg}}$$ Cross-multiply

$$X = 60 \times \frac{1}{400}$$

$$X = 0.15 \text{ mg}$$ Label the units to match the unknown X

Order: **Nitrostat gr $\frac{1}{400}$ = 0.15 mg**

Supply: Nitrostat 0.3 mg tablets

Step 2 Think Look at the supply dosage and add a zero at the end of the decimal number: 0.3 mg = 0.30 mg. Now you can compare the ordered dosage of 0.15 mg with the supply dosage of 0.30 mg per tablet. You can reason that you want to give less than 1 tablet. Further, you can see that 0.15 is $\frac{1}{2}$ of 0.30, and you know that you want to give $\frac{1}{2}$ tablet. Check your reasoning in Step 3.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{0.3 \text{ mg}}{1 \text{ tablet}} \times \frac{0.15 \text{ mg}}{\text{X tablets}}$$ Cross-multiply

$$0.3X = 0.15$$

$$\frac{0.3X}{0.3} = \frac{0.15}{0.3}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$X = \frac{1}{2} \text{ tablet}$$ Label the units to match the unknown X

Give $\frac{1}{2}$ tablet Nitrostat sublingually as needed for angina pain.

QUICK REVIEW

Simple Three-Step Approach to Dosage Calculations

Step 1	**Convert**	To units of the same system and the same size.
Step 2	**Think**	Estimate for a reasonable amount to give.
Step 3	**Calculate**	The ratio for the dosage you have on hand equals the ratio for the dosage desired.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

- For most dosage calculation problems:
  - convert to smaller size unit. Example: g → mg
  - convert from the apothecary or household system to the metric system. Example: gr → mg
- Consider the reasonableness of the calculated amount to give. Example: You would question giving more than three tablets or capsules per dose for oral administration.

Review Set 24

Calculate the correct number of tablets or capsules to be administered per dose. Tablets are scored.

1. Order: **Diabinese 0.1 g p.o. daily**

   Supply: Diabinese 100 mg tablets

   Give: ________ tablet(s)

2. Order: **Duricef 0.5 g p.o. b.i.d.**

   Supply: Duricef 500 mg tablets

   Give: ________ tablet(s)

3. Order: **Urecholine 15 mg p.o. t.i.d.**

   Supply: Urecholine 10 mg tablets

   Give: ________ tablet(s)

4. Order: **Hydrochlorothiazide 12.5 mg p.o. t.i.d.**

   Supply: Hydrochlorothiazide 25 mg tablets

   Give: ________ tablet(s)

5. Order: **Lanoxin 0.125 mg p.o. daily.**

   Supply: Lanoxin 0.25 mg tablets

   Give: ________ tablet(s)

6. Order: **Motrin 600 mg p.o. b.i.d.**

   Supply: Motrin 300 mg tablets

   Give: ________ tablet(s)

7. Order: **Slow-K 16 mEq p.o. stat**

   Supply: Slow-K 8mEq tablets

   Give: ________ tablet(s)

8. Order: **Cytoxan 50 mg p.o. daily**

   Supply: Cytoxan 25 mg tablets

   Give: ________ tablet(s)

9. Order: **Zaroxolyn 7.5 mg p.o. b.i.d.**

   Supply: Zaroxolyn 5 mg tablets

   Give: ________ tablet(s)

10. Order: **Coumadin 5 mg p.o. daily**

    Supply: Coumadin 2.5 mg tablets

    Give: ________ tablet(s)

11. Order: **Levaquin 0.5 g p.o. daily**

    Supply: Levaquin 500 mg tablets

    Give: ________ tablet(s)

12. Order: **Trandate 150 mg p.o. b.i.d.**

    Supply: Trandate 300 mg tablets

    Give: ________ tablet(s)

13. Order: **Duricef 1 g p.o. b.i.d.**

    Supply: Duricef 500 mg capsules

    Give: ________ capsule(s)

14. Order: **Synthroid 0.1 mg p.o. daily**

    Supply: Synthroid 50 mcg tablets

    Give: ________ tablet(s)

15. Order: **Tranxene 7.5 mg p.o. q.i.d.**

    Supply: Tranxene 3.75 mg capsules

    Give: ________ capsule(s)

16. Order: **Inderal 15 mg p.o. t.i.d.**

    Supply: Inderal 10 mg tablets

    Give: ________ tablets(s)

17. The doctor orders **Loniten gr $\frac{1}{6}$ p.o. stat** and you have available Loniten 10 mg and 2.5 mg scored tablets. Select ________ mg tablets and give ________ tablet(s).

18. Order: **Reglan 15 mg p.o. 1 h a.c. et bedtime.** You have available Reglan 10 mg and Reglan 5 mg scored tablets. Select ________ mg tablets and give ________ tablet(s). How many doses of Reglan will the patient receive in 24 hours? ________ dose(s)

19. Order: **phenobarbital gr $\frac{1}{4}$ p.o. daily.**

    Supply: phenobarbital 15 mg, 30 mg, and 60 mg scored tablets

    Select ________ mg tablets and give ________ tablet(s).

20. Order: **Tylenol $\bar{c}$ codeine gr i p.o. q.4h p.r.n. pain**

    Supply: Tylenol with codeine 7.5 mg, 15 mg, 30 mg, and 60 mg tablets

    Select ________ mg tablets and give ________ tablet(s).

Calculate one dose for each of the medication orders 21 through 30. The labels lettered A through I are the drugs you have available. Indicate the letter corresponding to the label you select.

21. Order: **verapamil sustained-release 240 mg p.o. daily**
    Select: ________
    Give: ________
22. Order: **carbamazepine 0.2 g p.o. t.i.d.**
    Select: ________
    Give: ________
23. Order: **Lopressor 50 mg p.o. b.i.d.**
    Select: ________
    Give: ________
24. Order: **potassium chloride 16 mEq p.o. daily**
    Select: ________
    Give: ________
25. Order: **Procanbid 1 g p.o. q.6h**
    Select: ________
    Give: ________
26. Order: **sulfasalazine 1 g p.o. b.i.d.**
    Select: ________
    Give: ________
27. Order: **levothyroxine sodium 0.2 mg p.o. daily**
    Select: ________
    Give: ________
28. Order: **digoxin 0.5 mg p.o. daily**
    Select: ________
    Give: ________
29. Order: **allopurinol 0.1 g p.o. t.i.d.**
    Select: ________
    Give: ________
30. Order: **procainamide hydrochloride 1,000 mg p.o. q.6h**
    Select: ________
    Give: ________

After completing these problems, see pages 484–485 to check your answers.

A

A09538-3

500 Caplets Rx only
NDC 0025-1891-51

Calan® SR
(verapamil hydrochloride)
240 mg
SUSTAINED-RELEASE

Usual Adult Dosage:
See attached literature.

SEARLE

Store at 59° to 77°F (15° to 25°C).
Protect from light and moisture.

Pharmacist: Dispense in a tight, light-resistant, child-resistant container.

G.D. Searle & Co.
Chicago IL 60680 USA

FOR POSITION ONLY UPC @100%
3 0025-1891-51

B

NDC 61570-071-60

Procanbid®
(Procainamide HCl
Extended-Release Tablets*)

1000 mg

℞ Only

60 TABLETS

Monarch Pharmaceuticals®

Each tablet contains 1000 mg of procainamide hydrochloride.
Usual Dosage–See package insert for complete prescribing information.
Keep this and all drugs out of the reach of children.
Dispense in a tight container as defined in the USP.
Store at controlled room temperature 20°–25°C (68°–77°F).
Do not chew tablets. *Procanbid is not USP for dissolution. Rev. 3/99

Exp. date and lot
Sample
0564G061

Distributed by: Monarch Pharmaceuticals, Inc., Bristol, TN 37620
Manufactured by: Warner-Lambert Co., Morris Plains, NJ 07950

3 61570 07160 0

C

NDC 0048-1070-03
NSN 6505-01-340-0152
Code 3P1073

SYNTHROID®
(Levothyroxine Sodium Tablets, USP)
100 mcg (0.1 mg)

100 TABLETS

Rx only

See full prescribing information for dosage and administration.

Dispense in a tight, light-resistant container as described in USP.

Store at 25°C (77°F); excursions permitted to 15°-30°C (59°-86°F). [See USP Controlled Room Temperature].

Knoll Pharmaceutical Company
Mount Olive, NJ 07828
USA

3 0048-1070-03 6

BASF Pharma knoll 7885-04

D

Azulfidine®
sulfasalazine tablets, USP

500 mg

℞ only

MADE IN SWEDEN
Mfd. for: Pharmacia & Upjohn Co.
Kalamazoo, MI 49001, USA
by: Pharmacia & Upjohn AB
Stockholm, Sweden

300 Tablets

Pharmacia & Upjohn

E

645122

Dosage: See package insert.
Store between 15°C - 30°C (59°F - 86°F).
Protect from moisture.
Dispense in tight, light-resistant container (USP).

Novartis Pharmaceuticals Corporation
East Hanover, New Jersey 07936

NDC **0028-0051-10**
6505-01-071-6557

Lopressor® 50 mg
metoprolol tartrate USP

1000 tablets

Rx only

NOVARTIS

PHARMACIST: Container closure is not child-resistant.
Keep this and all drugs out of the reach of children.

N 3 0028-0051-10 6

EXP
LOT

F

1000 Tablets NDC 0173-0249-75

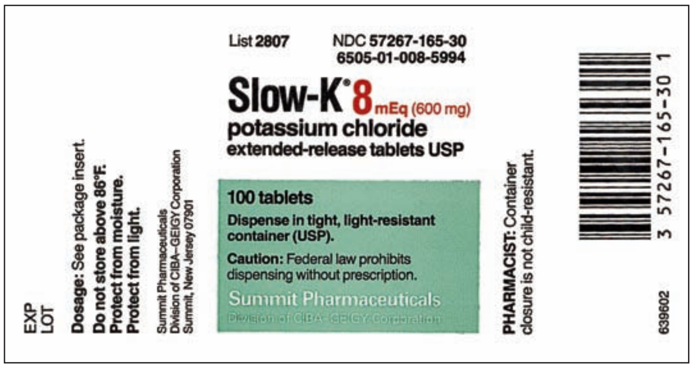
LANOXIN®
(digoxin)
Tablets
Each scored tablet contains
250 mcg (0.25 mg)
℞ only

See package insert for Dosage and Administration.
Store at 25°C (77°F) in a dry place (see insert).
Dispense in tight container as defined in the USP.
Do not use if black printed safety seal under cap is broken or missing.

GlaxoSmithKline
GlaxoSmithKline
Research Triangle Park, NC 27709
4140796 Rev. 3/02

N 3 0173-0249-75

G



List 2807 NDC 57267-165-30
6505-01-008-5994

Slow-K® 8 mEq (600 mg)
potassium chloride
extended-release tablets USP

100 tablets
Dispense in tight, light-resistant container (USP).
Caution: Federal law prohibits dispensing without prescription.
Summit Pharmaceuticals
Division of CIBA-GEIGY Corporation

EXP
LOT

Dosage: See package insert.
Do not store above 86°F.
Protect from moisture.
Protect from light.

Summit Pharmaceuticals
Division of CIBA–GEIGY Corporation
Summit, New Jersey 07901

PHARMACIST: Container closure is not child-resistant.

3 57267-165-30 1

639602

H

NDC 0083-0052-30 FSC 1821
6505-01-153-4524

Tegretol® 100 mg
carbamazepine USP

Chewable Tablets

100 tablets
Dispense in tight, light-resistant container (USP).
Caution: Federal law prohibits dispensing without prescription.

ciba

EXP
LOT

Do not store above 86°F (30°C).
Dosage: See package insert.
Protect from light and moisture.

Ciba-Geigy Corporation
Pharmaceuticals Division
Summit, NJ 07901

Keep this and all drugs out of the reach of children.

N 3 0083-0052-30 0

643330

I

ORAL LIQUIDS

Oral liquids are supplied in solution form and contain a specific amount of drug in a given amount of solution as stated on the label (Figures 10-3a through 10-3d).

In solving dosage problems when the drug is supplied in solid form, you calculated the number of tablets or capsules that contained the prescribed dosage. The supply container label indicates the amount of medication per one tablet or one capsule. For medications supplied in liquid form, you must calculate the volume of the liquid that contains the prescribed dosage of the drug. The supply dosage noted on the label may indicate the amount of drug per one milliliter or per multiple milliliters of solution, such as 10 mg per 2 mL, 125 mg per 5 mL, or 1.2 g per 30 mL.

Steps 1, 2, and 3 can be used to solve liquid oral dosage calculations in the same way that solid-form oral dosages are calculated. Let's apply the three steps to dosage calculations in a few examples.

FIGURE 10-3(a) Oral liquid: Ceclor 125 mg per 5 mL

FIGURE 10-3(b) Oral liquid: Ceclor 187 mg per 5 mL

FIGURE 10-3(c) Oral liquid: Ceclor 250 mg per 5 mL

FIGURE 10-3(d) Oral liquid: Ceclor 375 mg per 5 mL

EXAMPLE 1 ■

The doctor orders **Ceclor 100 mg p.o. q.i.d.**

Look at the labels of Ceclor available in Figure 10-3. You choose *Ceclor 125 mg per 5 mL.* Follow the three steps to dosage calculations.

Step 1 Convert No conversion is necessary, because the order and supply dosage are both in the same units.

Step 2 Think You want to give less than 125 mg, so you want to give less than 5 mL. Double-check your thinking with ratio-proportion.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{125 \text{ mg}}{5 \text{ mL}} \times \frac{100 \text{ mg}}{\text{X mL}}$$ Cross-multiply

$$125\text{X} = 100 \times 5$$

$$125\text{X} = 500$$

$$\frac{125\text{X}}{125} = \frac{500}{125}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 4 \text{ mL}$$ Label the units to match the unknown X

Give 4 mL of the Ceclor (concentration 125 mg per 5 mL) orally four times daily.

Notice that the label says the dosage strength (or concentration) is 125 mg per 5 mL. The order is for only 100 mg so you know you will give less than 5 mL. You will give 4 mL of the Ceclor with the dosage strength of 125 mg per 5 mL. Double-check to be sure your calculated dosage is consistent with your reasonable dosage from Step 2. If, for instance, you calculate to give more than 5 mL, then you should suspect a calculation error.

EXAMPLE 2 ■

Suppose, using the same drug order in Example 1, **Ceclor 100 mg p.o. q.i.d.**, you choose a stronger solution, *Ceclor 250 mg per 5 mL.* Follow the three steps to dosage calculations.

Step 1 Convert No conversion is necessary, because the order and supply dosage are both in the same units and system.

Step 2 Think You want to give 100 mg, and you have 250 mg per 5 mL so you will give less than half of 5 mL. Double-check your thinking by using ratio-proportion.

Step 3 **Calculate**

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{250\text{ mg}}{5\text{ mL}} \times \frac{100\text{ mg}}{\text{X mL}}$$ Cross-multiply

$$250\text{X} = 100 \times 5$$

$$250\text{X} = 500$$

$$\frac{250\text{X}}{250} = \frac{500}{250}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 2\text{ mL}$$ Label the units to match the unknown X

Give 2 mL of the Ceclor (concentration 250 mg per 5 mL) orally four times daily.

Notice that in both Example 1 and Example 2, the supply quantity is the same (5 mL), but the dosage strength (weight) of medication is different (125 mg per 5 mL versus 250 mg per 5 mL). This results in the calculated dose volume (amount to give) being different (4 mL versus 2 mL). This difference is the result of each liquid's *concentration. Ceclor 125 mg per 5 mL* is half as concentrated as *Ceclor 250 mg per 5 mL.* In other words, there is half as much drug in 5 mL of the *125 mg per 5 mL* supply as there is in 5 mL of the *250 mg per 5 mL* supply. Likewise, *Ceclor 250 mg per 5 mL* is twice as concentrated as *Ceclor 125 mg per 5 mL.* The more concentrated solution allows you to give the patient less volume per dose for the same dosage. This is significant when administering medication to infants and small children when a smaller quantity is needed. Think about this carefully until it is clear.

CAUTION

Think before you calculate. It is important to estimate before you apply any formula. In this way, if you make a careless error in math or if you set up the problem incorrectly, your thinking will alert you to try again.

EXAMPLE 3 ■

The doctor orders **potassium chloride 40 mEq p.o. daily.**

The label on the package reads *potassium chloride 20 mEq per 15 mL.* How many mL should you administer?

Step 1 **Convert** No conversion is necessary.

Step 2 **Think** You want to give more than 15 mL. In fact, you want to give exactly twice as much as 15 mL. You know this is true because 40 mEq is twice as much as 20 mEq. Therefore, it will take 2 × 15 mL or 30 mL to give 40 mEq. Continue to step 3 to double-check your thinking.

Step 3 **Calculate**

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{20\text{ mEq}}{15\text{ mL}} \times \frac{40\text{ mEq}}{\text{X mL}}$$ Cross-multiply

$$20\text{X} = 40 \times 15$$

$$20\text{X} = 600$$

$$\frac{20\text{X}}{20} = \frac{600}{20}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 30\text{ mL}$$ Label the units to match the unknown X

Give 30 mL of potassium chloride (concentration 20 mEq per 15 mL) orally daily.

QUICK REVIEW

Look again at steps 1 through 3 as a valuable dosage calculation checklist.

Step 1 **Convert** Be sure that all measurements are in the same system, and all units are in the same size.

Step 2 **Think** Carefully estimate the reasonable amount of the drug that you should administer.

Step 3 **Calculate** $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

Review Set 25

Calculate one dose of the drugs ordered.

1. Order: **Demerol syrup 75 mg p.o. q.4h p.r.n. pain**

   Supply: Demerol syrup 50 mg per 5 mL

   Give: ________ mL

2. Order: **Phenergan $\bar{c}$ codeine gr $\frac{1}{6}$ p.o. q.6h p.r.n. cough**

   Supply: Phenergan $\bar{c}$ codeine solution 10 mg per 5 mL

   Give: ________ mL

3. Order: **Pen-Vee K 1 g p.o. 1 h pre-op dental surgery**

   Supply: Pen-Vee K oral suspension 250 mg (400,000 units) per 5 mL

   Give: ________ mL

4. Order: **amoxicillin 100 mg p.o. q.i.d.**

   Supply: 80 mL bottle of Amoxil (amoxicillin) oral pediatric suspension 125 mg per 5 mL

   Give: ________ mL

5. Order: **Tylenol 0.5 g p.o. q.4h p.r.n. pain**

   Supply: Tylenol 500 mg per 5 mL

   Give: ________ t

6. Order: **promethazine HCl 25 mg p.o. at bedtime pre-op**

   Supply: Phenergan Plain (promethazine HCl) 6.25 mg per teaspoon

   Give: ________ mL

7. Order: **Pathocil 125 mg p.o. q.6h**

   Supply: Pathocil suspension 62.5 mg per 5 mL

   Give: ________ t

8. Order: **erythromycin suspension 600 mg p.o. q.6h**

   Supply: erythromycin 400 mg per 5 mL

   Give: ________ mL

9. Order: **Ceclor suspension 225 mg p.o. b.i.d.**

   Supply: Ceclor suspension 375 mg per 5 mL

   Give: ________ mL

10. Order: **Septra-DS suspension 200 mg p.o. b.i.d.**

    Supply: Septra-DS suspension 400 mg per 5 mL

    Give: ________ mL

11. Order: **Elixophyllin liquid 0.24 g p.o. stat**

    Supply: Elixophyllin liquid 80 mg per 7.5 mL

    Give: ________ mL

12. Order: **Trilisate liquid 750 mg p.o. t.i.d.**

    Supply: Trilisate liquid 250 mg per 2.5 mL

    Give: ________ mL

13. Order: **Esidrix solution 100 mg p.o. b.i.d.**

    Supply: Esidrix solution 50 mg per 5 mL

    Give: ________ t

14. Order: **Pepcid 20 mg p.o. q.i.d.**

    Supply: Pepcid 80 mg per 10 mL

    Give: ________ mL

15. Order: **digoxin elixir 0.25 mg p.o. daily**

    Supply: digoxin elixir 50 mcg/mL

    Give: ________ mL

16. Order: **nafcillin sodium 0.75 g p.o. q.6h**

Supply: nafcillin sodium 250 mg per 5 mL

Give: _________ oz

17. Order: **cephalexin 375 mg p.o. t.i.d.**

Supply: cephalexin 250 mg per 5 mL

Give: _________ t

18. Order: **lactulose 20 g via gastric tube b.i.d. today**

Supply: lactulose 10 g per 15 mL

Give: _________ oz

19. Order: **erythromycin 1.2 g p.o. q.8h**

Supply: erythromycin 400 mg per 5 mL

Give: _________ mL

20. Order: **oxacillin sodium 0.25 g p.o. q.8h**

Supply: oxacillin sodium 125 mg per 2.5 mL

Give: _________ t

21. Order: **amoxicillin suspension 100 mg p.o. q.6h**

Supply: amoxicillin suspension 250 mg per 5 mL

Give: _________ mL

Use the labels A, B, and C below to calculate one dose of the following orders (22, 23, and 24). Indicate the letter corresponding to the label you select.

22. Order: **Amoxil 500 mg p.o. q.8h**

Select: _________

Give: _________

23. Order: **Vantin 200 mg p.o. q.12h**

Select: _________

Give: _________

24. Order: **Vistaril 10 mg p.o. q.i.d.**

Select: _________

Give: _________

A

NDC 0069-5440-97

Vistaril® hydroxyzine pamoate equivalent to 25 mg /5 ml* hydroxyzine HCl

Dye Free Formula

ORAL SUSPENSION

120 ml

CAUTION: Federal law prohibits dispensing without prescription.

Pfizer LABORATORIES DIVISION PFIZER INC., NEW YORK, N.Y. 10017

RECOMMENDED STORAGE
STORE BELOW 77°F (25°C)
SHAKE WELL BEFORE USING
FOR ORAL USE ONLY
MADE IN U.S.A. 4

READ ACCOMPANYING PROFESSIONAL INFORMATION

*Each teaspoonful (5 ml) contains hydroxyzine pamoate equivalent to 25 mg hydroxyzine hydrochloride

USUAL DAILY DOSAGE
Adults: 1 to 4 teaspoonfuls 3-4 times daily.
Children: 6 years and over—2 to 4 teaspoonfuls daily in divided doses.
Under 6 years—2 teaspoonfuls daily in divided doses.

PUL

B

AMOXIL® 250mg/5mL

Directions for mixing: Tap bottle until all powder flows freely. Add approximately 1/3 total amount of water for reconstitution (total=74 mL); shake vigorously to wet powder. Add remaining water; again shake vigorously. Each 5 mL (1 teaspoonful) will contain amoxicillin trihydrate equivalent to 250 mg amoxicillin.
Usual Adult Dosage: 250 to 500 mg every 8 hours.
Usual Child Dosage: 20 to 40 mg/kg/day in divided doses every 8 hours, depending on age, weight and infection severity. See accompanying prescribing information.

Keep tightly closed.
Shake well before using.
Refrigeration preferable but not required.
Discard suspension after 14 days.

250mg/5mL
NDC 0029-6009-23

AMOXIL®
AMOXICILLIN
FOR ORAL SUSPENSION

100mL
(when reconstituted)

SB SmithKline Beecham

C

NDC 0009-3615-03
50 mL (when mixed)

Vantin® For Oral Suspension
cefpodoxime proxetil for oral suspension

100 mg per 5 mL

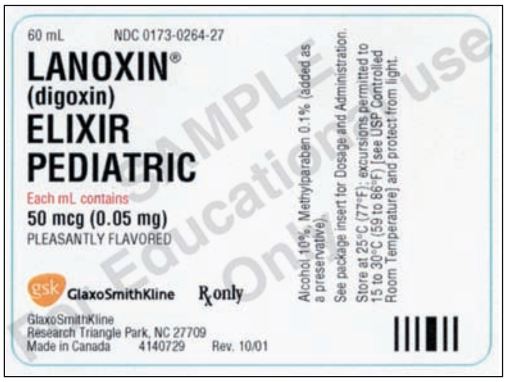
Equivalent to 100 mg per 5 mL cefpodoxime when constituted

Pharmacia &Upjohn

Calculate the information requested based on the drugs ordered. The labels provided are the drugs available.

25. Order: **Lanoxin elixir 0.25 mg p.o. daily**

Give: ________ mL



60 mL NDC 0173-0264-27

LANOXIN®
(digoxin)
ELIXIR
PEDIATRIC

Each mL contains
50 mcg (0.05 mg)
PLEASANTLY FLAVORED

GlaxoSmithKline ℞ only

GlaxoSmithKline
Research Triangle Park, NC 27709
Made in Canada 4140729 Rev. 10/01

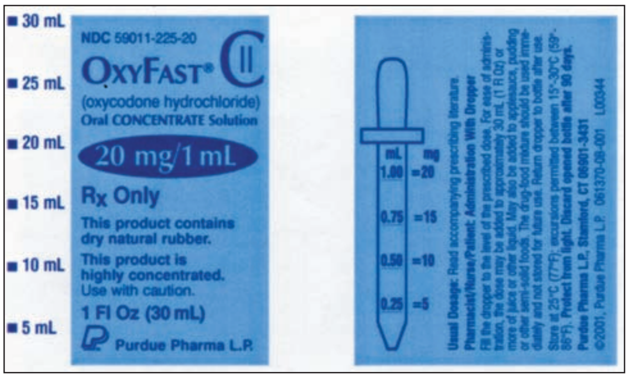
Alcohol 10%, Methylparaben 0.1% (added as a preservative).

See package insert for Dosage and Administration.

Store at 25°C (77°F); excursions permitted to 15 to 30°C (59 to 86°F) [see USP Controlled Room Temperature] and protect from light.

26. Order: **OxyFast (oral solution concentrate) 15 mg p.o. q.6h p.r.n., pain**

Give: ________ mL



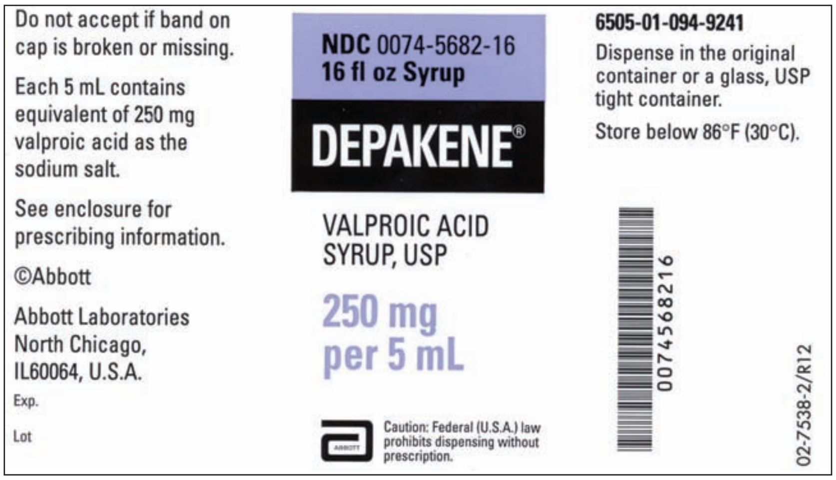
NDC 59011-225-20
OXYFAST® CII
(oxycodone hydrochloride)
Oral CONCENTRATE Solution
20 mg/1 mL
Rx Only
This product contains dry natural rubber.
This product is highly concentrated. Use with caution.
1 Fl Oz (30 mL)
Purdue Pharma L.P.

Usual Dosage: Read accompanying prescribing literature.
Pharmacist/Nurse/Patient: Administration With Dropper
Fill the dropper to the level of the prescribed dose. For ease of administration, the dose may be added to approximately 30 mL (1 Fl Oz) or more of juice or other liquid. May also be added to applesauce, pudding or other semi-solid foods. The drug-food mixture should be used immediately and not stored for future use. Return dropper to bottle after use.
Store at 25°C (77°F); excursions permitted between 15°-30°C (59°-86°F). **Protect from light. Discard opened bottle after 90 days.**
Purdue Pharma L.P., Stamford, CT 06901-3431
©2001, Purdue Pharma L.P. 061370-08-001 L00344

27. Order: **valproic acid 0.5 g p.o. t.i.d.**

Give: ________ mL

How many full doses are available in this bottle? ________



Do not accept if band on cap is broken or missing.

Each 5 mL contains equivalent of 250 mg valproic acid as the sodium salt.

See enclosure for prescribing information.

©Abbott

Abbott Laboratories
North Chicago,
IL60064, U.S.A.

Exp.

Lot

NDC 0074-5682-16
16 fl oz Syrup

DEPAKENE®

VALPROIC ACID
SYRUP, USP

250 mg
per 5 mL

Caution: Federal (U.S.A.) law prohibits dispensing without prescription.

6505-01-094-9241

Dispense in the original container or a glass, USP tight container.

Store below 86°F (30°C).

0074568216

02-7538-2/R12

28. Order: **Biaxin 75 mg p.o. q.12h**

Give: ________ mL

May be taken before, after or with meals. Shake well before each use. Oversize bottle provides shake space. Keep tightly closed. After mixing, store at 15° to 30°C (59° to 86° F) and use within 14 days. **DO NOT REFRIGERATE.**
NDC 0074-3163-13
02-7716-R5

Exp.
Lot

SPECIMEN

TEAR PERFORATION BETWEEN ARROWS

Store granules at 15° to 30°C (59° to 86°F).
CONSTITUTING INSTRUCTIONS:
VOLUME OF WATER: 55 mL
Measure the required volume of water using a graduated cylinder. Add half the volume of water to the bottle and shake vigorously. Add the remainder of water to the bottle and shake.
Contains 2.5 g clarithromycin.
When mixed as directed, each teaspoonful (5 mL) contains:
Clarithromycin..........125 mg
in a fruit punch-flavored, aqueous vehicle.
DOSAGE MAY BE ADMINISTERED WITHOUT REGARD TO MEALS.
Usual dose: Children: 15 mg/kg/day divided in 2 equal doses. See enclosure for adult dose and full prescribing information.
Abbott Laboratories
North Chicago, IL60064, U.S.A.

NDC 0074-3163-13
100 mL (when mixed)
BIAXIN®
GRANULES
clarithromycin for oral suspension
125 mg per 5 mL
when reconstituted
Flavor change adopted Sept. 1995.

Caution: Federal (U.S.A.) law prohibits dispensing without prescription.

PEEL

0074316313

29. Order: **Maalox Plus 30 mL p.o. 30 min. p.c. and hour of sleep**

    How many containers will be needed for a 24-hour period? __________

30. Meals are served at 8 AM, noon, and 6 PM. Using international time, what are the administration times for the 30 min p.c. dosages for the order in question 29? (Allow 30 minutes for each meal to be eaten.) __________

After completing these problems, see pages 485–486 to check your answers.

SUMMARY

Let's examine where you are in mastering the skill of dosage calculations. You have learned to convert equivalent units within systems of measurements and from one system to another. You have also applied this conversion skill to the calculation of oral dosages—both solid and liquid forms. By now, you know that solving dosage problems requires that all units of measurement first be expressed in the same system and same size.

Next, you learned to think through the dosage ordered and dosage supplied to estimate the amount to be given. *To minimize medication errors, it is essential that you consider the reasonableness of the amount before applying a calculation method or formula.*

Finally, you have learned to set up and solve a drug dosage proportion of two equivalent ratios with one unknown, X. This method is so simple and easy to recall that it will stick with you throughout your career:

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

Review the Critical Thinking Skills and work the practice problems for Chapter 10. If you are having difficulty, get help from an instructor before proceeding to Chapter 11. Continue to concentrate on accuracy. Keep in mind that one error can be a serious mistake when you are calculating the dosages of medicines. Medication administration is a legal responsibility. Remember, when you give a medication, you are legally responsible for your action.

CRITICAL THINKING SKILLS

Inaccuracy in dosage calculation is often attributed to errors in calculating the dosage. By first asking the question, "What is the reasonable amount to give?" many medication errors can be avoided.

ERROR

Incorrect calculation and not assessing the reasonableness of the calculation before administering the medication.

Possible Scenario

The physician ordered *phenobarbital 60 mg p.o. b.i.d.* for a patient with seizures. The pharmacy supplied *phenobarbital 30 mg per tablet.* The nurse did not use Step 2 to think about the reasonable dosage and calculated the dosage this way:

$$
\begin{aligned}
\frac{\text{Dosage on hand}}{\text{Amount on hand}} &= \frac{\text{Dosage desired}}{\text{X Amount desired}} \\
\frac{30\text{ mg}}{1\text{ tablet}} &\times \frac{60\text{ mg}}{\text{X tablets}} \\
30\text{ X} &= 60 \\
\frac{30\text{X}}{30} &= \frac{60}{30} \\
\text{X} &= 20\text{ tablets}
\end{aligned}
$$

(Answer is incorrect! But what if the nurse did not realize this?)

Suppose the nurse then gave the patient 20 tablets of the 30 mg per tablet of phenobarbital. The patient would have received 600 mg of phenobarbital, or 10 times the correct dosage. This is a serious error.

Potential Outcome

The patient would likely develop signs of phenobarbital toxicity, such as nystagmus (rapid eye movement), ataxia (lack of coordination), central nervous system depression, respiratory depression, hypothermia, and hypotension. When the error was caught and the physician notified, the patient would likely be given doses of charcoal to hasten elimination of the drug. Depending on the severity of the symptoms, the patient would likely be moved to the intensive care unit for monitoring of respiratory and neurological status.

Prevention

This medication error could have been prevented if the nurse had used the three-step method and estimated for the reasonable dosage of the drug to give. The order is for 60 mg of phenobarbital, and the available drug has 30 mg per tablet, so the nurse should give two tablets. The incorrect calculation that indicated such a large number of tablets to give per dose should have alerted the nurse to a possible error. Ratio-proportion $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$ should be used to verify thinking about the *reasonable* dosage. Further, the nurse should double-check the math to find the error.

$$
\begin{aligned}
\frac{\text{Dosage on hand}}{\text{Amount on hand}} &\times \frac{\text{Dosage desired}}{\text{X Amount desired}} \\
\frac{30\text{ mg}}{1\text{ tablet}} &= \frac{60\text{ mg}}{\text{X tablets}} \\
30\text{ X} &= 60 \\
\frac{30\text{X}}{30} &= \frac{60}{30} \\
\text{X} &= 2\text{ tablets} \qquad \text{(Not 20 tablets)}
\end{aligned}
$$

PRACTICE PROBLEMS—CHAPTER 10

Calculate one dose of the following drug orders. The tablets are scored in half.

1. Order: Orinase 250 mg p.o. b.i.d.

   Supply: Orinase 0.5 g tablets

   Give: __________ tablet(s)

2. Order: codeine gr $\frac{1}{2}$ p.o. q.4h p.r.n., pain

   Supply: codeine 15 mg tablets

   Give: __________ tablet(s)

3. Order: Synthroid 0.075 mg p.o. daily

   Supply: Synthroid 150 mcg tablets

   Give: __________ tablet(s)

4. Order: phenobarbital gr $\frac{1}{6}$ p.o. t.i.d.

   Supply: phenobarbital elixir 20 mg per 5 mL

   Give: __________ mL

5. Order: Keflex 500 mg p.o. q.i.d.

   Supply: Keflex 250 mg per 5 mL

   Give: __________ mL

6. Order: Inderal 20 mg p.o. q.i.d.

   Supply: Inderal 10 mg tablets

   Give: __________ tablet(s)

7. Order: Amoxil 400 mg p.o. q.6h

   Supply: Amoxil 250 mg per 5 mL

   Give: __________ mL

8. Order: Diabenese 150 mg p.o. b.i.d.

   Supply: Diabenese 0.1 g tablets

   Give: __________ tablet(s)

9. Order: Aspirin gr v p.o. daily

   Supply: Aspirin 325 mg tablets

   Give: __________ tablet(s)

10. Order: codeine gr $\frac{1}{4}$ p.o. daily

    Supply: codeine 30 mg tablets

    Give: __________ tablet(s)

11. Order: Inderal 30 mg p.o. q.i.d.

    Supply: Inderal 20 mg tablets

    Give: __________ tablet(s)

12. Order: Synthroid 300 mcg p.o. daily

    Supply: Synthroid 0.3 mg tablets

    Give: __________ tablet(s)

13. Order: Lasix 60 mg p.o. daily

    Supply: Lasix 40 mg tablets

    Give: __________ tablet(s)

14. Order: Tylenol $\bar{c}$ codeine gr $\frac{1}{8}$ p.o. daily

    Supply: Tylenol with 7.5 mg codeine tablets

    Give: __________ tablet(s)

15. Order: penicillin G 400,000 units p.o. q.i.d.

    Supply: Pentids (penicillin G) 250 mg (400,000 units) tablets

    Give: __________ tablet(s)

16. Order: Vasotec 7.5 mg p.o. daily

    Supply: Vasotec 5 mg and 10 mg tablets

    Select: __________ mg tablets

    and give __________ tablet(s)

17. Order: V-Cillin K 300,000 units p.o. q.i.d.

    Supply: V-Cillin K 200,000 units per 5 mL

    Give: __________ mL

18. Order: Neomycin 0.75 g p.o. b.i.d.

    Supply: Neomycin 500 mg tablets

    Give: __________ tablet(s)

19. Order: Halcion 0.25 mg p.o. h.s.

    Supply: Halcion 0.125 mg tablets

    Give: __________ tablet(s)

20. Order: **Roxanol gr $\frac{1}{10}$ p.o. q.4h p.r.n. pain**

Supply: Roxanol 10 mg per 5 mL

Give: ________ mL

21. Order: **Decadron 750 mcg p.o. b.i.d.**

Supply: Decadron 0.75 mg and 1.5 mg tablets

Select: ________ mg tablets

Give: ________ tablet(s)

22. Order: **Edecrin 12.5 mg p.o. b.i.d.**

Supply: Edecrin 25 mg tablets

Give: ________ tablet(s)

23. Order: **Urecholine 50 mg p.o. t.i.d.**

Supply: Urecholine 25 mg tablets

Give: ________ tablet(s)

24. Order: **erythromycin 0.5 g p.o. q.12h**

Supply: erythromycin 250 mg tablets

Give: ________ tablet(s)

25. Order: **glyburide 2.5 mg p.o. daily**

Supply: glyburide 1.25 mg tablets

Give: ________ tablet(s)

26. Order: **Tranxene 7.5 mg p.o. q.AM**

Supply: Tranxene 3.75 mg capsules

Give: ________ capsules

27. Order: **phenobarbital gr $\frac{3}{4}$ p.o. daily**

Supply: phenobarbital 15 mg, 30 mg, and 60 mg scored tablets

Which strength of tablet(s) would you select, and how much would you give?

Select: ________ mg tablets

Give: ________ tablet(s)

28. Order: **acetaminophen 240 mg p.o. q.4h p.r.n., pain or T greater than 102°F**

Supply: acetaminophen drops 80 mg per 0.8 mL

Give: ________ mL

29. Order: **acetaminophen 160 mg p.o. q.4h p.r.n., pain or T 102°F or greater**

Supply: acetaminophen liquid 80 mg per $\frac{1}{2}$ t

Give: ________ mL

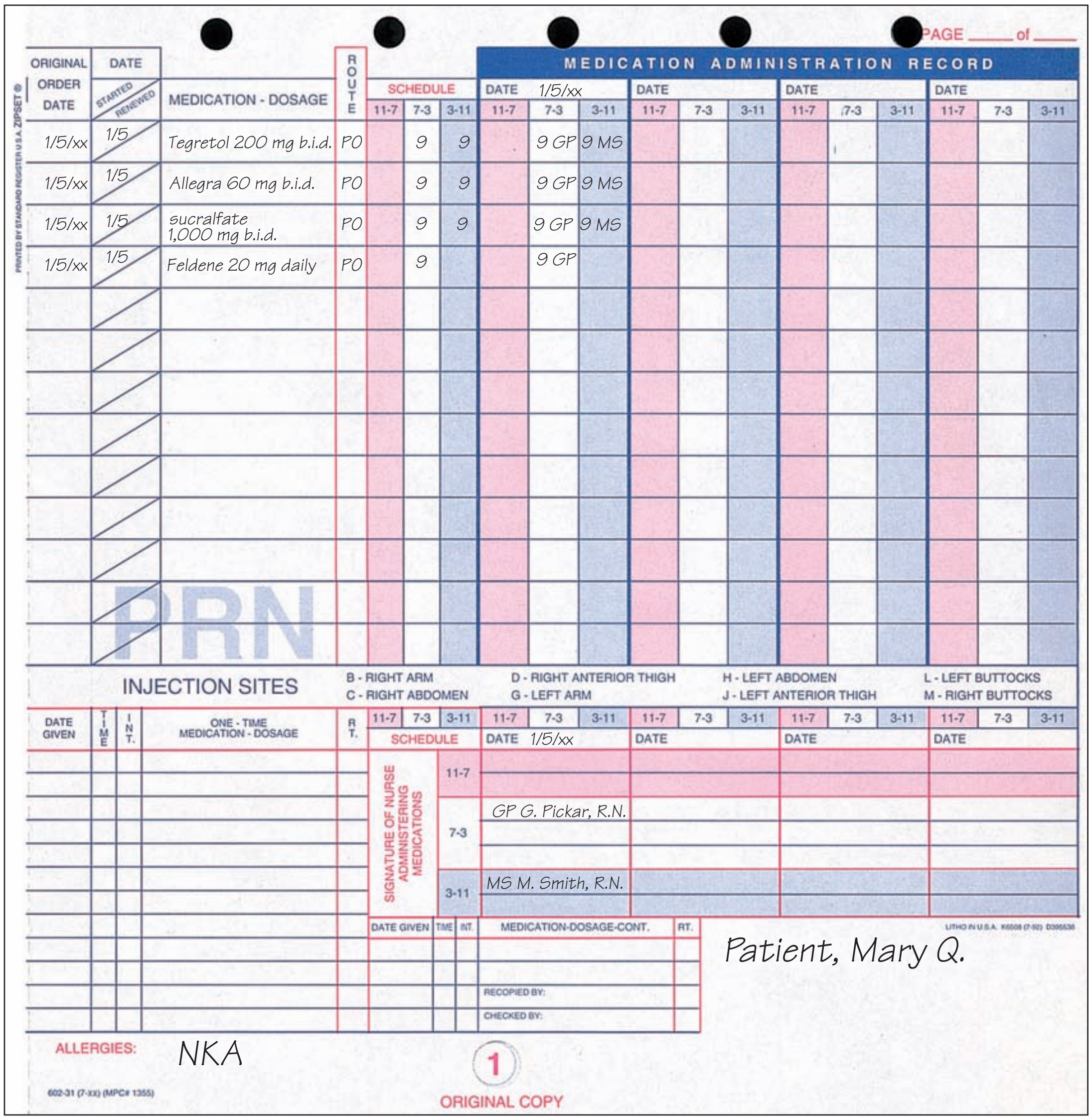
30. Order: **Coumadin 7.5 mg p.o. daily**

Supply: Coumadin 2.5 mg tablets

Give: ________ tablet(s)

See the three medication administration records (MAR) and accompanying labels on the following pages for questions 31 through 45.

Calculate one dose of each of the drugs prescribed. Labels A–O provided on pages 197–199 are the drugs you have available. Indicate the letter corresponding to the label you select.



PAGE ____ of ____

MEDICATION ADMINISTRATION RECORD

	ORIGINAL ORDER DATE	DATE STARTED / RENEWED	MEDICATION - DOSAGE	ROUTE	SCHEDULE			DATE 1/5/xx			DATE			DATE			DATE		
					11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11
31.	1/5/xx	1/5	Tegretol 200 mg b.i.d.	PO		9	9		9 GP	9 MS									
32.	1/5/xx	1/5	Allegra 60 mg b.i.d.	PO		9	9		9 GP	9 MS									
33.	1/5/xx	1/5	sucralfate 1,000 mg b.i.d.	PO		9	9		9 GP	9 MS									
34.	1/5/xx	1/5	Feldene 20 mg daily	PO		9			9 GP										

PRN

INJECTION SITES

B - RIGHT ARM
C - RIGHT ABDOMEN
D - RIGHT ANTERIOR THIGH
G - LEFT ARM
H - LEFT ABDOMEN
J - LEFT ANTERIOR THIGH
L - LEFT BUTTOCKS
M - RIGHT BUTTOCKS

DATE GIVEN	TIME	INT.	ONE - TIME MEDICATION - DOSAGE	RT.

SIGNATURE OF NURSE ADMINISTERING MEDICATIONS	DATE 1/5/xx	DATE	DATE	DATE
11-7				
7-3	GP G. Pickar, R.N.			
3-11	MS M. Smith, R.N.			

DATE GIVEN	TIME	INT.	MEDICATION-DOSAGE-CONT.	RT.
			RECOPIED BY:	
			CHECKED BY:	

Patient, Mary Q.

ALLERGIES: NKA

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602-31 (7-xx) (MPC# 1355)

1 ORIGINAL COPY

31. Select: ________

Give: ________

32. Select: ________

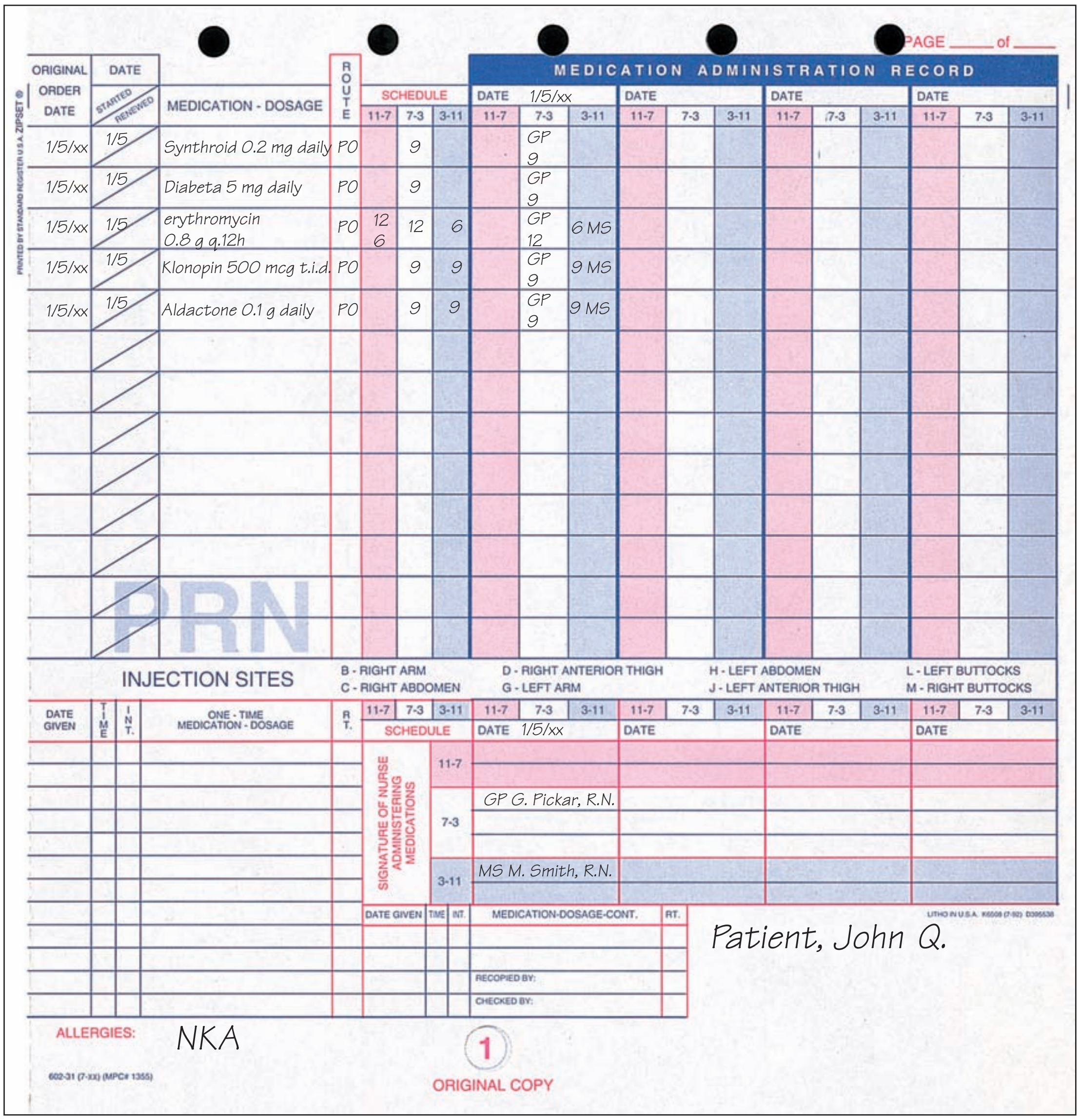
Give: ________

33. Select: ________

Give: ________

34. Select: ________

Give: ________



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PAGE ____ of ____

MEDICATION ADMINISTRATION RECORD

	ORIGINAL ORDER DATE	DATE STARTED / RENEWED	MEDICATION - DOSAGE	ROUTE	SCHEDULE			DATE 1/5/xx			DATE			DATE			DATE		
					11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11
35.	1/5/xx	1/5	Synthroid 0.2 mg daily	PO		9			GP 9										
36.	1/5/xx	1/5	Diabeta 5 mg daily	PO		9			GP 9										
37.	1/5/xx	1/5	erythromycin 0.8 g q.12h	PO	12 6	12	6		GP 12	6 MS									
38.	1/5/xx	1/5	Klonopin 500 mcg t.i.d.	PO		9	9		GP 9	9 MS									
39.	1/5/xx	1/5	Aldactone 0.1 g daily	PO		9	9		GP 9	9 MS									

PRN

INJECTION SITES

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D - RIGHT ANTERIOR THIGH
G - LEFT ARM
H - LEFT ABDOMEN
J - LEFT ANTERIOR THIGH
L - LEFT BUTTOCKS
M - RIGHT BUTTOCKS

DATE GIVEN	TIME	INT.	ONE - TIME MEDICATION - DOSAGE	RT.

SIGNATURE OF NURSE ADMINISTERING MEDICATIONS	DATE 1/5/xx	DATE	DATE	DATE
11-7				
7-3	GP G. Pickar, R.N.			
3-11	MS M. Smith, R.N.			

DATE GIVEN	TIME	INT.	MEDICATION-DOSAGE-CONT.	RT.
			RECOPIED BY:	
			CHECKED BY:	

LITHO IN U.S.A. K6508 (7-92) D395536

Patient, John Q.

ALLERGIES: NKA

602-31 (7-XX) (MPC# 1355)

① ORIGINAL COPY

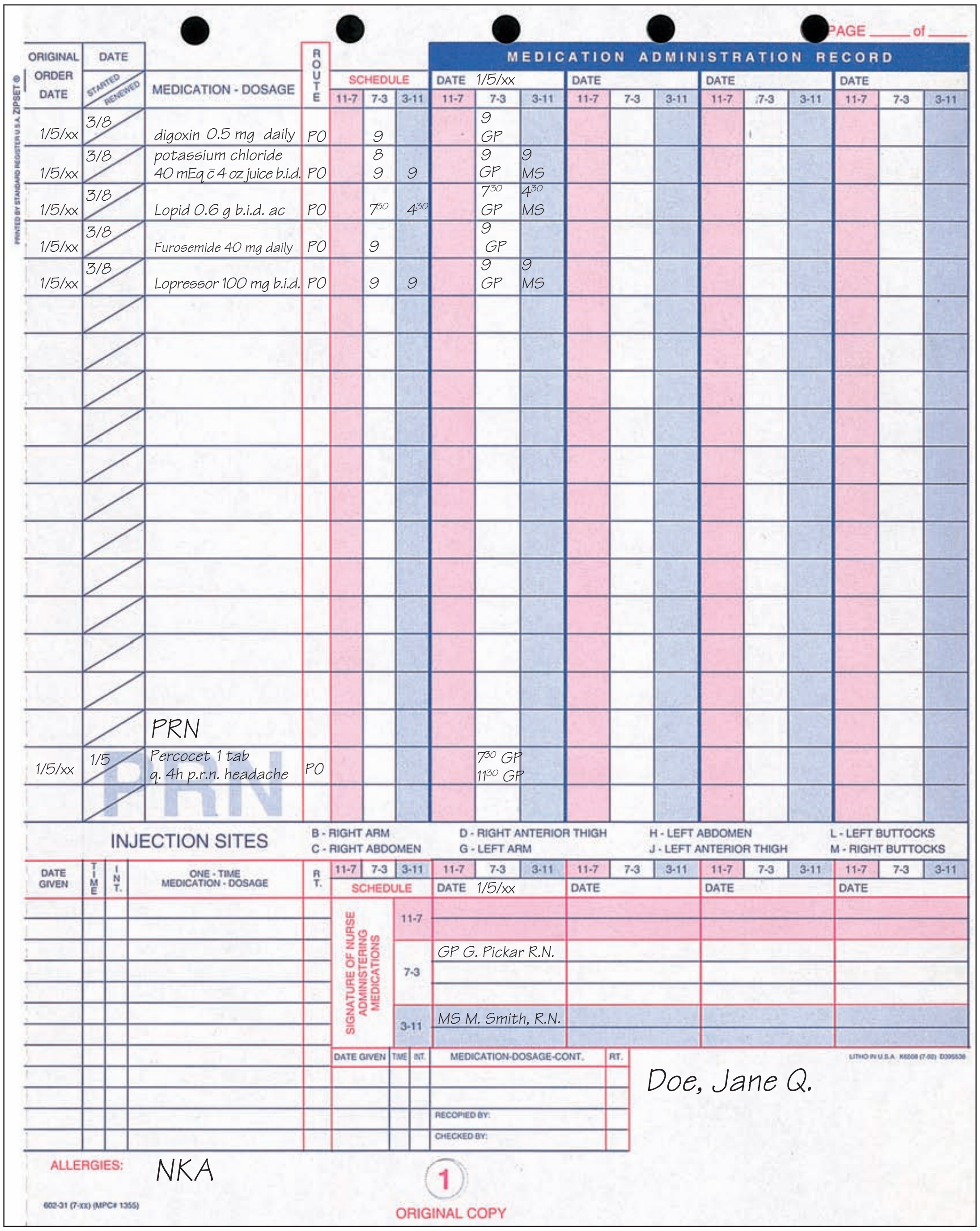
35. Select: __________
Give: __________

36. Select: __________
Give: __________

37. Select: __________
Give: __________

38. Select: __________
Give: __________

39. Select: __________
Give: __________



PAGE ____ of ____

MEDICATION ADMINISTRATION RECORD

	ORIGINAL ORDER DATE	DATE STARTED / RENEWED	MEDICATION - DOSAGE	ROUTE	SCHEDULE 11-7	SCHEDULE 7-3	SCHEDULE 3-11	DATE 1/5/xx 11-7	DATE 1/5/xx 7-3	DATE 1/5/xx 3-11	DATE 11-7	DATE 7-3	DATE 3-11	DATE 11-7	DATE 7-3	DATE 3-11	DATE 11-7	DATE 7-3	DATE 3-11
40.	1/5/xx	3/8	digoxin 0.5 mg daily	PO		9			9 GP										
41.	1/5/xx	3/8	potassium chloride 40 mEq $\bar{c}$ 4 oz juice b.i.d.	PO		8 9	9		9 GP	9 MS									
42.	1/5/xx	3/8	Lopid 0.6 g b.i.d. ac	PO		7^{30}	4^{30}		7^{30} GP	4^{30} MS									
43.	1/5/xx	3/8	Furosemide 40 mg daily	PO		9			9 GP										
44.	1/5/xx	3/8	Lopressor 100 mg b.i.d.	PO		9	9		9 GP	9 MS									
			PRN																
45.	1/5/xx	1/5	Percocet 1 tab q. 4h p.r.n. headache	PO					7^{30} GP 11^{30} GP										

PRN

INJECTION SITES

B - RIGHT ARM
C - RIGHT ABDOMEN
D - RIGHT ANTERIOR THIGH
G - LEFT ARM
H - LEFT ABDOMEN
J - LEFT ANTERIOR THIGH
L - LEFT BUTTOCKS
M - RIGHT BUTTOCKS

DATE GIVEN	TIME	INT.	ONE - TIME MEDICATION - DOSAGE	RT.

SIGNATURE OF NURSE ADMINISTERING MEDICATIONS	DATE 1/5/xx	DATE	DATE	DATE
11-7				
7-3	GP G. Pickar R.N.			
3-11	MS M. Smith, R.N.			

DATE GIVEN	TIME	INT.	MEDICATION-DOSAGE-CONT.	RT.
			RECOPIED BY:	
			CHECKED BY:	

LITHO IN U.S.A. K6008 (7-02) D395538

Doe, Jane Q.

ALLERGIES: NKA

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602-31 (7-xx) (MPC# 1355)

1

ORIGINAL COPY

40. Select: ________

Give: ________

41. Select: ________

Give: ________

42. Select: ________

Give: ________

43. Select: ________

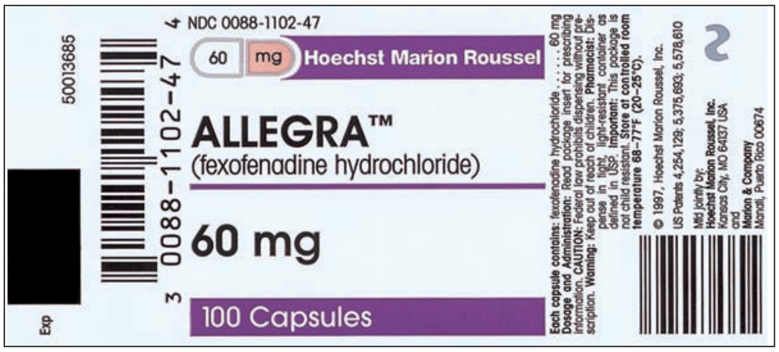
Give: ________

44. Select: ________

Give: ________

45. Select: ________

Give: ________



NDC 0088-1102-47

60 mg Hoechst Marion Roussel

ALLEGRA™
(fexofenadine hydrochloride)

60 mg

100 Capsules

50013685

[redacted]

Exp

3 0088-1102-47 4

Each capsule contains: fexofenadine hydrochloride .... 60 mg
Dosage and Administration: Read package insert for prescribing information. **CAUTION:** Federal law prohibits dispensing without prescription. **Warning:** Keep out of reach of children. **Pharmacist:** Dispense in tight, light-resistant container as defined in USP. **Important:** This package is not child resistant. **Store at controlled room temperature 68–77°F (20–25°C).**

© 1997, Hoechst Marion Roussel, Inc.

US Patents 4,254,129; 5,375,693; 5,578,610

Mfd jointly by:
Hoechst Marion Roussel, Inc.
Kansas City, MO 64137 USA
and
Marion & Company
Manati, Puerto Rico 00674

A

Store below 86°F (30°C)

Dispense in tight, light-resistant containers (USP).

DOSAGE AND USE
See accompanying prescribing information.
One capsule per day.

Each capsule contains 20 mg piroxicam.

IMPORTANT: This closure is not child-resistant.

CAUTION: Federal law prohibits dispensing without prescription.

NDC 0069-3230-66

100 Capsules

Feldene®
(piroxicam) 20

20 mg

Pfizer **Pfizer Labs**
Division of Pfizer Inc, NY, NY 10017

3 0069-3230-66 2

6505-01-137-4628

[redacted]

05-4300-00-5
MADE IN USA

1292

B

NDC 0088-1712-53

Carafate®
Tablets
sucralfate

1 gram

120 Tablets

Aventis

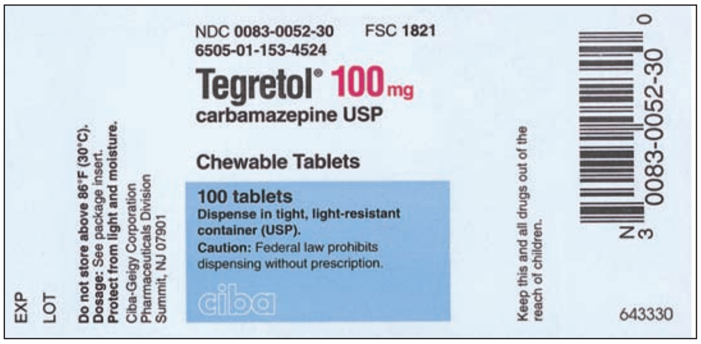
℞ ONLY
Each CARAFATE® Tablet contains 1g sucralfate.
Dosage and Administration: See package insert for dosage information.
WARNING: Keep out of reach of children.
Pharmacist: Dispense in light-resistant, tight container with child-resistant closure.
Important: This package is not child-resistant.
Store at controlled room temperature 59–86°F (15–30°C).
Aventis Pharmaceuticals Inc.
Kansas City, MO 64137
USA ©2000
www.aventispharma-us.com

Exp

3 0088-1712-53 6

50059224

C



NDC **0083-0052-30** FSC **1821**
6505-01-153-4524

Tegretol® 100mg
carbamazepine USP

Chewable Tablets

100 tablets
Dispense in tight, light-resistant container (USP).
Caution: Federal law prohibits dispensing without prescription.

ciba

EXP

LOT

Do not store above 86°F (30°C).
Dosage: See package insert.
Protect from light and moisture.
Ciba-Geigy Corporation
Pharmaceuticals Division
Summit, NJ 07901

Keep this and all drugs out of the reach of children.

N 3 0083-0052-30 0

643330

D

Delivers **15 mL**
NDC 0121-0465-15
POTASSIUM CHLORIDE
ORAL SOLUTION USP 10%
20 mEq per 15 mL
Sugar Free Alcohol 5%
DILUTE BEFORE USING
(01) 0 03 01210 46515 4
Rx ONLY
FOR INSTITUTIONAL USE ONLY
PHARMACEUTICAL ASSOCIATES, INC.
GREENVILLE, SC 29605
SEE INSERT

E

N 3 0378-6400-01 0

400 mg

Each tablet contains:
Erythromycin ethylsuccinate equivalent to 400 mg erythromycin activity.

NDC 0378-6400-01

MYLAN®

ERYTHROMYCIN
ETHYLSUCCINATE
TABLETS, USP
400 mg
Erythromycin Activity

100 TABLETS ℞ only

Dispense in a tight, light-resistant container using a child-resistant closure.

STORE AT CONTROLLED ROOM TEMPERATURE 15°-30°C (59°-86°F). PROTECT FROM LIGHT.

Usual Adult Dose: One tablet every six hours. See insert.

DOSAGE MAY BE GIVEN WITHOUT REGARD TO MEALS.

Mylan Pharmaceuticals Inc.
Morgantown, WV 26505

RM6400A5

F

G

NDC 0039-0051-10

DiaBeta® 2.5mg

glyburide USP

100 Tablets Aventis

3 0039-0051-10 2

℞ ONLY

Each DiaBeta® Tablet contains 2.5mg glyburide. **Dosage and Administration:** See package insert for dosage information. **WARNING:** Keep out of reach of children. **Pharmacist:** Dispense in well-closed container with child-resistant closure. **Store at 25°C (77°F); excursions permitted to 15–30°C (59–86°F) [See USP Controlled Room Temperature].**

HOECHST-ROUSSEL Pharmaceuticals
Division of **Aventis Pharmaceuticals Inc.**
Kansas City, MO 64137 USA ©2000
www.aventispharma-us.com

50054975 50054975 50054975

H

Bulk Package - Not Intended for Dispensing
Dispense in tight, light-resistant containers as defined in USP/NF.
STORE AT 59° TO 86° F (15° TO 30° C)

LOT 6NSL9 EXPIRES

26154893-0996

NDC 0004-0068-01

Roche

KLONOPIN® C IV
(clonazepam)

0.5 mg

CAUTION: Federal law prohibits dispensing without prescription.

100 Tablets

Each tablet contains 0.5 mg clonazepam.
USUAL DOSAGE: For dosage recommendations and other important prescribing information, read accompanying insert.
Distr. by: **ROCHE LABORATORIES INC.** Nutley, New Jersey 07110
Mfd. by: **ROCHE PHARMA, INC.** Manati, Puerto Rico 00674

0004-0068-01

I

3 0048-1070-03 6

NDC 0048-1070-03
NSN 6505-01-340-0152
Code 3P1073

SYNTHROID®
(Levothyroxine Sodium Tablets, USP)

100 mcg (0.1 mg)

100 TABLETS

Rx only

BASF Pharma knoll

See full prescribing information for dosage and administration.

Dispense in a tight, light-resistant container as described in USP.

Store at 25°C (77°F); excursions permitted to 15°-30°C (59°-86°F). [See USP Controlled Room Temperature].
Knoll Pharmaceutical Company
Mount Olive, NJ 07828
USA

7885-04

J

NDC 0039-0067-50

Lasix® 20mg

furosemide

500 Tablets Aventis

3 0039-0067-50 9

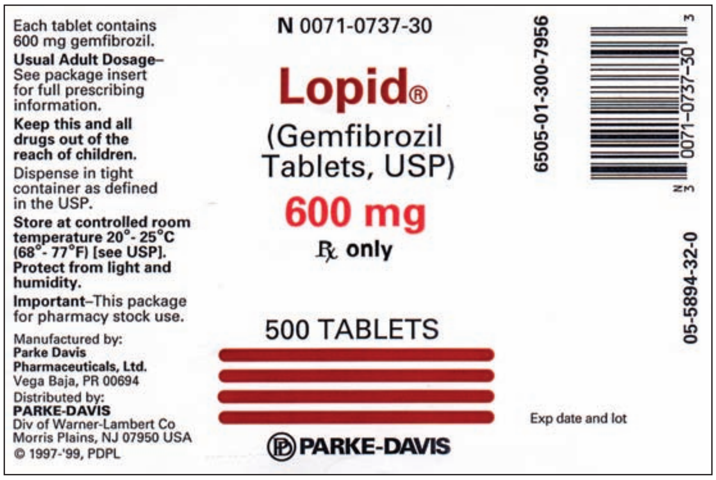
℞ ONLY

Each LASIX® Tablet contains 20mg furosemide. **Dosage and Administration:** See package insert for dosage information. **WARNING:** Keep out of reach of children. Do not use if bottle closure seal is broken. **Pharmacist:** Dispense in well-closed, light-resistant container with child-resistant closure. **Store at room temperature.**

Hoechst-Roussel Pharmaceuticals
Division of **Aventis Pharmaceuticals Inc.**
Kansas City, MO 64137 USA ©2000
www.aventispharma-us.com

50058803 50058803 50058803

K



Each tablet contains 600 mg gemfibrozil.

Usual Adult Dosage– See package insert for full prescribing information.

Keep this and all drugs out of the reach of children.

Dispense in tight container as defined in the USP.

Store at controlled room temperature 20°- 25°C (68°- 77°F) [see USP]. Protect from light and humidity.

Important–This package for pharmacy stock use.

Manufactured by:
Parke Davis Pharmaceuticals, Ltd.
Vega Baja, PR 00694
Distributed by:
PARKE-DAVIS
Div of Warner-Lambert Co
Morris Plains, NJ 07950 USA
© 1997-'99, PDPL

N 0071-0737-30

Lopid®

(Gemfibrozil Tablets, USP)

600 mg

℞ only

500 TABLETS

PARKE-DAVIS

6505-01-300-7956

N 3 0071-0737-30 3

05-5894-32-0

Exp date and lot

L

N 3 0173-0249-55 5

See package insert for Dosage and Administration.
Store at 25°C (77°F) in a dry place (see insert).
Dispense in tight container as defined in the USP.
Do not use if blue printed safety seal under cap is broken or missing.

100 Tablets NDC 0173-0249-55

LANOXIN® (digoxin) Tablets

Each scored tablet contains
250 mcg (0.25 mg)

℞ only

GlaxoSmithKline

GlaxoSmithKline
Research Triangle
Park, NC 27709

Rev. 10/01

M

A07774-1

Store below 77°F (25°C).
Pharmacist: Dispense in a tight, light-resistant, child-resistant container.

100 Tablets
NDC 0025-1041-31

Rx only

Aldactone®
(spironolactone USP)
50 mg

SEARLE

Usual Adult Dosage: Two tablets daily or as recommended in attached literature.

G.D. Searle & Co.
Chicago IL 60680 USA

FOR POSITION ONLY
UPC @100%

3 0025-1041-31

NDC 0028-0051-10
6505-01-071-6557
Lopressor® 50 mg
metoprolol tartrate USP
1000 tablets
Rx only
NOVARTIS
645122
Dosage: See package insert.
Store between 15°C - 30°C (59°F - 86°F).
Protect from moisture.
Dispense in tight, light-resistant container (USP).
Novartis Pharmaceuticals Corporation
East Hanover, New Jersey 07936
PHARMACIST: Container closure is not child-resistant.
Keep this and all drugs out of the reach of children.
EXP
LOT

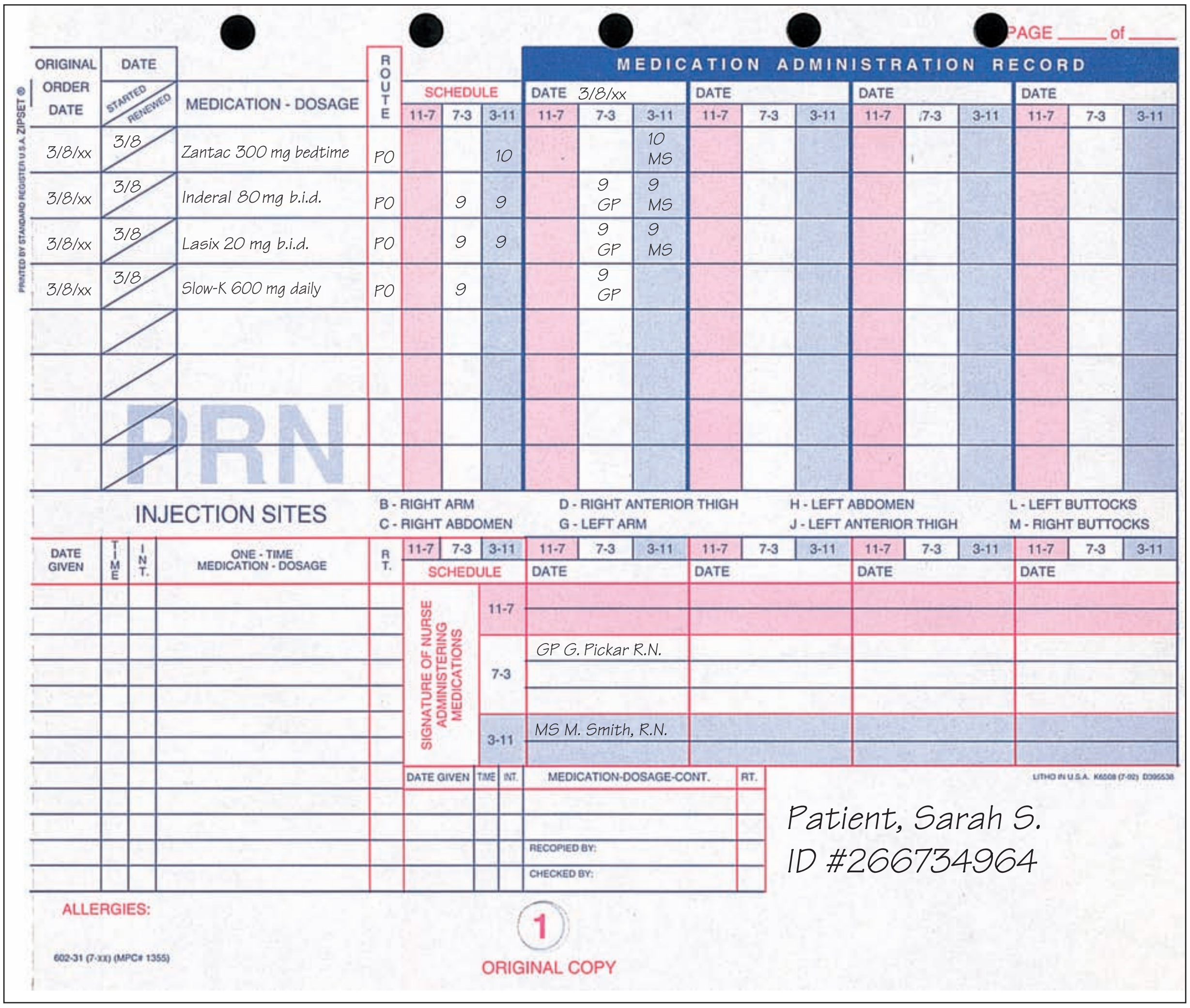
N

NDC 63481-623-70 NSN 6505-01-082-5509
Endo®
ENDO LABORATORIES
PERCOCET®
(Oxycodone and Acetaminophen Tablets, USP)
5 mg/325 mg
CII
Rx only
Each tablet contains:
Oxycodone Hydrochloride . . . . 5 mg*
Acetaminophen, USP . . . . 325 mg
*5 mg oxycodone HCl is equivalent to 4.4815 mg of oxycodone.
Usual Dosage: See package insert for complete prescribing information.
Dispense in a tight, light-resistant container as defined in the USP, with a child-resistant closure (as required).
Store at controlled room temperature 15°-30°C (59°-86°F).
DEA ORDER FORM REQUIRED.
100 TABLETS
Lot:
Exp: SAMPLE
Manufactured for:
Endo Pharmaceuticals Inc.
Chadds Ford, PA 19317
By: DuPont Pharma
Wilmington, DE 19880
70447/PF

O

Calculate one dose of the medications indicated on the MAR. Labels P–S provided on the following page are the drugs available. Indicate the letter corresponding to the label you select.

46. Select: ________
    Give: ________
47. Select: ________
    Give: ________
48. Select: ________
    Give: ________
49. Select: ________
    Give: ________



PAGE ____ of ____

MEDICATION ADMINISTRATION RECORD

	ORIGINAL ORDER DATE	DATE STARTED / RENEWED	MEDICATION - DOSAGE	ROUTE	SCHEDULE 11-7	SCHEDULE 7-3	SCHEDULE 3-11	DATE 3/8/xx 11-7	7-3	3-11	DATE 11-7	7-3	3-11	DATE 11-7	7-3	3-11	DATE 11-7	7-3	3-11
46.	3/8/xx	3/8	Zantac 300 mg bedtime	PO			10			10 MS									
47.	3/8/xx	3/8	Inderal 80 mg b.i.d.	PO		9	9		9 GP	9 MS									
48.	3/8/xx	3/8	Lasix 20 mg b.i.d.	PO		9	9		9 GP	9 MS									
49.	3/8/xx	3/8	Slow-K 600 mg daily	PO		9			9 GP										
			PRN																

PRINTED BY STANDARD REGISTER U.S.A. ZIPSET ®

INJECTION SITES
B - RIGHT ARM
C - RIGHT ABDOMEN
D - RIGHT ANTERIOR THIGH
G - LEFT ARM
H - LEFT ABDOMEN
J - LEFT ANTERIOR THIGH
L - LEFT BUTTOCKS
M - RIGHT BUTTOCKS

DATE GIVEN	TIME	INT.	ONE - TIME MEDICATION - DOSAGE	RT.

SIGNATURE OF NURSE ADMINISTERING MEDICATIONS	SCHEDULE	DATE	DATE	DATE	DATE
	11-7				
	7-3	GP G. Pickar R.N.			
	3-11	MS M. Smith, R.N.			

DATE GIVEN	TIME	INT.	MEDICATION-DOSAGE-CONT.	RT.
			RECOPIED BY:	
			CHECKED BY:	

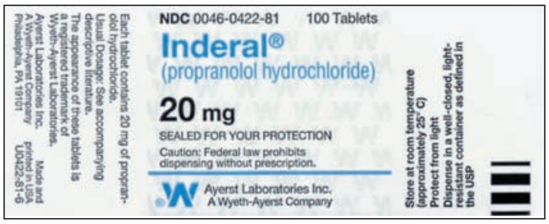
LITHO IN U.S.A. K6508 (7-02) D395536

Patient, Sarah S.
ID #266734964

ALLERGIES:

602-31 (7-XX) (MPC# 1355)

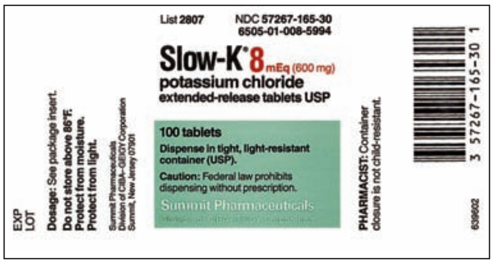
① ORIGINAL COPY



P

Q

R



S

50. Describe the strategy to prevent this medication error.

Possible Scenario

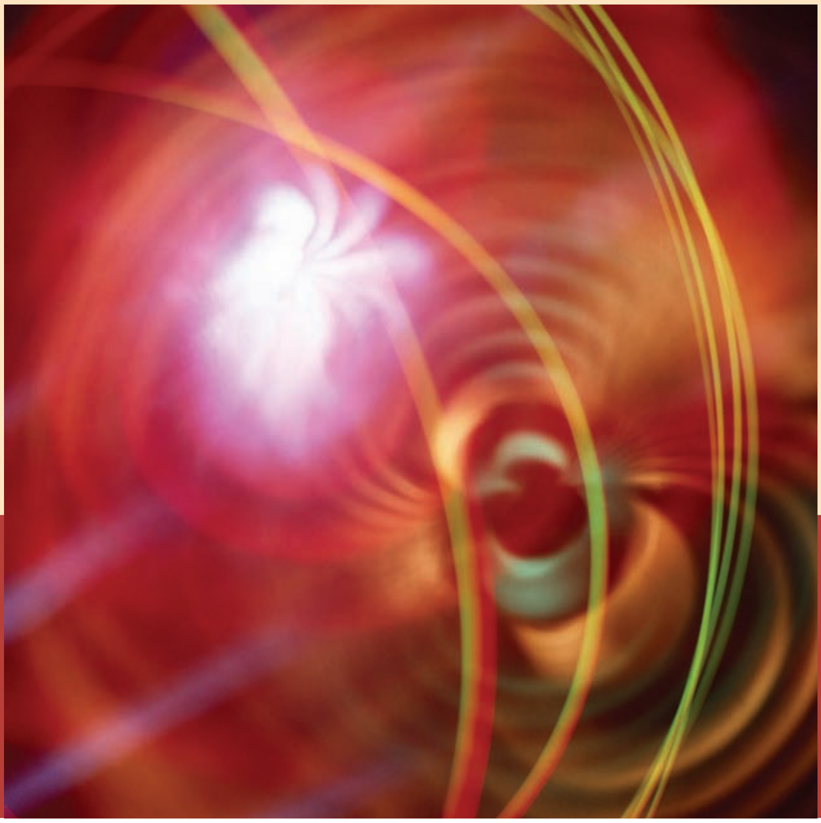
Suppose the physician ordered **Betapen VK 5 mL (250 mg) p.o. q.i.d.** for a patient with an upper respiratory tract infection. The pharmacy supplied Betapen VK 125 mg per 5 mL. In a rush to administer the medication on time, the nurse read the order as *Betapen VK 5 mL,* checked the label for Betapen VK and poured that amount and administered the drug. In a hurry, the nurse failed to recognize that 5 mL of the supply dosage of 125 mg per 5 mL did not provide the ordered dosage of 250 mg and underdosed the patient.

Potential Outcome

The patient received one-half of the ordered dosage of antibiotic needed to treat the respiratory infection. If this error was not caught, the patient's infection would not be halted. This would add to the patient's illness time and might lead to a more severe infection. Additional tests might be required to determine why the patient was not responding to the medication.

Prevention

After completing these problems, see page 487–488 to check your answers.



11

Parenteral Dosage of Drugs

OBJECTIVES

Upon mastery of Chapter 11, you will be able to calculate the parenteral dosages of drugs. To accomplish this you will also be able to:

- Apply the three steps for dosage calculations: convert, think, and calculate.
- Use ratio-proportion to calculate the amount to give.
- Measure insulin in a matching insulin syringe.
- Compare the calibration of U-100 insulin syringe units to milliliters (100 units per 1 mL).

The term *parenteral* is used to designate routes of administration other than gastrointestinal, such as the injection routes of IM, subcut, ID, and IV. In this chapter, intramuscular (IM), subcutaneous (subcut), and intravenous (IV) injections will be emphasized. Intravenous flow-rate calculations are discussed in Chapters 14–16.

Intramuscular indicates an injection given into a muscle, such as Demerol given IM for pain. *Subcutaneous* means an injection given into the subcutaneous tissue, such as an insulin injection for the management of diabetes given subcut. *Intravenous* refers to an injection given directly into a vein, either by direct injection (IV push) or diluted in a larger volume of intravenous fluid and administered as part of an intravenous infusion. When a patient has an IV site or IV infusing, the IV injection route is frequently used to administer parenteral drugs rather than the IM route. *Intradermal* (ID) means an injection given under the skin, such as an allergy test or tuberculin skin test.

INJECTABLE SOLUTIONS

Most parenteral medications are prepared in liquid or solution form and packaged in dosage vials, ampules, or prefilled syringes (Figure 11-1). Injectable drugs are measured in syringes.

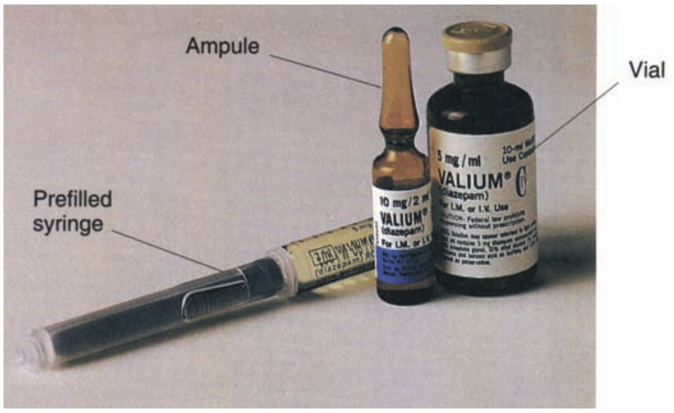


FIGURE 11-1 Parenteral solutions (courtesy of Roche Laboratories)

RULE

The maximum dosage volume to be administered per intramuscular injection site for:

1. An average 150 lb adult = 3 mL (maximum for deltoid site is 2 mL)
2. Children age 6 to 12 years = 2 mL
3. Children birth to age 5 years = 1 mL

For example, if you must give an adult patient four milliliters of a drug, divide the dose into two injections of two milliliters each. The condition of the patient must be considered when applying this rule. Adults or children who have decreased muscle or subcutaneous tissue mass or poor circulation may not be able to tolerate the maximum dosage volumes.

To solve parenteral dosage problems, apply the same steps used for the calculation of oral dosages.

REMEMBER

Step 1	**Convert**	All units of measurement to the same system and all units to the same size.
Step 2	**Think**	Estimate the logical amount.
Step 3	**Calculate**	$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

Use the following rules to help you decide which size syringe to select to administer parenteral dosages.

RULE

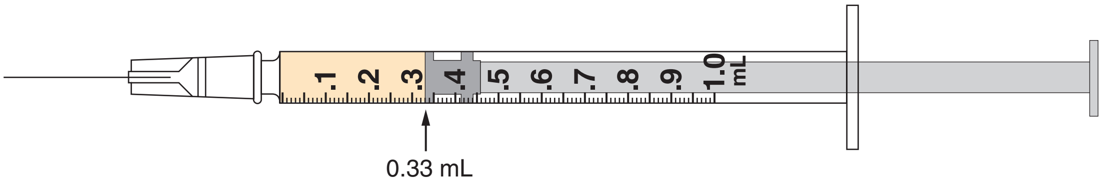
As you calculate parenteral dosages:

1. Round the amount to be administered (X) to tenths if the amount is greater than 1 mL, and measure it in a 3 mL syringe.
2. Measure amounts of less than 1 mL rounded to hundredths and all amounts less than 0.5 mL, in a 1 mL syringe.
3. Amounts of 0.5 to 1 mL, calculated in tenths, can be accurately measured in either a 1 mL or 3 mL syringe.

Let's look at some examples of appropriate syringe selections for the dosages to be measured and review how to read the calibrations. Refer to Chapter 6, *Equipment Used in Dosage Measurement,* regarding how to measure medication in a syringe. To review, the top black ring should align with the desired calibration, not the raised midsection and not the bottom ring. Look carefully at the illustrations that follow.

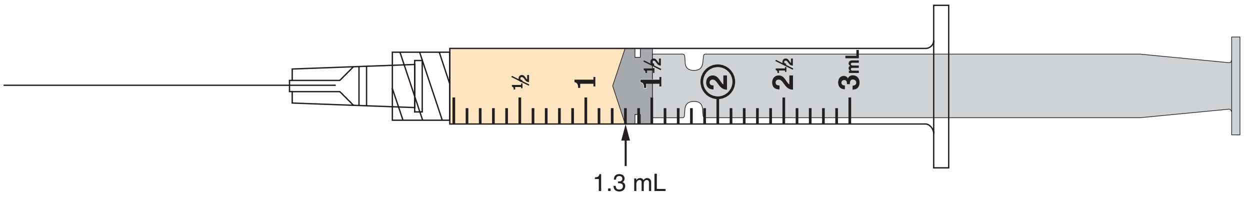
EXAMPLE 1 ■

Measure 0.33 mL in a 1 mL syringe.



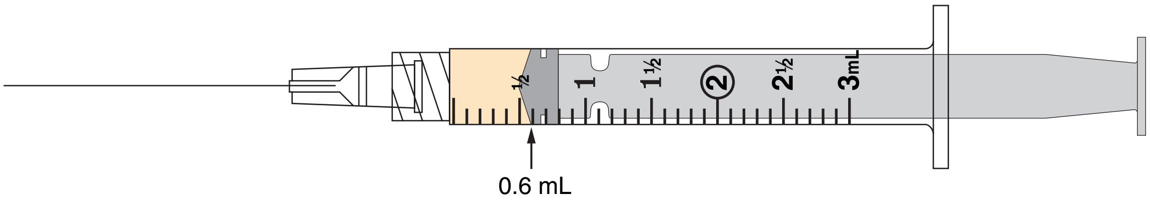
EXAMPLE 2 ■

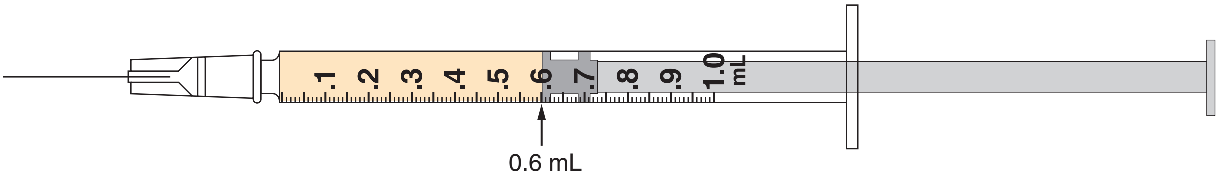
Round 1.33 mL to 1.3 mL, and measure in a 3 mL syringe.



EXAMPLE 3 ■

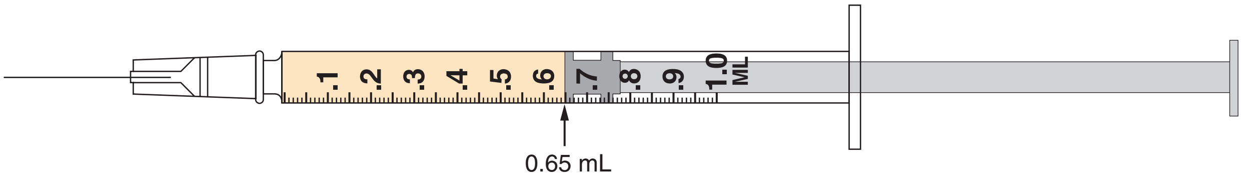
Measure 0.6 mL in either a 1 mL or 3 mL syringe. (Notice that the amount is measured in tenths so the 3 mL syringe would be preferable.)





EXAMPLE 4 ■

Measure 0.65 mL in a 1 mL syringe. (Notice that the amount is measured in hundredths and is less than 1 mL.)



An amber color has been added to selected syringe drawings throughout the text to *simulate a specific amount of medication,* as indicated in the example or problem. Because the color used may not correspond to the actual color of the medications named, **it must not be used as a reference for identifying medications.**

Let's look at some examples of parenteral dosage calculations.

EXAMPLE 1 ■

FOR INTRAMUSCULAR USE ONLY.
USUAL ADULT DOSE: Intramuscularly: 25 - 100 mg stat; repeat every 4 to 6 hours, as needed.
See accompanying prescribing information.
Each mL contains **50 mg** of hydroxyzine hydrochloride, 0.9% benzyl alcohol and sodium hydroxide to adjust to optimum pH.
To avoid discoloration, protect from prolonged exposure to light.
Rx only

10 mL NDC 0049-5460-74
Vistaril®
(hydroxyzine hydrochloride)
Intramuscular Solution
50 mg/mL
Pfizer Roerig

Store below 86°F (30°C).
PROTECT FROM FREEZING.
PATIENT: __________
ROOM NO.: __________
05-1111-32-4
MADE IN USA
9249

The drug order reads *Vistaril 100 mg IM stat.*

Available is Vistaril intramuscular solution 50 mg/mL in a 10 mL multiple-dose vial. How many milliliters should be administered to the patient?

Step 1 Convert No conversion is necessary.

Step 2 Think You want to give more than 1 mL. In fact, you want to give twice as much, because 100 mg is twice as much as 50 mg.

Step 3 Calculate $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

$\frac{50 \text{ mg}}{1 \text{ mL}} \times \frac{100 \text{ mg}}{\text{X mL}}$ Cross-multiply

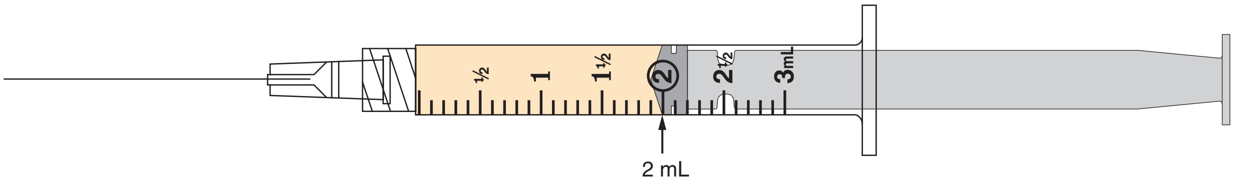
$50X = 100$

$\frac{50X}{50} = \frac{100}{50}$ Simplify: Divide both sides of the equation by the number before the unknown X

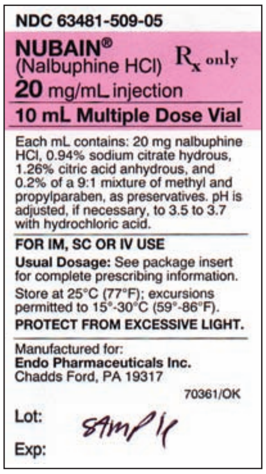
$X = 2 \text{ mL}$ Label the units to match the unknown X

2 mL given intramuscularly immediately

Select a 3 mL syringe and measure 2 mL of Vistaril 50 mg/mL. Look carefully at the illustration to clearly identify the part of the black rubber stopper that measures the exact dosage.



EXAMPLE 2 ■



NDC 63481-509-05
NUBAIN®
(Nalbuphine HCl) R_x only
20 mg/mL injection
10 mL Multiple Dose Vial
Each mL contains: 20 mg nalbuphine HCl, 0.94% sodium citrate hydrous, 1.26% citric acid anhydrous, and 0.2% of a 9:1 mixture of methyl and propylparaben, as preservatives. pH is adjusted, if necessary, to 3.5 to 3.7 with hydrochloric acid.
FOR IM, SC OR IV USE
Usual Dosage: See package insert for complete prescribing information.
Store at 25°C (77°F); excursions permitted to 15°-30°C (59°-86°F).
PROTECT FROM EXCESSIVE LIGHT.
Manufactured for:
Endo Pharmaceuticals Inc.
Chadds Ford, PA 19317
70361/OK
Lot: sample
Exp:

The drug order reads **Nubain 5 mg subcut q.4h p.r.n., pain.**

The 10 mL multiple dose vial is labeled Nubain 20 injection.

Step 1 Convert No conversion necessary.

Step 2 Think You want to give less than 1 mL. Actually you want to give $\frac{1}{4}$ or 0.25 of a mL.

Step 3 Calculate $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

$\frac{20 \text{ mg}}{1 \text{ mL}} \times \frac{5 \text{ mg}}{\text{X mL}}$ Cross-multiply

$20X = 5$

$\frac{20X}{20} = \frac{5}{20}$ Simplify: Divide both sides of the equation by the number before the unknown X

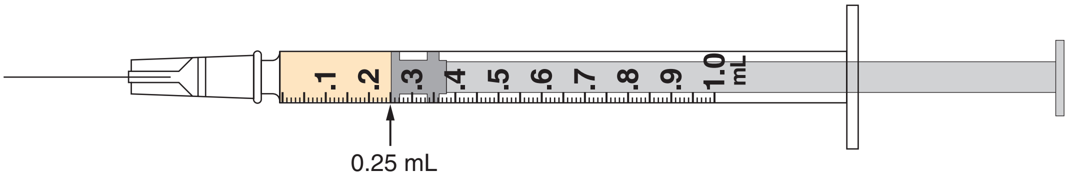
$X = 0.25 \text{ mL}$ Label the units to match the unknown X

0.25 mL given subcutaneously as needed for pain every 4 hours

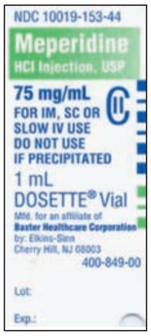
REMEMBER

Dosages measured in hundredths (such as 0.25 mL) and all amounts less than 0.5 mL should be prepared in a 1 mL syringe, which is calibrated in hundredths. However, if the route is IM, you may need to change needles to a more appropriate length.

Select a 1 mL syringe and measure 0.25 mL of Nubain 20 mg/mL. Look carefully at the illustration to clearly identify the part of the black rubber stopper that measures the exact dosage.



EXAMPLE 3 ■


NDC 10019-153-44
Meperidine
HCl Injection, USP
75 mg/mL
FOR IM, SC OR
SLOW IV USE
DO NOT USE
IF PRECIPITATED
1 mL
DOSETTE® Vial
Mfd. for an affiliate of
Baxter Healthcare Corporation
by: Elkins-Sinn
Cherry Hill, NJ 08003
400-849-00
Lot:
Exp.:

Drug order: **meperidine hydrochloride 60 mg IM q.4h p.r.n., pain**

Supply: meperidine HCl injection 75 mg/mL

Step 1 **Convert** No conversion is necessary.

Step 2 **Think** You want to give less than 1 mL but more than 0.5 mL.

Step 3 **Calculate** $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

$$\frac{75 \text{ mg}}{1 \text{ mL}} \times \frac{60 \text{ mg}}{\text{X mL}}$$ Cross-multiply

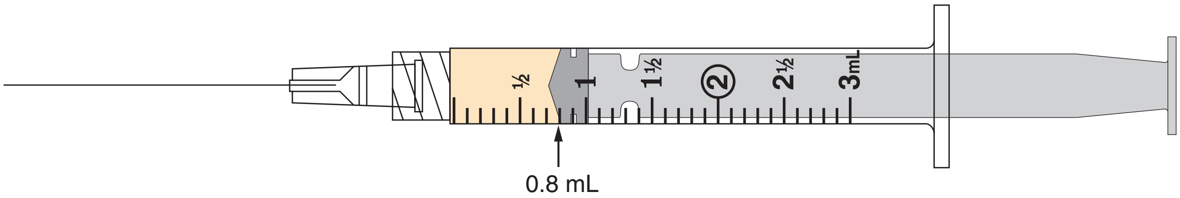
$$75\text{X} = 60$$

$$\frac{75\text{X}}{75} = \frac{60}{75}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 0.8 \text{ mL}$$ Label the units to match the unknown X

0.8 mL given intramuscularly every 4 hours as needed for pain

Select a 1 mL or 3 mL syringe and draw up all of the contents of the 1 mL Dosette vial. Then discard 0.2 mL to administer 0.8 mL of meperidine 75 mg/mL. You must discard the 0.2 mL in the presence of another nurse because meperidine is a controlled substance. As a controlled substance, you cannot just leave 0.2 mL in the single Dosette vial.



EXAMPLE 4 ■


4 mL MULTIPLE DOSE Vial
NDC 0641-2470-41 ℞ only
HEPARIN
SODIUM INJECTION USP
10,000 units /1 mL
FOR IV OR SC USE
ELKINS-SINN, INC. Cherry Hill, NJ 08003

Order: **heparin 8,000 units subcut b.i.d.**

Supply: A vial of heparin sodium injection 10,000 units/mL

Step 1 **Convert** No conversion is necessary.

Step 2 **Think** You want to give less than 1 mL but more than 0.5 mL.

Step 3 **Calculate** $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

$$\frac{10{,}000 \text{ units}}{1 \text{ mL}} \times \frac{8{,}000 \text{ units}}{X \text{ mL}}$$ Cross-multiply

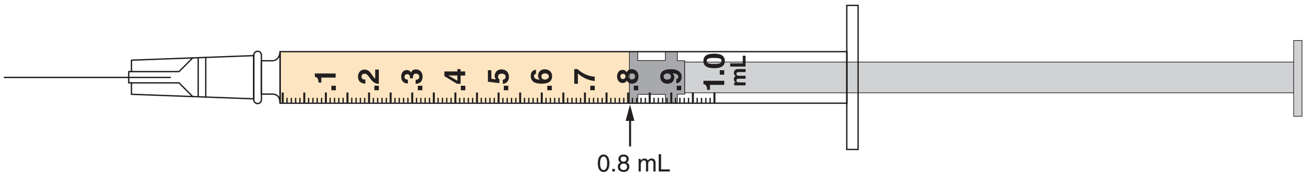
$$10{,}000X = 8{,}000$$

$$\frac{10{,}000X}{10{,}000} = \frac{8{,}000}{10{,}000}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$X = 0.8 \text{ mL}$$ Label the units to match the unknown X

0.8 mL given subcutaneously twice daily

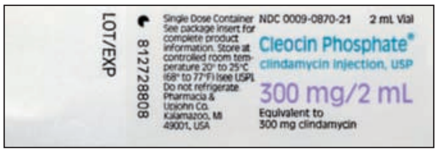
Select a 1 mL or a 3 mL syringe and measure 0.8 mL of heparin 10,000 units/mL. Heparin is a potent anticoagulant drug. It is safest to measure it in a 1 mL syringe.



EXAMPLE 5 ■

Order: Cleocin Phosphate 150 mg IM q.12h

Supply: Cleocin Phosphate (clindamycin injection) 300 mg per 2 mL



LOT/EXP

812728808

Single Dose Container See package insert for complete product information. Store at controlled room temperature 20° to 25°C (68° to 77°F) [see USP]. Do not refrigerate Pharmacia & Upjohn Co. Kalamazoo, MI 49001, USA

NDC 0009-0870-21 2 mL Vial

Cleocin Phosphate®

clindamycin injection, USP

300 mg/2 mL

Equivalent to 300 mg clindamycin

Step 1 Convert No conversion is necessary.

Step 2 Think You want to give less than 2 mL. Actually, you want to give 150 mg, which is $\frac{1}{2}$ of 300 mg and $\frac{1}{2}$ of 2 mL, or 1 mL. Calculate to double-check your estimate.

Step 3 Calculate $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

$$\frac{300 \text{ mg}}{2 \text{ mL}} \times \frac{150 \text{ mg}}{X \text{ mL}}$$ Cross-multiply

$$300X = 150 \times 2$$

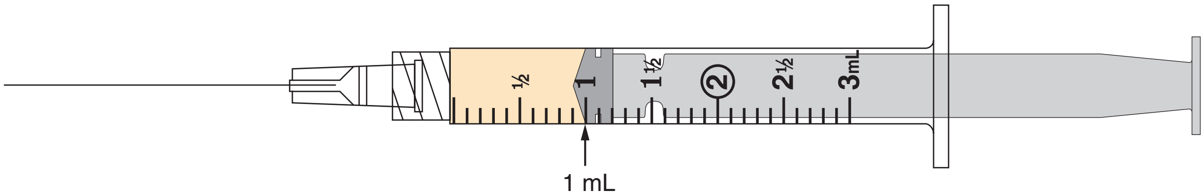
$$300X = 300$$

$$\frac{300X}{300} = \frac{300}{300}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$X = 1 \text{ mL}$$ Label the units to match the unknown X

1 mL given intramuscularly every 12 hours

Select a 3 mL syringe, and measure 1 mL of Cleocin 300 mg per 2 mL.



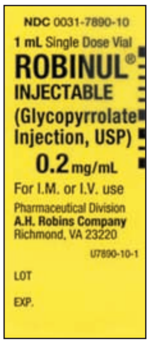
EXAMPLE 6 ■

Order: Robinul 150 mcg IM stat

Supply: Robinul 0.2 mg/mL

Step 1 Convert Order: Robinul 150 mcg

Supply: Robinul 0.2 mg = 0.2 × 1,000 = 200 mcg



NDC 0031-7890-10

1 mL Single Dose Vial

ROBINUL®

INJECTABLE

(Glycopyrrolate Injection, USP)

0.2 mg/mL

For I.M. or I.V. use

Pharmaceutical Division

A.H. Robins Company

Richmond, VA 23220

U7890-10-1

LOT

EXP.

Convert 0.2 mg to mcg to eliminate decimal fraction.

Equivalent: 1 mg = 1,000 mcg

$\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{0.2\text{ mg}}{X\text{ mcg}}$ Cross-multiply

$X = 1{,}000 \times 0.2$ 0.200. Move the decimal three places to the right. Add zeros to complete the operation.

$X = 200\text{ mcg}$ Label the units to match the unknown X

Step 2 **Think** You want to give less than 1 mL but more than 0.5 mL. Be careful with the units and decimals. Don't be fooled into thinking 0.2 mg is less than 150 mcg. After conversion you can clearly see that 0.2 mg is more than 150 mcg; because 0.2 mg = 200 mcg, which is more than 150 mcg.

Step 3 **Calculate** $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

$\frac{200\text{ mcg}}{1\text{ mL}} \times \frac{150\text{ mcg}}{X\text{ mL}}$ Cross-multiply

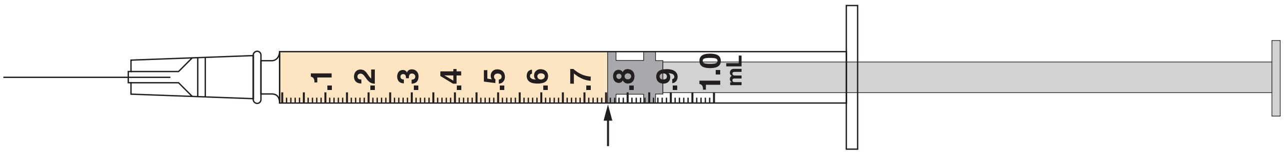
$200X = 150$

$\frac{200X}{200} = \frac{150}{200}$ Simplify: Divide both sides of the equation by the number before the unknown X

$X = 0.75\text{ mL}$ Label the units to match the unknown X

0.75 mL given intramuscularly immediately

Select a 1 mL syringe, and measure 0.75 mL of Robinul 0.2 mg/mL. You may have to change needles, as this is an IM injection.



0.75 mL

EXAMPLE 7 ■

The drug order reads **morphine sulfate gr $\frac{1}{6}$ IM q.4h p.r.n., pain.**

The label on the dosette vial states morphine sulfate 10 mg/mL.

Step 1 **Convert** Order: **morphine sulfate gr $\frac{1}{6}$**

Convert gr to mg to eliminate the fraction.

Equivalent: gr i = 60 mg

$\frac{\text{gr } 1}{60\text{ mg}} \times \frac{\text{gr } \frac{1}{6}}{X\text{ mg}}$ Cross-multiply

$X = 60 \times \frac{1}{6}$ $\frac{60}{1} \times \frac{1}{6} = \frac{\overset{10}{\cancel{60}}}{\underset{1}{\cancel{6}}}$

$X = 10\text{ mg}$ Label the units to match the unknown X

Supply: morphine sulfate 10 mg/mL

Step 2 **Think** Now it is obvious that you want to give 1 mL.

Step 3 **Calculate** $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

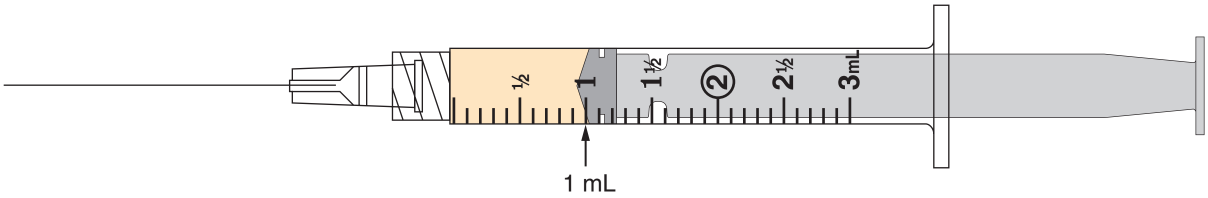
$\frac{10 \text{ mg}}{1 \text{ mL}} \times \frac{10 \text{ mg}}{\text{X mL}}$ Cross-multiply

$10X = 10$

$\frac{10X}{10} = \frac{10}{10}$ Simplify: Divide both sides of the equation by the number before the unknown X

$X = 1 \text{ mL}$ Label the units to match the unknown X

1 mL given intramuscularly every 4 hours as needed for pain



QUICK REVIEW

- To solve parenteral dosage problems, apply the three steps to dosage calculations:

  STEP 1 CONVERT

  STEP 2 THINK

  STEP 3 CALCULATE $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

- Prepare a maximum of 3 mL per IM injection site for an average-size adult, 2 mL per site for adult deltoid site and children ages 6 through 12, and 0.5 to 1 mL for children under age 6.
- Calculate dose volumes and prepare injectable fractional doses in a syringe using these guidelines:
  - Standard doses more than 1 mL: Round to tenths and measure in a 3 mL syringe. The 3 mL syringe is calibrated to 0.1 mL increments. Example: 1.53 mL is rounded to 1.5 mL and drawn up in a 3 mL syringe.
  - Small (less than 0.5 mL) doses: Round to hundredths and measure in a 1 mL syringe. Critical care and children's doses less than 1 mL calculated in hundredths should also be measured in a 1 mL syringe. The 1 mL syringe is calibrated in 0.01 mL increments. Example: 0.257 mL is rounded to 0.26 mL and drawn up in a 1 mL syringe.
  - Amounts of 0.5 to 1 mL calculated in tenths, can be accurately measured in either a 1 mL or 3 mL syringe.

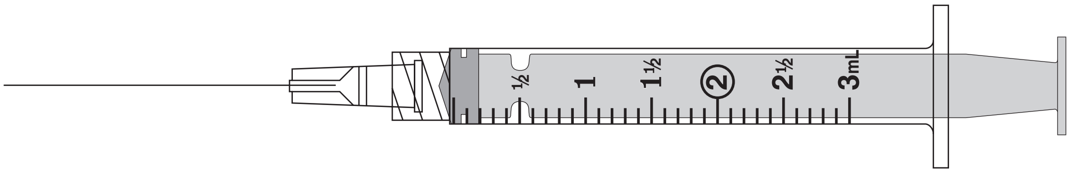
Review Set 26

Calculate the amount you will prepare for each dose. The labels provided represent the drugs available. Draw an arrow to the syringe calibration that corresponds to the amount you will administer. Indicate doses that have to be divided.

1. Order: *Depo-Provera 1 g IM stat*

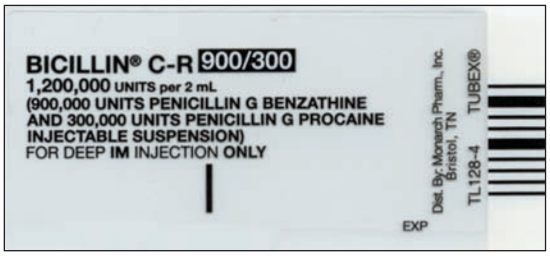
   Give: __________ mL


LOT / EXP
81224806
For IM use only.
See package insert for complete product information.
Shake vigorously immediately before each use.
Pharmacia & Upjohn Company
Kalamazoo, MI 49001, USA
NDC 0009-0626-01 2.5 mL Vial
Depo-Provera®
medroxyprogesterone acetate injectable suspension, USP
400 mg/mL

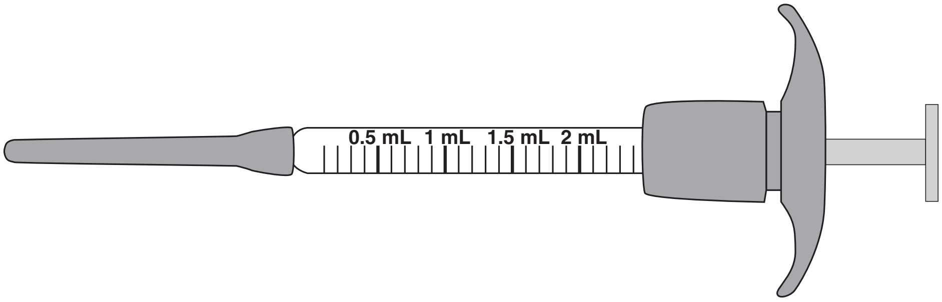


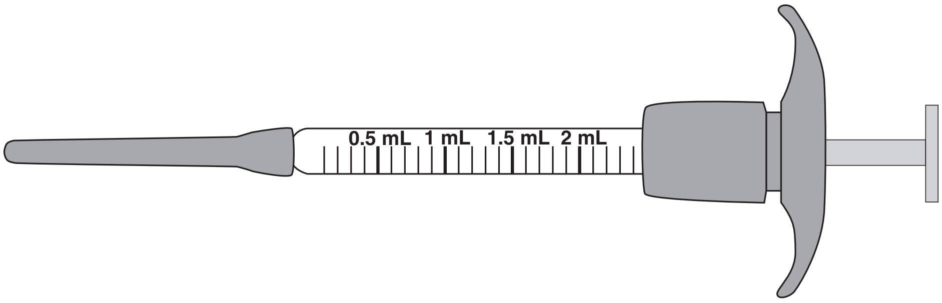
2. Order: Bicillin CR 900/300 2,400,000 units IM stat

   Give: ________ mL



BICILLIN® C-R 900/300
1,200,000 UNITS per 2 mL
(900,000 UNITS PENICILLIN G BENZATHINE
AND 300,000 UNITS PENICILLIN G PROCAINE
INJECTABLE SUSPENSION)
FOR DEEP IM INJECTION ONLY
Dist. By: Monarch Pharm., Inc.
Bristol, TN
TL128-4
TUBEX®
EXP

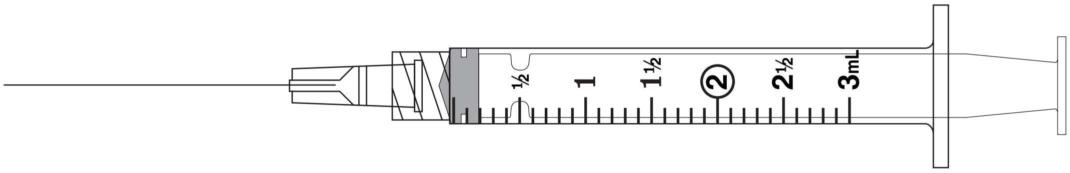




3. Order: digoxin 600 mcg IV stat

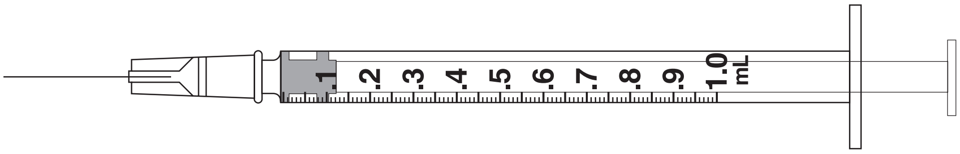
   Give: ________ mL

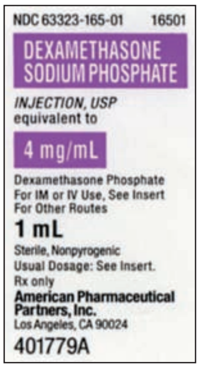
LANOXIN® 2 mL
(digoxin) Injection Rx only
500 mcg (0.5 mg) in 2 mL
(250 mcg [0.25 mg] per mL)
Store at 25°C (77°F) [see insert].
PROTECT FROM LIGHT.
Dist.: GlaxoSmithKline
Research Triangle Park, NC 27709
Made in Canada
4144627
Rev. 3/02
220201
LOT
EXP



4. Order: dexamethasone sodium phosphate 1.5 mg IM q.12h

   Give: ________ mL





NDC 63323-165-01 16501
DEXAMETHASONE SODIUM PHOSPHATE
INJECTION, USP
equivalent to
4 mg/mL
Dexamethasone Phosphate
For IM or IV Use, See Insert
For Other Routes
1 mL
Sterile, Nonpyrogenic
Usual Dosage: See Insert.
Rx only
American Pharmaceutical Partners, Inc.
Los Angeles, CA 90024
401779A

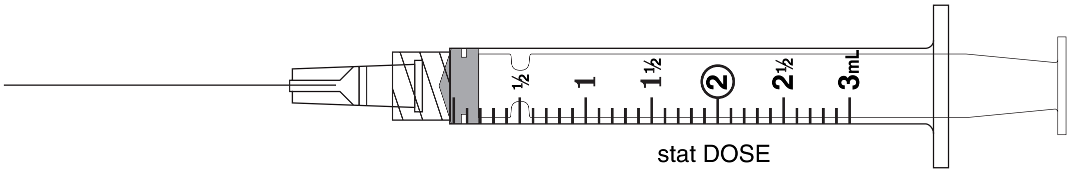
5. Order: Tigan 200 mg IM stat, then 100 mg q.6h p.r.n., nausea

Give: _________ mL stat and

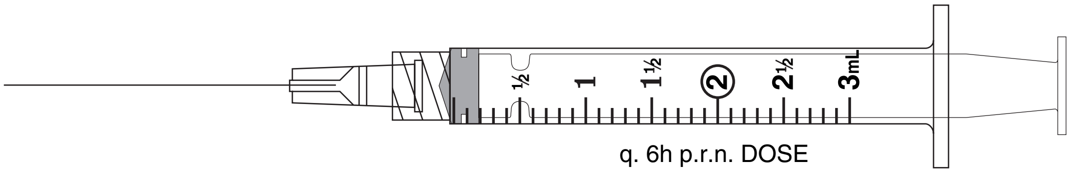
_________ mL q.6h

NDC 61570-541-20
100mg/mL
Tigan®
(trimethobenzamide HCl)
Injection ℞ Only
20mL Multi-Dose Vial
Monarch Pharmaceuticals®

NOT FOR USE IN CHILDREN.
For IM USE ONLY.
Store from 15° to 30° C (59° to 86°F).
Each mL of solution contains 100 mg trimethobenzamide hydrochloride compounded with 0.45% phenol as preservative, 0.5 mg sodium citrate and 0.2 mg citric acid as buffers, and sodium hydroxide to adjust pH to approximately 5.0.
Dosage: See accompanying prescribing information. For IM use only (preferably by deep IM Injection).
Distributed by:
Monarch Pharmaceuticals, Inc., Bristol, TN 37620
Manufactured by:
King Pharmaceuticals, Inc., Bristol, TN 37620
0934063 Rev. 11/99
Exp.
LOT



stat DOSE



q. 6h p.r.n. DOSE

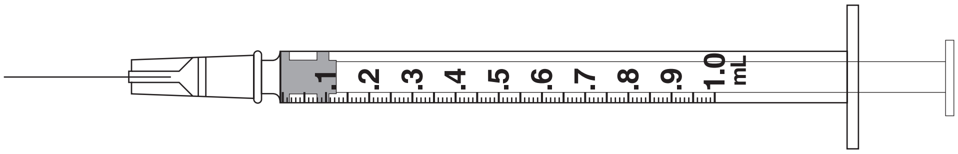
6. Order: heparin 4,000 units subcut q.8h

Give: _________ mL

10 mL MULTIPLE DOSE Vial
NDC 0641-2460-41 ℞ only
HEPARIN
SODIUM INJECTION, USP
5000 units / 1 mL
FOR IV OR SC USE
esi® ELKINS-SINN, INC. Cherry Hill, NJ 08003

Each mL contains heparin sodium 5000 USP units, sodium chloride 7 mg and benzyl alcohol 0.01 mL in Water for Injection. pH 5.0 - 7.5; sodium hydroxide and/or hydrochloric acid added, if needed, for pH adjustment.

DERIVED FROM PORCINE INTESTINES
Store at controlled room temperature 20° to 25°C (68° to 77°F) [see USP].
USUAL DOSAGE: See package insert for complete prescribing information.
U2460-41-2
LOT
EXP.

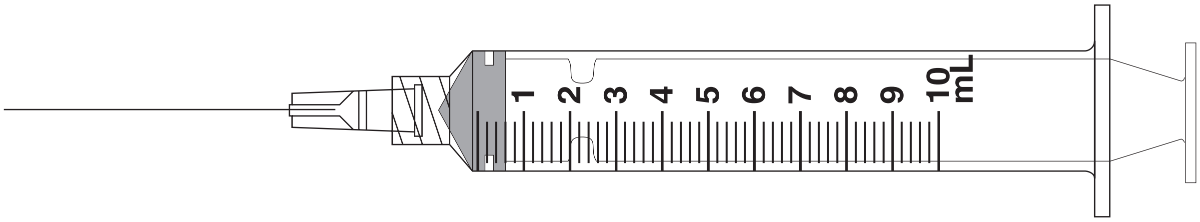


7. Order: potassium chloride 16 mEq added to each 1,000 mL IV fluids

Give: _________ mL

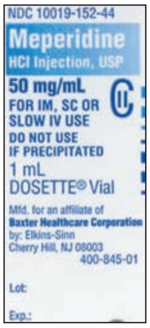
NDC 63323-965-15 96515
POTASSIUM CHLORIDE
For Injection Concentrate, USP
Concentrate Must Be Diluted Before Use
30 mEq (2 mEq/mL)
15 mL
Single Dose Vial
Rx only

Preservative Free
MUST BE DILUTED PRIOR TO IV ADMINISTRATION
Sterile, Nonpyrogenic
Each mL contains:
Potassium chloride 2 mEq (149 mg); Water for Injection q.s. HCl and/or KOH may have been added for pH adjustment.
4000 mOsmol/L (calc.)
Usual Dosage: See Insert.
Store at controlled room temperature 15°-30°C (59°-86°F).
APP AMERICAN PHARMACEUTICAL PARTNERS, INC.
Los Angeles, CA 90024
401700B
LOT
EXP

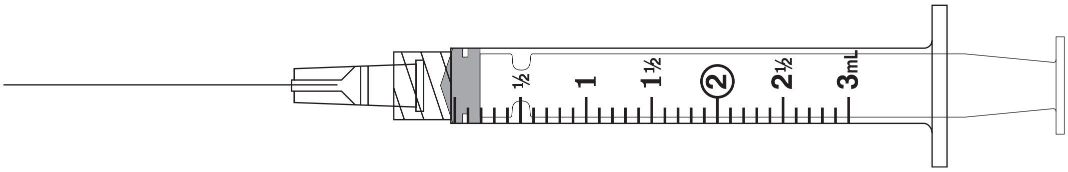


8. Order: meperidine hydrochloride 35 mg IM q.4h p.r.n., pain

Give: _________ mL

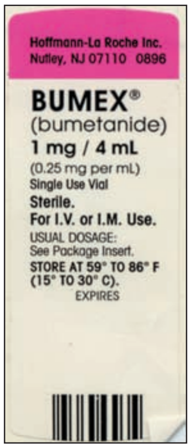


NDC 10019-152-44
Meperidine
HCl Injection, USP
50 mg/mL
C II
FOR IM, SC OR SLOW IV USE
DO NOT USE IF PRECIPITATED
1 mL
DOSETTE® Vial
Mfd. for an affiliate of
Baxter Healthcare Corporation
by: Elkins-Sinn
Cherry Hill, NJ 08003
400-845-01
Lot:
Exp.:

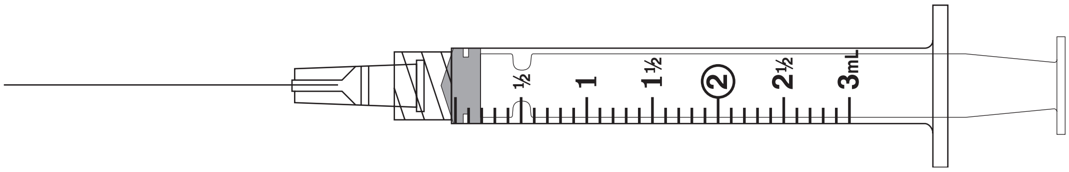


9. Order: Bumex 500 mcg IV bolus stat

Give: __________ mL

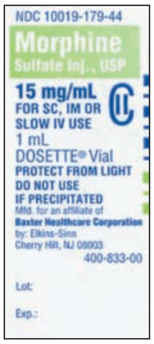

Hoffmann-La Roche Inc.
Nutley, NJ 07110 0896

BUMEX®
(bumetanide)
1 mg / 4 mL
(0.25 mg per mL)
Single Use Vial
Sterile.
For I.V. or I.M. Use.
USUAL DOSAGE:
See Package Insert.
STORE AT 59° TO 86° F
(15° TO 30° C).
EXPIRES



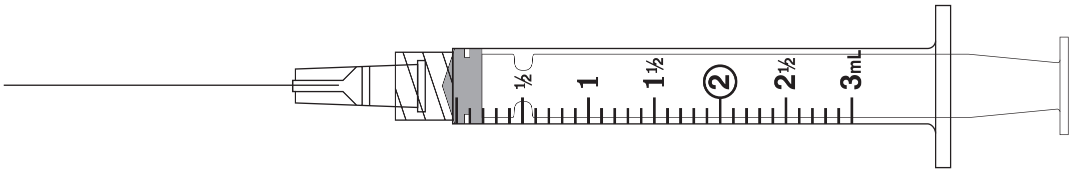
10. Order: morphine sulfate gr $\frac{1}{4}$ IM q.4h p.r.n., pain

Give: __________ mL


NDC 10019-179-44
Morphine
Sulfate Inj., USP
15 mg/mL
FOR SC, IM OR
SLOW IV USE
1 mL
DOSETTE® Vial
PROTECT FROM LIGHT
DO NOT USE
IF PRECIPITATED
Mfd. for an affiliate of
Baxter Healthcare Corporation
by: Elkins-Sinn
Cherry Hill, NJ 08003
400-833-00

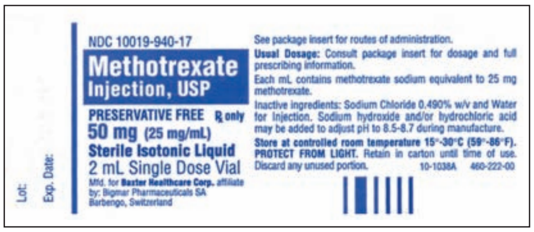
Lot:

Exp.:



11. Order: methotrexate 30 mg IM daily × 5 days

Give: __________ mL


Lot:
Exp. Date:

NDC 10019-940-17
Methotrexate
Injection, USP
PRESERVATIVE FREE ℞ **only**
50 mg (25 mg/mL)
Sterile Isotonic Liquid
2 mL Single Dose Vial
Mfd. for **Baxter Healthcare Corp.** affiliate
by: Bigmar Pharmaceuticals SA
Barbengo, Switzerland

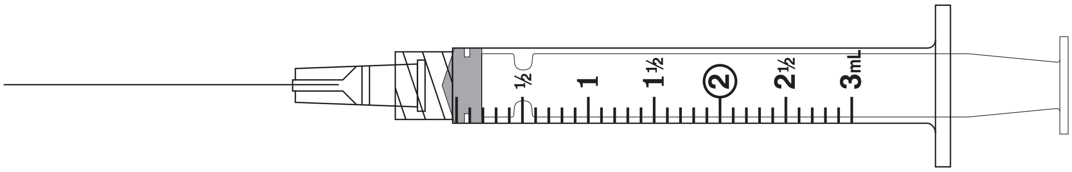
See package insert for routes of administration.

Usual Dosage: Consult package insert for dosage and full prescribing information.

Each mL contains methotrexate sodium equivalent to 25 mg methotrexate.

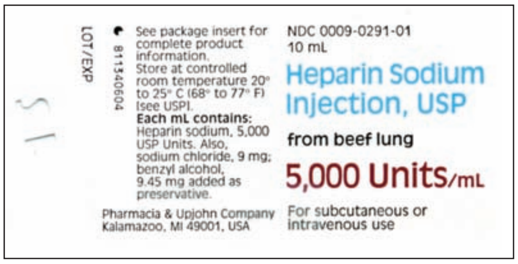
Inactive ingredients: Sodium Chloride 0.490% w/v and Water for Injection. Sodium hydroxide and/or hydrochloric acid may be added to adjust pH to 8.5-8.7 during manufacture.

Store at controlled room temperature 15°-30°C (59°-86°F). PROTECT FROM LIGHT. Retain in carton until time of use. Discard any unused portion. 10-1038A 460-222-00



12. Order: heparin 4,500 units subcut daily

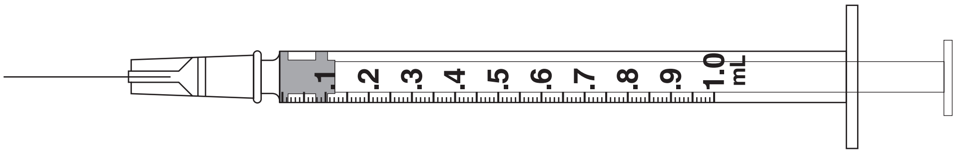
Give: __________ mL


LOT/EXP
811340604

See package insert for complete product information.
Store at controlled room temperature 20° to 25° C (68° to 77° F) [see USP].
Each mL contains:
Heparin sodium, 5,000 USP Units. Also, sodium chloride, 9 mg; benzyl alcohol, 9.45 mg added as preservative.

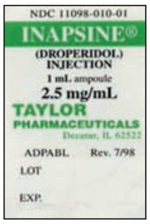
Pharmacia & Upjohn Company
Kalamazoo, MI 49001, USA

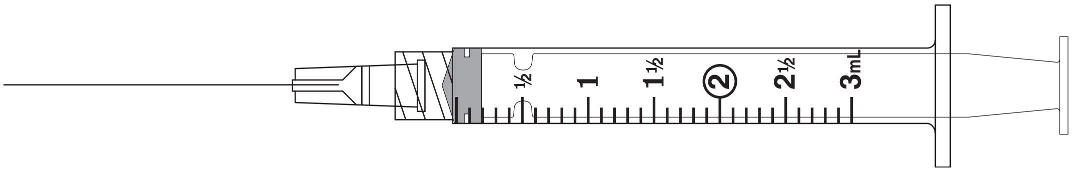
NDC 0009-0291-01
10 mL
Heparin Sodium
Injection, USP
from beef lung
5,000 Units/mL
For subcutaneous or intravenous use



13. Order: Inapsine 1.25 mg IV 30 min preoperatively

Give: _________ mL


NDC 11098-010-01
INAPSINE®
(DROPERIDOL)
INJECTION
1 mL ampoule
2.5 mg/mL
TAYLOR
PHARMACEUTICALS
Decatur, IL 62522
ADPABL Rev. 7/98
LOT
EXP.



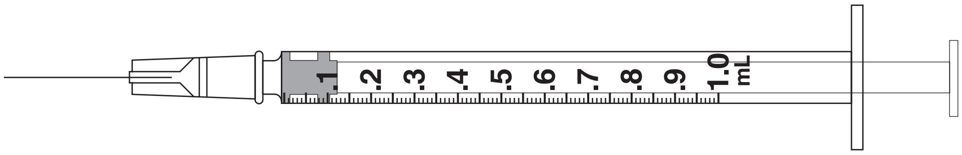
14. Order: Vistaril 20 mg IM q.4h p.r.n., nausea

Give: _________ mL


FOR INTRAMUSCULAR USE ONLY.
USUAL ADULT DOSE: Intramuscularly: 25 - 100 mg stat; repeat every 4 to 6 hours, as needed.
See accompanying prescribing information.
Each mL contains 50 mg of hydroxyzine hydrochloride, 0.9% benzyl alcohol and sodium hydroxide to adjust to optimum pH.
To avoid discoloration, protect from prolonged exposure to light.
Rx only

10 mL NDC 0049-5460-74
Vistaril®
(hydroxyzine hydrochloride)
Intramuscular Solution
50 mg/mL
Pfizer Roerig
Division of Pfizer Inc, NY, NY 10017

Store below 86°F (30°C).
PROTECT FROM FREEZING.
PATIENT: ____________
ROOM NO.: ____________
05-1111-32-4
MADE IN USA
9249



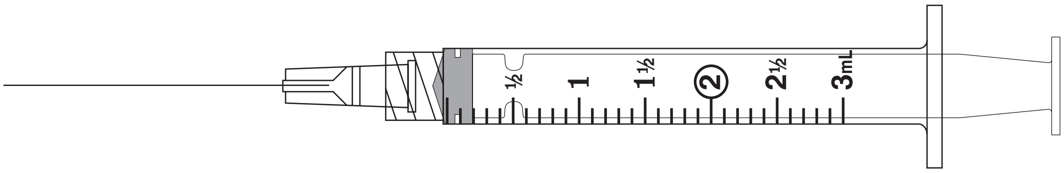
15. Order: Terramycin 150 mg IM q.12h

Give: _________ mL


Rx only
8885
SEE ACCOMPANYING PRESCRIBING INFORMATION.

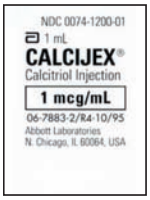
10 mL Vial NDC 0049-0750-77
Terramycin®
(oxytetracycline)
Intramuscular Solution*
contains 2% lidocaine
50 mg/mL
Pfizer Roerig
Division of Pfizer Inc, NY, NY 10017

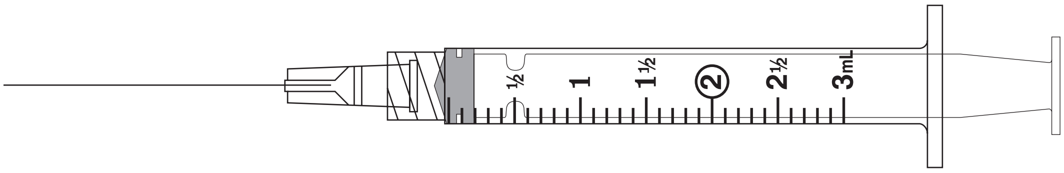
Store below 86°F (30°C).
FOR INTRAMUSCULAR USE ONLY.
MADE IN USA
05-1051-32-4



16. Order: Calcijex 1.5 mcg IV 3 times/wk every other day M-W-F

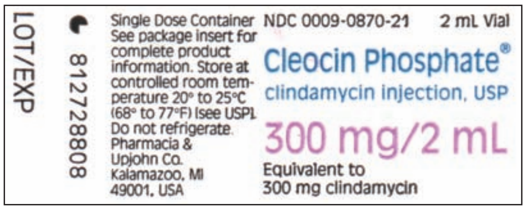
Give: _________ mL

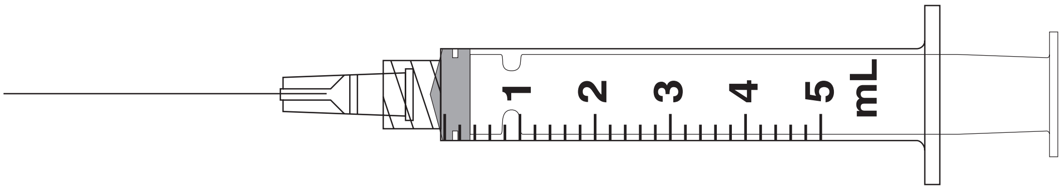

NDC 0074-1200-01
1 mL
CALCIJEX®
Calcitriol Injection
1 mcg/mL
06-7883-2/R4-10/95
Abbott Laboratories
N. Chicago, IL 60064, USA



17. Order: clindamycin 0.6 g IV q.12h

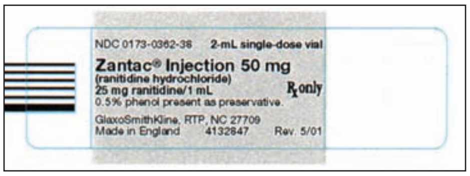
Give: _________ mL

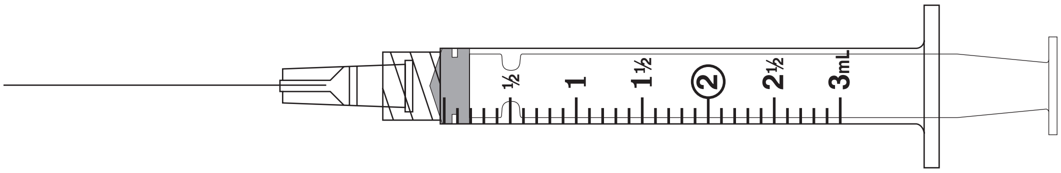

LOT/EXP
812728808
Single Dose Container
See package insert for complete product information. Store at controlled room temperature 20° to 25°C (68° to 77°F) [see USP].
Do not refrigerate.
Pharmacia & Upjohn Co.
Kalamazoo, MI 49001, USA
NDC 0009-0870-21 2 mL Vial
Cleocin Phosphate®
clindamycin injection, USP
300 mg/2 mL
Equivalent to 300 mg clindamycin



18. Order: Zantac 20 mg IM q.6h

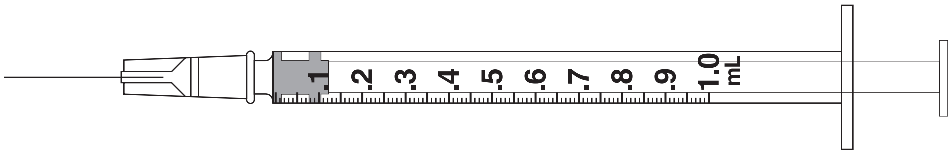
Give: _________ mL





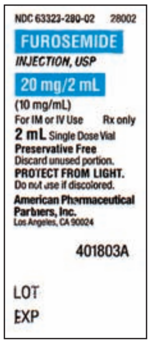
19. Order: Phenergan 12.5 mg IM stat

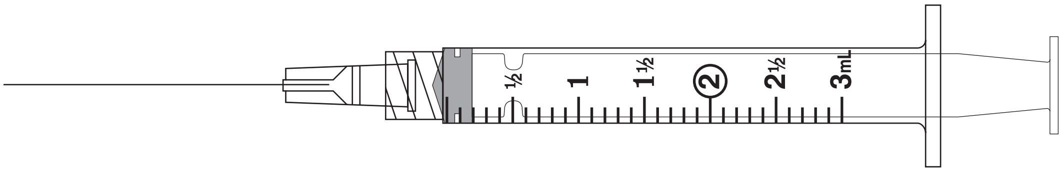
Give: _________ mL



20. Order: furosemide 15 mg IM daily

Give: _________ mL





After completing these problems, see pages 488–491 to check your answers.

INSULIN

Insulin, a hormone made in the pancreas, is necessary for the metabolism of glucose, proteins, and fats. Patients who are deficient in insulin (insulin-dependent diabetics) are required to take insulin by injection daily. Insulin is a ready-to-use solution that is measured in units. The most common supply dosage is *100 units per mL.*

MATH TIP

The supply dosage of insulin is **100 units per mL**, which is abbreviated on the label as **U-100.** Think: U-100 = 100 units per mL.

Insulin is also available as 500 units per mL (or U-500). This supply dosage is used only under special circumstances and is not commercially dispensed.

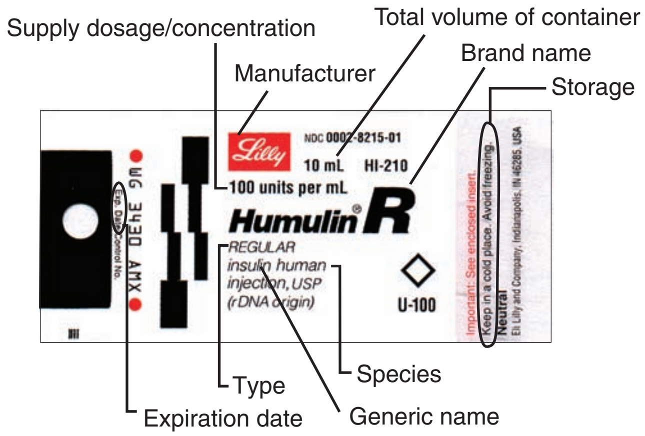
CAUTION

Accuracy in insulin preparation and administration is critical. Inaccuracy is potentially life-threatening. It is essential for nurses to understand the information on the insulin label, to correctly interpret the insulin order, and to select the correct syringe to measure insulin for administration.

Insulin Label

Figure 11-2 identifies the essential components of insulin labels. The insulin label includes important information. For example, the *brand* and *generic names,* the *supply dosage* or *concentration,* and the *storage* instructions are details commonly found on most parenteral drug labels. Chapter 8 explains these and other typical drug label components. Let's look closely at different insulin types classified by the insulin *action times* and insulin *species,* which are critical identifiers of this important hormone supplement.

FIGURE 11-2 Insulin label



Insulin Action Times

Figure 11-3 shows a sampling of insulin labels arranged by the three action times: rapid-acting (Regular, Lispro), intermediate-acting (Lente, NPH or Neutral Protamine Hagedorn), and long-acting (Ultralente). Lantus, a new insulin, has a 24-hour duration of action, but unlike the other insulins, it has no peak. Regular and NPH insulin are the two types of insulin used most often. Notice the uppercase, bold letters on each insulin label: **R** for Regular insulin; **L** for Lente insulin; **N** for NPH insulin; and **U** for Ultralente insulin. These letters are important visual identifiers when selecting the insulin type.

FIGURE 11-3 Labels for insulin types grouped by action times

Rapid-Acting

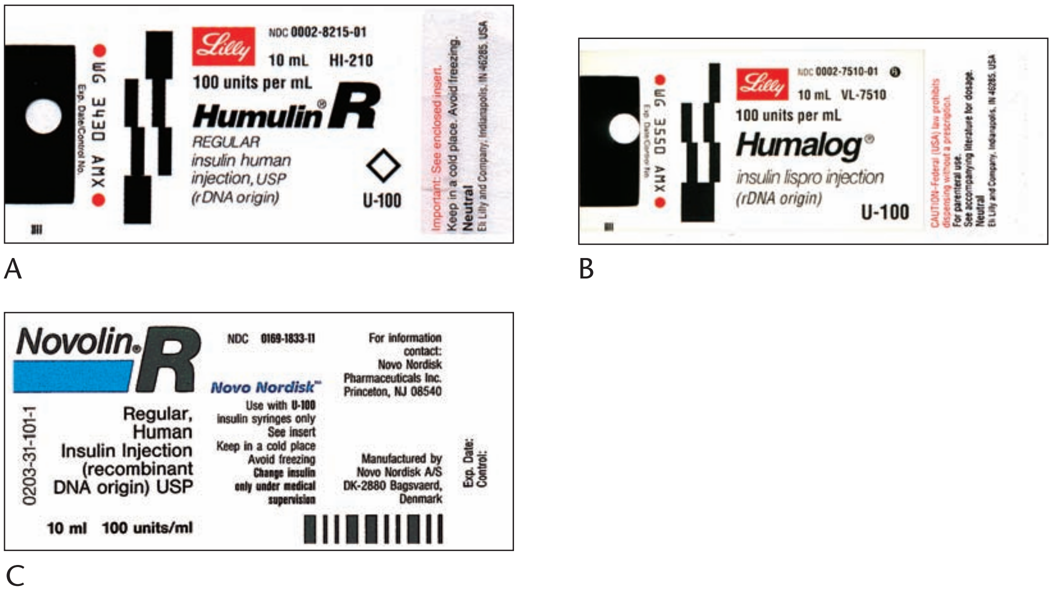
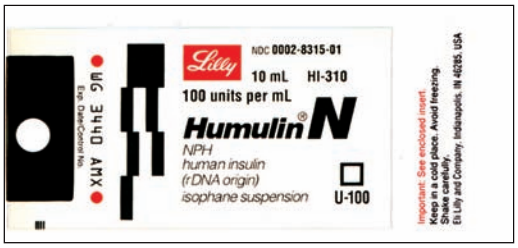


FIGURE 11-3 cont'd

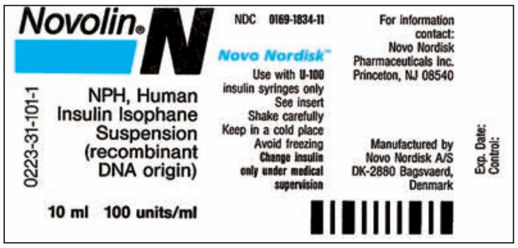
Intermediate-Acting


Lilly 10 mL HI-410
100 units per mL
Humulin® L
LENTE®
human insulin
(rDNA origin)
zinc suspension
U-100
WG 2870 AMX
Exp. Date/Control No.
PROFESSIONAL PACKAGE–NOT TO BE SOLD
Important: See enclosed circular.
Keep in a cold place. Avoid freezing.
To mix, roll or carefully shake the insulin bottle several times.
If pregnant or nursing, see carton.
Eli Lilly and Co., Indianapolis, IN 46285, USA

D


Lilly NDC 0002-8315-01
10 mL HI-310
100 units per mL
Humulin® N
NPH
human insulin
(rDNA origin)
isophane suspension
U-100
WG 3440 AMX
Exp. Date/Control No.
Important: See enclosed insert.
Keep in a cold place. Avoid freezing.
Shake carefully.
Eli Lilly and Company, Indianapolis, IN 46285, USA

E

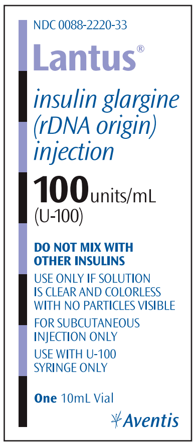

Novolin® N
0223-31-101-1
NPH, Human Insulin Isophane Suspension (recombinant DNA origin)
10 ml 100 units/ml
NDC 0169-1834-11
Novo Nordisk™
Use with U-100 insulin syringes only
See insert
Shake carefully
Keep in a cold place
Avoid freezing
Change insulin only under medical supervision
For information contact:
Novo Nordisk Pharmaceuticals Inc.
Princeton, NJ 08540
Manufactured by
Novo Nordisk A/S
DK-2880 Bagsvaerd, Denmark
Exp. Date:
Control:

F

Long-Acting


Lilly NDC 0002-8615-01
10 mL HI-610
100 units per mL
Humulin® U
ULTRALENTE®
human insulin
(rDNA origin)
extended zinc suspension
U-100
WG 3460 AMX
Exp. Date/Control No.
Important: See enclosed insert.
Keep in a cold place. Avoid freezing.
Shake carefully.
Eli Lilly and Company, Indianapolis, IN 46285, USA

G


NDC 0088-2220-33
Lantus®
insulin glargine
(rDNA origin)
injection
100 units/mL
(U-100)
DO NOT MIX WITH OTHER INSULINS
USE ONLY IF SOLUTION IS CLEAR AND COLORLESS WITH NO PARTICLES VISIBLE
FOR SUBCUTANEOUS INJECTION ONLY
USE WITH U-100 SYRINGE ONLY
One 10mL Vial
Aventis

H

Species of Insulin

Insulin comes from various sources:

- Human insulin (the most common species)
  a. biosynthetic—bacteria genetically altered to create human insulin
  b. semisynthetic—pork insulin chemically altered to produce human insulin
- Beef insulin—from the pancreas of cattle
- Pork insulin—from the pancreas of pigs
- Beef–pork mixture—a combination of beef and pork insulin

  Note: Beef–pork insulins are being phased out.

CAUTION

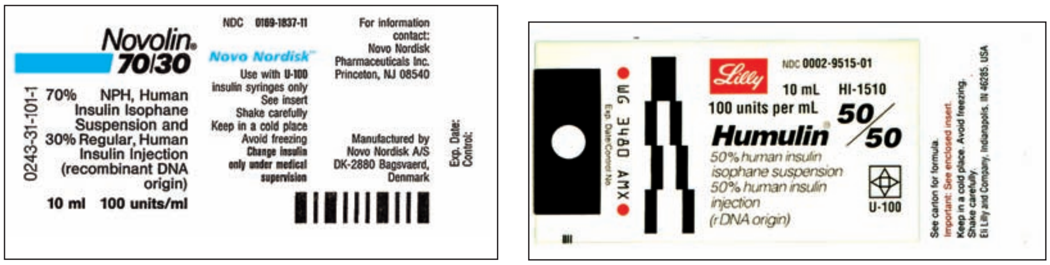
Avoid a potentially life-threatening medication error. Carefully read the label, and compare it to the drug order to ensure that you select the correct action time and species of insulin.

Premixed, Combination Insulin

Two premixed insulin combinations that are commercially available are 70/30 U-100 insulin and 50/50 U-100 insulin (Figure 11-4). The 70/30 insulin concentration means there is 70% NPH insulin and 30% Regular insulin in each unit. Therefore, if the physician orders 10 units of 70/30 insulin, the patient would receive 7 units of NPH insulin (70% or 0.7 × 10 units = 7 units) and 3 units of Regular insulin (30% or 0.3 × 10 units = 3 units) in the 70/30 concentration. If the physician orders 20 units of 70/30 insulin, the patient would receive 14 units (0.7 × 20 = 14) of NPH and 6 units (0.3 × 20 = 6) of Regular insulin.

The 50/50 insulin concentration means there is 50% NPH insulin and 50% Regular insulin in each unit. Therefore, if the physician orders 12 units of 50/50 insulin, the patient would receive 6 units of NPH insulin (50% or 0.5 × 12 units = 6 units) and 6 units of Regular insulin (50% or 0.5 × 12 units = 6 units).

FIGURE 11-4 Premixed, combination insulins



A B

Interpreting the Insulin Order

Insulin orders must be written clearly and contain specific information to ensure correct administration and prevent errors. An insulin order should contain:

1. The *brand name, including the species and action time.* Patients are instructed to stay with the same manufacturer's brand-name insulin and species. Slight variations between brands can affect an individual's response. Verify both the usual brand name used and the actual insulin supplied with the patient before administration. Different species of insulin may cause allergy-like symptoms in some patients, so check carefully. Look for one of the three action times: rapid-acting (Regular), intermediate-acting (Lente, NPH), and long-acting (Ultralente or Lantus).

2. The *supply dosage (concentration)* and *number of units* to be given; for example, U-100 insulin 40 units.

3. The *route* of administration and *time* or *frequency.* All insulin may be administered subcutaneously (subcut), and Regular insulin may additionally be administered intravenously (IV).

EXAMPLES ■

Humulin R Regular U-100 insulin 14 units subcut stat

Novolin N NPH U-100 insulin 24 units subcut $\frac{1}{2}$ hour $\bar{a}$ breakfast

Insulin Coverage—The “Sliding Scale”

A special insulin order is sometimes needed to “cover” a patient’s increasing blood sugar level that is not yet regulated. Because of the rapid action, Lispro or Regular insulin will be used. The physician will specify the amount of insulin in units, which “slide” up or down based on a specific blood sugar level range. Sliding scales are individualized for each patient. Here’s an example of a sliding-scale order:

EXAMPLE ■

Order: **Humulin R Regular U-100 insulin subcut a.c. based on glucose reading at 1600**

If the patient’s blood glucose is 290, you would administer 6 units of Humulin R Regular U-100 insulin.

Insulin Dose	Glucose Reading*
No coverage	Glucose less than 160
2 units	160–220
4 units	221–280
6 units	281–340
8 units	341–400

*Glucose greater than 400: Hold insulin; call MD stat.

Insulin Administration

The primary route of insulin administration is by subcutaneous injection. Regular insulin can also be administered intravenously. The schedule and frequency for insulin administration varies based on the needs of the individual patient. The insulin pump is one method for insulin administration (Figure 11-5). Insulin pumps deliver rapid- or short-acting insulin 24 hours a day through a catheter placed under the skin. Pumps can be programmed to deliver a basal rate and/or bolus doses. Basal insulin is delivered continuously over 24 hours to keeps blood glucose levels in range between meals and overnight. The basal rate can be programmed to deliver different rates at different times of the day and night. Bolus doses can be delivered at mealtimes to provide control for additional food intake.

FIGURE 11-5 Insulin pump

Measuring Insulin in an Insulin Syringe

The insulin syringe and measurement of insulin were introduced in Chapter 6. This critical skill warrants your attention again. Once you understand how insulin is packaged and how to use the insulin syringe, you will find insulin dosage simple.

RULE

- Measure insulin in an insulin syringe only. Do not use a 3 mL or 1 mL syringe to measure insulin.
- Use U-100 insulin syringes to measure U-100 insulin only. Do not measure other drugs supplied in units in an insulin syringe.

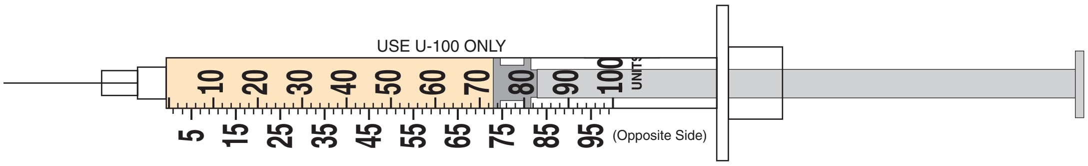
Measuring insulin with the insulin syringe is simple. The insulin syringe makes it possible to obtain a correct dosage without mathematical calculation. Let's look at three different insulin syringes. They are the *standard* (100 unit) capacity and the *lo-dose* (50 unit and 30 unit) capacity.

Standard U-100 Insulin Syringe

EXAMPLE 1 ■

The Standard U-100 insulin syringe in Figure 11-6 is a dual-scale syringe with 100 units/mL capacity. It is calibrated on one side in even-numbered, 2-unit increments (2, 4, 6, . . .) with every 10 units labeled (10, 20, 30, . . .). It is calibrated on the reverse side in odd-numbered, 2 unit increments (1, 3, 5, . . .) with every 10 units labeled (5, 15, 25, . . .). The measurement of 73 units of U-100 insulin is illustrated in Figure 11-6.

FIGURE 11-6 Standard U-100 insulin syringe measuring 73 units



CAUTION

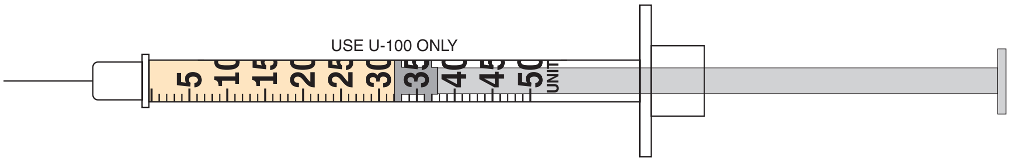
Look carefully at the increments on the dual scale. The volume from one mark to the next (on either side) is two units. You are probably comfortable counting by twos for even numbers. Pay close attention when counting by twos with odd numbers.

Lo-Dose U-100 Insulin Syringes

EXAMPLE 1 ■

The Lo-Dose U-100 insulin syringe in Figure 11-7 is a single-scale syringe with 50 units per 0.5 mL capacity. It is calibrated in 1 unit increments with every 5 units (5, 10, 15, . . .) labeled up to 50 units. The enlarged 50 unit calibration of this syringe makes it easy to read and use to measure low dosages of insulin. To measure 32 units, withdraw U-100 insulin to the 32 unit mark (Figure 11-7).

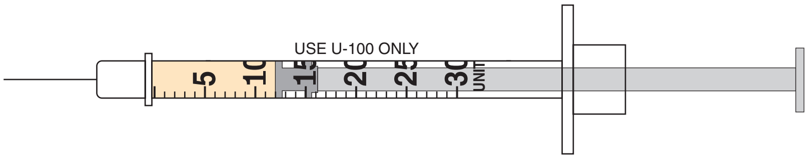
FIGURE 11-7 50-U Lo-Dose U-100 insulin syringe measuring 32 units



EXAMPLE 2 ■

The Lo-Dose U-100 insulin syringe in Figure 11-8 is a single-scale syringe with 30 units per 0.3 mL capacity. It is calibrated in 1 unit increments with every 5 units (5, 10, 15, . . .) labeled up to 30 units. The enlarged 30 unit calibration accurately measures small amounts of insulin, such as for children. To measure 12 units, withdraw U-100 insulin to the 12 unit mark (Figure 11-8).

FIGURE 11-8 30-U Lo-Dose U-100 insulin syringe measuring 12 units



CAUTION

Always choose the smallest capacity insulin syringe available for accurate insulin measurement. Use Standard and Lo-Dose U-100 syringes to measure U-100 insulin only. Although the Lo-Dose U-100 insulin syringes only measure a maximum of 30 or 50 units, they are still intended for the measurement of U-100 insulin only.

Be cautious when measuring. The Lo-Dose U-100 syringe is calibrated in 1-unit increments; the Standard U-100 insulin syringe is calibrated in 2-unit increments on the even and odd scales.

Combination Insulin Dosage

The patient may have two types of insulin prescribed to be administered at the same time. To avoid injecting the patient twice, it is common practice to draw up both insulins into the same syringe.

RULE

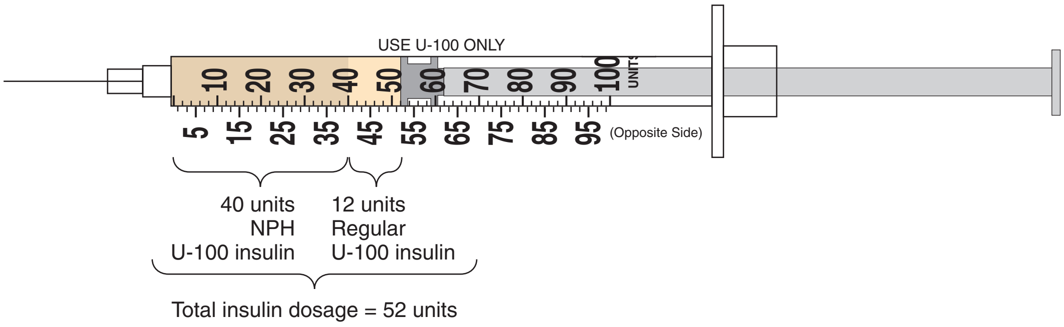
Draw up clear insulin first, then draw up cloudy insulin.
Regular insulin is clear. NPH insulin is cloudy.
Think: *First clear, then cloudy.* **Think:** *First Regular, then NPH.*

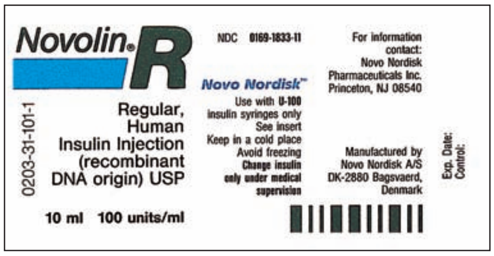
EXAMPLE 1 ■

Order: **Novolin R Regular U-100 insulin 12 units with Novolin N NPH U-100 insulin 40 units subcut ā breakfast.**

To accurately draw up both insulins into the same syringe, you will need to know the total units of both insulins: 12 + 40 = 52 units. Withdraw 12 units of the Regular U-100 insulin (clear) and then withdraw 40 more units of the NPH U-100 insulin (cloudy) up to the 52 unit mark (Figure 11-9). In this case, the smallest capacity syringe you can use is the Standard U-100 insulin syringe. Notice that the NPH insulin is drawn up last and is closest to the needle in the diagram. In reality, the drugs mix right away.

FIGURE 11-9 Combination insulin dosage





Novolin® R

Regular, Human Insulin Injection (recombinant DNA origin) USP

10 ml 100 units/ml

0203-31-101-1

NDC 0169-1833-11

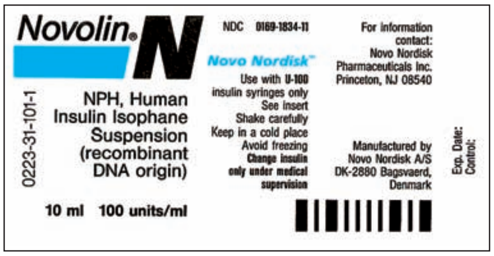
Novo Nordisk™

Use with U-100 insulin syringes only
See insert
Keep in a cold place
Avoid freezing
Change insulin only under medical supervision

For information contact:
Novo Nordisk Pharmaceuticals Inc.
Princeton, NJ 08540

Manufactured by
Novo Nordisk A/S
DK-2880 Bagsvaerd,
Denmark

Exp. Date:
Control:



Novolin® N

NPH, Human Insulin Isophane Suspension (recombinant DNA origin)

10 ml 100 units/ml

0223-31-101-1

NDC 0169-1834-11

Novo Nordisk™

Use with U-100 insulin syringes only
See insert
Shake carefully
Keep in a cold place
Avoid freezing
Change insulin only under medical supervision

For information contact:
Novo Nordisk Pharmaceuticals Inc.
Princeton, NJ 08540

Manufactured by
Novo Nordisk A/S
DK-2880 Bagsvaerd,
Denmark

Exp. Date:
Control:

The second example gives step-by-step directions for this procedure. Look closely at Figures 11-10 and 11-11 to demonstrate the procedure as you study Example 2. Notice that to withdraw Regular insulin (clear) first and then NPH insulin (cloudy), you must inject the dose amount of air into the NPH insulin *before* you inject the dose amount of air into the Regular insulin.

FIGURE 11-10 Procedure for drawing up combination insulin dosage: 10 units Regular U-100 Insulin with 30 units NPH U-100 Insulin

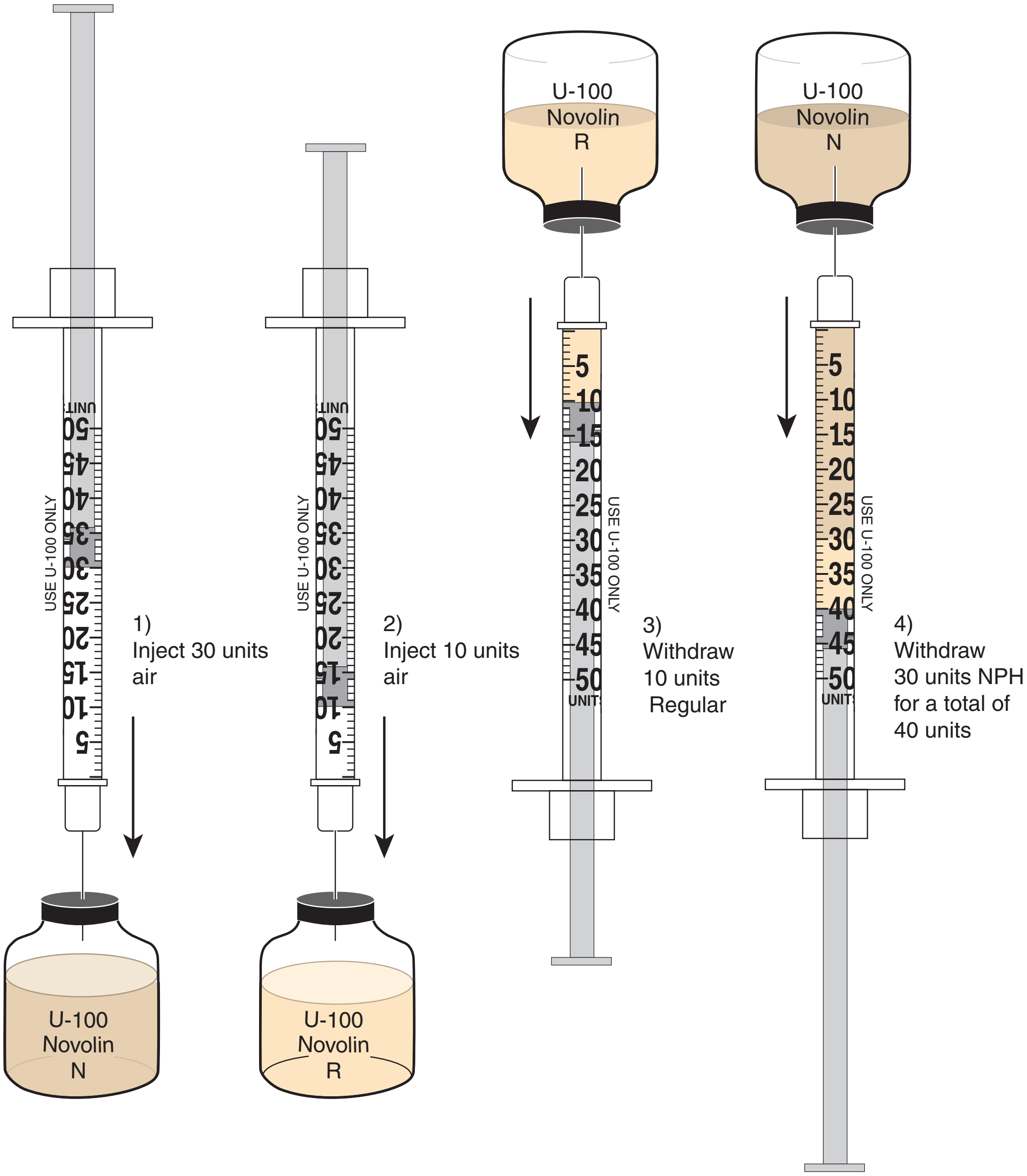
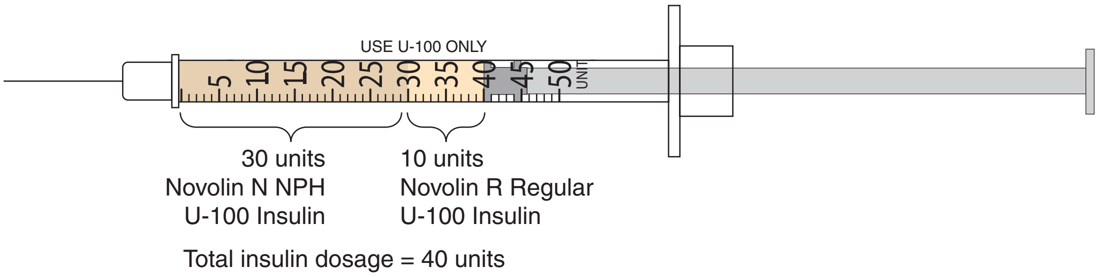


FIGURE 11-11 Combination insulin dosage



EXAMPLE 2 ■

The physician orders **Novolin R Regular U-100 insulin 10 units with Novolin N NPH U-100 insulin 30 units subcut $\frac{1}{2}$ hour $\overline{a}$ dinner.**

1. Draw back and inject 30 units of air into the NPH insulin vial (cloudy liquid). Remove needle.
2. Draw back and inject 10 units of air into the Regular insulin vial (clear liquid) and leave the needle in the vial.
3. Turn the vial of Regular insulin upside down, and draw out the insulin to the 10-unit mark on the syringe. Make sure all air bubbles are removed.
4. Roll the vial of the NPH insulin in your hands to mix; do not shake it. Insert the needle into the NPH insulin vial, turn the vial upside down and slowly draw back to the 40-unit mark, being careful not to exceed the 40-unit calibration. In Figure 11-11, 10 units of Regular + 30 units of NPH = 40 units of insulin total.

CAUTION

If you withdraw too much of the second insulin (NPH), you must discard the entire medication and start over.

Avoiding Insulin Dosage Errors

Insulin dosage errors are costly and, unfortunately, too common. They can be avoided by following two important rules.

RULE

1. Insulin dosages must be checked by two nurses.
2. When combination dosages are prepared, two nurses must verify each step of the process.

QUICK REVIEW

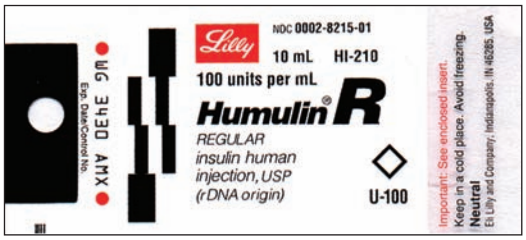
- Carefully read the physician's order, and match the supply dosage for type and species of insulin.
- Always measure insulin in an insulin syringe.
- An insulin syringe is used to *only* measure insulin. Insulin syringes must not be used to measure other medications measured in units.
- Use the smallest capacity insulin syringe possible to most accurately measure insulin doses.
- When drawing up combination insulin doses, think *clear first, then cloudy.*
- Avoid insulin dosage errors. The insulin dosage should be checked by two nurses.
- There are 100 units per mL for U-100 insulin.

Review Set 27

Read the following labels. Identify the insulin brand name and its action time (rapid-acting, intermediate-acting, or long-acting).

1. Insulin brand name ________

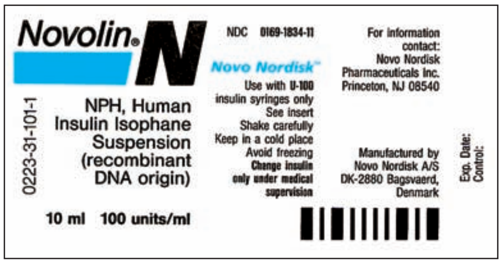
   Action time ________



NDC 0002-8215-01
10 mL HI-210
100 units per mL
Humulin R
REGULAR
insulin human
injection, USP
(rDNA origin)
U-100
WG 3490 AMX
Exp. Date/Control No.
Important: See enclosed insert.
Keep in a cold place. Avoid freezing.
Neutral
Eli Lilly and Company, Indianapolis, IN 46285, USA

2. Insulin brand name ________

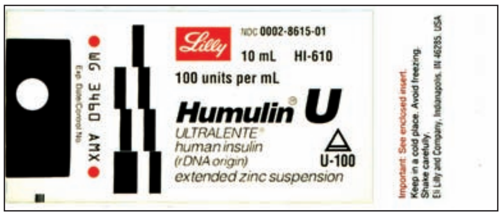
   Action time ________



Novolin N
NPH, Human
Insulin Isophane
Suspension
(recombinant
DNA origin)
0223-31-101-1
10 ml 100 units/ml
NDC 0169-1834-11
Novo Nordisk
Use with U-100
insulin syringes only
See insert
Shake carefully
Keep in a cold place
Avoid freezing
Change insulin
only under medical
supervision
For information
contact:
Novo Nordisk
Pharmaceuticals Inc.
Princeton, NJ 08540
Manufactured by
Novo Nordisk A/S
DK-2880 Bagsvaerd,
Denmark
Exp. Date:
Control:

3. Insulin brand name ________

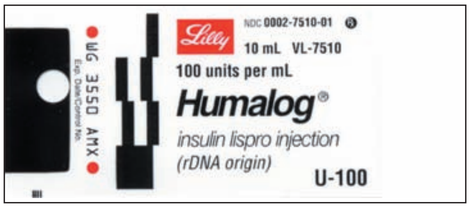
   Action time ________



NDC 0002-8615-01
10 mL HI-610
100 units per mL
Humulin U
ULTRALENTE®
human insulin
(rDNA origin)
extended zinc suspension
U-100
WG 3460 AMX
Exp. Date/Control No.
Important: See enclosed insert.
Keep in a cold place. Avoid freezing.
Shake carefully.
Eli Lilly and Company, Indianapolis, IN 46285, USA

4. Insulin brand name ________

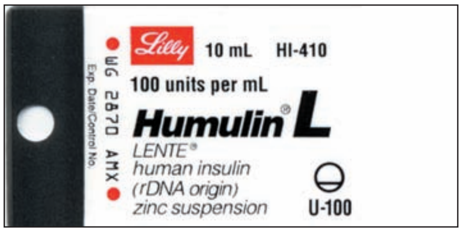
   Action time ________



NDC 0002-7510-01
10 mL VL-7510
100 units per mL
Humalog®
insulin lispro injection
(rDNA origin)
U-100
WG 3550 AMX
Exp. Date/Control No.

5. Insulin brand name ________

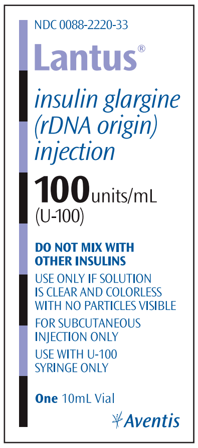
   Action time ________



10 mL HI-410
100 units per mL
Humulin L
LENTE®
human insulin
(rDNA origin)
zinc suspension
U-100
WG 2870 AMX
Exp. Date/Control No.

6. Insulin brand name ________

   Action time ________



NDC 0088-2220-33
Lantus®
insulin glargine
(rDNA origin)
injection
100 units/mL
(U-100)
DO NOT MIX WITH
OTHER INSULINS
USE ONLY IF SOLUTION
IS CLEAR AND COLORLESS
WITH NO PARTICLES VISIBLE
FOR SUBCUTANEOUS
INJECTION ONLY
USE WITH U-100
SYRINGE ONLY
One 10mL Vial
Aventis

7. Describe the three syringes available to measure U-100 insulin. ________________________

____

8. What would be your preferred syringe choice to measure 35 units of U-100 insulin?

____

9. There are 60 units of U-100 insulin per ________ mL.

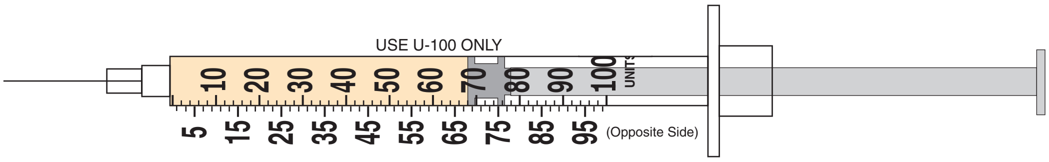
10. There are 25 units of U-100 insulin per ________ mL.

11. Sixty-five (65) units of U-100 insulin should be measured in a(n) ________ syringe.

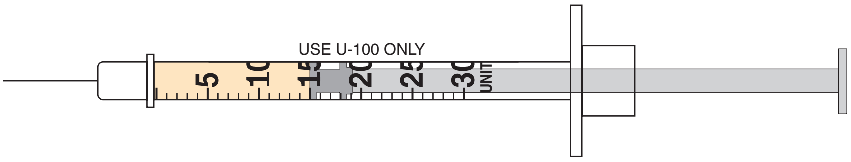
12. The 50 unit Lo-Dose U-100 insulin syringe is intended to measure U-50 insulin only.
________ (True) (False)

Identify the U-100 insulin dosage indicated by the colored area of the syringe.

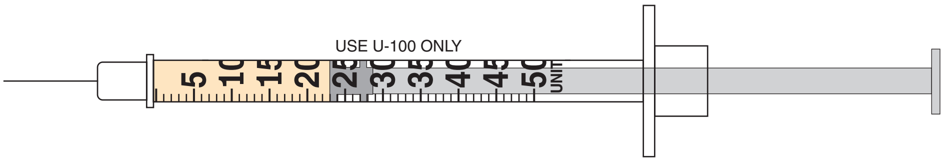
13. ________ units



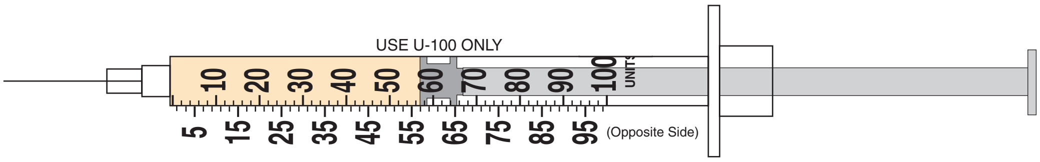
14. ________ units



15. ________ units

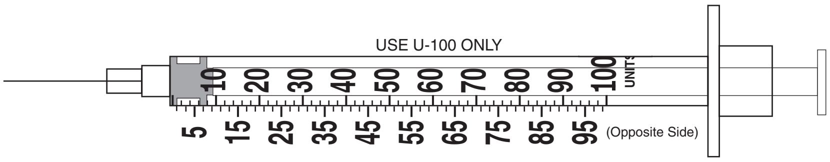


16. ________ units

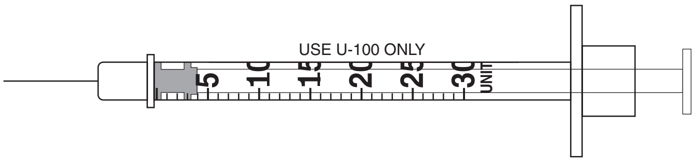


Draw an arrow on the syringe to identify the given dosages.

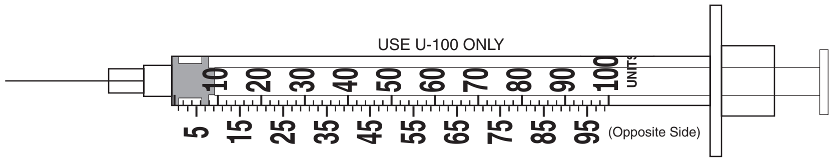
17. 80 units U-100 insulin



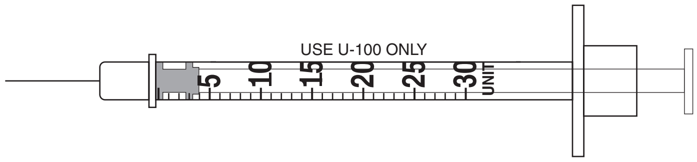
18. 15 units U-100 insulin



19. 66 units U-100 insulin



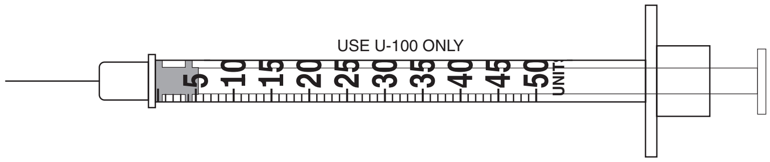
20. 16 units U-100 insulin



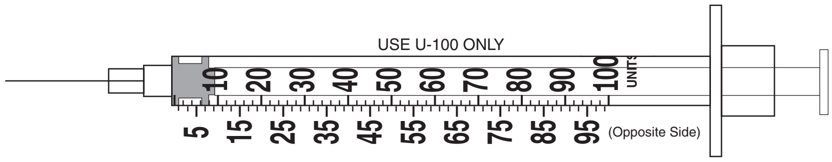
21. 32 units of U-100 insulin

Draw arrows, and label the dosage for each of the combination insulin orders to be measured in the same syringe. Label and measure the insulins in the correct order, indicating which insulin will be drawn up first.

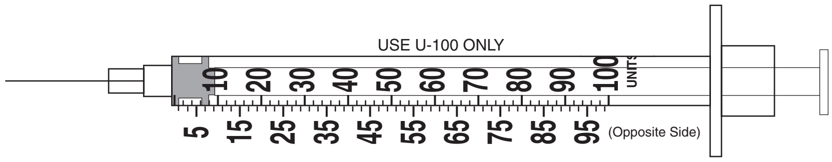
22. Novolin R Regular U-100 insulin 21 units with Novolin N NPH U-100 insulin 15 units subcut stat



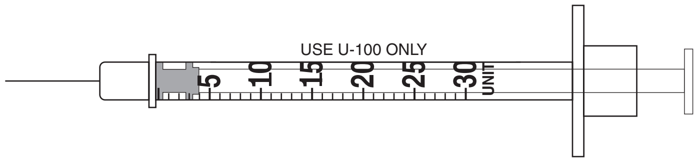
23. Humulin R Regular U-100 insulin 16 units with Humulin N NPH U-100 insulin 42 units subcut stat



24. Humulin R Regular U-100 insulin 32 units with Humulin N NPH U-100 insulin 40 units subcut ā dinner



25. Humulin R Regular U-100 insulin 8 units with Humulin N NPH U-100 insulin 12 units subcut stat



Use the following insulin sliding scale and medication order to answer questions 26 through 30.

INSULIN SLIDING SCALE

Insulin Dose	Glucose Reading*
No coverage	Glucose less than 160
2 units	160–220
4 units	221–280
6 units	281–340
8 units	341–400

*Glucose greater than 400: Hold insulin; call MD stat.

Order: **Humulin R Regular U-100 insulin subcut a.c. per sliding scale.**

26. When will you check the patient's blood glucose level to determine the amount of insulin to give?

27. At what range of blood glucose levels will you administer insulin?

28. The patient's blood glucose level before breakfast is 250. What should you do?

29. The patient's blood glucose level before lunch is 150. How much insulin should you give now?

30. The patient's blood glucose level before dinner is 410. What should you do now?

After completing these problems, see pages 492–493 to check your answers.

SUMMARY

You are now prepared to solve many of the dosage calculations you will encounter in your health care career. Oral and parenteral drug orders, written in the forms presented thus far, account for a large percentage of prescriptions. You have learned to think through the process from order to supply to amount administered, and to apply dosage calculation ratio-proportion: $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$.

Work the practice problems for Chapter 11. After completing the practice problems, you should feel comfortable and confident working dosage calculations. If not, seek additional instruction. Concentrate on accuracy. Remember, one error in dosage calculation can be a serious mistake for your patient.

CRITICAL THINKING SKILLS

Many insulin errors occur when the nurse fails to clarify an incomplete order. Let's look at an example of an insulin error when the order did not include the type of insulin to be given.

ERROR

Failing to clarify an insulin order when the type of insulin is not specified.

Possible Scenario

Suppose the physician wrote an insulin order this way:

Humulin U-100 insulin 50 units subcut $\bar{a}$ breakfast

Because the physician did not specify the type of insulin, the nurse assumed it was Regular insulin and noted that on the medication administration record. Suppose the patient was given the Regular insulin for three days. On the morning of the third day, the patient developed signs of hypoglycemia (low blood glucose), including shakiness, tremors, confusion, and sweating.

PRACTICE PROBLEMS—CHAPTER 11

Calculate the amount you will prepare for one dose. Indicate the syringe you will select to measure the medication.

1. Order: Demerol 20 mg IM q.4h p.r.n., pain

   Supply: Demerol 50 mg/mL

   Give: ________ mL Select ________ syringe

2. Order: morphine sulfate gr $\frac{1}{4}$ IM stat

   Supply: morphine sulfate 10 mg/mL

   Give: ________ mL Select ________ syringe

3. Order: Lanoxin 0.6 mg IV stat

   Supply: Lanoxin 500 mcg per 2 mL

   Give: ________ mL Select ________ syringe

4. Order: Vistaril 15 mg IM stat

   Supply: Vistaril 25 mg/mL

   Give: ________ mL Select ________ syringe

5. Order: Cleocin 300 mg IM q.i.d.

   Supply: Cleocin 0.6 g per 4 mL

   Give: ________ mL Select ________ syringe

Potential Outcome

A stat blood glucose would likely reveal a dangerously low glucose level. The patient would be given a glucose infusion to increase the blood sugar. The nurse may not realize the error until she and the doctor check the original order and find that the incomplete order was filled in by the nurse. When the doctor did not specify the type of insulin, the nurse assumed the physician meant Regular, which is short-acting, when in fact intermediate-acting NPH insulin was desired.

Prevention

This error could have been avoided by remembering all the essential components of an insulin order: species, type of insulin (such as Regular or NPH), supply dosage, the amount to give in units, and the frequency. When you fill in an incomplete order, you are essentially practicing medicine without a license. This would be a clear malpractice incident. It does not make sense to put you and your patient in such jeopardy. A simple phone call would clarify the situation for everyone involved. Further, the nurse should have double-checked the dosage with another licensed practitioner. Had the nurse done so, the error could have been discovered prior to administration.

6. Order: potassium chloride 30 mEq added to each 1,000 mL IV fluids

   Supply: 30 mL multiple-dose vial potassium chloride 2 mEq/mL

   Give: ________ mL Select ________ syringe

7. Order: Atarax 40 mg IM q.4h p.r.n., agitation

   Supply: Atarax 50 mg/mL

   Give: ________ mL Select ________ syringe

8. Order: Valium 5 mg IM q.4h p.r.n., agitation

   Supply: Valium 10 mg per 2 mL

   Give: ________ mL Select ________ syringe

9. Order: Tigan 100 mg IM q.6h p.r.n., nausea and vomiting

   Supply: Tigan 200 mg per 2 mL

   Give: ________ mL Select ________ syringe

10. Order: Dilantin 25 mg IV q.8h

    Supply: Dilantin 100 mg per 2 mL ampule

    Give: ________ mL Select ________ syringe

11. Order: atropine gr $\frac{1}{100}$ IM on call to O.R.

    Supply: atropine 0.4 mg/mL

    Give: ________ mL Select ________ syringe

12. Order: Valium 3 mg IV stat

    Supply: Valium 10 mg per 2 mL

    Give: ________ mL Select ________ syringe

13. Order: heparin 6,000 units subcut q.12h

    Supply: heparin 10,000 units/mL vial

    Give: ________ mL Select ________ syringe

14. Order: tobramycin sulfate 75 mg IM q.8h

    Supply: Nebcin (tobramycin sulfate) 80 mg per 2 mL

    Give: ________ mL Select ________ syringe

15. Order: morphine sulfate gr $\frac{1}{10}$ IM q.3h p.r.n., pain

    Supply: morphine sulfate 10 mg/mL ampule

    Give: ________ mL Select ________ syringe

16. Order: atropine gr $\frac{1}{150}$ IM on call to O.R.

    Supply: atropine 0.4 mg/mL

    Give: ________ mL Select ________ syringe

17. Order: ketorolac 20 mg IM q.6h p.r.n., severe pain

    Supply: ketorolac 30 mg/mL

    Give: ________ mL Select ________ syringe

18. Order: Garamycin 40 mg IM q.8h

    Supply: Garamycin 80 mg per 2 mL

    Give: ________ mL Select ________ syringe

19. Order: Demerol 60 mg IM q.3h p.r.n., pain

    Supply: Demerol 75 mg per 1.5 mL

    Give: ________ mL Select ________ syringe

20. Order: Demerol 35 mg IM q.4h p.r.n., pain

    Supply: Demerol 50 mg/mL

    Give: ________ mL Select: ________ syringe

21. Order: vitamin B_{12} 0.75 mg IM daily.

    Supply: vitamin B_{12} 1,000 mcg/mL

    Give: ________ mL Select ________ syringe

22. Order: Aquamephyton 15 mg IM stat

    Supply: Aquamephyton 10 mg/mL

    Give: ________ mL Select ________ syringe

23. Order: **Phenergan 35 mg IM q.4h p.r.n., nausea and vomiting**

Supply: Phenergan 50 mg/mL

Give: ________ mL Select ________ syringe

24. Order: **heparin 8,000 units subcut stat**

Supply: heparin 10,000 units/mL

Give: ________ mL Select ________ syringe

25. Order: **morphine sulfate gr $\frac{1}{6}$ SC q.4h p.r.n., pain**

Supply: morphine sulfate 8 mg/mL

Give: ________ mL Select ________ syringe

26. Order: **Lanoxin 0.4 mg IV stat**

Supply: Lanoxin 500 mcg per 2 mL

Give: ________ mL Select ________ syringe

27. Order: **Lasix 60 mg IV stat**

Supply: Lasix 20 mg per 2 mL ampule

Give: ________ mL Select ________ syringe

28. Order: **heparin 4,000 units subcut q.6h**

Supply: heparin 5,000 units/mL

Give: ________ mL Select ________ syringe

29. Order: **Apresoline 30 mg IV q.6h**

Supply: hydralazine (Apresoline) 20 mg/mL

Give: ________ mL Select ________ syringe

30. Order: **lidocaine 50 mg IV stat**

Supply: lidocaine 2%

Give: ________ mL Select ________ syringe

31. Order: **Calan 2.5 mg IV push stat**

Supply: Calan 10 mg per 4 mL

Give: ________ mL Select ________ syringe

32. Order: **heparin 3,500 units subcut q.12h**

Supply: heparin 5,000 units/mL

Give: ________ mL Select ________ syringe

33. Order: **neostigmine 0.5 mg IM t.i.d.**

Supply: neostigmine 1:2,000

Give: ________ mL Select ________ syringe

34. Order: **KCl 60 mEq added to each 1,000 mL IV fluid**

Supply: KCl 2 mEq/mL

Give: __________ mL Select __________ syringe

35. Order: **Novolin R Regular U-100 insulin 16 units subcut a.c.**

Supply: Novolin R Regular U-100 insulin, with Standard 100 units and Lo-Dose 30 units U-100 insulin syringes

Give: __________ units Select __________ syringe

36. Order: **Novolin N NPH U-100 insulin 25 units subcut ā breakfast**

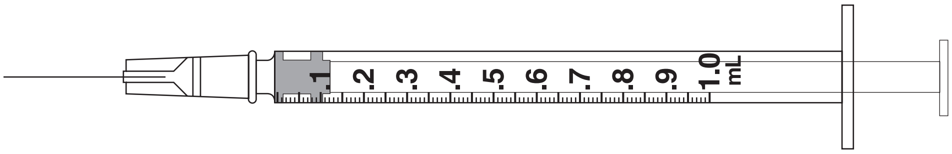
Supply: Novolin N NPH U-100 insulin with Standard 100 units and Lo-Dose 50 units U-100 insulin syringes

Give: __________ units Select __________ syringe

Calculate one dose of each of the drug orders numbered 37 through 48. Draw an arrow on the syringe indicating the calibration line that corresponds to the dose to be administered. The labels provided on pages 231–232 are the medications you have available. Indicate dosages that must be divided.

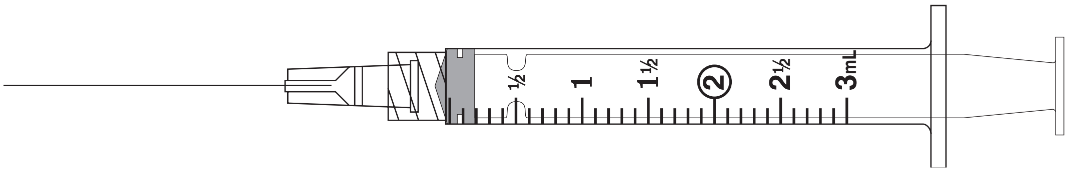
37. **Haldol 1.5 mg IM q.8h**

Give: __________ mL



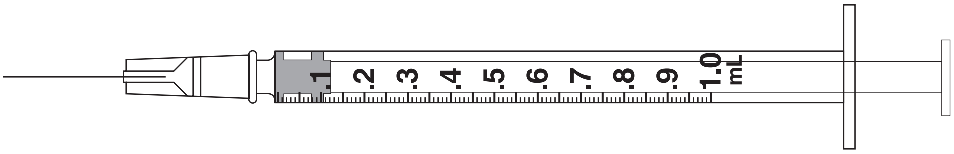
38. **Thorazine 40 mg IM q.6h**

Give: __________ mL



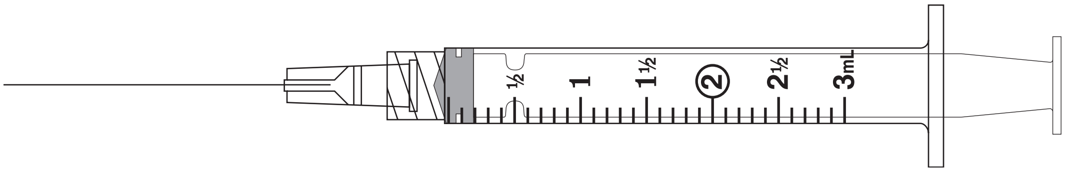
39. **Inapsine 1 mg IV stat**

Give: __________ mL



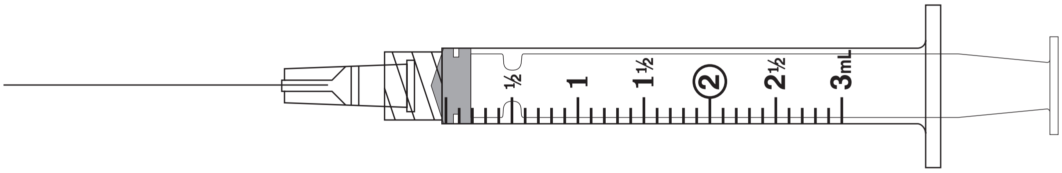
40. **furosemide 15 mg IV stat**

Give: __________ mL



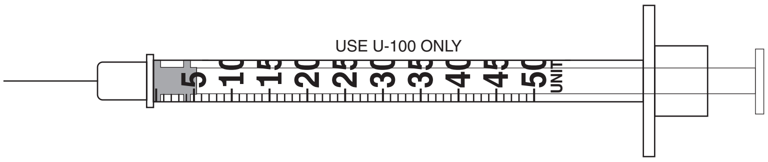
41. epoetin alpha 12,000 units subcut daily × 10 days

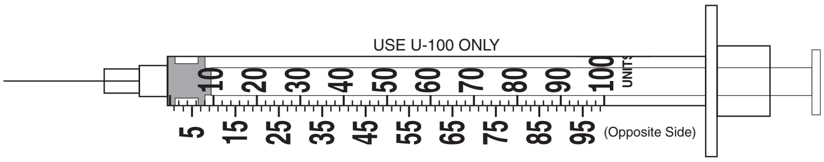
Give: _________ mL



42. Humulin R Regular U-100 insulin 22 units subcut stat

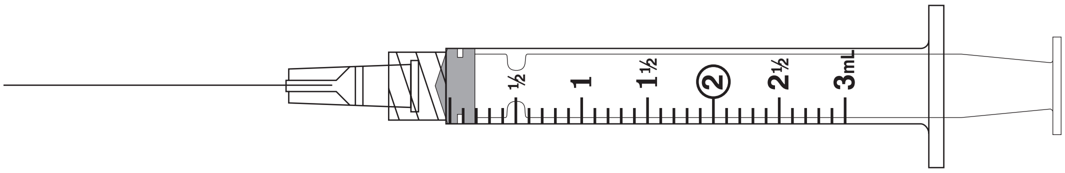
Give: _________ units





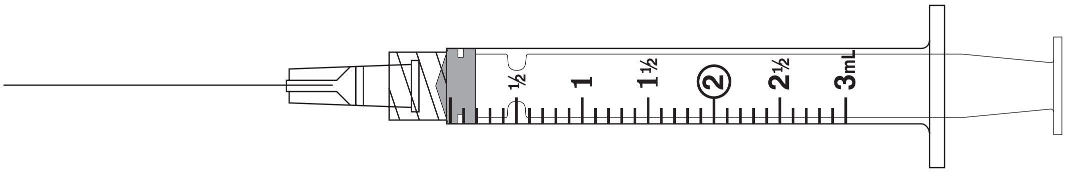
43. meperidine 60 mg IM q.4h p.r.n., pain

Give: _________ mL



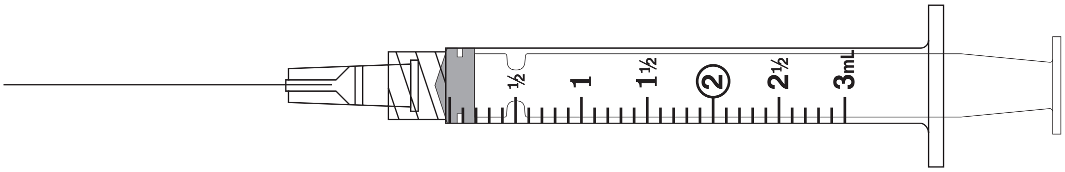
44. Phenergan 15 mg IM q.4h p.r.n., nausea and vomiting

Give: _________ mL



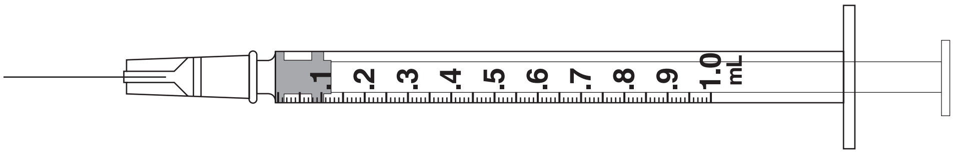
45. Reglan 7 mg IM stat

Give: _________ mL



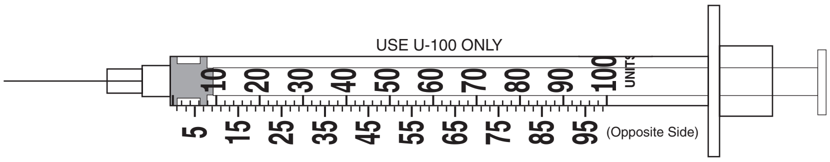
46. Neupogen 225 mcg subcut daily × 2 weeks

Give: _________ mL



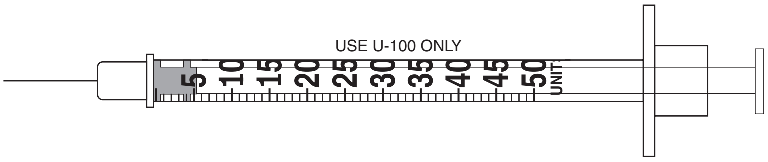
47. Novolin R Regular U-100 insulin 32 units with Novolin N NPH U-100 insulin 54 units subcut ā breakfast

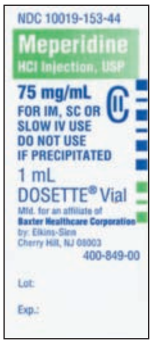
Give: ________ total units

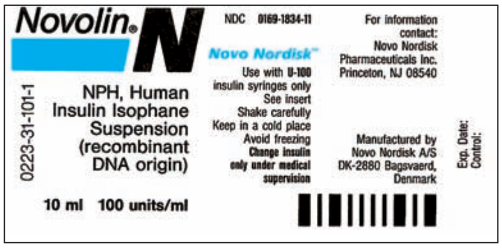


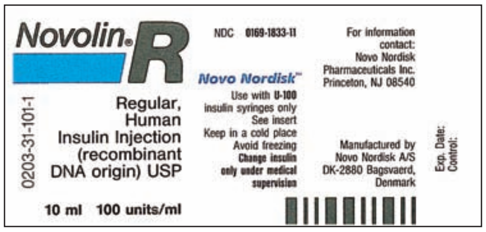
48. Novolin 70/30 U-100 insulin 46 units subcut ā dinner

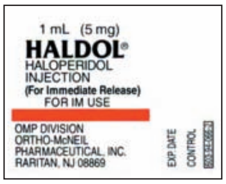
Give: ________ units

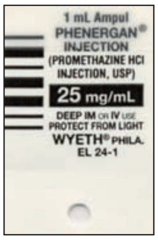


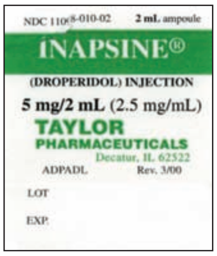


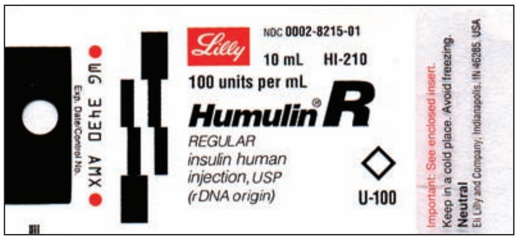


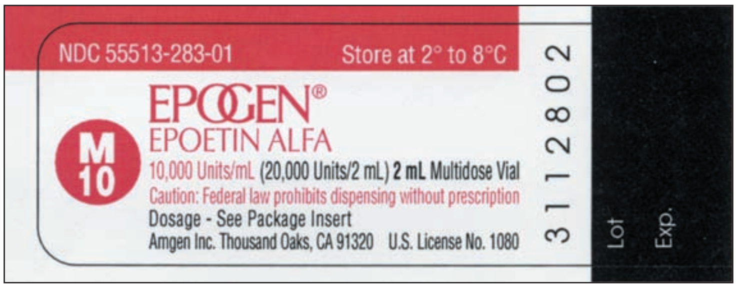












NDC 55513-283-01 Store at 2° to 8°C

EPOGEN®

EPOETIN ALFA

M 10

10,000 Units/mL (20,000 Units/2 mL) 2 mL Multidose Vial

Caution: Federal law prohibits dispensing without prescription

Dosage - See Package Insert

Amgen Inc. Thousand Oaks, CA 91320 U.S. License No. 1080

3 1 1 2 8 0 2

Lot

Exp.

NDC 55513-546-01 Refrigerate at 36° to 46°F

Neupogen®

Filgrastim

480 mcg

480 mcg/1.6 mL (300 mcg/1.0 mL) 1.6 mL Single Use Vial

Caution: Federal law prohibits dispensing without prescription

Amgen Inc. Thousand Oaks, CA 91320 U.S. License No. 1080

3 1 5 1 9 0 1

Lot

Exp.

10 mL SINGLE DOSE VIAL

Reglan® Injectable

(Metoclopramide Injection, USP)

PRESERVATIVE-FREE FORMULA 50 mg/10 mL (5 mg/mL)

metoclopramide base (as the monohydrochloride monohydrate)

CONTAINS NO PRESERVATIVE

FOR IV INFUSION ONLY. INFUSE OVER A MINIMUM OF 15 MINUTES. DILUTE BEFORE USING—SEE PACKAGE INSERT.

CAUTION: Federal law prohibits dispensing without prescription.

A·H·ROBINS

Each 10 mL contain Metoclopramide base (as the monohydrochloride monohydrate) 50 mg, Sodium Chloride, USP 85 mg, Water for Injection, USP q.s. pH 4.5-6.5. pH adjusted, when necessary, with hydrochloric acid and/or sodium hydroxide.

For dosage and other directions for use, consult accompanying product literature.

Store at Controlled Room Temperature. Between 20°C and 25°C (68°F and 77°F).

STORE VIAL IN CARTON UNTIL USED

MANUFACTURED FOR PHARMACEUTICAL DIVISION

A. H. ROBINS COMPANY, RICHMOND, VA 23220

by ELKINS-SINN, INC., CHERRY HILL, N.J. 08003 U.S.A.

A Division of A. H. Robins Company A-9858 8.94

Lot

Exp.

49. Describe the strategy you would implement to prevent this medication error.

Possible Scenario

Suppose the physician ordered *Humulin R U-100 insulin 20 units* mixed with *Humulin N U-100 insulin 40 units* to be administered subcut before breakfast. The nurse selected the vials of Humulin R and Humulin N U-100 insulin from the medication drawer and injected 20 units of air in the Humulin N vial and 40 units of air in the Humulin R vial, drew up 40 units of Humulin R and then drew up 20 units of Humulin N.

Potential Outcome

The patient received the incorrect dosage of insulin because the nurse drew up 40 units of Humulin R and 20 units of Humulin N instead of the dosage that was ordered: 20 units of Humulin R and 40 units of Humulin N. Because the patient received too much short-acting insulin (twice the amount ordered), the patient would likely show signs of hypoglycemia, such as shakiness, confusion, and diaphoresis.

Prevention

---

50. Describe the strategy you would implement to prevent this medication error.

Possible Scenario

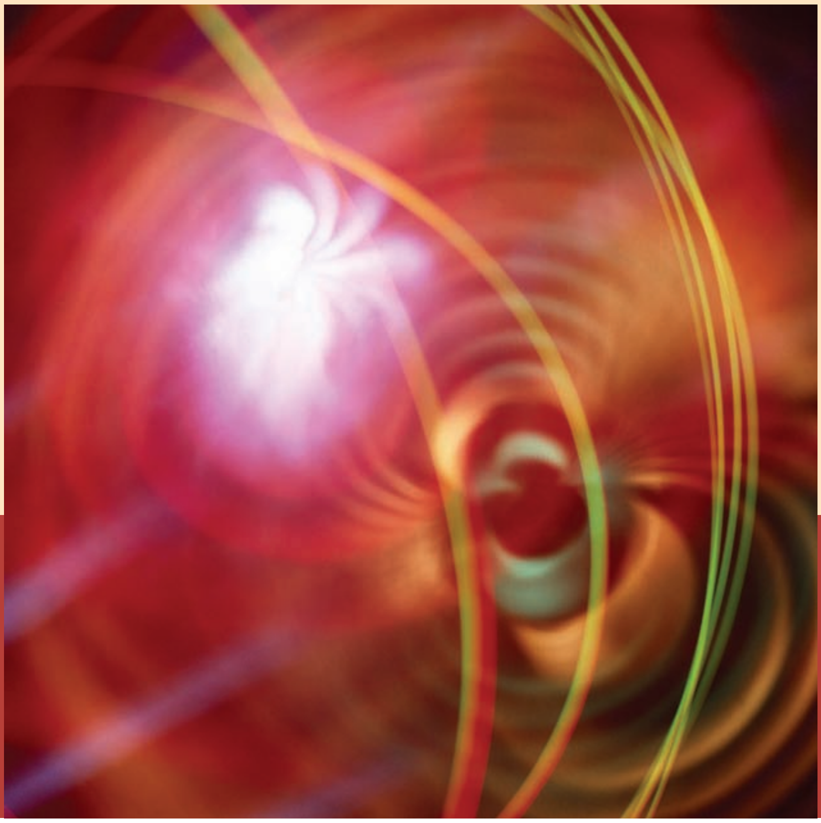
Suppose the physician ordered *10 units of Novolin R U-100 insulin subcut stat* for a patient with a blood glucose of 300. The nurse selected the Novolin R U-100 insulin from the patient's medication drawer and selected a 1 mL syringe to administer the dose. The nurse looked at the syringe for the 10-unit mark and was confused as to how much should have been drawn up. The nurse finally decided to draw up 1 mL of insulin into the syringe, administered the dose, and then began to question whether the correct dosage was administered. The nurse called the supervisor for advice.

Potential Outcome

The patient would have received 10 times the correct dosage of insulin. Because this was a short-acting insulin, the patient would likely show signs of severe hypoglycemia, such as loss of consciousness and seizures. The likelihood of a successful outcome is questionable.

Prevention

After completing these problems, see pages 493–496 to check your answers.



12

Reconstitution of Solutions

OBJECTIVES

Upon mastery of Chapter 12, you will be prepared to reconstitute injectable and noninjectable solutions. To accomplish this you will also be able to:

- Define and apply the terms *solvent (diluent), solute,* and *solution.*
- Reconstitute and label medications supplied in powder or dry form.
- Differentiate between varying directions for reconstitution and select the correct set to prepare the dosage ordered.
- Calculate the amount of solute and solvent needed to prepare a desired strength and quantity of an irrigating solution or enteral feeding.

Some parenteral medications are supplied in powder form and must be mixed with water or some other liquid before administration. As more health care is provided in the home setting, nurses and other health care workers must dilute topical irrigants, soaks, and nutritional feedings. This process of mixing and diluting solutions is referred to as *reconstitution.*

The process of reconstitution is comparable to the preparation of hot chocolate from a powdered mix. By adding the correct amount of hot water (referred to as the *solvent* or *diluent*) to the package of powdered, hot chocolate drink mix (referred to as the *solute*), you prepare a tasty, hot beverage (the resulting *solution*).

The properties of solutions are important concepts to understand. Learn them well now, as we will apply them again when we examine intravenous solutions.

SOLUTION PROPERTIES

As you look at Figures 12-1 and 12-2, let's define the terms of reconstitution.

FIGURE 12-1 Concentrated liquid solute: 50 milliliters of concentrated solute diluted with 50 milliliters of solvent make 100 milliliters of diluted solution

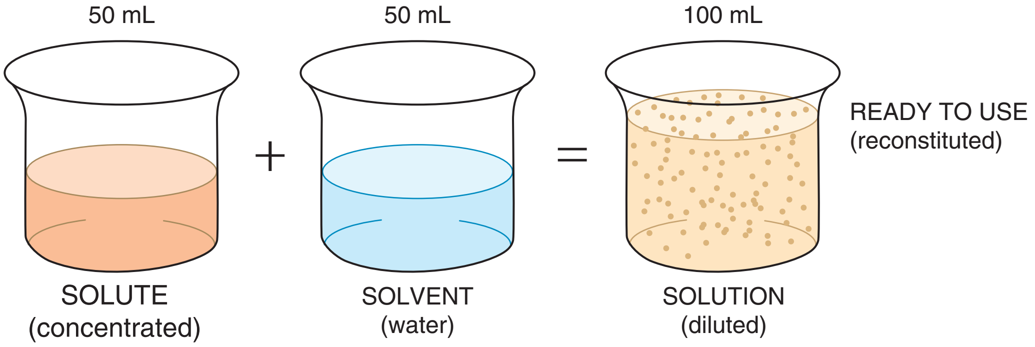
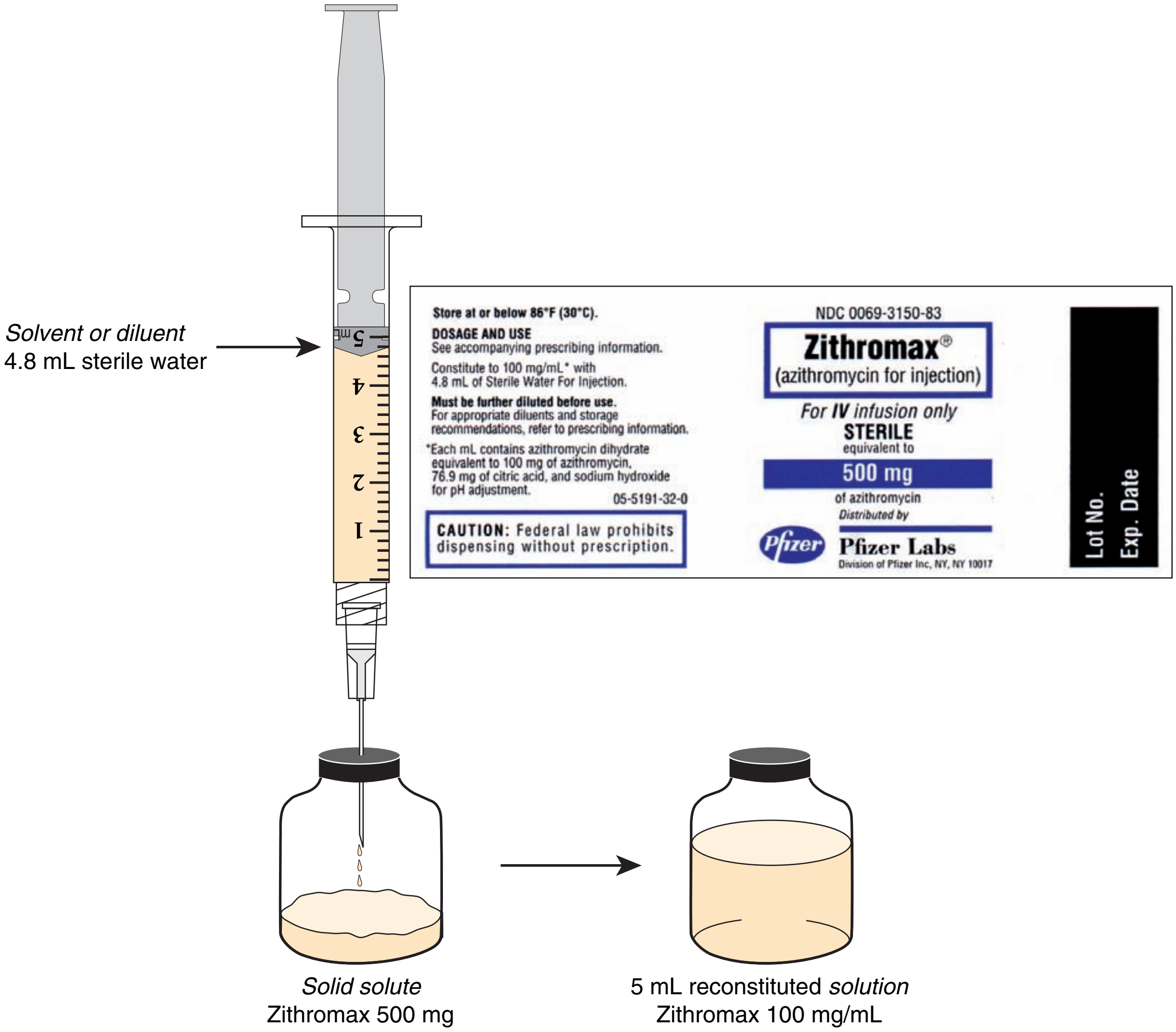


FIGURE 12-2 Solid Solute: the solid powder form of 500 mg of Zithromax is reconstituted with 4.8 mL of sterile water as the diluent to make 5 mL of Zithromax IV solution with the supply dosage of 100 mg/mL



Store at or below 86°F (30°C).

DOSAGE AND USE
See accompanying prescribing information.

Constitute to 100 mg/mL* with
4.8 mL of Sterile Water For Injection.

Must be further diluted before use.
For appropriate diluents and storage
recommendations, refer to prescribing information.

*Each mL contains azithromycin dihydrate
equivalent to 100 mg of azithromycin,
76.9 mg of citric acid, and sodium hydroxide
for pH adjustment.

05-5191-32-0

CAUTION: Federal law prohibits
dispensing without prescription.

NDC 0069-3150-83

Zithromax®
(azithromycin for injection)

*For **IV** infusion only*
STERILE
equivalent to
500 mg
of azithromycin
Distributed by
Pfizer
Pfizer Labs
Division of Pfizer Inc, NY, NY 10017

Lot No.
Exp. Date

- *Solute*—a substance to be dissolved or diluted. It can be in solid or liquid form.
- *Solvent*—a substance (liquid) that dissolves another substance to prepare a solution. *Diluent* is a synonymous term.
- *Solution*—the resulting mixture of a solute plus a solvent.

To prepare a therapeutic solution, you will add a solvent or diluent (usually normal saline or water) to a solute (solid substance or concentrated stock solution) to obtain the required strength of a stated volume of a solution. This means that the solid substance or concentrate, called a solute, is diluted with a solvent to obtain a reconstituted solution of a weaker strength. However, the amount of the drug that was in the pure solute or concentrated stock solution still equals the amount of pure drug in the diluted solution. Only the solvent has been added to the solute, expanding the total volume.

Figure 12-1 shows that the amount of pure drug (solute) remains the same in the concentrated form and in the resulting solution. However, in solution, notice the solute particles are dispersed or suspended throughout the resulting weaker solution. The particles evident in Figure 12-1 are for illustration purposes only. In a solution, the solute would be dissolved.

The *strength* of a solution or *concentration* was briefly discussed in Chapters 8 and 10. Solution strength indicates the ratio of solute to solvent. Consider how each of these substances—solute and solvent—contributes a certain number of parts to the total solution.

Look at the Zithromax 500 mg label (Figure 12-2). The label directions indicate that 4.8 mL of sterile water (solvent) should be added to the powder (solid solute) to prepare the reconstituted solution. As the label indicates, the resulting supply dosage would be 100 mg of Zithromax per 1 mL of solution.

Let's thoroughly examine the reconstitution of powdered injectable medications.

RECONSTITUTION OF INJECTABLE MEDICATIONS IN POWDER FORM

Some medications are unstable when stored in solution or liquid form. Thus they are packaged in powdered form and must be dissolved or reconstituted by a liquid solvent or diluent and mixed thoroughly. Reconstitution is a necessary step in medication preparation to create a measurable and usable dosage form. The pharmacist often does this before dispensing liquid medications, for oral as well as parenteral routes. However, nurses need to understand reconstitution and know how to accomplish it. Some medications must be prepared by the nurse just prior to administration, because they become unstable when stored.

CAUTION

Before reconstituting injectable drugs, read and follow the label or package insert directions carefully, including checking the drug and diluent expiration dates. Consult a pharmacist with any questions.

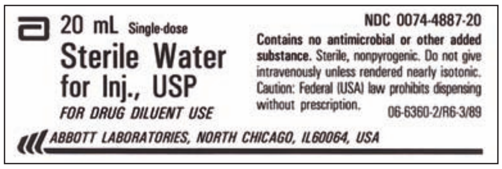
Let's look at the rules for reconstituting injectable medications from powder to liquid form. Follow these rules carefully to ensure that the patient receives the correct dose of the intended solution.

RULE

When reconstituting injectable medications, you must determine both the type and amount of diluent to be used.

Some powdered medications are packaged by the manufacturer with special diluents for reconstitution. Sterile water and 0.9% sodium chloride (normal saline) are most commonly used as diluents in parenteral medications. Both sterile water (Figure 12-3) and normal saline are available *preservative-free* when intended for a single use only, as well as in *bacteriostatic* form with preservative when intended for more than one use. Carefully check the instructions, expiration date, and vial label for the appropriate diluent.

FIGURE 12-3 Reconstitution diluent for parenteral powdered drugs



20 mL Single-dose
Sterile Water
for Inj., USP
FOR DRUG DILUENT USE

NDC 0074-4887-20
Contains no antimicrobial or other added substance. Sterile, nonpyrogenic. Do not give intravenously unless rendered nearly isotonic. Caution: Federal (USA) law prohibits dispensing without prescription.
06-6360-2/R6-3/89

ABBOTT LABORATORIES, NORTH CHICAGO, IL60064, USA

RULE

When reconstituting injectable medications, you must determine the volume in mL of diluent to be used for the route as ordered, then reconstitute the drug and note the resulting supply dosage on the vial.

Because many reconstituted parenteral medications can be administered either intramuscularly (IM) or intravenously (IV), it is essential to verify the route of administration before reconstituting the medication. Remember that the intramuscular volume of 3 mL or less per adult injection site (or 2 mL if deltoid site) is determined by the patient's age and condition and the intramuscular site selected. The directions take this into account by stating the minimum volume or quantity of diluent that should be added to the powdered drug for IM use. Often the powdered drug itself adds volume to the solution. The powder displaces the liquid as it dissolves and increases the total resulting volume. The resulting volume of the reconstituted drug is usually given on the label. This resulting volume determines the liquid's concentration or supply dosage.

Look at the directions on the Kefzol label, Figure 12-4. It states, "To prepare solution add 2 mL Sterile Water for Injection or 0.9% Sodium Chloride Injection. Provides a total volume of 2.2 mL (225 mg per mL)." Notice that when 2 mL of diluent is added and the powder is dissolved, the bulk of the powder adds an additional 0.2 mL for a total solution volume of 2.2 mL. (The amount of diluent added will vary with each medication.) Thus, the supply dosage available after reconstitution is *225 mg of Kefzol per mL of solution.* Figure 12-4 demonstrates the reconstitution procedure for Kefzol 500 mg, to fill the order of *Kefzol 225 mg IM q.6h.*

Single-dose vials contain only enough medication for one dose, and the resulting contents are administered after the powder is diluted. But in some cases the nurse also may dilute a powdered medication in a multiple-dose vial that will yield more than one dose. When this is the case, it is important to clearly label the vial after reconstitution. Labeling is discussed in the next section.

TYPES OF RECONSTITUTED PARENTERAL SOLUTIONS

There are two types of reconstituted parenteral solutions: single strength and multiple strength. The simplest type to dilute is a *single-strength* solution. This type usually has the recommended dilution directions and resulting supply dosage printed on the label, such as the Kefzol 500 mg label in Figure 12-4 (page 239) and the Zithromax label in Figure 12-5(a).

Some medications have several directions for dilution that allow the nurse to select the best supply dosage. This is called a *multiple-strength* solution and requires even more careful reading of the instructions, such as the Pfizerpen label shown in Figure 12-5(b). Sometimes these directions for reconstitution will not fit on the vial label. You must consult the package insert or other printed instructions to ensure accurate dilution of the parenteral medication.

Let's look at some examples to clarify what the health care professional needs to do to correctly reconstitute and calculate dosages of parenteral medications supplied in powder form.

Single-Strength Solution

EXAMPLE 1 ■

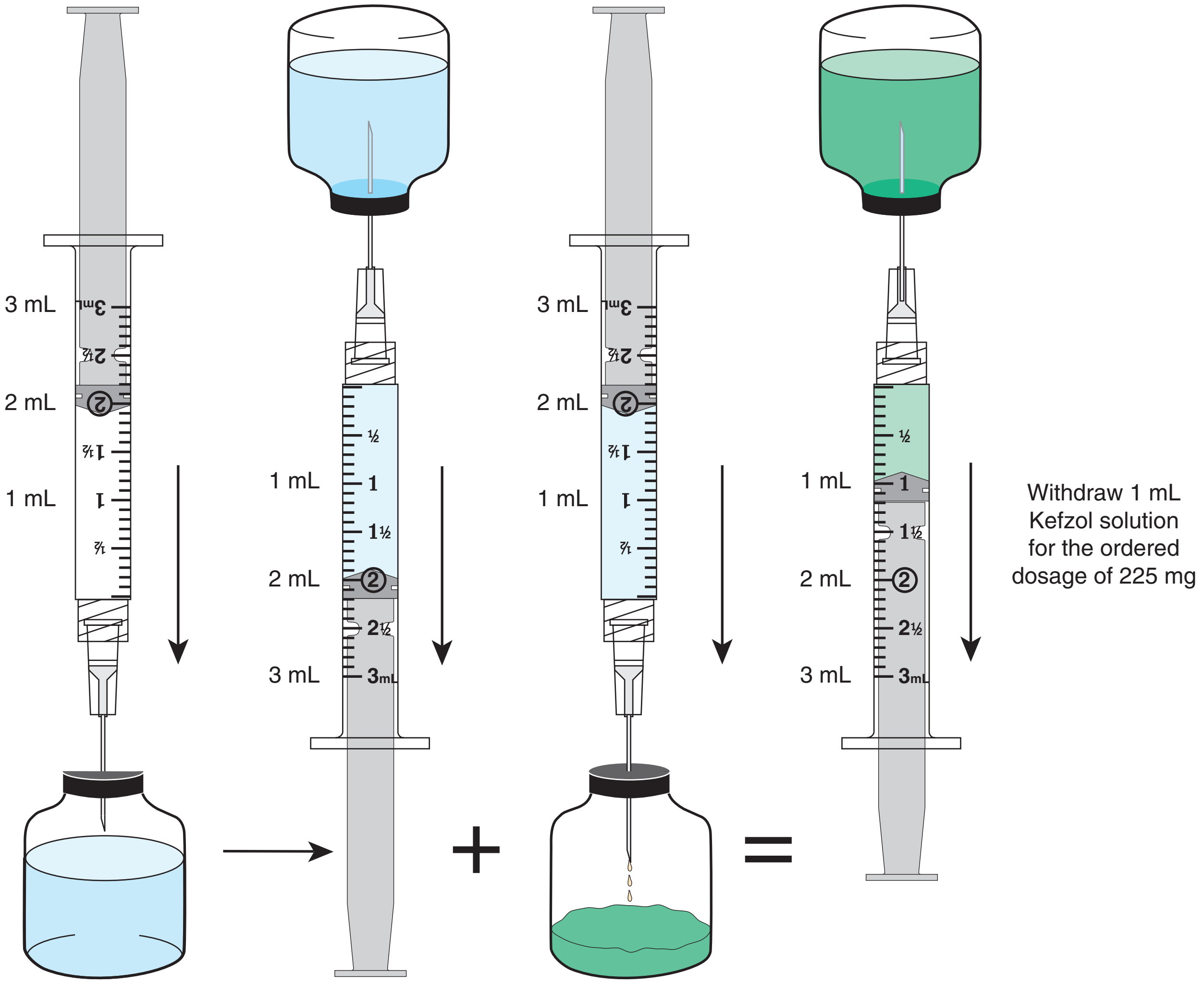
Order: Zithromax 400 mg IV daily × 2 days

Supply: 500 mg vial of powdered Zithromax with directions on the left side of the label as follows: "Constitute to 100 mg/mL with 4.8 mL of Sterile Water for injection," see Figure 12-5(a).

FIGURE 12-4 Kefzol reconstitution procedure to fill the order Kefzol 225 mg IM q.6h


NDC 0002-1497-01
VIAL No. 767
℞ Lilly
KEFZOL®
STERILE
CEFAZOLIN
SODIUM, USP
Equiv. to
500 mg
Cefazolin

CAUTION—Federal (U.S.A.) law prohibits dispensing without prescription.
For I.M. or I.V. Use
Dosage—See literature.
To prepare solution add 2 mL Sterile Water for Injection or 0.9% Sodium Chloride Injection. Provides an approximate volume of 2.2 mL (225 mg per mL)
SHAKE WELL. Protect from Light
Prior to Reconstitution: Store at Controlled Room Temperature 59° to 86°F (15° to 30°C)
After Reconstitution: Store in a refrigerator. For Storage Time - See Accompanying Literature. If kept at room temperature, use within 24 hours.
Lyophilized
WV 4520 AMX
Eli Lilly & Co., Indianapolis, IN 46285, U.S.A.
Exp. Date/Control No.



Inject 2 mL air into sterile water diluent vial

Withdraw 2 mL sterile water

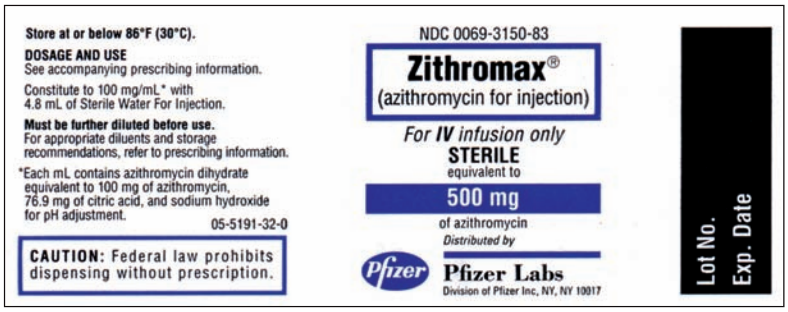
Add 2 mL sterile water to Kefzol 500 mg powder and shake well

Make Kefzol 500 mg in 2.2 mL reconstituted solution for Kefzol 225 mg/mL

Withdraw 1 mL Kefzol solution for the ordered dosage of 225 mg

Carefully sort through and analyze the information provided on the label.

- First, how much and what type of diluent must you add? The directions state to *add 4.8 mL of Sterile Water.*
- Second, what is the resulting supply dosage or concentration? When reconstituted, the *supply dosage is Zithromax 100 mg/mL.*
- Third, what is the resulting total volume of the reconstituted solution? The *total volume is 5 mL.* The powder added 0.2 mL to the solution. You know this because the supply dosage is 100 mg/mL, and you added 4.8 mL of diluent. Therefore, it is only logical that the total volume is 5 mL.



Store at or below 86°F (30°C).

DOSAGE AND USE
See accompanying prescribing information.

Constitute to 100 mg/mL* with
4.8 mL of Sterile Water For Injection.

Must be further diluted before use.
For appropriate diluents and storage
recommendations, refer to prescribing information.

*Each mL contains azithromycin dihydrate
equivalent to 100 mg of azithromycin,
76.9 mg of citric acid, and sodium hydroxide
for pH adjustment.

05-5191-32-0

CAUTION: Federal law prohibits dispensing without prescription.

NDC 0069-3150-83

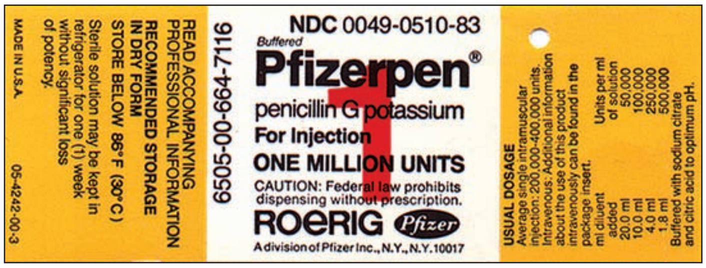
Zithromax®
(azithromycin for injection)

*For **IV** infusion only*
STERILE
equivalent to
500 mg
of azithromycin

Distributed by
Pfizer
Pfizer Labs
Division of Pfizer Inc, NY, NY 10017

Lot No.
Exp. Date

FIGURE 12-5(a) Zithromax label: single-strength solution



READ ACCOMPANYING
PROFESSIONAL INFORMATION
RECOMMENDED STORAGE
IN DRY FORM
STORE BELOW 86°F (30°C)
Sterile solution may be kept in
refrigerator for one (1) week
without significant loss
of potency.

MADE IN U.S.A.
05-4242-00-3

6505-00-664-7116

NDC 0049-0510-83
Buffered
Pfizerpen®
penicillin G potassium
For Injection
ONE MILLION UNITS
CAUTION: Federal law prohibits
dispensing without prescription.
ROERIG Pfizer
A division of Pfizer Inc., N.Y., N.Y. 10017

USUAL DOSAGE
Average single intramuscular
injection: 200,000-400,000 units.
Intravenous: Additional information
about the use of this product
intravenously can be found in the
package insert.

ml diluent added	Units per ml of solution
20.0 ml	50,000
10.0 ml	100,000
4.0 ml	250,000
1.8 ml	500,000

Buffered with sodium citrate
and citric acid to optimum pH.

FIGURE 12-5(b) Pfizerpen label: multiple-strength solution

- Finally, to fill the order as prescribed, how many full doses are available in this vial? The order is for 400 mg, and the single-dose vial contains 500 mg. This is enough for one full dose, but not enough for two full doses. Two doses would require 800 mg.

Now, let's put it all together.

This means you have available a vial of 500 mg of Zithromax to which you will add 4.8 mL of sterile water as the diluent. The powdered drug displaces 0.2 mL. The resulting 5 mL of the solution contains 500 mg of the drug, and there are 100 mg of Zithromax in each 1 mL of solution.

After reconstitution, you are ready to apply the same three steps of dosage calculation that you learned in Chapters 10 and 11.

Step 1 Convert No conversion is necessary.

Order: *Zithromax 400 mg IV daily × 2 days*

Supply: 100 mg/mL

Step 2 Think You want to give more than 1 mL. In fact, you want to give four times 1 mL.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

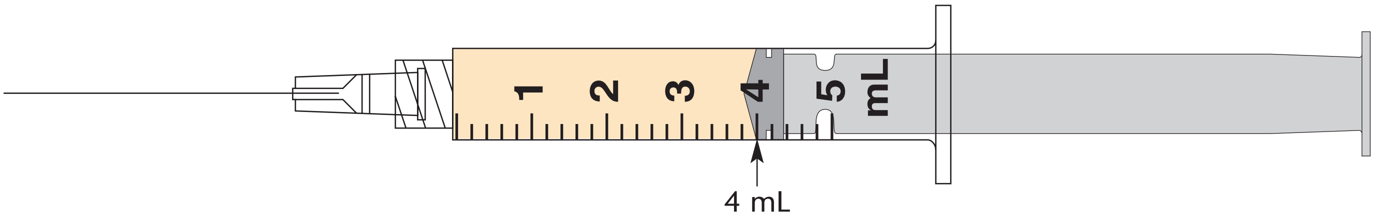
$$\frac{100 \text{ mg}}{1 \text{ mL}} \times \frac{400 \text{ mg}}{\text{X mL}}$$ Cross-multiply

$$100\text{X} = 400$$

$$\frac{100\text{X}}{100} = \frac{400}{100}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 4 \text{ mL}$$ Label the units to match the unknown X

Give 4 mL Zithromax reconstituted to 100 mg/mL, intravenously each day for two days.



This vial of Zithromax 500 mg contains only one full ordered dose of reconstituted drug. Any remaining medication is usually discarded. Because this vial provides only one dose, you will not have to label and store any of the reconstituted drug.

EXAMPLE 2 ■

Suppose the drug order reads **Zithromax 250 mg IM daily.**

Using the same size vial of Zithromax and the same dilution instructions as in the previous example, you would now have two full doses of Zithromax, making this a *multiple-dose vial.*

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

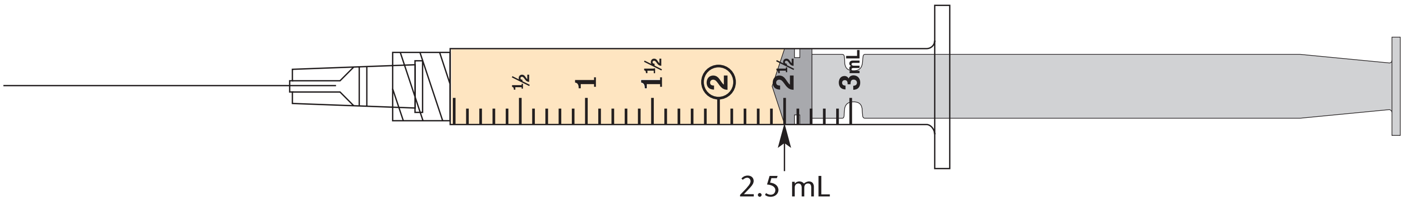
$$\frac{100 \text{ mg}}{1 \text{ mL}} \times \frac{250 \text{ mg}}{\text{X mL}}$$ Cross-multiply

$$100X = 250$$

$$\frac{100X}{100} = \frac{250}{100}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$X = 2.5 \text{ mL}$$ Label the units to match the unknown X

Select a 3 mL syringe and measure 2.5 mL of Zithromax reconstituted to 100 mg/mL (inject into a large muscle; avoid the deltoid).



RULE

When reconstituting multiple-dose injectable medications, verify the length of drug potency. Store the reconstituted drug appropriately with a reconstitution label attached.

If multiple doses result from the reconstitution of a powdered drug, the solution must be used in a timely manner. Because the drug potency (or stability) may be several hours to several days, check the drug label, package information sheet, or *Hospital Formulary* for how long the drug may be used after reconstitution. Store the drug appropriately at room temperature or refrigerate per the manufacturer's instructions. The package insert for Zithromax states, "Reconstituted solution is stable for 24 hours at or below room temperature (86° F) and 7 days when refrigerated."

CAUTION

The length of potency is different from the expiration date. The expiration date is provided by the manufacturer on the label. It indicates the last date the drug may be reconstituted and used.

When you reconstitute or mix a multiple-dose vial of medication in powdered form, it is important that the vial be clearly labeled with the date and time of preparation, the strength or supply dosage you prepared, length of potency, storage directions, and your initials. Because the medication becomes unstable after storage for long periods, the date and time are especially important. Figure 12-6 shows the proper label for the Zithromax reconstituted to 100 mg/mL. Because there are two doses of reconstituted drug in this vial, and two doses will be administered 24 hours apart (now at 0800, then again the next day at 0800), this drug should be refrigerated. Refrigeration will protect the potency of the drug in case the second dose is administered slightly later than 0800. Indicate the need for refrigeration on the label.

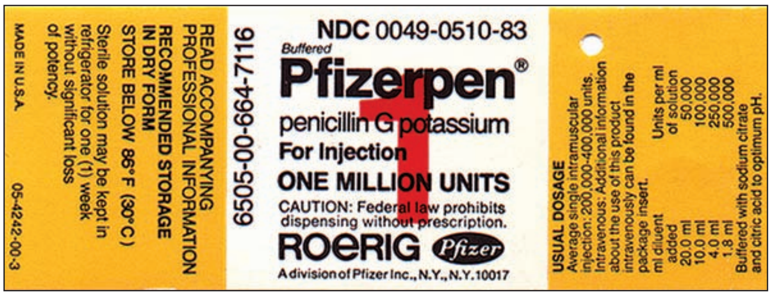
FIGURE 12-6 Reconstitution label for Zithromax

1/10/xx, 0800, reconstituted
as 100 mg/mL. Expires 1/17/xx,
0800. Keep refrigerated. G.D.P.

Multiple-Strength Solution

Some parenteral powdered medications have directions for preparing several different solution strengths, to allow you to select a particular dosage strength (Figure 12-7). This results in a reasonable amount to be given to a particular patient.

FIGURE 12-7 Pfizerpen label



READ ACCOMPANYING
PROFESSIONAL INFORMATION
RECOMMENDED STORAGE
IN DRY FORM
STORE BELOW 86°F (30°C)
Sterile solution may be kept in
refrigerator for one (1) week
without significant loss
of potency.

MADE IN U.S.A. 05-4242-00-3

6505-00-664-7116

NDC 0049-0510-83

Buffered
Pfizerpen®
penicillin G potassium
For Injection
ONE MILLION UNITS
CAUTION: Federal law prohibits
dispensing without prescription.
ROERIG Pfizer
A division of Pfizer Inc., N.Y., N.Y. 10017

USUAL DOSAGE
Average single intramuscular
injection: 200,000-400,000 units.
Intravenous: Additional information
about the use of this product
intravenously can be found in the
package insert.

ml diluent added	Units per ml of solution
20.0 ml	50,000
10.0 ml	100,000
4.0 ml	250,000
1.8 ml	500,000

Buffered with sodium citrate
and citric acid to optimum pH.

EXAMPLE ■

Order: penicillin G potassium 300,000 units IM q.i.d.

Supply: Pfizerpen (penicillin G potassium) 1,000,000 units vial

This vial contains a total of 1,000,000 units of penicillin. The reconstitution instructions are shown on the right side of the label. The instructions detail four different parenteral solution supply dosages or concentrations that are determined by the added diluent volume. Let's look at each of the four instructions. Notice how these reconstituted concentrations differ and when each might be selected.

Add 20 mL Diluent

Refer to the first set of directions, which indicates to add 20 mL diluent to prepare 50,000 units per milliliter of solution. Is this a good choice for preparing the medication to fill the order?

What do we know?

- First, to follow the first set of directions, how much and what type of diluent must you add? The directions state to *add 20 mL of diluent.* (You must check the package insert to determine the type of diluent, as this information is not stated on the label. The package insert recommends 1%–2% lidocaine for intramuscular injection to lessen the pain at the injection site.)
- Second, what is the concentration of the reconstituted penicillin? When adding 20 mL of diluent, the *supply dosage or concentration is 50,000 units/mL.*
- Third, what is the resulting total volume of this reconstituted solution? The *total volume is 20 mL.* You know this because the supply dosage is 50,000 units/mL or 1,000,000 units per 20 mL. The volume of diluent is large enough that the powder dissolves without adding any significant additional volume.
- Finally, how many full doses of penicillin as ordered are available in this vial? The vial contains 1,000,000 units, and the order is for 300,000 units. There are *three full doses* (plus some extra) in this vial. If you choose this concentration, a reconstitution label would be required. This means that when you add 20 mL of sterile diluent to this vial of powdered penicillin, the result is 1,000,000 units of penicillin in 20 mL of solution, with a concentration of 50,000 units per mL.

Apply the three steps of dosage calculation:

Step 1 Convert No conversion is necessary.

Order: penicillin G potassium 300,000 units IM q.i.d.

Supply: 50,000 units/mL

Step 2 Think You want to give more than 1 mL. In fact, you want to give six times 1 mL.

Step 3 Calculate $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

$$\frac{50{,}000 \text{ units}}{1 \text{ mL}} \times \frac{300{,}000 \text{ units}}{\text{X mL}}$$ Cross-multiply

$$50{,}000\text{X} = 300{,}000$$

$$\frac{50{,}000\text{X}}{50{,}000} = \frac{300{,}000}{50{,}000}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 6 \text{ mL}$$ Label the units to match the unknown X

Because each dose is 6 mL and the total volume is 20 mL, you would have enough for two additional full doses. However, this is an IM dose, and 3 mL is the maximum volume for a large, adult muscle. To administer this order using this concentration, you would need to inject the patient with two 3 mL syringes filled with 3 mL of penicillin each. Therefore, this is a poor choice of reconstitution instructions to prepare this order.

Add 10 mL Diluent

Refer to the second set of directions on the penicillin label, which indicates to add 10 mL of diluent for 100,000 units per mL of solution. Would this prepare an appropriate concentration to fill the order?

What do we know?

- First, to correctly follow the second set of directions, how much and what type of diluent must you add? The directions state to add *10 mL of diluent.* (You must check the package insert to determine the type of diluent, as this information is not stated on the label. The package insert recommends 1%–2% lidocaine for IM injection.)
- Second, what is the concentration of the reconstituted penicillin? When adding 10 mL of diluent, the *supply dosage or concentration is 100,000 units/mL.*
- Third, what is the resulting total volume of this reconstituted solution? The *total volume is 10 mL.* You know this because the supply dosage is 100,000 units/mL or 1,000,000 units per 10 mL. The solution volume is large enough that the powder does not add volume to the solution.
- Finally, how many full doses of penicillin as ordered are available in this vial? The vial contains 1,000,000 units, and the order is for 300,000 units. There are *three full doses* (plus some extra) in this vial. If you select this set of instructions, you will need to add a reconstitution label to the vial after mixing.

This means when you add 10 mL of sterile diluent to this vial of powdered penicillin, the result is 1,000,000 units of penicillin in 10 mL of solution with a concentration of 100,000 units per mL.

Apply the three steps of dosage calculation:

Step 1 Convert No conversion is necessary.

Order: penicillin G potassium 300,000 units IM q.i.d.

Supply: 100,000 units/mL

Step 2 Think You want to give more than 1 mL. In fact, you want to give three times 1 mL.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{100{,}000 \text{ units}}{1 \text{ mL}} \times \frac{300{,}000 \text{ units}}{\text{X mL}}$$ Cross-multiply

$$100{,}000\text{X} = 300{,}000$$

$$\frac{100{,}000\text{X}}{100{,}000} = \frac{300{,}000}{100{,}000}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 3 \text{ mL}$$ Label the units to match the unknown X

Because each dose is 3 mL and the total volume is 10 mL, you would have enough for two additional full doses. As an IM dose, 3 mL is the maximum volume for a large, adult muscle. Although this is a safe volume and would require only one injection, perhaps another concentration would result in a lesser volume that would be more readily absorbed.

Add 4 mL Diluent

Refer to the third set of directions on the penicillin label, which indicates to add 4 mL of diluent for 250,000 units per mL of solution. Would this prepare an appropriate concentration to fill the order?

What is different about this set of directions? Let's analyze the information provided on the label.

- First, to follow the third set of directions, how much and what type of diluent must you add? The directions state to *add 4 mL of diluent.* (Remember, you must check the package insert to determine the type of diluent, as this information is not stated on the label. The recommendation is for 1%–2% lidocaine.)
- Second, what is the supply dosage of the reconstituted penicillin? When adding 4 mL of diluent, the supply dosage is *250,000 units/mL.*
- Third, what is the resulting total volume of this reconstituted solution? The *total volume is 4 mL.* You know this because the supply dosage is 250,000 units/mL or 1,000,000 units per 4 mL. The powder does not add volume to the solution.
- Finally, how many full doses of penicillin are available in this vial? The vial contains 1,000,000 units, and the order is for 300,000 units. Regardless of the concentration, there are still *three full doses* (plus some extra) in this vial. A reconstitution label would be needed.

This means that when you add 4 mL of sterile diluent to the vial of powdered penicillin, the result is 4 mL of solution with 250,000 units of penicillin per mL.

Calculate one dose.

Step 1 Convert No conversion is necessary.

Order: **penicillin G potassium 300,000 units IM q.i.d.**

Supply: 250,000 units/mL

Step 2 Think You want to give more than 1 mL but less than 2 mL.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{250{,}000 \text{ units}}{1 \text{ mL}} \times \frac{300{,}000 \text{ units}}{\text{X mL}}$$ Cross-multiply

$$250{,}000\text{X} = 300{,}000$$

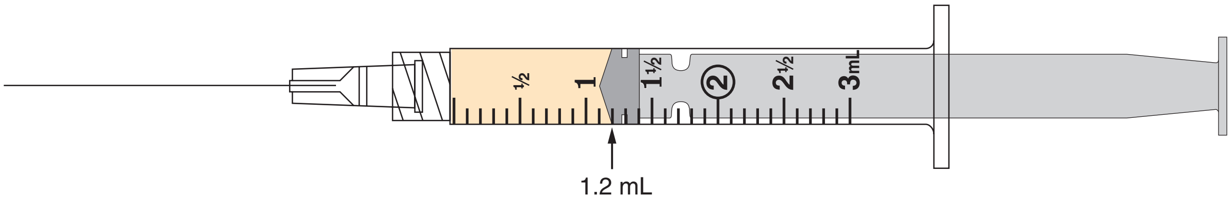
$$\frac{250{,}000\text{X}}{250{,}000} = \frac{300{,}000}{250{,}000}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 1.2 \text{ mL}$$ Label the units to match the unknown X

given intramuscularly four times a day

Because each dose is 1.2 mL and the total volume is 4 mL, you would have enough for two additional full doses. As an IM dose, 3 mL is the maximum volume for a large, adult muscle. This concentration would result in a reasonable volume that would be readily absorbed. This is a good choice of concentration instructions to use to prepare this order.

Select a 3 mL syringe, and measure 1.2 mL of Pfizerpen reconstituted to 250,000 units/mL.



CAUTION

The supply dosage of a reconstituted drug is an essential detail that the preparer must write on the multiple-dose vial label. Once a powdered drug is reconstituted, there is no way to verify how much diluent was actually added unless it is properly labeled.

Be sure to add a label to the reconstituted Pfizerpen 250,000 units/mL vial, Figure 12-8.

FIGURE 12-8 Reconstitution label for Pfizerpen 1,000,000 units with 4 mL diluent

1/30/xx, 0800, reconstituted as 250,000 units/mL. Expires 2/06/xx, 0800, keep refrigerated. G.D.P.

Add 1.8 mL Diluent

The fourth set of directions instructs you to add 1.8 mL diluent for a solution concentration of 500,000 units/mL. Let's examine this information.

- First, to fulfill the fourth set of directions, how much and what type of diluent must you add? The directions state to *add 1.8 mL of diluent.* (You must check the package insert to determine the type of diluent, as this information is not stated on the label. Use 1%–2% lidocaine.)
- Second, what is the supply dosage of the reconstituted penicillin? When adding 1.8 mL of diluent, the supply dosage is *500,000 units/mL.*
- Third, what is the resulting total volume of this reconstituted solution? The *total volume is 2 mL.* You know this because the supply dosage is 500,000 units/mL or 1,000,000 units per 2 mL. The powder displaces 0.2 mL of the solution. (Notice that this is the most concentrated, or the strongest, of the four concentrations.)
- Finally, how many full doses of penicillin are available in this vial? The vial contains 1,000,000 units, and the order is for 300,000 units. Notice that regardless of the concentration, there are *three full doses* (plus some extra) in this vial. You must prepare a different reconstitution label, as this is a different concentration.

Following the fourth set of directions, you add 1.8 mL of diluent to prepare 2 mL of solution with a resulting concentration of 500,000 units of penicillin in each 1 mL.

Calculate one dose.

Step 1 Convert No conversion is necessary.

Order: **penicillin G potassium 300,000 units IM q.i.d.**

Supply: 500,000 units/mL

Step 2 Think You want to give less than 1 mL.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{500{,}000 \text{ units}}{1 \text{ mL}} \times \frac{300{,}000 \text{ units}}{\text{X mL}}$$ Cross-multiply

$$500{,}000\text{X} = 300{,}000$$

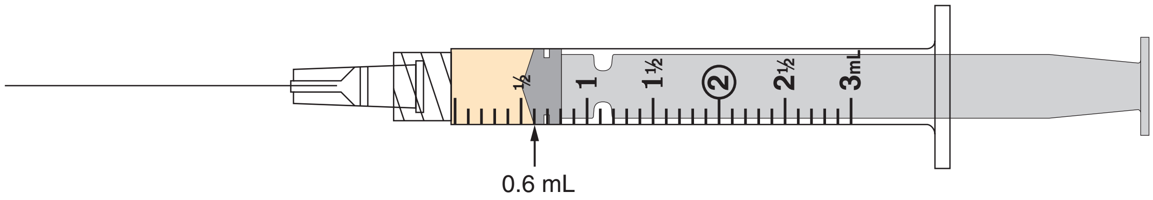
$$\frac{500{,}000\text{X}}{500{,}000} = \frac{300{,}000}{500{,}000}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 0.6 \text{ mL}$$ Label the units to match the unknown X

given intramuscularly four times a day

Because each dose is 0.6 mL and the total volume is 2 mL, you would have enough for two additional full doses. This supply dosage would result in a reasonable volume for an IM injection for an infant, small child, or anyone with wasted muscle mass.

Select a 3 mL syringe, and measure 0.6 mL of penicillin reconstituted to 500,000 units/mL.



Finally, add the label to the reconstituted penicillin G 500,000 units/mL vial, Figure 12-9.

FIGURE 12-9 Reconstitution label for Pfizerpen 1,000,000 units with 1.8 mL diluent

1/30/xx, 0800, reconstituted as 500,000 units/mL. Expires 2/06/xx, 0800, keep refrigerated. G.D.P.

As you can see from these four possible reconstituted strengths, three full doses are available from this multiple-dose vial in each case. The added diluent volume is the vital factor that determines the resulting concentration. The *supply dosage* ultimately determines the *injectable volume per dose.*

MATH TIP

When multiple directions for diluting are given, the smaller the amount of diluent added, the greater or stronger the resulting solution concentration will be.

RECONSTITUTED PARENTERAL SOLUTIONS WITH VARIOUS ROUTES

A variety of drugs are labeled and packaged with reconstitution instructions. Some drugs are for IM use only and some are for IV use only, whereas others may be used for either. Some are even suitable for subcut, IM, or IV administration. Carefully check the route and related reconstitution directions. The following material gives examples of several types of directions you will encounter.

Drugs with Injection Reconstitution Instructions—Either IM or IV

EXAMPLE ■

Order: Solu-Medrol 200 mg IV q.6h

Supply: 500 mg vial of powdered Solu-Medrol for IM or IV injection (Figure 12-10) with directions on the left side of the label that state, "Reconstitute with 8 mL Bacteriostatic Water for Injection with Benzyl Alcohol. When reconstituted as directed each 8 mL contains: Methylprednisolone sodium succinate equivalent to 500 mg methylprednisolone (62.5 mg per mL)."

LOT/EXP

812365909

℞ only

See package insert for complete product information. Store at controlled room temperature 20° to 25°C (68° to 77°F) [see USP]. Protect from light. Reconstitute with 8 mL Bacteriostatic Water for Injection with Benzyl Alcohol. **When reconstituted as directed each 8 mL contains:**
*Methylprednisolone sodium succinate equivalent to 500 mg methylprednisolone (62.5 mg per mL). Store solution at controlled room temperature 20° to 25°C (68° to 77°F) [see USP] and use within 48 hours after mixing. Lyophilized in container. Protect from light.

Reconstituted: ____________

Pharmacia & Upjohn Co., Kalamazoo, MI 49001, USA

NDC 0009-0758-01
4—125 mg doses

Solu-Medrol®

methylprednisolone sodium succinate for injection, USP

500 mg*

For intramuscular or intravenous use

Diluent Contains Benzyl Alcohol as a Preservative

FIGURE 12-10 Solu-Medrol 500 mg label

What do we know?

- First, to fill the order, how much and what type of diluent must you add? The directions state to *add 8 mL of bacteriostatic water for injection with benzyl alcohol.*
- Second, what is the supply dosage of the reconstituted Solu-Medrol? When adding 8 mL of diluent, the supply dosage is 62.5 mg/mL.
- Third, what is the resulting total volume of this reconstituted solution? The *total volume is 8 mL.* Any amount that the powdered drug displaces in solution is insignificant and does not add volume. You know this because 62.5 mg/mL × 8 mL = 500 mg, which is the total dosage amount of the container.
- Finally, how many full doses of Solu-Medrol are available in this vial? The vial contains 500 mg, and the order is for 200 mg. There are two full doses in the vial (plus some extra). A reconstitution label is needed. The label indicates that the reconstituted drug can be stored for 48 hours.

This means that you have available a vial of 500 mg of Solu-Medrol to which you will add 8 mL of diluent. The final yield of the solution is 62.5 mg per mL, which is your supply dosage.

Calculate one dose.

Step 1 Convert No conversion is necessary.

Order: Solu-Medrol 200 mg IV q.6h

Supply: 62.5 mg/mL

Step 2 Think You want to give more than 1 mL. In fact, you want to give more than three times 1 mL.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{6.25 \text{ mg}}{1 \text{ mL}} \times \frac{200 \text{ mg}}{\text{X mL}}$$ Cross-multiply

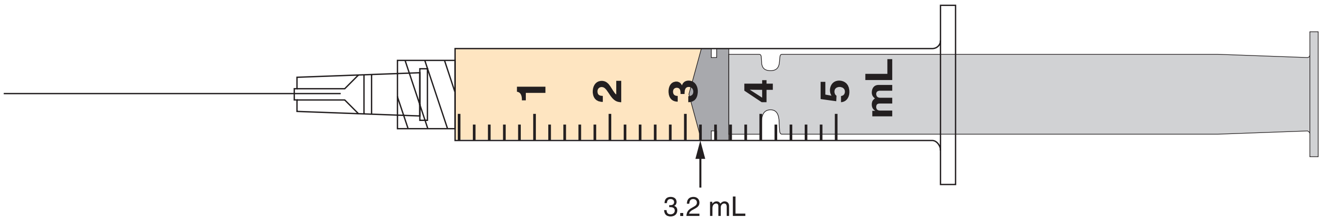
$$6.25\text{X} = 200$$

$$\frac{6.25\text{X}}{6.25} = \frac{200}{6.25}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 3.2 \text{ mL}$$ Label the units to match the unknown X

given intravenously every 6 hours

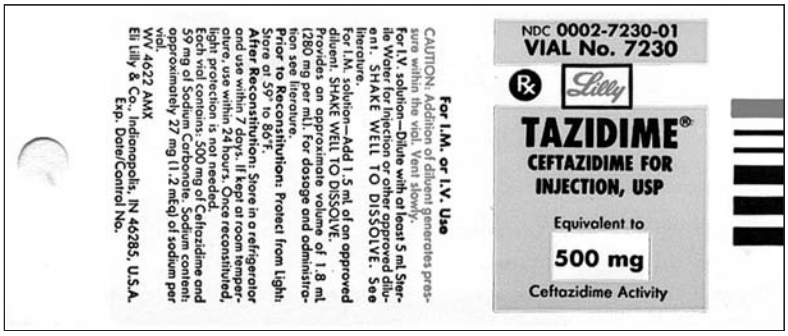
1/30/xx, 0800, reconstituted
as 62.5 mg/mL. Expires
2/01/xx, 0800, store at room
temperature 68°F–77°F. G.D.P.



Drugs with Different IM and IV Reconstitution Instructions

Notice that the Tazidime label (Figure 12-11) has one set of instructions for IM use and another set for IV administration. The nurse must carefully check the route ordered and then follow the directions that correspond to that route. In such cases, it is important not to interchange the dilution instructions for IM and IV administrations.

FIGURE 12-11 Tazidime label



NDC 0002-7230-01
VIAL No. 7230
℞ Lilly
TAZIDIME®
CEFTAZIDIME FOR INJECTION, USP
Equivalent to
500 mg
Ceftazidime Activity

For I.M. or I.V. Use
CAUTION: Addition of diluent generates pressure within the vial. Vent slowly.
For I.V. solution—Dilute with at least 5 mL Sterile Water for Injection or other approved diluent. SHAKE WELL TO DISSOLVE. See literature.
For I.M. solution—Add 1.5 mL of an approved diluent. SHAKE WELL TO DISSOLVE. Provides an approximate volume of 1.8 mL (280 mg per mL). For dosage and administration see literature.
Prior to Reconstitution: Protect from Light. Store at 59° to 86°F.
After Reconstitution: Store in a refrigerator and use within 7 days. If kept at room temperature, use within 24 hours. Once reconstituted, light protection is not needed.
Each vial contains: 500 mg of Ceftazidime and 59 mg of Sodium Carbonate. Sodium content: approximately 27 mg (1.2 mEq) of sodium per vial.
WV 4622 AMX
Eli Lilly & Co., Indianapolis, IN 46285, U.S.A.
Exp. Date/Control No.

EXAMPLE 1 ■

Order: Tazidime 250 mg IM q.12h

Supply: 500 mg vial of powdered Tazidime (Figure 12-11) with IM reconstitution directions that state, "For IM solution—Add 1.5 mL of an approved diluent. Provides an approximate volume of 1.8 mL (280 mg per mL)."

- First, to fill the order, how much and what type of diluent must you add? The directions state to *add 1.5 mL of diluent.* The label does not indicate what diluent you should use. You would refer to the package insert, which recommends sterile water, bacteriostatic water, or 0.5%–1% lidocaine for injection.
- Second, what is the supply dosage of the reconstituted Tazidime? When adding 1.5 mL of diluent, the resulting *supply dosage is 280 mg/mL.*
- Third, how many full doses of Tazidime are available in this vial? The vial contains 500 mg, and the order is for 250 mg. There are *two full doses* in the vial. A reconstitution label is needed.
- Finally, what is the resulting total volume of this reconstituted solution? The *total volume is 1.8 mL,* as indicated on the label for IM reconstitution.

This means that you have available a vial of 500 mg of Tazidime to which you will add 1.5 mL of diluent. The final yield of the solution is 1.8 mL with a supply dosage of 280 mg/mL.

Calculate one dose.

Step 1 Convert No conversion is necessary.

Order: Tazidime 250 mg IM q.12h

Supply: 280 mg/mL

Step 2 Think You want to give less than 1 mL.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{280\text{ mg}}{1\text{ mL}} \times \frac{250\text{ mg}}{\text{X mL}}$$

Cross-multiply

$$280X = 250$$

$$\frac{280X}{280} = \frac{250}{280}$$

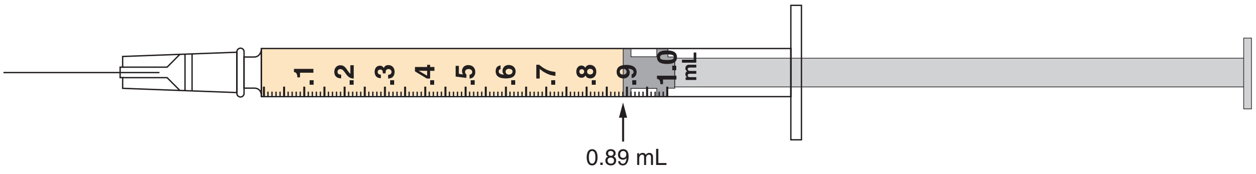
Simplify: Divide both sides of the equation by the number before the unknown X

$$X = 0.89\text{ mL}$$

Label the units to match the unknown X

given intramuscularly every 12 hours

1/30/xx, 0800, reconstituted
as 280 mg/mL. Expires
1/31/xx, 0800, store at room
temperature 68°F–77°F. G.D.P.



CAUTION

Because this is an IM dose, you may need to change needles.

EXAMPLE 2 ■

Order: Tazidime 400 mg IV q.8h

Supply: 500 mg vial of powdered Tazidime with IV reconstitution directions that state, “For IV solution—Dilute with at least 5 mL Sterile Water for injection or other approved diluent.”

- First, to prepare the order, how much and what type of diluent must you add? The directions state to add *5 mL of sterile water.*
- Second, what is the supply dosage of the reconstituted Tazidime? Notice that the insert does not give a final supply dosage. In this case, the diluent will be used in the supply dosage. When adding 5 mL of diluent, the resulting *supply dosage is 500 mg per 5 mL or 100 mg/mL.*
- Third, what is the resulting total volume of this reconstituted solution? The *total volume is 5 mL.* Unless indicated otherwise, the solution volume is sufficient to dilute the powder without adding additional volume.
- Finally, how many full doses of Tazidime are available in this vial? The vial contains 500 mg, and the order is for 400 mg. There is *one full dose* in the vial (plus some extra). No reconstitution label is needed.

This means that you have available a vial of 500 mg of Tazidime to which you will add 5 mL of diluent. The final yield of the solution is 5 mL with a supply dosage of 100 mg/mL. Most IV antibiotics are then further diluted in an approved IV solution and infused over a specified time period. You will learn more about this in the next section and in Chapter 16.

Calculate one dose.

Step 1 Convert No conversion is necessary.

Order: Tazidime 400 mg IV q.8h

Supply: 100 mg/mL

Step 2 Think You want to give more than 1 mL.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

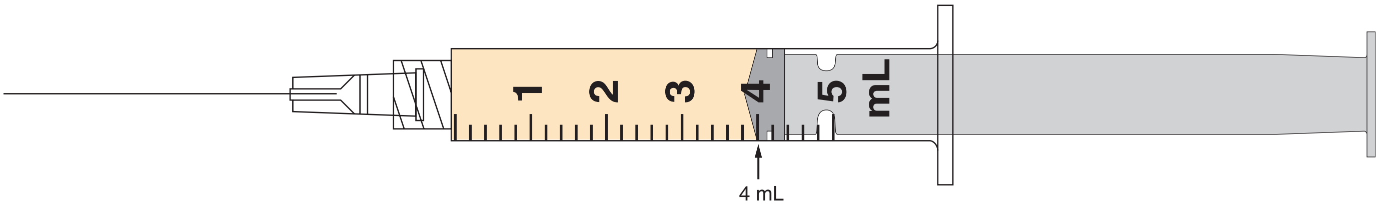
$$\frac{100 \text{ mg}}{1 \text{ mL}} \times \frac{400 \text{ mg}}{\text{X mL}}$$ Cross-multiply

$$100\text{X} = 400$$

$$\frac{100\text{X}}{100} = \frac{400}{100}$$ Simplify: Divide both sides of the equation by the number before the unknown X

$$\text{X} = 4 \text{ mL}$$ Label the units to match the unknown X

given intravenously every 8 hours



Drugs with Instructions to "See Package Insert" for Dilution and Administration

Some labels only give the dosage strength contained in the vial and other minimal information that is insufficient to properly reconstitute or safely store the drug. To prepare the powdered medication, you must see the package insert. Look at the Amphocin label and the accompanying package insert (Figure 12-12). The label instructs you to "See insert for reconstitution and dosage information." The following example demonstrates the use of the package insert for calculating the dosage.

EXAMPLE ■

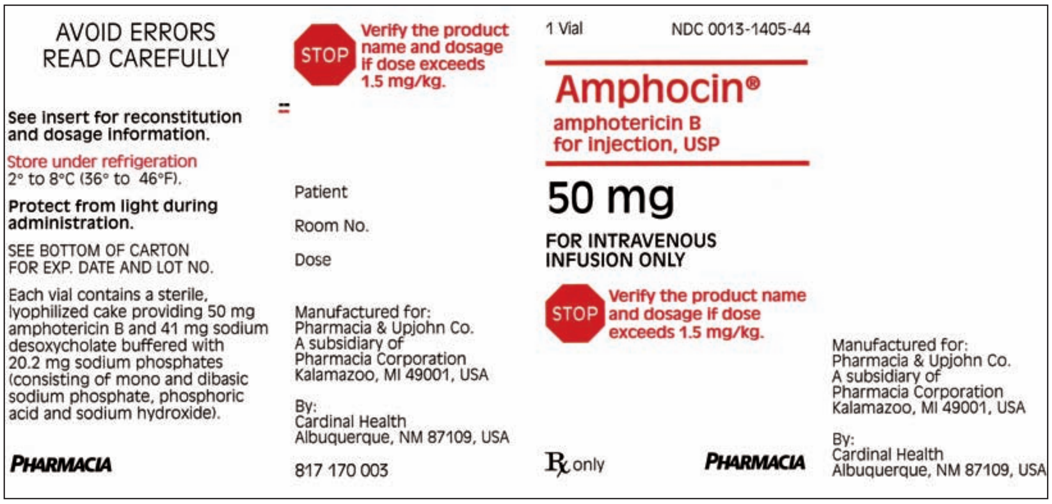
Order: Amphocin 37.5 mg IV daily

Supply: Amphocin 50 mg

Look at the preparation instructions given in the package insert (Figure 12-12).

- First, to fill the order, how much and what type of diluent must you add? The directions advise the preparer, for initial concentration, to *add 10 mL of sterile water for injection without a bacteriostatic agent and then to further dilute the solution containing 5 mg/mL to 0.1 mg/mL by adding 1 mL (5 mg) of solution to 49 mL of 5% Dextrose and Water Injection for a 1:50 dilution.* (We will use the latter information after we calculate the dosage.)
- Second, what is the supply dosage of the reconstituted Amphocin? When adding 10 mL of diluent, the *supply dosage is 5 mg/mL.*

FIGURE 12-12 Amphocin label and portion of package insert



AVOID ERRORS
READ CAREFULLY

See insert for reconstitution and dosage information.

Store under refrigeration
2° to 8°C (36° to 46°F).

Protect from light during administration.

SEE BOTTOM OF CARTON
FOR EXP. DATE AND LOT NO.

Each vial contains a sterile, lyophilized cake providing 50 mg amphotericin B and 41 mg sodium desoxycholate buffered with 20.2 mg sodium phosphates (consisting of mono and dibasic sodium phosphate, phosphoric acid and sodium hydroxide).

PHARMACIA

STOP **Verify the product name and dosage if dose exceeds 1.5 mg/kg.**

Patient

Room No.

Dose

Manufactured for:
Pharmacia & Upjohn Co.
A subsidiary of
Pharmacia Corporation
Kalamazoo, MI 49001, USA

By:
Cardinal Health
Albuquerque, NM 87109, USA

817 170 003

1 Vial NDC 0013-1405-44

Amphocin®
amphotericin B
for injection, USP

50 mg

FOR INTRAVENOUS INFUSION ONLY

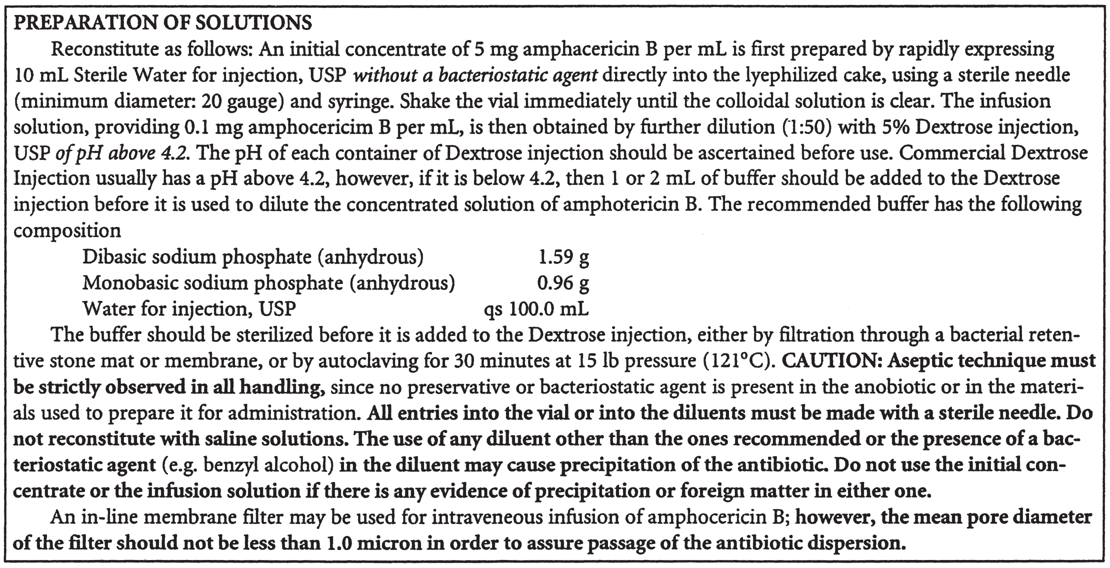
STOP **Verify the product name and dosage if dose exceeds 1.5 mg/kg.**

℞ only

PHARMACIA

Manufactured for:
Pharmacia & Upjohn Co.
A subsidiary of
Pharmacia Corporation
Kalamazoo, MI 49001, USA

By:
Cardinal Health
Albuquerque, NM 87109, USA



PREPARATION OF SOLUTIONS

Reconstitute as follows: An initial concentrate of 5 mg amphacericin B per mL is first prepared by rapidly expressing 10 mL Sterile Water for injection, USP *without a bacteriostatic agent* directly into the lyephilized cake, using a sterile needle (minimum diameter: 20 gauge) and syringe. Shake the vial immediately until the colloidal solution is clear. The infusion solution, providing 0.1 mg amphocericim B per mL, is then obtained by further dilution (1:50) with 5% Dextrose injection, USP *of pH above 4.2.* The pH of each container of Dextrose injection should be ascertained before use. Commercial Dextrose Injection usually has a pH above 4.2, however, if it is below 4.2, then 1 or 2 mL of buffer should be added to the Dextrose injection before it is used to dilute the concentrated solution of amphotericin B. The recommended buffer has the following composition

Dibasic sodium phosphate (anhydrous)	1.59 g
Monobasic sodium phosphate (anhydrous)	0.96 g
Water for injection, USP	qs 100.0 mL

The buffer should be sterilized before it is added to the Dextrose injection, either by filtration through a bacterial retentive stone mat or membrane, or by autoclaving for 30 minutes at 15 lb pressure (121°C). **CAUTION: Aseptic technique must be strictly observed in all handling,** since no preservative or bacteriostatic agent is present in the anobiotic or in the materials used to prepare it for administration. **All entries into the vial or into the diluents must be made with a sterile needle. Do not reconstitute with saline solutions. The use of any diluent other than the ones recommended or the presence of a bacteriostatic agent** (e.g. benzyl alcohol) **in the diluent may cause precipitation of the antibiotic. Do not use the initial concentrate or the infusion solution if there is any evidence of precipitation or foreign matter in either one.**

An in-line membrane filter may be used for intraveneous infusion of amphocericin B; **however, the mean pore diameter of the filter should not be less than 1.0 micron in order to assure passage of the antibiotic dispersion.**

- Third, what is the resulting total volume of this reconstituted solution? The *total volume is 10 mL.* You know this because the supply dosage is 5 mg/mL or 50 mg per 10 mL. The powder does not add significant volume to this solution.
- Finally, how many full doses of Amphocin are available in this vial? The vial contains 50 mg, and the order is for 37.5 mg. There is enough for *one full dose* (plus some extra) in the vial, but not enough for two full doses. No reconstitution label is needed.

This means that you have available a vial of 50 mg of Amphocin to which you will add 10 mL of diluent. The final yield of the solution is 5 mg/mL, which is your supply dosage. Each 1 mL (5 mg) must be further diluted with 49 mL of IV solution for administration.

Calculate one dose of the initial concentration (before further dilution).

Step 1 **Convert** No conversion is necessary.

Order: Amphocin 37.5 mg IV daily

Supply: Amphocin 5 mg/mL

Step 2 **Think** You want to give more than 1 mL but less than 10 mL.

Step 3 Calculate $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

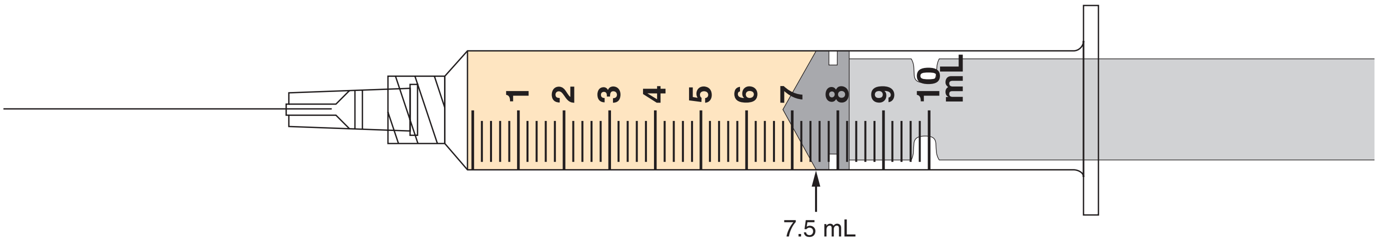
$\frac{5 \text{ mg}}{1 \text{ mL}} \times \frac{37.5 \text{ mg}}{\text{X mL}}$ Cross-multiply

$5X = 37.5$

$\frac{5X}{5} = \frac{37.5}{5}$ Simplify: Divide both sides of the equation by the number before the unknown X

$X = 7.5 \text{ mL}$ Label the units to match the unknown X

given intravenously daily



Recall that the instructions indicate that further dilution of the initial concentration is required before administration: *further dilute the solution containing 5 mg/mL to 0.1 mg/mL by adding 49 mL of 5% Dextrose and Water Injection* to each 1 mL (5 mg) of solution. We have 7.5 mL of concentrated solution; therefore, we need to add it to *7.5 × 49 = 367.5 or 368 mL* of IV solution before administering this drug intravenously. You can also use ratio-proportion to calculate this.

$\frac{49}{1} \times \frac{X}{7.5}$

$X = 367.5 \text{ mL} = 368 \text{ mL}$

QUICK REVIEW

- Check expiration dates of the drug and diluent before beginning reconstitution.

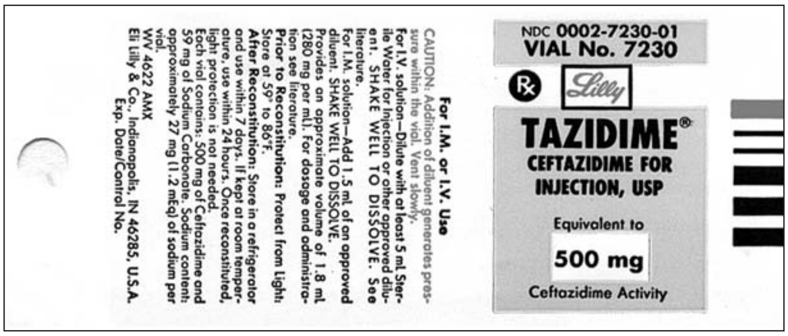
It is important that you remember the following points when reconstituting drugs:

- If any medicine remains for future use after reconstitution, clearly label:
  1. Date and time of preparation.
  2. Strength or concentration per volume.
  3. Potency expiration.
  4. Recommended storage.
  5. Your initials.
- Read all instructions carefully. If no instructions accompany the vial, confer with the pharmacist before proceeding.
- When reconstituting multiple-strength parenteral powders, select the dosage strength that is appropriate for the patient's age, size, and condition.
- Carefully select the correct reconstitution directions for IM or IV administration.

Review Set 28

Calculate the amount you will prepare for each dose. The labels provided are the drugs available. Draw an arrow to the syringe calibration that corresponds with the amount you will draw up and prepare a reconstitution label, if neded.

1. Order: ceftazidime 200 mg IM q.i.d.



NDC 0002-7230-01
VIAL No. 7230
℞ Lilly
TAZIDIME®
CEFTAZIDIME FOR INJECTION, USP
Equivalent to
500 mg
Ceftazidime Activity

For I.M. or I.V. Use
CAUTION: Addition of diluent generates pressure within the vial. Vent slowly.
For I.V. solution—Dilute with at least 5 mL Sterile Water for Injection or other approved diluent. SHAKE WELL TO DISSOLVE. See literature.
For I.M. solution—Add 1.5 mL of an approved diluent. SHAKE WELL TO DISSOLVE.
Provides an approximate volume of 1.8 mL (280 mg per mL). For dosage and administration see literature.
Prior to Reconstitution: Protect from Light: Store at 59° to 86°F.
After Reconstitution: Store in a refrigerator and use within 7 days. If kept at room temperature, use within 24 hours. Once reconstituted, light protection is not needed.
Each vial contains: 500 mg of Ceftazidime and 59 mg of Sodium Carbonate. Sodium content: approximately 27 mg (1.2 mEq) of sodium per vial.
WV 4622 AMX
Eli Lilly & Co., Indianapolis, IN 46285, U.S.A.
Exp. Date/Control No.

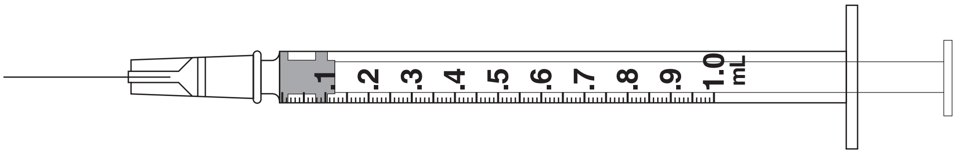
Reconstitute with _________ mL diluent for a concentration of _________ mg/mL.

Give: _________ mL

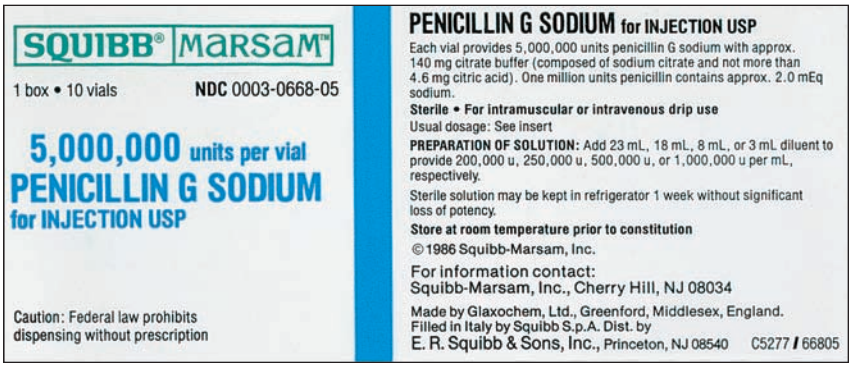
How many full doses are available in this vial? _________ dose(s).

Prepare a reconstitution label for the remaining solution.

Reconstitution label



2. Order: penicillin G 150,000 units IM q.12h



SQUIBB® | MARSAM™
1 box • 10 vials
NDC 0003-0668-05
5,000,000 units per vial
PENICILLIN G SODIUM
for INJECTION USP
Caution: Federal law prohibits dispensing without prescription

PENICILLIN G SODIUM for INJECTION USP
Each vial provides 5,000,000 units penicillin G sodium with approx. 140 mg citrate buffer (composed of sodium citrate and not more than 4.6 mg citric acid). One million units penicillin contains approx. 2.0 mEq sodium.
Sterile • For intramuscular or intravenous drip use
Usual dosage: See insert
PREPARATION OF SOLUTION: Add 23 mL, 18 mL, 8 mL, or 3 mL diluent to provide 200,000 u, 250,000 u, 500,000 u, or 1,000,000 u per mL, respectively.
Sterile solution may be kept in refrigerator 1 week without significant loss of potency.
Store at room temperature prior to constitution
©1986 Squibb-Marsam, Inc.
For information contact:
Squibb-Marsam, Inc., Cherry Hill, NJ 08034
Made by Glaxochem, Ltd., Greenford, Middlesex, England.
Filled in Italy by Squibb S.p.A. Dist. by
E. R. Squibb & Sons, Inc., Princeton, NJ 08540 C5277 / 66805

Reconstitute with _________ mL diluent for a concentration of _________ units/mL.

Give _________ mL.

Reconstitute with _________ mL diluent for a concentration of _________ units/mL.

Give _________ mL.

Reconstitute with _________ mL diluent for a concentration of _________ units/mL.

Give _________ mL.

Reconstitute with _________ mL diluent for a concentration of _________ units/mL.

Give _________ mL.

Indicate the concentration you would choose and explain the rationale for your selection.

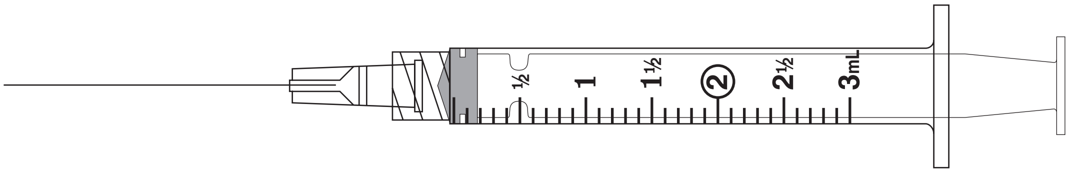
Select _________ units/mL and give _________ mL. Rationale: ______________________________

____

How many full doses are available in this vial? _________ dose(s).

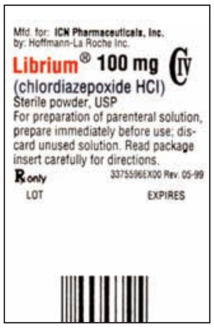
Prepare a reconstitution label for the remaining solution.

Reconstitution label



3. Order: **Librium 25 mg IM q.6h p.r.n., agitation**

Mfd. for: **ICN Pharmaceuticals, Inc.**
by: Hoffmann-La Roche Inc.
2 mL SIZE Special Intramuscular Diluent
For use with LIBRIUM® (chlordiazepoxide HCl) sterile powder
FOR I.M. USE ONLY. NOT FOR I.V. USE. DO NOT USE IF OPALESCENT OR HAZY. 3375696EX00 Rev. 05-99
EXPIRES



Mfd. for: **ICN Pharmaceuticals, Inc.**
by: Hoffmann-La Roche Inc.
Librium® 100 mg CIV
(chlordiazepoxide HCl)
Sterile powder, USP
For preparation of parenteral solution, prepare immediately before use; discard unused solution. Read package insert carefully for directions.
℞ only 3375596EX00 Rev. 05-99
LOT EXPIRES

Package insert states: "Add 2 mL Special Diluent to yield 100 mg per 2 mL."

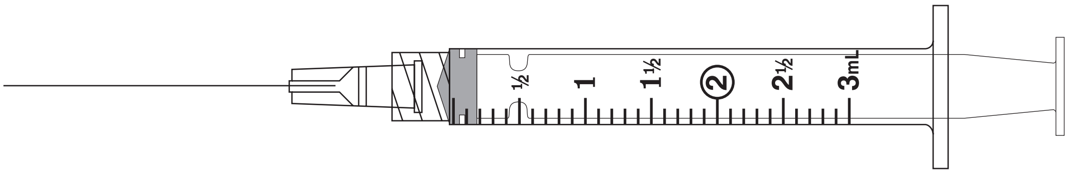
Reconstitute with _________ mL diluent for a concentration of _________ mg per _________ mL.

Give: ________ mL

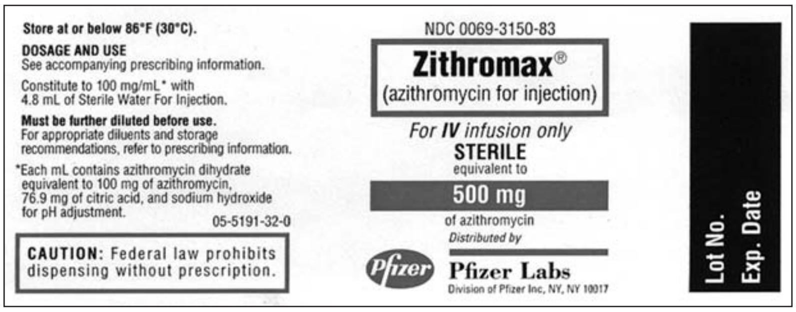
How many full doses are available in this vial? ________ dose(s).

Does this reconstituted medication require a reconstitution label? ________

Explain: ____



4. Order: **Zithromax 0.5 g IV daily**


Store at or below 86°F (30°C).

DOSAGE AND USE
See accompanying prescribing information.

Constitute to 100 mg/mL* with
4.8 mL of Sterile Water For Injection.

Must be further diluted before use.
For appropriate diluents and storage
recommendations, refer to prescribing information.

*Each mL contains azithromycin dihydrate
equivalent to 100 mg of azithromycin,
76.9 mg of citric acid, and sodium hydroxide
for pH adjustment.

05-5191-32-0

CAUTION: Federal law prohibits
dispensing without prescription.

NDC 0069-3150-83

Zithromax®
(azithromycin for injection)

For ***IV*** *infusion only*
STERILE
equivalent to
500 mg
of azithromycin
Distributed by

Pfizer

Pfizer Labs
Division of Pfizer Inc, NY, NY 10017

Lot No.
Exp. Date

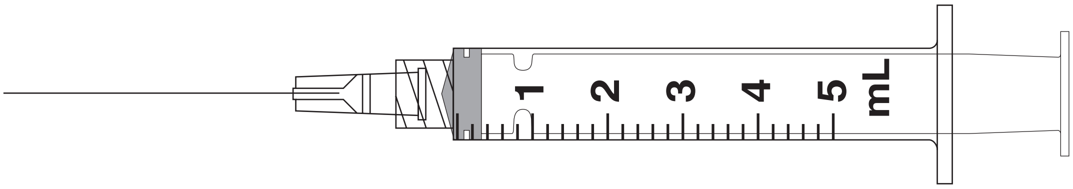
Reconstitute with ________ mL diluent for a concentration of ________ mg/mL.

Give: ________ mL

How many full doses are available in this vial? ________ dose(s).

Does this reconstituted medication require a reconstitution label? ________

Explain: ____

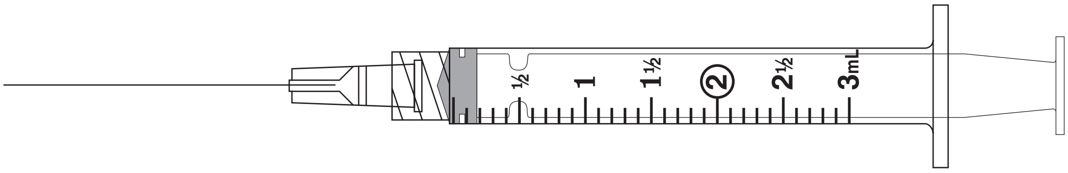


5. Order: **Rocephin 750 mg IM daily**

Reconstitute with ________ mL diluent for an initial concentration of ________ mg/mL.

Give: ________ mL

How many full doses are available in this vial? ________ dose(s)

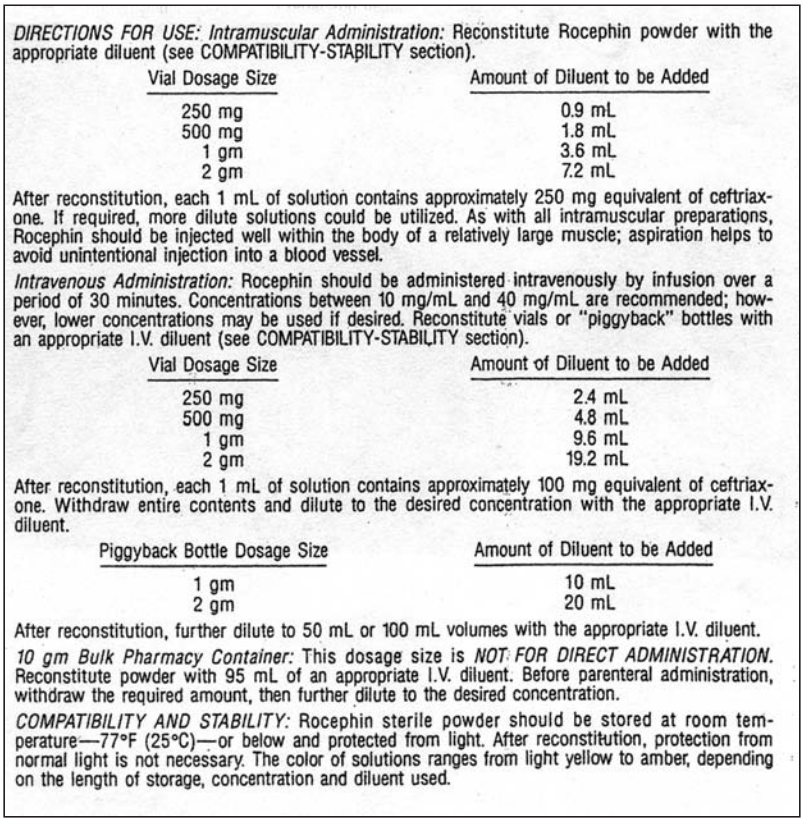



ROCEPHIN®
(ceftriaxone injection)

ROCHE®

1 g

See portion of package insert on next page.



DIRECTIONS FOR USE: Intramuscular Administration: Reconstitute Rocephin powder with the appropriate diluent (see COMPATIBILITY-STABILITY section).

Vial Dosage Size	Amount of Diluent to be Added
250 mg	0.9 mL
500 mg	1.8 mL
1 gm	3.6 mL
2 gm	7.2 mL

After reconstitution, each 1 mL of solution contains approximately 250 mg equivalent of ceftriaxone. If required, more dilute solutions could be utilized. As with all intramuscular preparations, Rocephin should be injected well within the body of a relatively large muscle; aspiration helps to avoid unintentional injection into a blood vessel.

Intravenous Administration: Rocephin should be administered intravenously by infusion over a period of 30 minutes. Concentrations between 10 mg/mL and 40 mg/mL are recommended; however, lower concentrations may be used if desired. Reconstitute vials or "piggyback" bottles with an appropriate I.V. diluent (see COMPATIBILITY-STABILITY section).

Vial Dosage Size	Amount of Diluent to be Added
250 mg	2.4 mL
500 mg	4.8 mL
1 gm	9.6 mL
2 gm	19.2 mL

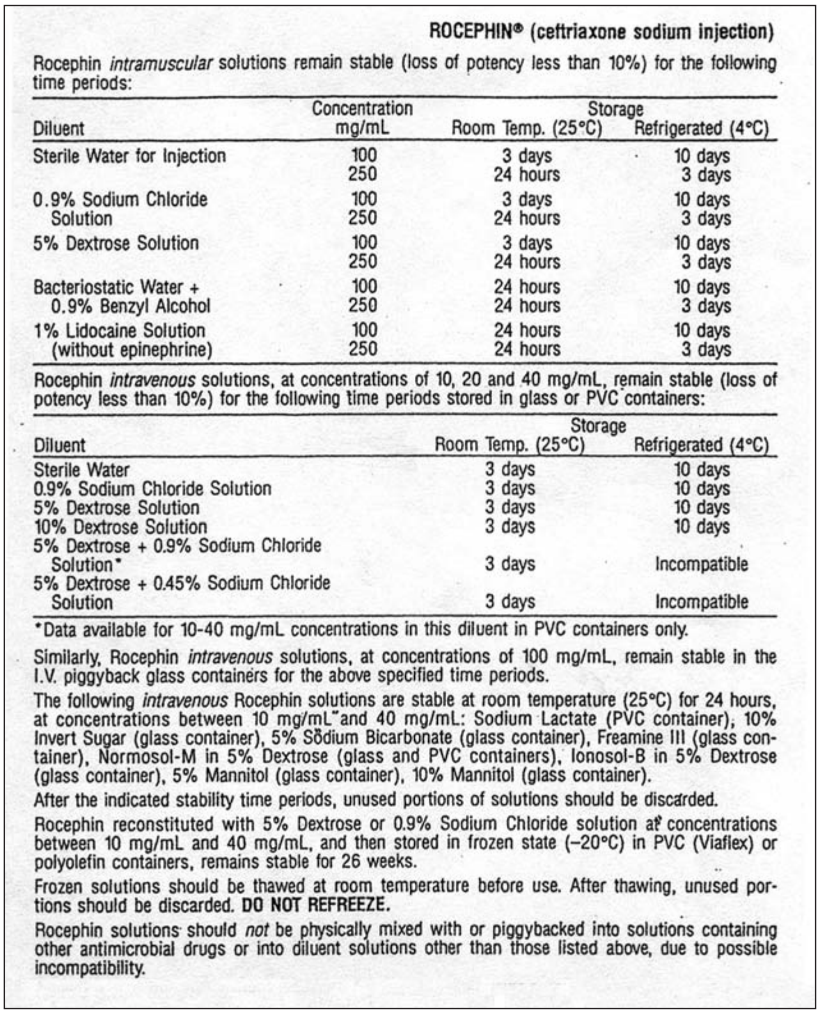
After reconstitution, each 1 mL of solution contains approximately 100 mg equivalent of ceftriaxone. Withdraw entire contents and dilute to the desired concentration with the appropriate I.V. diluent.

Piggyback Bottle Dosage Size	Amount of Diluent to be Added
1 gm	10 mL
2 gm	20 mL

After reconstitution, further dilute to 50 mL or 100 mL volumes with the appropriate I.V. diluent.

10 gm Bulk Pharmacy Container: This dosage size is *NOT FOR DIRECT ADMINISTRATION.* Reconstitute powder with 95 mL of an appropriate I.V. diluent. Before parenteral administration, withdraw the required amount, then further dilute to the desired concentration.

COMPATIBILITY AND STABILITY: Rocephin sterile powder should be stored at room temperature—77°F (25°C)—or below and protected from light. After reconstitution, protection from normal light is not necessary. The color of solutions ranges from light yellow to amber, depending on the length of storage, concentration and diluent used.



ROCEPHIN® (ceftriaxone sodium injection)

Rocephin *intramuscular* solutions remain stable (loss of potency less than 10%) for the following time periods:

	Concentration	Storage	
Diluent	mg/mL	Room Temp. (25°C)	Refrigerated (4°C)
Sterile Water for Injection	100 250	3 days 24 hours	10 days 3 days
0.9% Sodium Chloride Solution	100 250	3 days 24 hours	10 days 3 days
5% Dextrose Solution	100 250	3 days 24 hours	10 days 3 days
Bacteriostatic Water + 0.9% Benzyl Alcohol	100 250	24 hours 24 hours	10 days 3 days
1% Lidocaine Solution (without epinephrine)	100 250	24 hours 24 hours	10 days 3 days

Rocephin *intravenous* solutions, at concentrations of 10, 20 and 40 mg/mL, remain stable (loss of potency less than 10%) for the following time periods stored in glass or PVC containers:

	Storage	
Diluent	Room Temp. (25°C)	Refrigerated (4°C)
Sterile Water	3 days	10 days
0.9% Sodium Chloride Solution	3 days	10 days
5% Dextrose Solution	3 days	10 days
10% Dextrose Solution	3 days	10 days
5% Dextrose + 0.9% Sodium Chloride Solution*	3 days	Incompatible
5% Dextrose + 0.45% Sodium Chloride Solution	3 days	Incompatible

*Data available for 10-40 mg/mL concentrations in this diluent in PVC containers only.

Similarly, Rocephin *intravenous* solutions, at concentrations of 100 mg/mL, remain stable in the I.V. piggyback glass containers for the above specified time periods.

The following *intravenous* Rocephin solutions are stable at room temperature (25°C) for 24 hours, at concentrations between 10 mg/mL and 40 mg/mL: Sodium Lactate (PVC container), 10% Invert Sugar (glass container), 5% Sodium Bicarbonate (glass container), Freamine III (glass container), Normosol-M in 5% Dextrose (glass and PVC containers), Ionosol-B in 5% Dextrose (glass container), 5% Mannitol (glass container), 10% Mannitol (glass container).

After the indicated stability time periods, unused portions of solutions should be discarded.

Rocephin reconstituted with 5% Dextrose or 0.9% Sodium Chloride solution at concentrations between 10 mg/mL and 40 mg/mL, and then stored in frozen state (–20°C) in PVC (Viaflex) or polyolefin containers, remains stable for 26 weeks.

Frozen solutions should be thawed at room temperature before use. After thawing, unused portions should be discarded. **DO NOT REFREEZE.**

Rocephin solutions should *not* be physically mixed with or piggybacked into solutions containing other antimicrobial drugs or into diluent solutions other than those listed above, due to possible incompatibility.

6. Order: **penicillin G potassium 1,000,000 units IM q.6h**

READ ACCOMPANYING PROFESSIONAL INFORMATION.

RECOMMENDED STORAGE IN DRY FORM.

Store below 86°F (30°C)

Sterile solution may be kept in refrigerator for one (1) week without significant loss of potency.

CAUTION: Federal law prohibits dispensing without prescription.

6505-00-958-3305

NDC 0049-0520-83

Buffered

Pfizerpen®

(penicillin G potassium)

For Injection

5

FIVE MILLION UNITS

Pfizer Roerig

Division of Pfizer Inc, NY, NY 10017

USUAL DOSAGE

Average single intramuscular injection: 200,000-400,000 units.

Intravenous: Additional information about the use of this product intravenously can be found in the package insert.

mL diluent added	Units per mL of solution
18.2 mL	250,000
8.2 mL	500,000
3.2 mL	1,000,000

Buffered with sodium citrate and citric acid to optimum pH.

PATIENT: __________

ROOM NO: __________

DATE DILUTED: __________

05-4243-00-3
MADE IN USA

Describe the three concentrations and calculate the amount to give for each of the supply dosage concentrations.

Reconstitute with _________ mL diluent for a concentration of _________ units/mL.

Give _________ mL.

Reconstitute with _________ mL diluent for a concentration of _________ units/mL.

Give _________ mL.

Reconstitute with _________ mL diluent for a concentration of _________ units/mL.

Give _________ mL.

Indicate the concentration you would choose and explain the rationale for your selection.

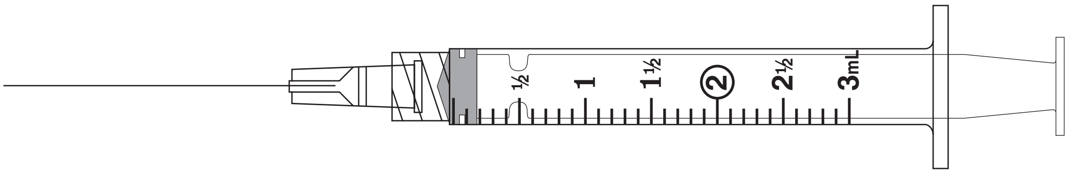
Select _________ units/mL and give _________ mL. Rationale: ________________________

____

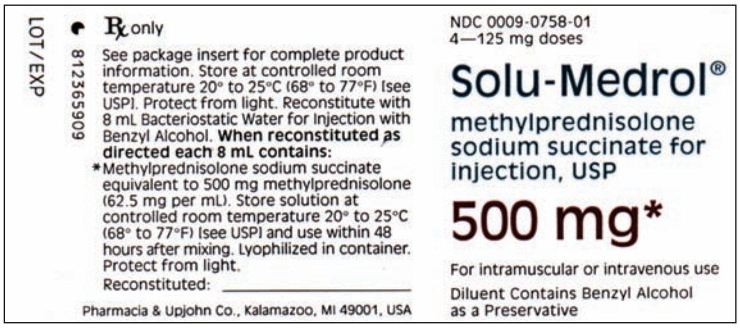
How many full doses are available in this vial? _________ dose(s)

Prepare a reconstitution label for the remaining solution.

Reconstitution label



7. Order: Solu-Medrol 175 mg IM daily



LOT/EXP

812365909

℞ only

See package insert for complete product information. Store at controlled room temperature 20° to 25°C (68° to 77°F) [see USP]. Protect from light. Reconstitute with 8 mL Bacteriostatic Water for Injection with Benzyl Alcohol. **When reconstituted as directed each 8 mL contains:**

*Methylprednisolone sodium succinate equivalent to 500 mg methylprednisolone (62.5 mg per mL). Store solution at controlled room temperature 20° to 25°C (68° to 77°F) [see USP] and use within 48 hours after mixing. Lyophilized in container. Protect from light.

Reconstituted: ______________

Pharmacia & Upjohn Co., Kalamazoo, MI 49001, USA

NDC 0009-0758-01
4—125 mg doses

Solu-Medrol®

methylprednisolone sodium succinate for injection, USP

500 mg*

For intramuscular or intravenous use

Diluent Contains Benzyl Alcohol as a Preservative

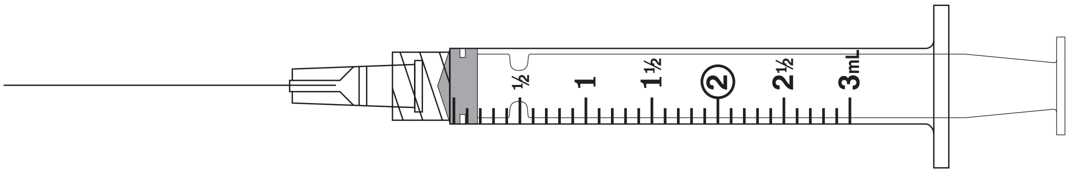
Reconstitute with ________ mL diluent for a concentration of ________ mg/mL.

Give: ________ mL

How many full doses are available in this vial? ________ dose(s).

Prepare a reconstitution label for the remaining solution.

Reconstitution label



8. Order: Pipracil 200 mg IM q.6h

Lederle

NDC 0206-3879-14

DX52

Pipracil®

Sterile Piperacillin Sodium

Contains sterile piperacillin sodium cryodesiccated powder equivalent to 2 grams of piperacillin.

For IV or IM Use

See package circular for reconstitution instructions and complete directions for use.
CAUTION: Federal law prohibits dispensing without prescription.

2 GRAM

SINGLE USE VIAL

Prior to Reconstitution: Store at Controlled Room Temperature 15-30°C (59-86°F)
After Reconstitution: Discard any unused portion after 24 hours if stored at room temperature or after 48 hours if refrigerated. See circular.
LEDERLE PIPERACILLIN, INC.
Carolina, Puerto Rico 00630

Contains no Preservative.

Control No.

Exp. Date

Package insert states, "Add 4 mL suitable diluent (sterile water or 0.9% NaCl) to yield 1 g per 2.5 mL."

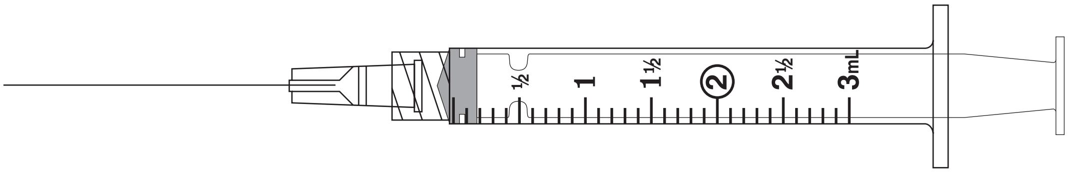
Reconstitute with ________ mL diluent for a concentration of ________ g per ________ mL or ________ mg per ________ mL.

Give: ________ mL

How many full doses are available in this vial? ________ dose(s).

Prepare a reconstitution label for the remaining solution.

Reconstitution label



9. Order: **penicillin G potassium 500,000 units IM q.6h**

READ ACCOMPANYING PROFESSIONAL INFORMATION
RECOMMENDED STORAGE IN DRY FORM
STORE BELOW 86°F (30°C)
Sterile solution may be kept in refrigerator for one (1) week without significant loss of potency.
MADE IN U.S.A.
05-4242-00-3

6505-00-664-7116

NDC 0049-0510-83
Buffered
Pfizerpen®
penicillin G potassium
For Injection
ONE MILLION UNITS
CAUTION: Federal law prohibits dispensing without prescription.
ROERIG Pfizer
A division of Pfizer Inc., N.Y., N.Y. 10017

USUAL DOSAGE
Average single intramuscular injection: 200,000-400,000 units. Intravenous: Additional information about the use of this product intravenously can be found in the package insert.

ml diluent added	Units per ml of solution
20.0 ml	50,000
10.0 ml	100,000
4.0 ml	250,000
1.8 ml	500,000

Buffered with sodium citrate and citric acid to optimum pH.

PATIENT: __________
ROOM NO.: __________
DATE DILUTED: __________

Describe the four concentrations and calculate the amount to give for each of the supply dosage concentrations.

Reconstitute with __________ mL diluent for a concentration of __________ units/mL.

Give __________ mL.

Reconstitute with __________ mL diluent for a concentration of __________ units/mL.

Give __________ mL.

Reconstitute with __________ mL diluent for a concentration of __________ units/mL.

Give __________ mL.

Reconstitute with __________ mL diluent for a concentration of __________ units/mL.

Give __________ mL.

Indicate the concentration you would choose and explain the rationale for your selection.

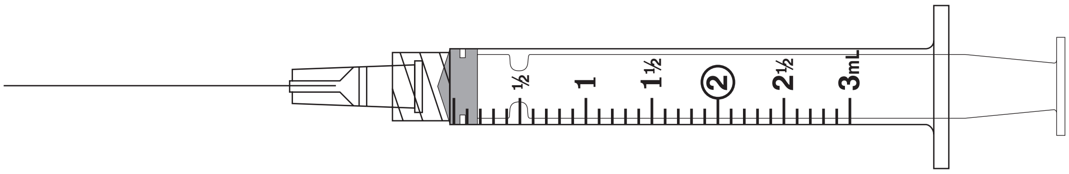
Select __________ units/mL and give __________ mL. Rationale: ______________________________

____

How many full doses are available in this vial? __________ dose(s)

Prepare a reconstitution label for the remaining solution.

Reconstitution label



10. Order: **Unasyn 1,500 mg IM q.6h**

NDC 0049-0013-83

Unasyn®
(ampicillin sodium/sulbactam sodium)
Sterile
1.5 g
For IM or IV use
equivalent to **1 g** of ampicillin plus **0.5 g** of sulbactam

Pfizer Roerig
Division of Pfizer Inc, NY, NY 10017

READ ACCOMPANYING PROFESSIONAL INFORMATION.
STORAGE *Before Reconstitution:*
Store at or below 86°F (30°C)
USUAL ADULT DOSAGE
1.5 g to 3 g every six hours, corresponding to 1 g ampicillin/0.5 g sulbactam to 2 g ampicillin/1 g sulbactam. The total dose of sulbactam should not exceed 4 g per day.
FOR IV USE
First reconstitute with appropriate amount of a diluent as cited in the package insert. Withdraw the entire contents of the vial and further dilute with a recommended diluent. Administer over 15-30 minutes.
STORAGE *After Reconstitution:*
Depending on diluent used for reconstitution, solutions may be stored from 2-8 hours at room temperature or from 24-72 hours under refrigeration. Discard solutions stored beyond periods recommended in accompanying professional information.
FOR IM USE
See RECONSTITUTION section of package insert.

CAUTION: Federal law prohibits dispensing without prescription.

05-4362-00-3
MADE IN USA

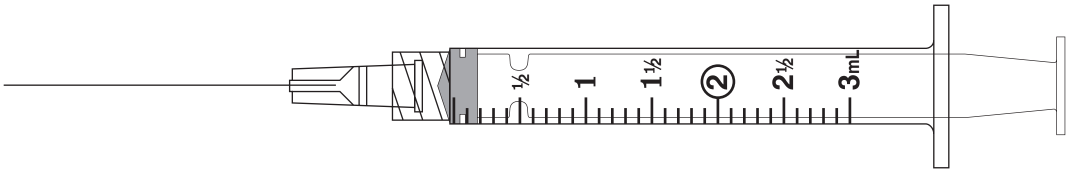
Package insert directions state:

Unasyn Vial Size	Volume Diluent to be Added	Withdrawal Volume
1.5 g	3.2 mL	4.0 mL
3.0 g	6.4 mL	8.0 mL

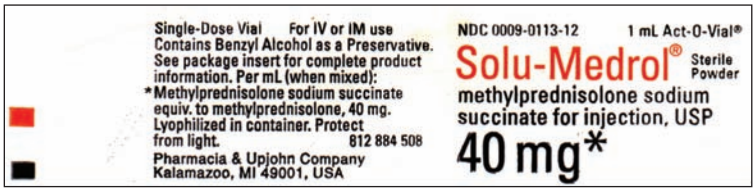
Reconstitute with ________ mL diluent for a concentration of ________ g per ________ mL or ________ mg/mL.

Give: ________ mL

How many full doses are in this vial? ________ dose(s)



11. Order: **methylprednisolone succinate 24 mg IM daily**



Single-Dose Vial For IV or IM use
Contains Benzyl Alcohol as a Preservative.
See package insert for complete product information. Per mL (when mixed):
*Methylprednisolone sodium succinate equiv. to methylprednisolone, 40 mg.
Lyophilized in container. Protect from light. 812 884 508
Pharmacia & Upjohn Company
Kalamazoo, MI 49001, USA

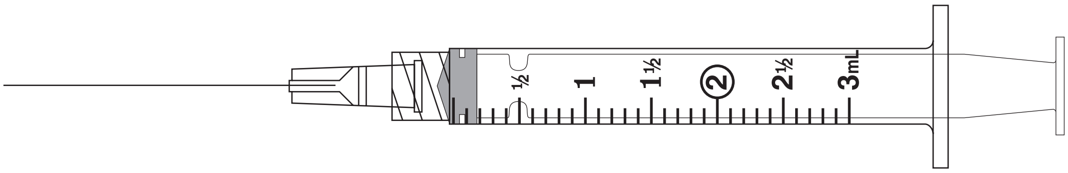
NDC 0009-0113-12 1 mL Act-O-Vial®
Solu-Medrol® Sterile Powder
methylprednisolone sodium succinate for injection, USP
40 mg*

Package insert with 40 mg Act-O-Vial system states, "Press down on plastic activator to force accompanying 1 mL diluent into the lower compartment."

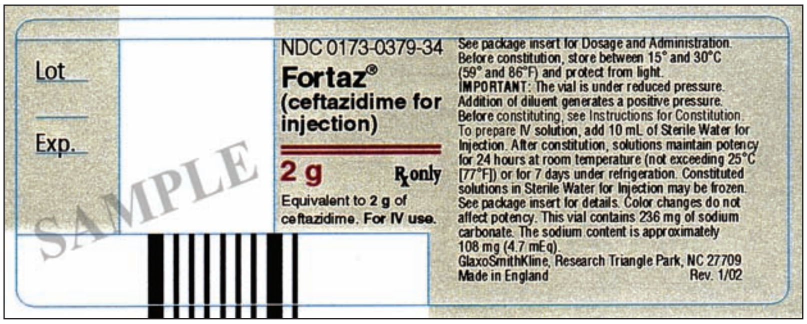
The resulting concentration is ________ mg/mL.

Give ________ mL

How many full doses are available in this vial? _________ dose(s)



12. Order: **Fortaz 250 mg IV q.12h**



Lot

Exp.

SAMPLE

NDC 0173-0379-34

Fortaz®
(ceftazidime for injection)

2 g ℞ only

Equivalent to 2 g of ceftazidime. For IV use.

See package insert for Dosage and Administration. Before constitution, store between 15° and 30°C (59° and 86°F) and protect from light. **IMPORTANT:** The vial is under reduced pressure. Addition of diluent generates a positive pressure. Before constituting, see Instructions for Constitution. To prepare IV solution, add 10 mL of Sterile Water for Injection. After constitution, solutions maintain potency for 24 hours at room temperature (not exceeding 25°C [77°F]) or for 7 days under refrigeration. Constituted solutions in Sterile Water for Injection may be frozen. See package insert for details. Color changes do not affect potency. This vial contains 236 mg of sodium carbonate. The sodium content is approximately 108 mg (4.7 mEq).
GlaxoSmithKline, Research Triangle Park, NC 27709
Made in England Rev. 1/02

Package insert: "Add 10 mL diluent for 11.5 mL approximate volume and 170 mg/mL approximate ceftazidime concentration."

Reconstitute with _________ mL diluent for a concentration of _________ g per _________ mL or _________ mg/mL.

Give: _________ mL

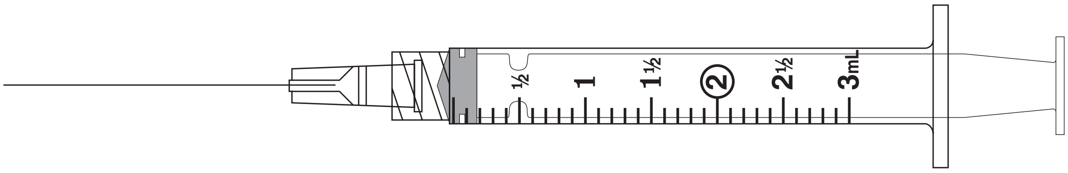
How many full doses are available in this vial? _________ dose(s).

Will the drug remain potent to use all available doses? _________

Explain: ____

Prepare a reconstitution label for the remaining solution.

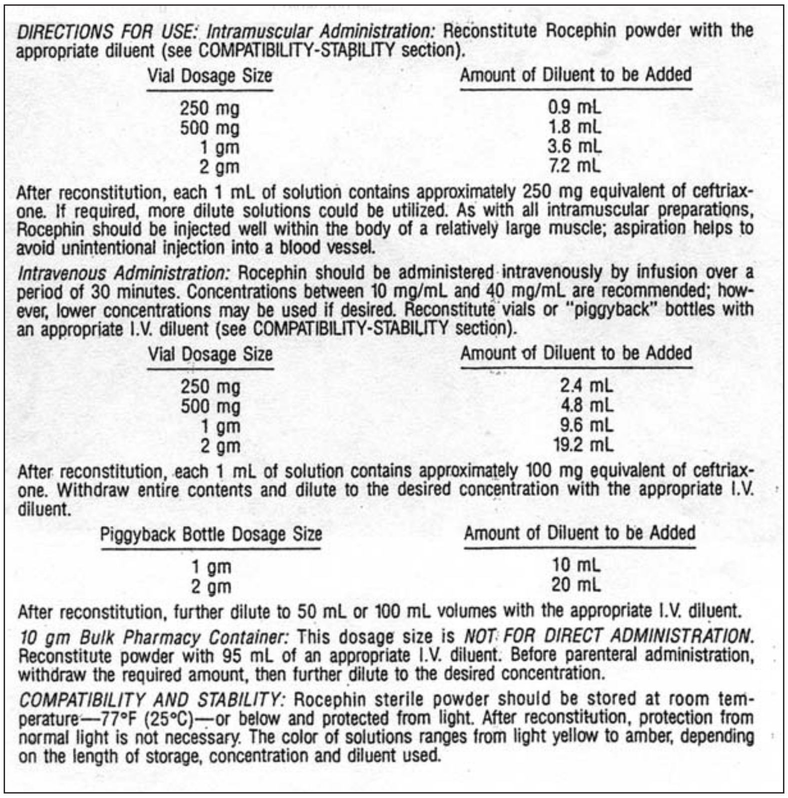
Reconstitution label



13. Order: **Rocephin 1,500 mg IV q.6h in 50 mL D$_5$W (5% Dextrose and Water IV solution)**

ROCEPHIN® ROCHE® **2 g**

ceftriaxone sodium injection



DIRECTIONS FOR USE: Intramuscular Administration: Reconstitute Rocephin powder with the appropriate diluent (see COMPATIBILITY-STABILITY section).

Vial Dosage Size	Amount of Diluent to be Added
250 mg	0.9 mL
500 mg	1.8 mL
1 gm	3.6 mL
2 gm	7.2 mL

After reconstitution, each 1 mL of solution contains approximately 250 mg equivalent of ceftriaxone. If required, more dilute solutions could be utilized. As with all intramuscular preparations, Rocephin should be injected well within the body of a relatively large muscle; aspiration helps to avoid unintentional injection into a blood vessel.

Intravenous Administration: Rocephin should be administered intravenously by infusion over a period of 30 minutes. Concentrations between 10 mg/mL and 40 mg/mL are recommended; however, lower concentrations may be used if desired. Reconstitute vials or "piggyback" bottles with an appropriate I.V. diluent (see COMPATIBILITY-STABILITY section).

Vial Dosage Size	Amount of Diluent to be Added
250 mg	2.4 mL
500 mg	4.8 mL
1 gm	9.6 mL
2 gm	19.2 mL

After reconstitution, each 1 mL of solution contains approximately 100 mg equivalent of ceftriaxone. Withdraw entire contents and dilute to the desired concentration with the appropriate I.V. diluent.

Piggyback Bottle Dosage Size	Amount of Diluent to be Added
1 gm	10 mL
2 gm	20 mL

After reconstitution, further dilute to 50 mL or 100 mL volumes with the appropriate I.V. diluent.

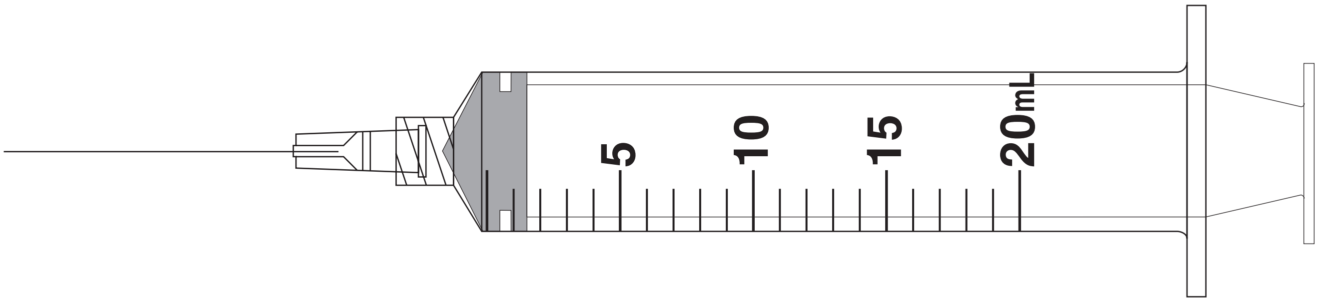
10 gm Bulk Pharmacy Container: This dosage size is *NOT FOR DIRECT ADMINISTRATION.* Reconstitute powder with 95 mL of an appropriate I.V. diluent. Before parenteral administration, withdraw the required amount, then further dilute to the desired concentration.

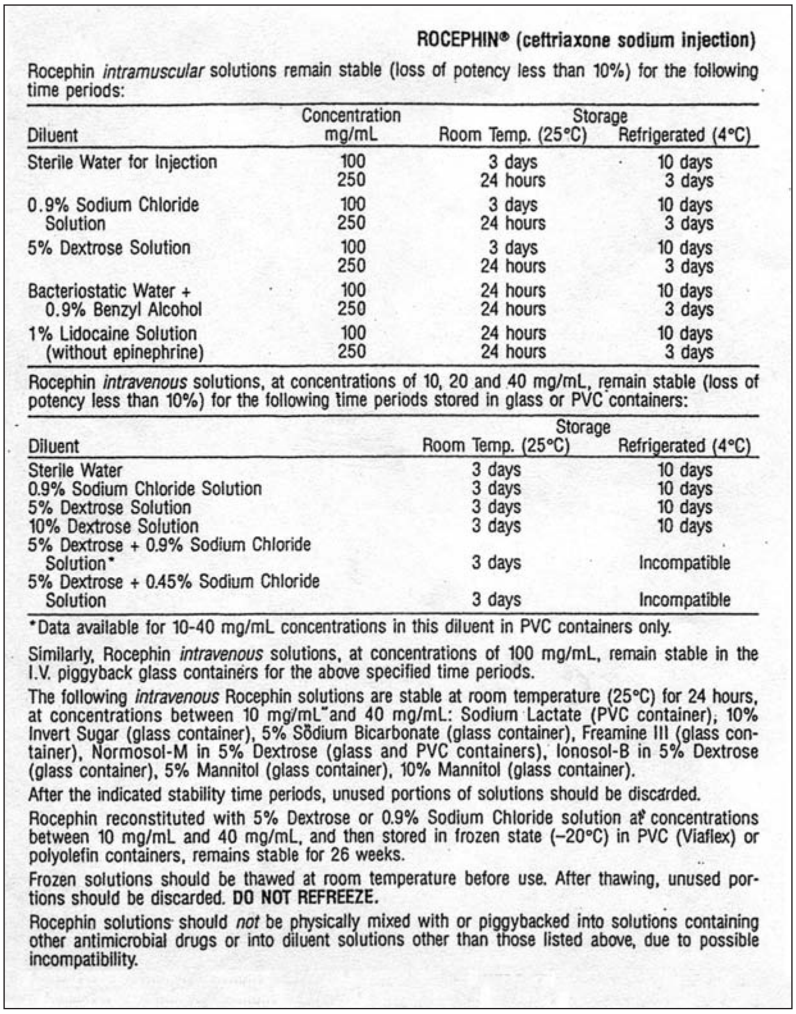
COMPATIBILITY AND STABILITY: Rocephin sterile powder should be stored at room temperature—77°F (25°C)—or below and protected from light. After reconstitution, protection from normal light is not necessary. The color of solutions ranges from light yellow to amber, depending on the length of storage, concentration and diluent used.

Reconstitute vial with ________ mL diluent for an initial concentration of ________ mg/mL.

Give: ________ mL

How many full doses are available in this vial? ________ dose(s)





ROCEPHIN® (ceftriaxone sodium injection)

Rocephin *intramuscular* solutions remain stable (loss of potency less than 10%) for the following time periods:

	Concentration	Storage	
Diluent	mg/mL	Room Temp. (25°C)	Refrigerated (4°C)
Sterile Water for Injection	100	3 days	10 days
	250	24 hours	3 days
0.9% Sodium Chloride Solution	100	3 days	10 days
	250	24 hours	3 days
5% Dextrose Solution	100	3 days	10 days
	250	24 hours	3 days
Bacteriostatic Water + 0.9% Benzyl Alcohol	100	24 hours	10 days
	250	24 hours	3 days
1% Lidocaine Solution (without epinephrine)	100	24 hours	10 days
	250	24 hours	3 days

Rocephin *intravenous* solutions, at concentrations of 10, 20 and 40 mg/mL, remain stable (loss of potency less than 10%) for the following time periods stored in glass or PVC containers:

	Storage	
Diluent	Room Temp. (25°C)	Refrigerated (4°C)
Sterile Water	3 days	10 days
0.9% Sodium Chloride Solution	3 days	10 days
5% Dextrose Solution	3 days	10 days
10% Dextrose Solution	3 days	10 days
5% Dextrose + 0.9% Sodium Chloride Solution*	3 days	Incompatible
5% Dextrose + 0.45% Sodium Chloride Solution	3 days	Incompatible

*Data available for 10-40 mg/mL concentrations in this diluent in PVC containers only.

Similarly, Rocephin *intravenous* solutions, at concentrations of 100 mg/mL, remain stable in the I.V. piggyback glass containers for the above specified time periods.

The following *intravenous* Rocephin solutions are stable at room temperature (25°C) for 24 hours, at concentrations between 10 mg/mL and 40 mg/mL: Sodium Lactate (PVC container), 10% Invert Sugar (glass container), 5% Sodium Bicarbonate (glass container), Freamine III (glass container), Normosol-M in 5% Dextrose (glass and PVC containers), Ionosol-B in 5% Dextrose (glass container), 5% Mannitol (glass container), 10% Mannitol (glass container).

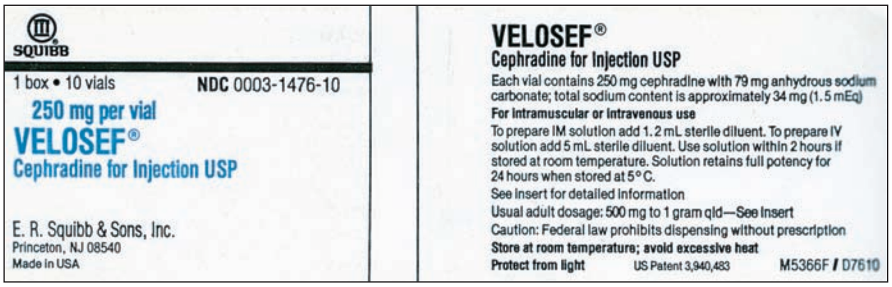
After the indicated stability time periods, unused portions of solutions should be discarded.

Rocephin reconstituted with 5% Dextrose or 0.9% Sodium Chloride solution at concentrations between 10 mg/mL and 40 mg/mL, and then stored in frozen state (–20°C) in PVC (Viaflex) or polyolefin containers, remains stable for 26 weeks.

Frozen solutions should be thawed at room temperature before use. After thawing, unused portions should be discarded. **DO NOT REFREEZE.**

Rocephin solutions should *not* be physically mixed with or piggybacked into solutions containing other antimicrobial drugs or into diluent solutions other than those listed above, due to possible incompatibility.

14. Order: *Velosef 250 mg IV q.i.d.*



SQUIBB

1 box • 10 vials **NDC** 0003-1476-10

250 mg per vial

VELOSEF®

Cephradine for Injection USP

E. R. Squibb & Sons, Inc.
Princeton, NJ 08540
Made in USA

VELOSEF®

Cephradine for Injection USP

Each vial contains 250 mg cephradine with 79 mg anhydrous sodium carbonate; total sodium content is approximately 34 mg (1.5 mEq)

For intramuscular or intravenous use

To prepare IM solution add 1.2 mL sterile diluent. To prepare IV solution add 5 mL sterile diluent. Use solution within 2 hours if stored at room temperature. Solution retains full potency for 24 hours when stored at 5°C.

See insert for detailed information

Usual adult dosage: 500 mg to 1 gram qid—See Insert

Caution: Federal law prohibits dispensing without prescription

Store at room temperature; avoid excessive heat

Protect from light US Patent 3,940,483 M5366F / D7610

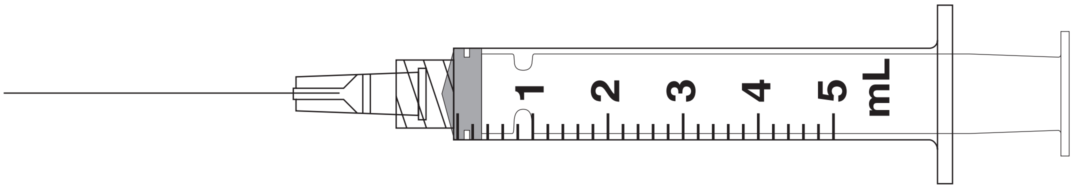
Reconstitute with _________ mL diluent for a concentration of _________ mg/mL.

Give: _________ mL

How many full doses are available in this vial? _________ dose(s).

Prepare a reconstitution label for the remaining solution.

Reconstitution label



15. Order: Kefzol 250 mg IM q.6h


NDC 0002-1497-01
VIAL No. 767
℞ Lilly
KEFZOL®
STERILE
CEFAZOLIN
SODIUM, USP
Equiv. to
500 mg
Cefazolin

CAUTION—Federal (U.S.A.) law prohibits dispensing without prescription.
For I.M. or I.V. Use
Dosage—See literature.
To prepare solution add 2 mL Sterile Water for Injection or 0.9% Sodium Chloride Injection. Provides an approximate volume of 2.2 mL (225 mg per mL)
SHAKE WELL Protect from Light
Prior to Reconstitution: Store at Controlled Room Temperature 59° to 86°F (15° to 30°C)
After Reconstitution: Store in a refrigerator. For Storage Time - See Accompanying Literature. If kept at room temperature, use within 24 hours.
Lyophilized
WV 4520 AMX
Eli Lilly & Co., Indianapolis, IN 46285, U.S.A.
Exp. Date/Control No.

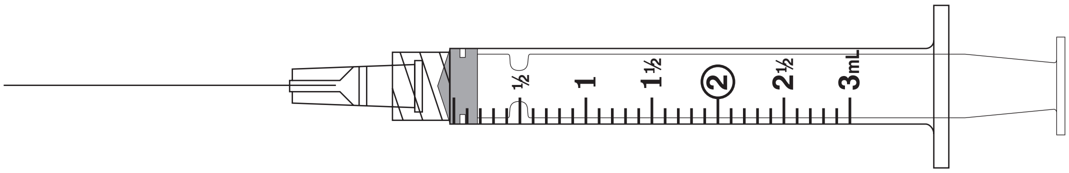
Reconstitute with ________ mL diluent for a concentration of ________ mg/mL.

Give: ________ mL

How many full doses are available in this vial? ________ dose(s).

Prepare a reconstitution label for the remaining solution.

Reconstitution label



After completing these problems, see pages 496-501 to check your answers.

RECONSTITUTION OF NONINJECTABLE SOLUTIONS

Now let's look at reconstitution of noninjectable solutions, such as nutritional formulas and irrigating solutions. In most cases, the nurse or health care professional must dilute a liquid concentrate (solute) with water or saline (solvent) to make a weaker solution.

Solution Concentration

An important concept for understanding solution concentration or strength is that the amount of solvent used to decrease the total concentration is determined by the desired final strength of the solution. The *less* solvent added, the *more concentrated* the final solution strength; the *more* solvent added, the *less concentrated* the final solution strength. Think of orange juice concentrate as a way to illustrate this concept. The directions call for three cans of water to be added to one can of orange juice concentrate. The result is "reconstituted juice," a ready-to-drink beverage. If you like a stronger orange taste, you might add only two cans of water, making it a *more* concentrated juice, but you get *less total volume* to drink. If you have several people wanting to drink orange juice, you might choose to add four cans of water to the final total volume. You get *more* volume, but the orange juice is *less* concentrated; therefore, it is more dilute, because you have increased the water (solvent) content. Note that in either case, the amount of orange juice concentrate in the final solution is the same.

Medical notation to express the strength of a solution uses either a ratio, percent, or fraction. The fraction is the preferred form, because it is easily applied in calculation and helps explain the ratio of solute to total solution. Recall that a ratio or percent can also be expressed as a fraction.

RULE

When a fraction expresses the strength of a solution, made from a liquid concentrate:

- The numerator of the fraction is the number of parts of solute.
- The denominator of the fraction is the total number of parts of total solution.
- The difference between the denominator (final solution) and the numerator (parts of solute) is the number of parts of solvent.

Let's describe some solutions made from liquid concentrates.

EXAMPLE 1 ■

$\frac{1}{4}$ *strength reconstituted orange juice* made from canned frozen concentrate

$$\frac{1}{4}\text{ strength} = \frac{\text{1 part (can) of frozen orange juice concentrate}}{\text{4 parts (cans) of total reconstituted orange juice}}$$

- 1 part (can) frozen orange juice concentrate (*solute,* numerator)
- 4 parts (cans) of total reconstituted orange juice (*solution,* denominator)
- $4 - 1 = 3$ parts (cans) of water (*solvent*)

Three cans of water added to one can frozen orange juice concentrate makes four cans of a final reconstituted orange juice solution. The resulting $\frac{1}{4}$ strength reconstituted orange juice is comparable to the strength of fresh juice.

EXAMPLE 2 ■

$\frac{1}{3}$ strength nutritional formula

- 1 part concentrate formula as the solute
- 3 parts of total solution
- 3 − 1 = 2 parts solvent (water)

Therefore, one can of nutritional formula concentrate and two cans of water make a $\frac{1}{3}$ strength nutritional formula.

Calculating Solutions

To prepare a prescribed solution of a certain strength from a solute, you can apply ratio-proportion similar to what you learned for calculating dosages.

RULE

To prepare solutions,

1. Apply ratio-proportion to find the amount of solute (X)

   $$\text{Ratio for desired solution strength} = \frac{\text{X Amount of solute}}{\text{Quantity of desired solution}}$$

2. Quantity of desired solution − Amount of solute = Amount of solvent

The unknown X you are solving for is the quantity or amount of solute you will need to add to the solvent to prepare the desired solution. Let's look at how this rule is applied in health care.

TOPICAL SOLUTIONS/IRRIGANTS

Topical or irrigating solutions may be mixed from powders, salts, or liquid concentrates. Asepsis in mixing, storage, and use is essential. Liquids can quickly harbor microorganisms. Our focus here is to review the essentials of reconstitution, but nurses and other health care professionals need to be alert at all times to the chain of infection.

Most often nurses and other health care professionals will further dilute ready-to-use solutions, which are called *full-strength* or stock solutions, to create a less concentrated liquid. Consider the desired solution strength as well as the final volume needed for the task.

EXAMPLE 1 ■

Hydrogen peroxide, which is usually available full strength as a 3% solution, can be drying to the skin and should not be directly applied undiluted. For use as a topical antiseptic, the therapeutic protocol is to reconstitute hydrogen peroxide to $\frac{1}{2}$ strength with normal saline used as the solvent. You decide to make four ounces that can be kept in a sterile container at the patient's bedside for traction pin care.

Step 1 Convert No conversion is necessary.

Step 2 Think The fraction represents the desired solution strength: $\frac{1}{2}$ strength means 1 part solute (hydrogen peroxide) to 2 total parts solution. The amount of solvent is 2 − 1 = 1 part saline. Because you need 4 oz of solution, you estimate that you will need $\frac{1}{2}$ of it as solute and $\frac{1}{2}$ of it as solvent, or 2 oz hydrogen peroxide and 2 oz saline to make a total of 4 oz of $\frac{1}{2}$ strength hydrogen peroxide.

Step 3 Calculate Remember that $\frac{1}{2}$ strength $= \frac{\text{1 part solute}}{\text{2 parts total solution}}$. Here, the desired solution strength is $\frac{1}{2}$. The quantity of solution desired is 4 oz. You want to know how much solute (X oz) you will need.

$$\frac{1}{2} \;\times\; \frac{X\text{ oz}}{4\text{ oz}}\begin{array}{l}\text{(solute)}\\ \text{(solution)}\end{array}$$

$$2X = 4$$

$$\frac{2X}{2} = \frac{4}{2}$$

$$X = 2\text{ oz of solute}$$

X (2 oz) is the quantity of solute (full-strength hydrogen peroxide) you will need to prepare the desired solution (4 oz of $\frac{1}{2}$ strength hydrogen peroxide). The amount of solvent is 4 oz − 2 oz = 2 oz. If you add 2 ounces of full-strength hydrogen peroxide (solute) to 2 ounces of normal saline (solvent) you will prepare 4 ounces of a $\frac{1}{2}$ strength hydrogen peroxide topical antiseptic.

EXAMPLE 2 ■

Suppose a physician orders a patient's wound irrigated with **$\frac{2}{3}$ strength hydrogen peroxide and normal saline solution q.4h while awake.** You will need 60 mL per irrigation and will do three irrigations during your 12-hour shift. You will need to prepare 60 mL × 3 irrigations = 180 mL total solution. How much stock hydrogen peroxide and normal saline will you need?

Step 1 Convert No conversion is necessary.

Step 2 Think You want to make $\frac{2}{3}$ strength, which means 2 parts solute (concentrated hydrogen peroxide) to 3 total parts solution. The amount of solvent is 3 − 2 = 1 part saline. Because you need 180 mL of solution, you estimate that you will need $\frac{2}{3}$ of it as solute ($\frac{2}{3} \times 180 = 120$ mL) and $\frac{1}{3}$ of it as solvent ($\frac{1}{3} \times 180 = 60$ mL).

Step 3 Calculate

$$\frac{2}{3} \;\times\; \frac{X\text{ mL}}{180\text{ mL}}\begin{array}{l}\text{(solute)}\\ \text{(solution)}\end{array}$$

$$3X = 360$$

$$\frac{3X}{3} = \frac{360}{3}$$

$$X = 120\text{ mL of solute}$$

X (120 mL) is the quantity of solute (hydrogen peroxide) you will need to prepare the desired solution (180 mL of $\frac{2}{3}$ strength). Because you want to make a total of 180 mL of solution for wound irrigation, the amount of solvent you need is 180 − 120 = 60 mL of normal saline. Therefore, to make 180 mL of $\frac{2}{3}$ strength hydrogen peroxide, mix 120 mL full-strength hydrogen peroxide and 60 mL normal saline.

ORAL AND ENTERAL FEEDINGS

The principles of reconstitution are frequently applied to nutritional liquids for children and adults with special needs. Premature infants require increased calories for growth yet cannot take large volumes of fluid. Children who suffer from intestinal malabsorption require incremental changes as their bodies adjust to more concentrated formulas. Adults, especially the elderly, also experience nutritional problems that can be remedied with liquid nutrition. Prepared solutions that are taken orally or through feeding tubes are usually available and ready to use from manufacturers. Nutritional solutions may also be mixed from powders or liquid concentrates. Figure 12-13 shows examples of the three forms of one nutritional formula. Directions on the label detail how much water should be added to the powdered form or liquid concentrate. Nutritionists provide further expertise in creating complex solutions for special patient needs.

As mentioned previously, health care professionals must be alert at all times to the chain of infection. Asepsis in mixing, storage, and use of nutritional liquids is essential. Because they contain

FIGURE 12-13 Nutritional formulas

sugars, such liquids have an increased risk for contamination during preparation and spoilage during storage and use. These are important concepts to teach a patient's family members.

Diluting Ready-to-Use Nutritional Liquids

Ready-to-use nutritional liquids are those solutions that are normally administered directly from the container without any further dilution. Most ready-to-use formulas contain 20 calories per ounce and are used for children and adults. The manufacturer balances the solute (nutrition) and solvent (water) to create a balanced, full-strength solution. However, some children and adults require less than full-strength formula for a short period to normalize intestinal absorption. Nutritional formulas are diluted with sterile water or tap water for oral use. Consult the facility policy regarding the use of tap water to reconstitute nutritional formulas. Let's look at a few typical examples.

EXAMPLE 1 ■

A physician orders **Ensure $\frac{1}{4}$ strength 120 mL q.2h via NG tube × 3 feedings** for a patient who is recovering from gastric surgery. Available are 4 and 8 ounce cans of Ensure ready-to-use formula.

Step 1 Convert Approximate equivalent: 1 oz $=$ 30 mL
$4 \text{ oz} = 4 \times 30 = 120 \text{ mL}$ and $8 \text{ oz} = 8 \times 30 = 240 \text{ mL}$

Step 2 Think You need 120 mL total reconstituted formula for each of 3 feedings. This is a total of $120 \times 3 = 360$ mL. But you must dilute the full-strength formula to $\frac{1}{4}$ strength. You know that $\frac{1}{4}$ strength means 1 part formula to 4 parts solution. The solvent needed is $4 - 1 = 3$ parts water. You will need $\frac{1}{4}$ of the solution as solute ($\frac{1}{4} \times 360 \text{ mL} = 90 \text{ mL}$) and $\frac{3}{4}$ of the solution as solvent ($\frac{3}{4} \times 360 \text{ mL} = 270 \text{ mL}$). Therefore, if you mix 90 mL of full-strength formula with 270 mL of water, you will have 360 mL of $\frac{1}{4}$ strength formula.

Step 3 Calculate

$$\frac{1}{4} \times \frac{X \text{ mL}}{360 \text{ mL}}$$

$$4X = 360$$

$$\frac{4X}{4} = \frac{360}{4}$$

$$X = 90 \text{ mL of full-strength Ensure}$$

You need 90 mL of the formula (solute). Use 90 mL from the 4-oz can because it contains 120 mL. (You will have 30 mL left over.) The amount of solvent needed is 360 − 90 = 270 mL water. Add 270 mL water to 90 mL of full-strength Ensure to make a total of 360 mL of $\frac{1}{4}$ strength Ensure. You now have enough for three full feedings. Administer 120 mL to the patient for each feeding.

EXAMPLE 2 ■

The physician orders *800 mL of $\frac{3}{4}$ strength Sustacal through a gastrostomy tube over 8 hours* to supplement a patient while he sleeps. Sustacal ready-to-use formula comes in 10-ounce cans.

Step 1 **Convert** 1 oz = 30 mL; 10 oz = 10 × 30 = 300 mL

Step 2 **Think** The ordered solution strength is $\frac{3}{4}$. This means "3 parts solute to 4 total parts in solution." You know that $\frac{3}{4}$ of the 800 mL will be solute or full-strength Sustacal ($\frac{3}{4}$ × 800 = 600 mL) and $\frac{1}{4}$ of the solution will be solvent or water ($\frac{1}{4}$ × 800 = 200 mL). This proportion of solute to solvent will reconstitute the Sustacal to the required $\frac{3}{4}$ strength and total volume of 800 mL.

Step 3 **Calculate**

$$\frac{3}{4} \times \frac{X \text{ mL}}{800 \text{ mL}}$$

$$4X = 2{,}400$$

$$\frac{4X}{4} = \frac{2{,}400}{4}$$

$$X = 600 \text{ mL of full-strength Sustacal}$$

You need 600 mL of the formula (solute). Because the 10-ounce can contains 300 mL, you will need 2 cans (600 mL) to prepare the $\frac{3}{4}$ strength Sustacal as ordered. The amount of solvent needed is 800 mL − 600 mL = 200 mL water. Add 200 mL water to 600 mL (or 2 cans) of full-strength Sustacal to make a total of 800 mL of $\frac{3}{4}$ strength Sustacal for the full feeding.

QUICK REVIEW

- *Solute*—a concentrated or solid substance to be dissolved or diluted.
- *Solvent*—or diluent, a liquid substance that dissolves another substance to prepare a solution.
- *Solution*—the resulting mixture of a solute plus a solvent.
- When a fraction expresses the strength of a desired solution to be made from a liquid concentrate:
  - The *numerator* of the fraction is the number of parts of *solute.*
  - The *denominator* of the fraction is the total number of parts of *solution.*
  - The *difference between the denominator and the numerator* is the number of parts of *solvent.*
- To prepare solutions:
  1. Ratio for desired solution strength = $\frac{\text{X Amount of solute}}{\text{Quantity of desired solution}}$
  2. Quantity of desired solution − Amount of solute = Amount of solvent.

Review Set 29

Explain how you would prepare each of the following solutions, using liquid stock hydrogen peroxide as the solute and saline as the solvent.

1. 480 mL of $\frac{1}{3}$ strength for wound irrigation. ______________________________

2. 4 ounces of $\frac{1}{4}$ strength for skin cleansing. ______________________________

3. 240 mL of $\frac{3}{4}$ strength for skeletal pin care. ______

4. 16 ounces of $\frac{1}{2}$ strength for wound care. ______

Explain how you would prepare each of the following from ready-to-use nutritional formulas for the specified time period. Note which supply would require the least discard of unused formula.

5. $\frac{1}{3}$ **strength Ensure 900 mL via NG tube over 9 h.** Supply: Ensure 4, 8, and 12 ounce cans.

______

6. $\frac{1}{4}$ **strength Isomil 4 oz p.o. q.4 h for 24 h.** Supply: Isomil 3, 6, and 12 ounce cans. ______

______

7. $\frac{2}{3}$ **strength Sustacal 300 mL p.o. q.i.d.** Supply: Sustacal 5 and 10 ounce cans. ______

______

8. $\frac{1}{2}$ **strength Ensure 26 oz via gastrostomy tube over 5 h.** Supply: 4, 8, and 12 ounce cans.

______

9. $\frac{1}{2}$ **strength Sustacal 250 mL p.o. q.i.d.** Supply: Sustacal 5 and 10 ounce cans. ______

______

10. $\frac{3}{4}$ **strength Isomil 8 oz p.o. q.4 h for 24 h.** Supply: Isomil 3, 6, and 12 ounce cans. ______

______

11. $\frac{2}{3}$ **strength Ensure 6 oz via gastrostomy tube over 2 h.** Supply: 4, 8, and 12 ounce cans.

______

12. $\frac{1}{4}$ **strength Ensure 16 oz via NG tube over 6 h.** Supply: Ensure 4, 8, and 12 ounce cans.

______

After completing these problems, see pages 501-502 to check your answers.

CRITICAL THINKING SKILLS

Errors in formula dilution occur when the nurse fails to correctly calculate the amount of solute and solvent needed for the required solution strength.

ERROR

Incorrect calculation of solute and solvent.

Possible Scenario

Suppose the physician ordered $\frac{1}{3}$ *strength Isomil 90 mL p.o. q.3h for four feedings* for an infant recovering from gastroenteritis. The concentration will be increased after these feedings. The nurse knows she will give all four feedings during her 12-hour shift, so she makes up 360 mL of formula. She takes a 3-ounce bottle of ready-to-use Isomil and adds three, 3-ounce bottles of water for oral use. She thinks, "One-third means one bottle of formula and three bottles of water. The amount I need even works out!"

Potential Outcome

What the nurse has actually mixed is a $\frac{1}{4}$ strength solution. Because the infant is getting a more dilute solution than intended, the amount of water to solute is increased and the incremental tolerance of more concentrated formula could be jeopardized. Thinking the child is tolerating $\frac{1}{3}$ strength, the physician might increase it to $\frac{2}{3}$ strength, and the infant may have problems digesting this more concentrated formula. His progress could be slowed or even set back.

Prevention

The nurse should have thought through the meaning of the terms of a solution. If so, she would have recognized that $\frac{1}{3}$ strength meant 1 part solute (formula) to 3 total parts of solution with 2 parts water, not 1 part formula to 3 parts water. She should have applied the calculation formula or ratio-proportion to determine the amount of solute (full-strength Isomil) needed and the amount of solvent (water) to add. If she did not know how to prepare the formula, she should have conferred with another nurse or called the pharmacy or dietary services for assistance. Never guess. Think and calculate with accuracy.

CRITICAL THINKING SKILLS

Medication errors are often caused by setting up ratio and proportion problems incorrectly. Let's look at an example to identify the nurse's error.

ERROR

Using the ratio and proportion method of calculation incorrectly.

Possible Scenario

Suppose the physician ordered **Keflex 80 mg p.o. q.i.d.** for a child with an upper respiratory infection, and the Keflex is supplied in an oral suspension with 250 mg per 5 mL. The nurse correctly reconstituted and labeled the medication. She calculated the dosage using the ratio and proportion method and set up the problem this way.

$$\frac{80 \text{ mg}}{5\text{mL}} = \frac{250 \text{ mg}}{\text{X mL}}$$

$$80\text{X} = 1{,}250$$

$$\frac{80\text{X}}{80} = \frac{1{,}250}{80}$$

$$\text{X} = 15.6 \text{ mL}$$

The nurse gave the child 15 mL of Keflex for two doses. The next day as the nurse prepared the medication in the medication room, another nurse observed the nurse pour 15 mL in a medicine cup and asked about the dosage. At that point, the nurse realized the error.

Potential Outcome

The child would likely have developed complications from overdosage of Keflex, such as renal impairment and liver damage. When the physician was notified of the errors, he would likely have ordered the medication discontinued and the child's blood urea nitrogen (BUN) and liver enzymes monitored. An incident report would be filed, and the family notified of the error.

PRACTICE PROBLEMS—CHAPTER 12

Calculate the amount you will prepare for one dose. Indicate the syringe you will select to measure the medication.

1. Order: **Zosyn 2.5 g IV q.8h**

   Supply: 3.375 g vial of powdered Zosyn

   Directions: Reconstitute Zosyn with 5 mL of a diluent from the list for a total solution volume of 5 mL.

   The concentration is ________ g per ________ mL

   Give: ________ mL

   Select: ________ syringe

2. Order: **Ampicillin 500 mg IM q.4h**

   Supply: Ampicillin 500 mg

   Directions: Reconstitute with 1.8 mL diluent for a concentration of 250 mg/mL

   Give: ________ mL

   Select: ________ syringe

Prevention

This type of calculation error occurred because the nurse set up the ratio and proportion problem incorrectly. The dosage on hand and amount on hand were not both set up on the left (or same) side of the proportion. The problem should have been calculated this way:

$$\frac{250\text{ mg}}{5\text{ mL}} = \frac{80\text{ mg}}{X\text{ mL}}$$

$$250X = 400$$

$$\frac{250X}{250} = \frac{400}{250}$$

$$X = 1.6\text{ mL}$$

In addition, had the nurse used Step 2 in the calculation process, the nurse would have realized the dose required was less than 5 mL, not more. In calculating ratio and proportion problems, remember to keep the weight of medication and the amount of the *known* together on the left side of the proportion, and the weight and the amount of the *unknown* together on the right side. In this scenario the patient would have received almost 10 times the amount of medication ordered by the physician each time the nurse committed the error. You know this because there are 250 mg in 5 mL, and the nurse gave 15 mL. You can use ratio and proportion to determine how many mg of Keflex the child received in the scenario.

$$\frac{250\text{ mg}}{5\text{ mL}} = \frac{X\text{ mg}}{15\text{ mL}}$$

$$5X = 3{,}750$$

$$X = 750\text{ mg, not 80 mg as ordered}$$

Obviously the nurse did not think through for the logical amount, and either miscalculated the dosage three times or did not bother to calculate the dosage again, preventing identification of the error.

3. Order: Ancef 500 mg IV q.6h

   Supply: Ancef 1 g

   Directions: Reconstitute with 2.5 mL diluent to yield 3 mL with concentration of 330 mg/mL

   Give: ________ mL

   Select: ________ syringe

4. Order: ceftriaxone sodium 750 mg IV q.6h in 50 mL 5% Dextrose and Water IV solution

   Supply: *See label and package insert for Rocephin IV vial.*

   Add ________ mL diluent to the vial.

   The concentration is ________ mg/mL

   Give: ________ mL

   How many full doses are available in this vial? ________

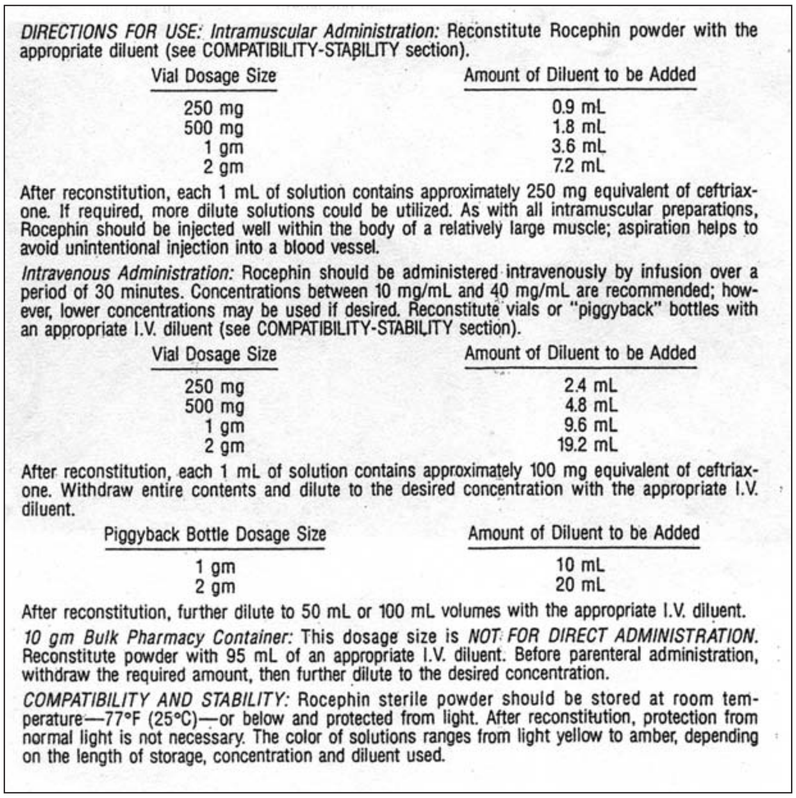
   Select: ________ syringe

ROCEPHIN®

ROCHE

2 g

ceftriaxone sodium injection



DIRECTIONS FOR USE: Intramuscular Administration: Reconstitute Rocephin powder with the appropriate diluent (see COMPATIBILITY-STABILITY section).

Vial Dosage Size	Amount of Diluent to be Added
250 mg	0.9 mL
500 mg	1.8 mL
1 gm	3.6 mL
2 gm	7.2 mL

After reconstitution, each 1 mL of solution contains approximately 250 mg equivalent of ceftriaxone. If required, more dilute solutions could be utilized. As with all intramuscular preparations, Rocephin should be injected well within the body of a relatively large muscle; aspiration helps to avoid unintentional injection into a blood vessel.

Intravenous Administration: Rocephin should be administered intravenously by infusion over a period of 30 minutes. Concentrations between 10 mg/mL and 40 mg/mL are recommended; however, lower concentrations may be used if desired. Reconstitute vials or "piggyback" bottles with an appropriate I.V. diluent (see COMPATIBILITY-STABILITY section).

Vial Dosage Size	Amount of Diluent to be Added
250 mg	2.4 mL
500 mg	4.8 mL
1 gm	9.6 mL
2 gm	19.2 mL

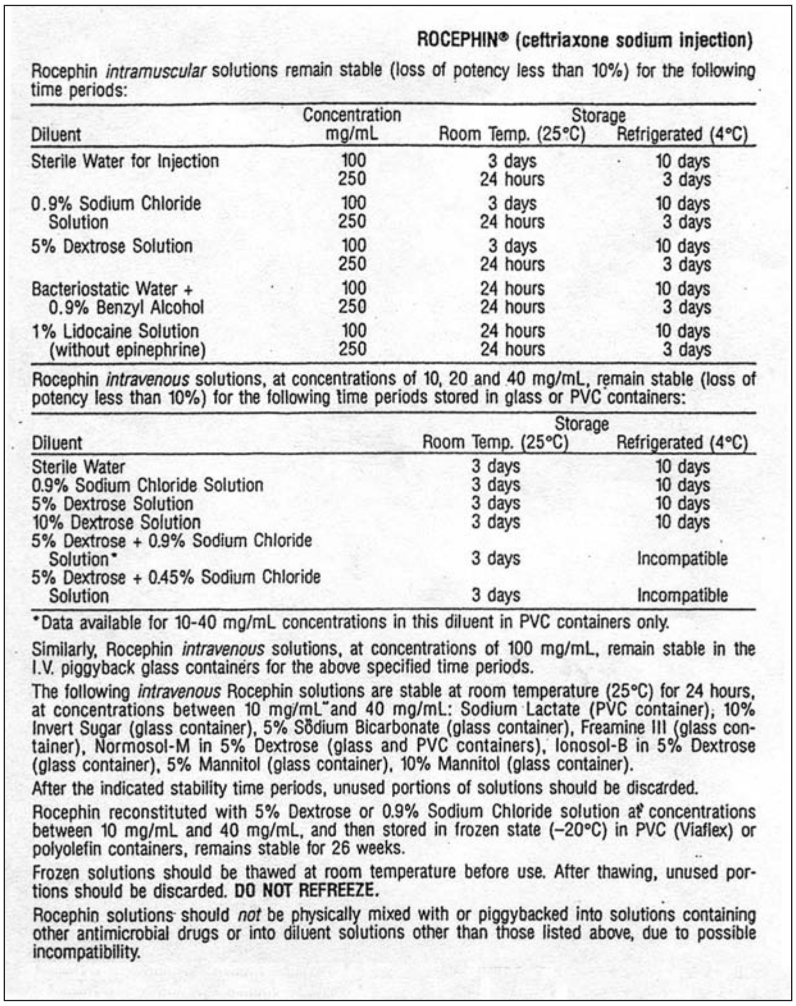
After reconstitution, each 1 mL of solution contains approximately 100 mg equivalent of ceftriaxone. Withdraw entire contents and dilute to the desired concentration with the appropriate I.V. diluent.

Piggyback Bottle Dosage Size	Amount of Diluent to be Added
1 gm	10 mL
2 gm	20 mL

After reconstitution, further dilute to 50 mL or 100 mL volumes with the appropriate I.V. diluent.

10 gm Bulk Pharmacy Container: This dosage size is *NOT FOR DIRECT ADMINISTRATION.* Reconstitute powder with 95 mL of an appropriate I.V. diluent. Before parenteral administration, withdraw the required amount, then further dilute to the desired concentration.

COMPATIBILITY AND STABILITY: Rocephin sterile powder should be stored at room temperature—77°F (25°C)—or below and protected from light. After reconstitution, protection from normal light is not necessary. The color of solutions ranges from light yellow to amber, depending on the length of storage, concentration and diluent used.



ROCEPHIN® (ceftriaxone sodium injection)

Rocephin *intramuscular* solutions remain stable (loss of potency less than 10%) for the following time periods:

		Storage	
Diluent	Concentration mg/mL	Room Temp. (25°C)	Refrigerated (4°C)
Sterile Water for Injection	100	3 days	10 days
	250	24 hours	3 days
0.9% Sodium Chloride Solution	100	3 days	10 days
	250	24 hours	3 days
5% Dextrose Solution	100	3 days	10 days
	250	24 hours	3 days
Bacteriostatic Water + 0.9% Benzyl Alcohol	100	24 hours	10 days
	250	24 hours	3 days
1% Lidocaine Solution (without epinephrine)	100	24 hours	10 days
	250	24 hours	3 days

Rocephin *intravenous* solutions, at concentrations of 10, 20 and 40 mg/mL, remain stable (loss of potency less than 10%) for the following time periods stored in glass or PVC containers:

	Storage	
Diluent	Room Temp. (25°C)	Refrigerated (4°C)
Sterile Water	3 days	10 days
0.9% Sodium Chloride Solution	3 days	10 days
5% Dextrose Solution	3 days	10 days
10% Dextrose Solution	3 days	10 days
5% Dextrose + 0.9% Sodium Chloride Solution*	3 days	Incompatible
5% Dextrose + 0.45% Sodium Chloride Solution	3 days	Incompatible

*Data available for 10-40 mg/mL concentrations in this diluent in PVC containers only.

Similarly, Rocephin *intravenous* solutions, at concentrations of 100 mg/mL, remain stable in the I.V. piggyback glass containers for the above specified time periods.

The following *intravenous* Rocephin solutions are stable at room temperature (25°C) for 24 hours, at concentrations between 10 mg/mL and 40 mg/mL: Sodium Lactate (PVC container), 10% Invert Sugar (glass container), 5% Sodium Bicarbonate (glass container), Freamine III (glass container), Normosol-M in 5% Dextrose (glass and PVC containers), Ionosol-B in 5% Dextrose (glass container), 5% Mannitol (glass container), 10% Mannitol (glass container).

After the indicated stability time periods, unused portions of solutions should be discarded.

Rocephin reconstituted with 5% Dextrose or 0.9% Sodium Chloride solution at concentrations between 10 mg/mL and 40 mg/mL, and then stored in frozen state (–20°C) in PVC (Viaflex) or polyolefin containers, remains stable for 26 weeks.

Frozen solutions should be thawed at room temperature before use. After thawing, unused portions should be discarded. **DO NOT REFREEZE.**

Rocephin solutions should *not* be physically mixed with or piggybacked into solutions containing other antimicrobial drugs or into diluent solutions other than those listed above, due to possible incompatibility.

5. Order: cefepime 500 mg IM q.12h

   Supply: Maxipime (cefepime) 1 g

   Directions: Reconstitute with 2.4 mL diluent for an approximate available volume of 3.6 mL and a concentration of 280 mg/mL.

   Give: ________ mL

   Select: ________ syringe

   How many full doses are available in this vial? ________ dose(s).

   Prepare a reconstitution label for the remaining solution. The drug is stable for up to 7 days refrigerated and 24 hours at controlled room temperature.

   Reconstitution label

6. Order: Synercid 375 mg IV q.8h

   Supply: Synercid 500 mg

   Directions: Reconstitute with 5 mL sterile water for a concentration of 100 mg/mL.

   Give: ________ mL

   Select: ________ syringe

   How many full doses are available in this vial? ________

Calculate one dose of each of the drug orders numbered 7 through 13. The labels shown on pages 276–278 are the medications you have available. Indicate which syringe you would select to measure the dose to be administered. Specify if a reconstitution label is required for multiple-dose vials.

7. Order: Kefzol 300 mg IV q.8h

   Reconstitute with ________ mL diluent for a concentration of ________ mg/mL and give ________ mL.

   Select: ________ syringe

   How many full doses are available in this vial? ________ dose(s)

   Is a reconstitution label required? ________

8. Order: Solu-Medrol 200 mg IV q.6h

   Reconstitute with ________ mL diluent for a concentration of ________ mg/mL and give ________ mL.

   Select: ________ syringe

   How many full doses are available in this vial? ________ dose(s)

   Is a reconstitution label required? ________

9. Order: Tazidime 350 mg IM q.12h

Reconstitute with ________ mL diluent for a concentration of ________ mg/mL and give ________ mL.

Select: ________ syringe

How many full doses are available in this vial? ________ dose(s)

Is a reconstitution label required? ________

10. Order: penicillin G sodium 500,000 units IM q.12h

Reconstitute with ________ mL diluent for a concentration of ________ units/mL and give ________ mL.

Select: ________ syringe

How many full doses are available in this vial? ________ dose(s)

Is a reconstitution label required? ________

11. Order: Fortaz 1.25 g IV q.12h

Reconstitute with ________ mL diluent for a concentration of ________ g per ________ mL and give ________ mL.

Select: ________ syringe

How many full doses are available in this vial? ________ dose(s)

Is a reconstitution label required? ________

12. Order: Vantin 200 mg p.o. q.12h

Reconstitute with ________ mL diluent for a concentration of ________ mg/mL and give ________ mL.

How many full doses are available in this bottle? ________ dose(s)

Is a reconstitution label required? ________

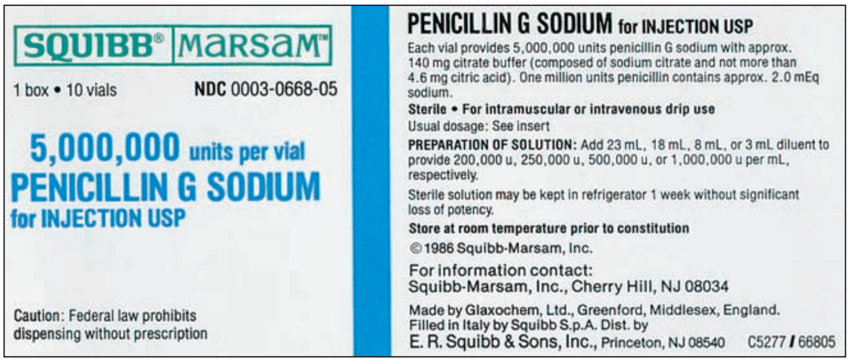
13. Order: Kefzol 400 mg IV q.6h

Reconstitute with ________ mL diluent for a concentration of ________ mg/mL and give ________ mL.

Select: ________ syringe

How many full doses are available in this vial? ________ dose(s)

Is a reconstitution label required? ________



SQUIBB® MARSAM™

1 box • 10 vials NDC 0003-0668-05

5,000,000 units per vial
PENICILLIN G SODIUM
for INJECTION USP

Caution: Federal law prohibits dispensing without prescription

PENICILLIN G SODIUM for INJECTION USP

Each vial provides 5,000,000 units penicillin G sodium with approx. 140 mg citrate buffer (composed of sodium citrate and not more than 4.6 mg citric acid). One million units penicillin contains approx. 2.0 mEq sodium.

Sterile • For intramuscular or intravenous drip use

Usual dosage: See insert

PREPARATION OF SOLUTION: Add 23 mL, 18 mL, 8 mL, or 3 mL diluent to provide 200,000 u, 250,000 u, 500,000 u, or 1,000,000 u per mL, respectively.

Sterile solution may be kept in refrigerator 1 week without significant loss of potency.

Store at room temperature prior to constitution

©1986 Squibb-Marsam, Inc.

For information contact:
Squibb-Marsam, Inc., Cherry Hill, NJ 08034

Made by Glaxochem, Ltd., Greenford, Middlesex, England.
Filled in Italy by Squibb S.p.A. Dist. by
E. R. Squibb & Sons, Inc., Princeton, NJ 08540 C5277 / 66805

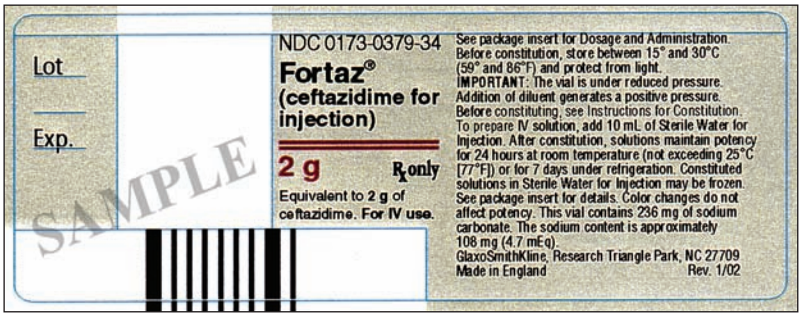
CAUTION—Federal (U.S.A.) law prohibits dispensing without prescription.
For I.M. or I.V. Use
Dosage—See literature.
To prepare solution add 2 mL Sterile Water for Injection or 0.9% Sodium Chloride Injection. Provides an approximate volume of 2.2 mL (225 mg per mL)
SHAKE WELL Protect from Light
Prior to Reconstitution: Store at Controlled Room Temperature 59° to 86°F (15° to 30°C)
After Reconstitution: Store in a refrigerator. For Storage Time - See Accompanying Literature. If kept at room temperature, use within 24 hours.
Lyophilized
WV 4520 AMX
Eli Lilly & Co., Indianapolis, IN 46285, U.S.A.
Exp. Date/Control No.

NDC 0002-1497-01
VIAL No. 767
℞ Lilly
KEFZOL®
STERILE
CEFAZOLIN
SODIUM, USP
Equiv. to
500 mg
Cefazolin

NDC 0002-7230-01
VIAL No. 7230
℞ Lilly
TAZIDIME®
CEFTAZIDIME FOR INJECTION, USP
Equivalent to
500 mg
Ceftazidime Activity

For I.M. or I.V. Use

CAUTION: Addition of diluent generates pressure within the vial. Vent slowly.
For I.V. solution—Dilute with at least 5 mL Sterile Water for Injection or other approved diluent. SHAKE WELL TO DISSOLVE. See literature.
For I.M. solution—Add 1.5 mL of an approved diluent. SHAKE WELL TO DISSOLVE. Provides an approximate volume of 1.8 mL (280 mg per mL). For dosage and administration see literature.
Prior to Reconstitution: Protect from Light: Store at 59° to 86°F.
After Reconstitution: Store in a refrigerator and use within 7 days. If kept at room temperature, use within 24 hours. Once reconstituted, light protection is not needed.
Each vial contains: 500 mg of Ceftazidime and 59 mg of Sodium Carbonate. Sodium content: approximately 27 mg (1.2 mEq) of sodium per vial.
WV 4622 AMX
Eli Lilly & Co., Indianapolis, IN 46285, U.S.A.
Exp. Date/Control No.



Lot
Exp.
SAMPLE

NDC 0173-0379-34
Fortaz®
(ceftazidime for injection)
2 g ℞ only
Equivalent to 2 g of ceftazidime. For IV use.

See package insert for Dosage and Administration.
Before constitution, store between 15° and 30°C (59° and 86°F) and protect from light.
IMPORTANT: The vial is under reduced pressure. Addition of diluent generates a positive pressure. Before constituting, see Instructions for Constitution.
To prepare IV solution, add 10 mL of Sterile Water for Injection. After constitution, solutions maintain potency for 24 hours at room temperature (not exceeding 25°C [77°F]) or for 7 days under refrigeration. Constituted solutions in Sterile Water for Injection may be frozen. See package insert for details. Color changes do not affect potency. This vial contains 236 mg of sodium carbonate. The sodium content is approximately 108 mg (4.7 mEq).
GlaxoSmithKline, Research Triangle Park, NC 27709
Made in England Rev. 1/02

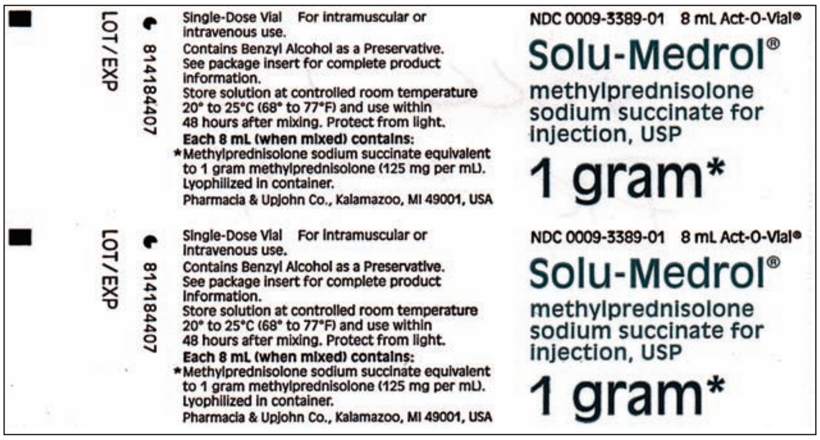
Package insert: "Add 10 mL diluent for 11.5 mL approximate volume and 170 mg/mL approximate ceftazidime concentration."

℞ only
See package insert for dosage and complete product information.
Warning: Not for injection
Store unconstituted product at controlled room temperature 20° to 25°C (68° to 77°F) (see USP). Store constituted suspension in a refrigerator 2° to 8°C (36° to 46°F). Shake well before using. Keep container tightly closed. The mixture may be used for 14 days. Discard unused portion after 14 days.
Directions for mixing: Shake bottle to loosen granules. Add approximately 1/2 the total amount of distilled water required for constitution (total water = 29 mL). Shake vigorously to wet the granules. Add remaining water and shake vigorously.
Each 5 mL of suspension contains cefpodoxime proxetil equivalent to 100 mg cefpodoxime.
U.S. Patent Nos. 4,486,425; 4,409,215
Licensed from Sankyo Company, Ltd., Japan
Manufactured by
Pharmacia & Upjohn S.A.-N.V., Puurs - Belgium
for
Pharmacia & Upjohn Company
Kalamazoo, MI 49001, USA
817 150 101
505358

NDC 0009-3615-03
50 mL (when mixed)
Vantin® *For Oral Suspension*
cefpodoxime proxetil for oral suspension
100 mg per 5 mL
Equivalent to 100 mg per 5 mL cefpodoxime when constituted
Pharmacia &Upjohn

CAUTION—Federal (U.S.A.) law prohibits dispensing without prescription.
For I.M. or I.V. Use
Dosage—See literature.
To prepare solution add 2 mL Sterile Water for Injection or 0.9% Sodium Chloride Injection. Provides an approximate volume of 2.2 mL (225 mg per mL)
SHAKE WELL Protect from Light
Prior to Reconstitution: Store at Controlled Room Temperature 59° to 86°F (15° to 30°C)
After Reconstitution: Store in a refrigerator. For Storage Time - See Accompanying Literature. If kept at room temperature, use within 24 hours.
Lyophilized
WV 4520 AMX
Eli Lilly & Co., Indianapolis, IN 46285, U.S.A.
Exp. Date/Control No.

NDC 0002-1497-01
VIAL No. 767
℞ Lilly
KEFZOL®
STERILE CEFAZOLIN SODIUM, USP
Equiv. to
500 mg
Cefazolin



LOT/EXP
814184407

Single-Dose Vial For intramuscular or intravenous use.
Contains Benzyl Alcohol as a Preservative.
See package insert for complete product information.
Store solution at controlled room temperature 20° to 25°C (68° to 77°F) and use within 48 hours after mixing. Protect from light.
Each 8 mL (when mixed) contains:
*Methylprednisolone sodium succinate equivalent to 1 gram methylprednisolone (125 mg per mL).
Lyophilized in container.
Pharmacia & Upjohn Co., Kalamazoo, MI 49001, USA

NDC 0009-3389-01 8 mL Act-O-Vial®
Solu-Medrol®
methylprednisolone sodium succinate for injection, USP
1 gram*

LOT/EXP
814184407

Single-Dose Vial For intramuscular or intravenous use.
Contains Benzyl Alcohol as a Preservative.
See package insert for complete product information.
Store solution at controlled room temperature 20° to 25°C (68° to 77°F) and use within 48 hours after mixing. Protect from light.
Each 8 mL (when mixed) contains:
*Methylprednisolone sodium succinate equivalent to 1 gram methylprednisolone (125 mg per mL).
Lyophilized in container.
Pharmacia & Upjohn Co., Kalamazoo, MI 49001, USA

NDC 0009-3389-01 8 mL Act-O-Vial®
Solu-Medrol®
methylprednisolone sodium succinate for injection, USP
1 gram*

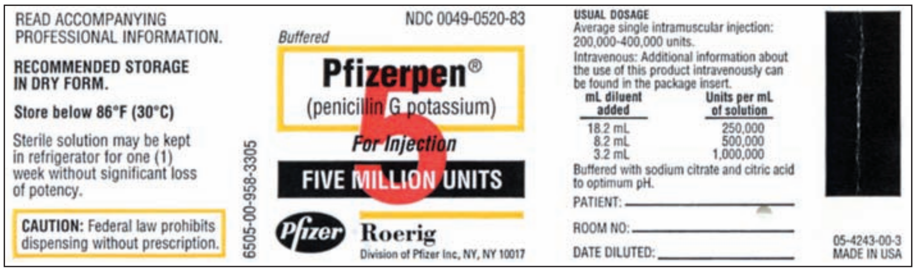
14. Order: Penicillin G potassium 2,000,000 units IM q.8h

Reconstitute with _________ mL diluent for a concentration of _________ units/mL and give _________ mL.

Select: _________ syringe

How many full doses are available in this vial? _________ dose(s)

Is a reconstitution label required? _________



READ ACCOMPANYING PROFESSIONAL INFORMATION.

RECOMMENDED STORAGE IN DRY FORM.

Store below 86°F (30°C)

Sterile solution may be kept in refrigerator for one (1) week without significant loss of potency.

CAUTION: Federal law prohibits dispensing without prescription.

6505-00-958-3305

NDC 0049-0520-83

Buffered

Pfizerpen®

(penicillin G potassium)

For Injection

FIVE MILLION UNITS

Pfizer Roerig

Division of Pfizer Inc, NY, NY 10017

USUAL DOSAGE

Average single intramuscular injection: 200,000-400,000 units.

Intravenous: Additional information about the use of this product intravenously can be found in the package insert.

mL diluent added	Units per mL of solution
18.2 mL	250,000
8.2 mL	500,000
3.2 mL	1,000,000

Buffered with sodium citrate and citric acid to optimum pH.

PATIENT: ____________

ROOM NO: ____________

DATE DILUTED: ____________

05-4243-00-3
MADE IN USA

15. Order: penicillin G potassium 1,000,000 units IM q.8h

Reconstitute with _________ mL diluent for a concentration of _________ units/mL and give _________ mL.

Select: _________ syringe

How many full doses are available in this vial? _________ dose(s)

Is a reconstitution label required? _________

READ ACCOMPANYING PROFESSIONAL INFORMATION

RECOMMENDED STORAGE IN DRY FORM

STORE BELOW 86°F (30°C)

Sterile solution may be kept in refrigerator for one (1) week without significant loss of potency.

MADE IN U.S.A.

05-4242-00-3

6505-00-664-7116

NDC 0049-0510-83

Buffered

Pfizerpen®

penicillin G potassium

For Injection

ONE MILLION UNITS

CAUTION: Federal law prohibits dispensing without prescription.

ROERIG Pfizer

A division of Pfizer Inc., N.Y., N.Y. 10017

USUAL DOSAGE

Average single intramuscular injection: 200,000-400,000 units.

Intravenous: Additional information about the use of this product intravenously can be found in the package insert.

ml diluent added	Units per ml of solution
20.0 ml	50,000
10.0 ml	100,000
4.0 ml	250,000
1.8 ml	500,000

Buffered with sodium citrate and citric acid to optimum pH.

PATIENT: ____________

ROOM NO.: ____________

DATE DILUTED: ____________

Explain how you would prepare each of the following hydrogen peroxide (solute) and normal saline (solvent) irrigation orders:

16. 16 ounces of $\frac{1}{8}$ strength solution ______________________________

17. 320 mL of $\frac{3}{8}$ strength solution ______________________________

18. 80 mL of $\frac{5}{8}$ strength solution ______________________________

19. 18 ounces of $\frac{2}{3}$ strength solution ______________________________

20. 1 pt of $\frac{7}{8}$ strength solution ______________________________

21. 1 L of $\frac{1}{4}$ strength solution ______________________________

Explain how you would prepare each of the following from ready-to-use nutritional formulas for the specified time period. Note how many cans or bottles of supply are needed and how much unused formula would remain from the used supply.

22. Order: **$\frac{1}{4}$ strength Enfamil 12 mL via NG tube q.h. for 10 hours**

    Supply: Enfamil 3-ounce bottles.

23. Order: **$\frac{3}{4}$ strength Sustacal 360 mL over 4 hours via gastrostomy**

    Supply: Sustacal 10-ounce cans

24. Order: **$\frac{2}{3}$ strength Ensure. Give 90 mL q.h. for 5 hours via NG tube.**

    Supply: Ensure 8-ounce cans

25. Order: **$\frac{3}{8}$ strength Enfamil.** Three patients need 32 ounces of the $\frac{3}{8}$ strength Enfamil for one feeding each.

    Supply: Enfamil 6-ounce bottles

26. Order: **$\frac{1}{8}$ strength Ensure. Give 160 mL stat via NG tube**

    Supply: Ensure 4-ounce cans

27. Order: **$\frac{1}{2}$ strength Ensure 55 mL hourly for 10 hours via gastrostomy tube**

    Supply: Ensure 12-ounce cans

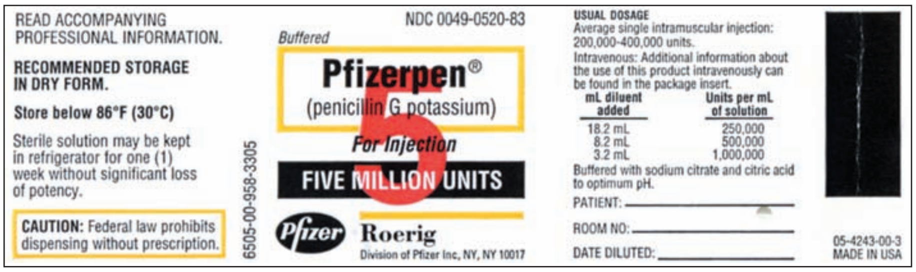
The nurse is making up $\frac{1}{4}$ strength Enfamil formula for several infants in the nursery.

28. If 8-ounce cans of ready-to-use Enfamil are available, how many cans of formula will be needed to make 48 ounces of reconstituted $\frac{1}{4}$ strength Enfamil? ________ can(s)

29. How many ounces of water will be added to the Enfamil in question 28 to correctly reconstitute the $\frac{1}{4}$ strength Enfamil? ________ ounce(s)

30. Describe the strategy you would implement to prevent this medication error.

    Possible Scenario
    Suppose a physician ordered **penicillin G potassium 1,000,000 units IM stat** for a patient with a severe staph infection. Look at the label of the medication available on hand.



READ ACCOMPANYING PROFESSIONAL INFORMATION.

RECOMMENDED STORAGE IN DRY FORM.

Store below 86°F (30°C)

Sterile solution may be kept in refrigerator for one (1) week without significant loss of potency.

CAUTION: Federal law prohibits dispensing without prescription.

6505-00-958-3305

NDC 0049-0520-83

Buffered

Pfizerpen®

(penicillin G potassium)

For Injection

FIVE MILLION UNITS

5

Pfizer Roerig

Division of Pfizer Inc, NY, NY 10017

USUAL DOSAGE
Average single intramuscular injection: 200,000-400,000 units.
Intravenous: Additional information about the use of this product intravenously can be found in the package insert.

mL diluent added	Units per mL of solution
18.2 mL	250,000
8.2 mL	500,000
3.2 mL	1,000,000

Buffered with sodium citrate and citric acid to optimum pH.

PATIENT: ____________

ROOM NO: ____________

DATE DILUTED: ____________

05-4243-00-3
MADE IN USA

The nurse, in a hurry to give the stat medication, selected the first concentration given on the label: 250,000 units/mL. Next the nurse calculated the dosage this way.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{250{,}000 \text{ units}}{1 \text{ mL}} = \frac{1{,}000{,}000 \text{ units}}{\text{X mL}}$$

$$250{,}000\text{X} = 1{,}000{,}000$$

$$\frac{250{,}000\text{X}}{250{,}000} = \frac{1{,}000{,}000}{250{,}000}$$

$$\text{X} = 4 \text{ mL}$$

The nurse added 18.2 mL diluent to the vial and drew up 4 mL of medication. It was not until the nurse drew up the 4 mL that the error was recognized. The nurse realized that 4 mL IM should not be administered in one injection site. The nurse called the pharmacy for another vial of penicillin G and prepared the dose again, using 3.2 mL of diluent for a concentration of 1,000,000 units/mL. To give 1,000,000 units the nurse easily calculated to give 1 mL, which was a safe volume of medication for IM injection in adults.

Potential Outcome

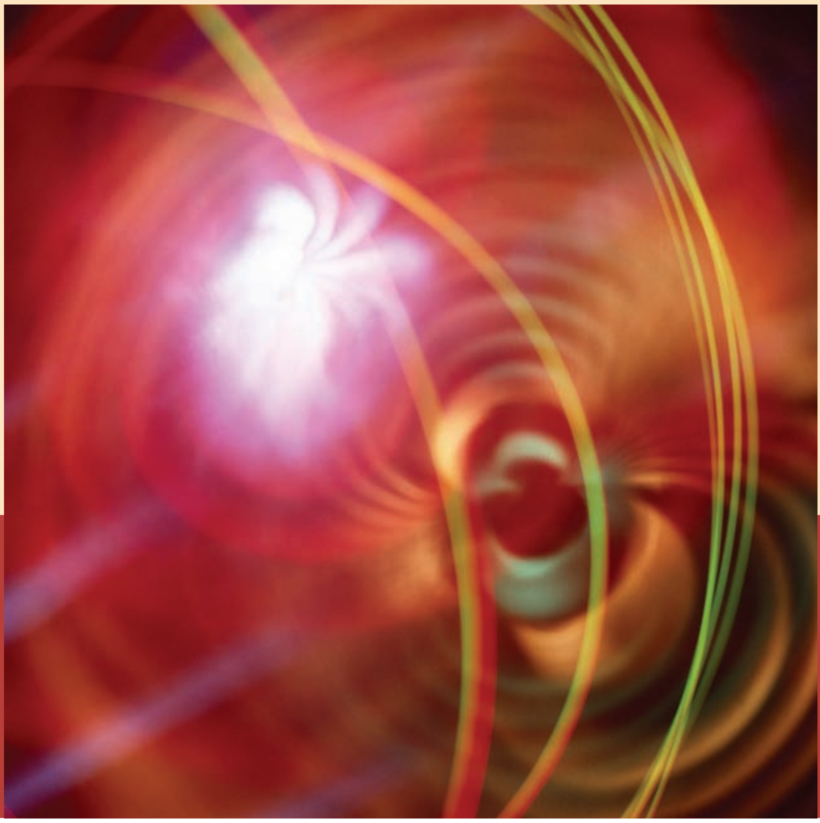
Had the nurse given the 4 mL in one intramuscular injection, the patient would likely have developed an abscess at the site, because of the excessive volume of medication being given into the muscle. The patient's hospital stay would likely have been lengthened. Further, the nurse and the hospital may have faced a malpractice suit. The alternative would have been to divide the dose into two injections. Although the patient would have received the correct dosage, to give two injections when only one was necessary would have been poor nursing judgment.

Prevention

____

____

After completing these problems, see pages 502-504 to check your answers.



13

Pediatric and Adult Dosages Based on Body Weight

OBJECTIVES

Upon mastery of Chapter 13, you will be able to calculate drug dosages based on body weight and verify the safety of medication orders. To accomplish this you will also be able to:

- Convert pounds to kilograms.
- Consult a reputable drug resource to calculate the recommended safe dosage per kilogram of body weight.
- Compare the ordered dosage with the recommended safe dosage.
- Determine whether the ordered dosage is safe to administer.
- Apply body weight dosage calculations to patients across the life span.

Only a doctor, dentist, physician assistant, or nurse practitioner (in some states) may prescribe the dosage of medications. However, before administering a drug, the nurse should know if the ordered dosage is safe. This is important for all patients, but of the utmost importance to infants, children, frail elderly, and critically ill adults.

CAUTION

Those who administer drugs to patients are legally responsible for recognizing incorrect and unsafe dosages and for alerting the prescribing practitioner.

The one who administers a drug is just as responsible for the patient's safety as the one who prescribes it. For the protection of the patient and yourself, you must familiarize yourself with the recommended dosage of drugs or consult a reputable drug reference, such as the *package insert* that accompanies the drug or the *Hospital Formulary.*

Standard adult dosage is determined by the drug manufacturer. Dosage is usually recommended based on the requirements of an average-weight adult. Frequently an adult range is given, listing a minimum and maximum safe dosage, allowing the nurse to simply compare what is ordered to what is recommended.

Dosages for infants and children are based on their unique and changing body differences. The prescribing practitioner must consider the weight, height, body surface, age, and condition of the child as contributing factors to safe and effective medication dosages. The two methods currently used for calculating safe pediatric dosages are *body weight* (such as mg/kg) and *body surface area* (BSA, measured in square meters, m^2). The body weight method is more common in pediatric situations and is emphasized in this chapter. The BSA method is based on both weight and height. It is used primarily in oncology and critical care situations. BSA is discussed in Chapter 15. Although used most frequently in pediatrics, both the body weight and BSA methods are also used for adults, especially in critical care situations. The calculations are the same.

ADMINISTERING MEDICATIONS TO CHILDREN

Numerically, the infant's or child's dosage appears smaller, but proportionally pediatric dosages are frequently much larger per kilogram of body weight than the usual adult dosage. Infants—birth to 1 year—have a greater percentage of body water and diminished ability to absorb water-soluble drugs, necessitating dosages of oral and some parenteral drugs that are higher than those given to persons of larger size. Children—age 1 to 12 years—metabolize drugs more readily than adults, which necessitates higher dosages. Both infants and children, however, are growing, and their organ systems are still maturing. Immature physiological processes related to absorption, distribution, metabolism, and excretion put them continuously at risk for overdose, toxic reactions, and even death. Adolescents—age 13 to 18 years—are often erroneously thought of as adults because of their body weight (greater than 110 pounds or 50 kilograms) and mature physical appearance. In fact, they should still be regarded as physiologically immature, with unpredictable growth spurts and hormonal surges. Drug therapy for the pediatric population is further complicated because little detailed pharmacologic research has been done on children and adolescents. The infant or child, therefore, must be frequently evaluated for desired clinical responses to medications, and serum drug levels are needed to help adjust some drug dosages. It is important to remember that administration of an incorrect dosage to adult patients is dangerous, but with a child, the risk is even greater. Therefore, using a reputable drug reference to verify safe pediatric dosages is a critical health care skill.

A well-written drug reference written especially for pediatrics is *Pediatric Drug Guide with Nursing Implications,* by Ruth McGillis Bindler et al., 2004, Upper Saddle River, NJ: Prentice Hall. There are also a variety of pocket-size pediatric drug handbooks. Two widely used handbooks are *Johns Hopkins Hospital: The Harriet Lane Handbook* (17th ed.), Johns Hopkins Hospital, 2005, St. Louis: Mosby-Year Book, Inc., and *Pediatric Dosage Handbook: Including Neonatal Dosing, Drug Administration, & Extemporaneous Preparations* (12th ed.), by Carol K. Taketomo, et al., 2005, Cleveland: LEXI-COMP.

CONVERTING POUNDS TO KILOGRAMS

The body weight method uses calculations based on the person's weight in kilograms. Recall that the pounds to kilograms conversion was introduced in Chapter 4.

REMEMBER

1 kg = 2.2 lb and **1 lb = 16 oz**
Simply stated, weight in pounds is approximately twice the metric weight in kg; or weight in kg is approximately $\frac{1}{2}$ of weight in pounds. You can estimate kg by halving the weight in lb.

MATH TIP

When converting pounds to kilograms, round kilogram weight to one decimal place (tenths).

EXAMPLE 1 ■

Convert 45 lb to kg

Approximate equivalent: 1 kg = 2.2 lb

$$
\begin{aligned}
\text{Think: } \tfrac{1}{2} \text{ of } 45 &= \text{approximately } 23 \\
\frac{1\text{ kg}}{2.2\text{ lb}} &\times \frac{X\text{ kg}}{45\text{ lb}} \\
2.2X &= 45 \\
\frac{2.2X}{2.2} &= \frac{45}{2.2} \\
X &= 20.5\text{ kg}
\end{aligned}
$$

EXAMPLE 2 ■

Convert 10 lb 12 oz to kg

Approximate equivalents: 1 kg = 2.2 lb
1 lb = 16 oz

First convert ounces to pounds.

$$
\begin{aligned}
\frac{1\text{ lb}}{16\text{ oz}} &\times \frac{X\text{ lb}}{12\text{ oz}} \\
16X &= 12 \\
\frac{16X}{16} &= \frac{12}{16} \\
X &= \frac{3}{4}\text{ lb}
\end{aligned}
$$

Now you know that 10 lb 12 oz = $10\frac{3}{4}$ lb

Now you are ready to convert $10\frac{3}{4}$ lb to kg. Because you are converting to the metric system, your answer must be in decimals.

$$
\begin{aligned}
\text{Think: } \tfrac{1}{2} \text{ of } 10\tfrac{3}{4} &= \text{approximately } 5 \\
10\tfrac{3}{4} &= 10.75 \\
\frac{1\text{ kg}}{2.2\text{ lb}} &\times \frac{X\text{ kg}}{10.75\text{ lb}} \\
2.2X &= 10.75 \\
\frac{2.2X}{2.2} &= \frac{10.75}{2.2} \\
X &= 4.88 = 4.9
\end{aligned}
$$

BODY WEIGHT METHOD FOR CALCULATING SAFE PEDIATRIC DOSAGE

The most common method of prescribing and administering the therapeutic amount of medication for a child is to calculate the amount of drug according to the child's body weight in **kilograms.** The nurse then compares the child's ordered dosage to the recommended safe dosage from a reputable drug resource before administering the medication. The intent is to ensure that the ordered dosage is safe and effective before calculating the amount to give and administering the dose to the patient.

RULE

To verify safe pediatric dosage:

1. Convert the child's weight from pounds to kilograms (rounded to tenths).
2. Calculate the safe dosage in mg/kg or mcg/kg (rounded to tenths) for a child of this weight, as recommended by a reputable drug reference: **Ratio for recommended mg/kg = Ratio for desired mg/kg;** or simply **multiply mg/kg by child's weight in kg.**
3. Compare the ordered dosage to the recommended dosage, and decide if the dosage is safe.
4. If safe, calculate the amount to give and administer the dose; if the dosage seems unsafe, consult with the ordering practitioner before administering the drug.

NOTE: The dosage per kg may be mg/kg, mcg/kg, g/kg, mEq/kg, unit/kg, milliunit/kg, etc.

For each pediatric medication order, you must ask yourself, "Is this dosage safe?" Let's work through some examples.

Single-Dosage Drugs

EXAMPLE ■

Single-dosage drugs are intended to be given once or p.r.n. Dosage ordered by the body weight method is based on **mg/kg/dose, calculated by multiplying the recommended mg by the patient's kg weight for each dose.**

The physician orders **morphine sulfate 1.8 mg IM stat.** The child weighs 79 lb. You need to determine if this dosage is safe.

1. **Convert lb to kg.** Approximate equivalent: 1 kg = 2.2 lb

   Think: $\frac{1}{2}$ of 79 = approximately 40

   $$\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{79\text{ lb}}$$

   $$2.2\,X = 79$$

   $$\frac{2.2X}{2.2} = \frac{79}{2.2}$$

   $$X = 35.9\text{ kg}$$

2. **Calculate mg/kg as recommended by a reputable drug resource.** A reputable drug resource indicates that the usual IM or subcut dosage may be initiated at 0.05 mg/kg/dose.

   Use ratio and proportion to calculate how many mg per dose of the medication to administer.

For each dose: Ratio for recommended mg/kg = Ratio for desired mg/kg

$$\begin{aligned} \frac{0.05 \text{ mg}}{1 \text{ kg}} &\times \frac{\text{X mg}}{35.9 \text{ kg}} \\ \text{X} &= 0.05 \times 35.9 \\ \text{X} &= 1.79 \text{ mg} = 1.8 \text{ mg (per dose)} \end{aligned}$$

Or, you can simply multiply mg/kg/dose by the child's weight in kg.

MATH TIP

Notice that the kg unit of measurement cancels out, leaving the unit as mg/dose.

$$\frac{\text{mg}/\cancel{\text{kg}}}{\text{dose}} \times \cancel{\text{kg}} = \text{mg/dose}$$

Or,

$$\text{mg}/\cancel{\text{kg}}/\text{dose} \times \cancel{\text{kg}} = \text{mg/dose}$$

Per dose: 0.05 mg/$\cancel{\text{kg}}$/dose × 35.9 $\cancel{\text{kg}}$ = 1.79 mg/dose = 1.8 mg/dose

3. **Decide if the dosage is safe by comparing ordered and recommended dosages.** For this child's weight, 1.8 mg is the recommended dosage, and 1.8 mg is the ordered dosage. Yes, the dosage is safe.

4. **Calculate one dose.** Apply the three steps of dosage calculation.

Order: morphine sulfate 1.8 mg IM stat

Supply: morphine sulfate 5 mg/mL (Figure 13-1)

FIGURE 13-1
Morphine label

NDC 10019-176-44
Morphine
Sulfate Inj., USP
5 mg/mL
FOR SC, IM OR
SLOW IV USE
1 mL DOSETTE® Vial
PROTECT FROM LIGHT
DO NOT USE
IF PRECIPITATED
Mfd. for an affiliate of
Baxter Healthcare Corporation
by: Elkins-Sinn
Cherry Hill, NJ 08003
400-823-01
Lot:
Exp.:

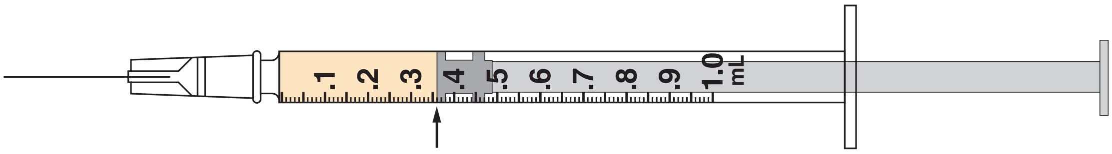
Step 1 **Convert** No conversion is necessary.

Step 2 **Think** You want to give less than 1 mL. Estimate that you want to give less than 0.5 mL.

Step 3 **Calculate**

$$\begin{aligned} \frac{\text{Dosage on hand}}{\text{Amount on hand}} &= \frac{\text{Dosage desired}}{\text{X Amount desired}} \\ \frac{5 \text{ mg}}{1 \text{ mL}} &\times \frac{1.8 \text{ mg}}{\text{X mL}} \\ 5\text{X} &= 1.8 \\ \frac{5\text{X}}{5} &= \frac{1.8}{5} \\ \text{X} &= 0.36 \text{ mL} \end{aligned}$$

This is a small, child's dose. Measure 0.36 mL in a 1 mL syringe. Route is IM. Needle may need to be changed.



0.36 mL

Single-Dosage Range

EXAMPLE ■

Some single-dosage medications indicate a minimum and maximum range, or a safe dosage range.

The practitioner orders **Vistaril 20 mg IM q.4h, p.r.n., nausea.** The child weighs 44 lb. Is this a safe dosage?

1. **Convert lb to kg.** Approximate equivalent: 1 kg = 2.2 lb

$$\text{Think: } \frac{1}{2} \text{ of } 44 = 22$$

$$\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{44\text{ lb}}$$

$$2.2\,X = 44$$

$$\frac{2.2\,X}{2.2} = \frac{44}{2.2}$$

$$X = 20\text{ kg}$$

2. **Calculate recommended dosage.** A reputable drug resource indicates that the usual IM dosage is 0.5 mg to 1 mg/kg/dose every 4 hours as needed. Notice that the recommended dosage is represented as a range of "0.5–1 mg/kg/dose" for dosing flexibility. Calculate the minimum and maximum safe dosage range.

   Use ratio-proportion to calculate mg/kg range for each dose.

$$\text{Minimum recommended mg/kg} = \text{Minimum desired mg/kg}$$

$$\frac{0.5\text{ mg}}{1\text{ kg}} \times \frac{X\text{ mg}}{20\text{ kg}}$$

$$X = 0.5 \times 20$$

$$X = 10\text{ mg (per dose)}$$

$$\text{Maximum recommended mg/kg} = \text{Maximum desired mg/kg}$$

$$\frac{1\text{ mg}}{1\text{ kg}} \times \frac{X\text{ mg}}{20\text{ kg}}$$

$$X = 1 \times 20$$

$$X = 20\text{ mg (per dose)}$$

   Or, you can simply multiply mg/kg/dose × the child's weight in kg.

   Minimum per dose: $0.5\text{ mg/}\cancel{\text{kg}}\text{/dose} \times 20\ \cancel{\text{kg}} = 10\text{ mg/dose}$

   Maximum per dose: $1\text{ mg/}\cancel{\text{kg}}\text{/dose} \times 20\ \cancel{\text{kg}} = 20\text{ mg/dose}$

3. **Decide if the ordered dosage is safe.** The recommended dosage range is 10 mg to 20 mg, and the ordered dosage of 20 mg is within this range. Yes, the ordered dosage is safe.

4. **Calculate one dose.** Apply the three steps of dosage calculation.

   Order: **Vistaril 20 mg IM q.4h p.r.n., nausea**

   Supply: Vistaril 50 mg/mL (Figure 13-2)

FIGURE 13-2 Vistaril label

FOR INTRAMUSCULAR USE ONLY.

USUAL ADULT DOSE: Intramuscularly: 25 - 100 mg stat; repeat every 4 to 6 hours, as needed.

See accompanying prescribing information.

Each mL contains **50 mg** of hydroxyzine hydrochloride, 0.9% benzyl alcohol and sodium hydroxide to adjust to optimum pH.

To avoid discoloration, protect from prolonged exposure to light.

Rx only

10 mL NDC 0049-5460-74

Vistaril®
(hydroxyzine hydrochloride)

Intramuscular Solution

50 mg/mL

Pfizer Roerig
Division of Pfizer Inc, NY, NY 10017

Store below 86°F (30°C).

PROTECT FROM FREEZING.

PATIENT: ______________

ROOM NO.: ______________

05-1111-32-4
MADE IN USA
9249

Step 1 **Convert** No conversion is necessary.

Step 2 **Think** Estimate that you want to give less than 1 mL; in fact, you want to give less than 0.5 mL.

Step 3 Calculate $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

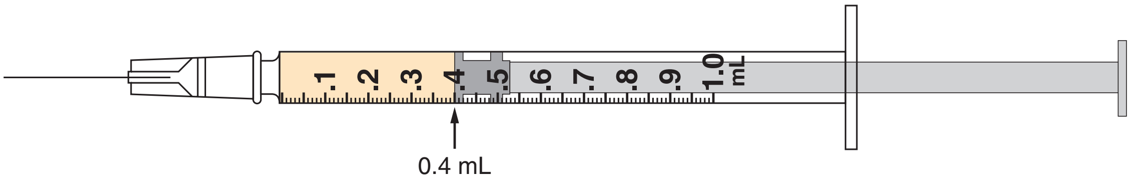
$$\frac{50\text{ mg}}{1\text{ mL}} \times \frac{20\text{ mg}}{\text{X mL}}$$

$$50\text{X} = 20$$

$$\frac{50\text{X}}{50} = \frac{20}{50}$$

$$\text{X} = 0.4\text{ mL}$$

This is a small, child's dose. Measure it in a 1 mL syringe. Route is IM. Needle may need to be changed.



Routine or Round-the-Clock Drugs

EXAMPLE ■

Routine or round-the-clock drugs are intended to produce a continuous effect on the body over 24 hours. They are recommended as a *total daily dosage:* **mg/kg/day to be divided into some number of individual doses,** such as "three divided doses," "four divided doses," "divided doses every 8 hours," and so on. "Three divided doses" means the drug total daily dosage is divided equally and is administered three times per day, either t.i.d. or q.8h. Likewise, "four divided doses" means the total daily drug dosage is divided equally and administered four times per day either q.i.d. or q.6h. Recommendations such as "divided doses every 8 hours" specifies that the total daily drug dosage should be divided equally and administered q.8h.

The practitioner orders **Ceclor 100 mg p.o. t.i.d.** The child weighs $33\frac{1}{2}$ lb. Is this dosage safe?

1. **Convert lb to kg.** Approximate equivalent: 1 kg = 2.2 lb

   Think: $\frac{1}{2}$ of 33 = approximately 17

   Represent $33\frac{1}{2}$ as 33.5 because you are converting lb to kg (metric measure) and the answer must be in decimals.

   $$\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{\text{X kg}}{33.5\text{ lb}}$$

   $$2.2\text{X} = 33.5$$

   $$\frac{2.2\text{X}}{2.2} = \frac{33.5}{2.2}$$

   $$\text{X} = 15.2\text{ kg}$$

2. **Calculate recommended dosage.** Figure 13-3 shows the recommended dosage on the drug label, "Usual dose—Children, 20 mg per kg a day . . . in three divided doses." First, calculate the total daily dosage: 20 mg/$\cancel{\text{kg}}$/day × 15.2 $\cancel{\text{kg}}$ = 304 mg/day. Then, divide this total daily dosage into 3 doses: 304 mg ÷ 3 doses = 101.3 mg/dose.

3. **Decide if the ordered dosage is safe.** Yes, the ordered dosage is safe, because this is an *oral* dose and 100 mg is a *reasonably safe* dosage for a 101.3 mg recommended single dosage.

FIGURE 13-3 Ceclor label

4. **Calculate one dose.** Apply the three steps of dosage calculation.

   Order: **Ceclor 100 mg p.o. t.i.d.**

   Supply: Ceclor 125 mg/5 mL

Step 1 Convert No conversion is necessary.

Step 2 Think You want to give less than 5 mL. Estimate that you want to give between 2.5 mL and 5 mL.

Step 3 Calculate

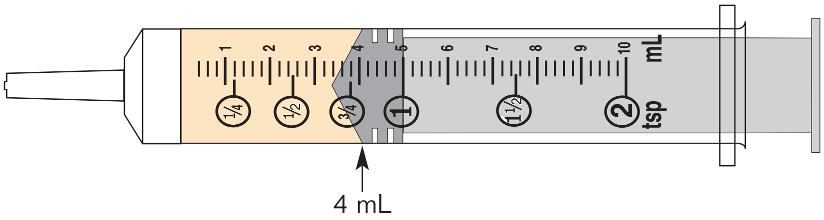
$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{125\text{ mg}}{5\text{ mL}} \times \frac{100\text{ mg}}{\text{X mL}}$$

$$125\text{X} = 500$$

$$\frac{125\text{X}}{125} = \frac{500}{125}$$

$$\text{X} = 4\text{ mL}$$



Total Daily Dosage Range per Kilogram

EXAMPLE ■

Many medications are recommended by a minimum and maximum mg/kg range per day to be divided into some number of doses. Amoxicillin is an antibiotic that is used to treat a variety of infections in adults and children. It is often given in divided doses round-the-clock for a total daily dosage.

Suppose the physician orders **amoxicillin 200 mg p.o. q.8h** for an infant who weighs 22 lb. Is this dosage safe?

1. **Convert lb to kg.** Approximate equivalent: 1 kg = 2.2 lb

$$\begin{array}{rcl} \text{Think: } \frac{1}{2} \text{ of } 22 & = & 11 \\ \frac{1 \text{ kg}}{2.2 \text{ lb}} & \times & \frac{X \text{ kg}}{22 \text{ lb}} \\ 2.2X & = & 22 \\ \frac{2.2X}{2.2} & = & \frac{22}{2.2} \\ X & = & 10 \text{ kg} \end{array}$$

2. **Calculate recommended dosage.** Look at the label for Amoxil (amoxicillin), Figure 13-4. The label describes the recommended dosage as "20 to 40 mg/kg/day in divided doses every 8 hours . . . ."

FIGURE 13-4 Amoxil label

Calculate the minimum and maximum dosage for each single dose. The label recommends that the total daily dosage be divided and administered every 8 hours, resulting in three doses in 24 hours.

Minimum total daily dosage: 20 mg/$\cancel{\text{kg}}$/day × 10 $\cancel{\text{kg}}$ = 200 mg/day

Minimum dosage for each single dose: 200 mg ÷ 3 doses = 66.7 mg/dose

Maximum total daily dosage: 40 mg/$\cancel{\text{kg}}$/day × 10 $\cancel{\text{kg}}$ = 400 mg/day

Maximum dosage for each single dose: 400 mg ÷ 3 doses = 133.3 mg/dose

The single dosage range is 66.7 to 133.3 mg/dose.

3. **Decide if the ordered dosage is safe.** The ordered dosage is 200 mg, and the allowable, safe dosage is 66.7 to 133.3 mg/dose. No, this dosage is too high and is not safe.
4. **Contact the prescriber to discuss the order.**

You can save yourself a calculation step with the following shortcut, based on the total daily dosage.

Calculate recommended minimum and maximum daily dosage range for *this* child.

You know the total daily dosage is divided into three doses in 24 hours.

Minimum total daily dosage: 20 mg/$\cancel{\text{kg}}$/day × 10 $\cancel{\text{kg}}$ = 200 mg/day

Maximum total daily dosage: 40 mg/$\cancel{\text{kg}}$/day × 10 $\cancel{\text{kg}}$ = 400 mg/day

Daily dosage per this order: 200 mg/$\cancel{\text{dose}}$ × 3 $\cancel{\text{doses}}$/day = 600 mg/day

Decide if the ordered daily dosage is safe. The ordered daily dosage is 600 mg, and the allowable safe daily dosage is 200 to 400 mg/day. No, the dosage ordered is too high and is not safe. It could result in serious harm to the infant, including renal damage, especially if this is continued for the full course of therapy. Further, the nurse who administered the dosage would be liable for any patient harm.

Total Daily Dosage Range per Kilogram with Maximum Daily Allowance

EXAMPLE ■

Some medications have a range of mg/kg/day recommended, with a maximum allowable total amount per day also specified.

The physician orders **cefazolin 2.1 g IV q.8h** for a child with a serious joint infection. The child weighs 95 lb. The drug reference indicates that the usual IM or IV dosage of cefazolin for infants and children is 50 to 100 mg/kg/day divided every 8 hours; maximum dosage is 6 g/day. This means that regardless of how much the child weighs, the maximum safe allowance of this drug is 6 g per 24 hours.

1. **Convert lb to kg.** Approximate equivalent: 1 kg = 2.2 lb

   Think: $\frac{1}{2}$ of 95 = approximately 48

   $$\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{95\text{ lb}}$$

   $$2.2X = 95$$

   $$\frac{2.2X}{2.2} = \frac{95}{2.2}$$

   $$X = 43.2\text{ kg}$$

2. **Calculate recommended dosage.**

   Minimum mg/kg/day: 50 mg/$\cancel{\text{kg}}$/day × 43.2 $\cancel{\text{kg}}$ = 2,160 mg/day

   Minimum mg/dose: 2,160 mg ÷ 3 doses = 720 mg/dose or 0.72 g/dose (1 g = 1,000 mg)

   Maximum mg/kg/day: 100 mg/$\cancel{\text{kg}}$/day × 43.2 $\cancel{\text{kg}}$ = 4,320 mg/day, which is still below the maximum allowable per day dosage of 6 g or 6,000 mg.

   Maximum mg/dose: 4,320 mg ÷ 3 doses = 1,440 mg/dose or 1.44 g/dose

3. **Decide if the dosage is safe.** No, the dosage is too high. It exceeds both the highest mg/kg/dose extreme of the range (1,440 mg/dose), and it exceeds the maximum allowable dosage. At 6 g/day, no more than 2 g/dose would be allowed. The ordered dosage of 2.1 g is not safe, because 3 doses/day would deliver 6.3 g of the drug (2.1 g × 3 = 6.3 g). This example points out the importance of carefully reading all dosage recommendations.

4. **Contact the prescriber to discuss the order.**

Underdosage

EXAMPLE ■

Underdosage, as well as overdosage, can be a hazard. If the medication is necessary for the treatment or comfort of the patient, then giving too little can be just as hazardous as giving too much. Dosage that is less than the recommended therapeutic amount is also considered unsafe, because it may be ineffective.

The nurse notices a baby's fever has not come down below 102.6°F in spite of several doses of ibuprofen that the physician ordered as an antipyretic (fever reducer). The order reads **ibuprofen 40 mg p.o. q.6h p.r.n., temp 101.6°F and above.** The 7-month-old baby weighs $17\frac{1}{2}$ lb.

1. **Convert lb to kg.** Approximate equivalent: 1 kg = 2.2 lb.

   Think: $\frac{1}{2}$ of $17\frac{1}{2}$ = approximately 9

   Represent $17\frac{1}{2}$ as 17.5 because you are converting lb to kg; kg is metric measured in decimals.

$$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{\text{X kg}}{17.5 \text{ lb}}$$

$$2.2\text{X} = 17.5$$

$$\frac{2.2\text{X}}{2.2} = \frac{17.5}{2.2}$$

$$\text{X} = 8 \text{ kg}$$

2. **Calculate safe dosage.** The drug reference states "Usual dosage . . . oral: Children: . . . Antipyretic: 6 months–12 years: Temperature less than 102.5°F (39°C) 5 mg/kg/dose; temperature greater than 102.5°F: 10 mg/kg/dose; given every 6–8 hr; Maximum daily dose: 40 mg/kg/day."

   The recommended safe mg/kg dosage to treat this child's fever of 102.6°F is based on 10 mg/kg/dose. For the 8 kg child, per dose, 10 mg/$\cancel{\text{kg}}$/dose × 8 $\cancel{\text{kg}}$ = 80 mg/dose.

3. **Decide if the dosage is safe.** The nurse realizes that the dosage as ordered is insufficient to lower the child's fever. Because it is below the recommended therapeutic dosage, it is unsafe.

4. **Contact the physician.** Upon discussion with the physician, the doctor agrees and revises the order to **ibuprofen 80 mg p.o. q.6h p.r.n., Temp greater than 102.5°F and ibuprofen 40 mg p.o. q.6h p.r.n., fever less than 102.5°F.** Underdosage with an antipyretic may result in serious complications of hyperthermia. Likewise, consider how underdosage with an antibiotic may lead to a superinfection, and underdosage of a pain reliever may be inadequate to effectively treat the patient's pain, delaying recovery. Remember, the information in the drug reference provides important details related to specific use of medications and appropriate dosages for certain age groups to provide safe, therapeutic dosing. Both the physician and nurse must work together to ensure accurate and safe dosages that are within the recommended parameters as stated by the manufacturer on the label, in a drug insert, or in a reputable drug reference.

CAUTION

Once an adolescent attains a weight of 50 kg (110 lb) or greater, the standard adult dosage is frequently prescribed instead of a calculated dosage by weight. The health care professional must carefully verify that the order for a child's dosage does not exceed the maximum adult dosage recommended by the manufacturer.

CAUTION

Many over-the-counter preparations, such as fever reducers and cold preparations, have printed dosing instructions that show the recommended child dose per pound, Figure 13-5. Manufacturers understand that most parents in the United States measure their child's weight in pounds and are most familiar with household measurement. The recommended dosage is measured in teaspoons. Recall that pounds and teaspoons are primarily used for measurement in the home setting. In the clinical setting, you should measure body weight in kg and calculate dosage by the body weight method, using recommended dosage in mg/kg, not mg/lb.

Active Ingredients (in each 5 mL tsp): Dextromethorphan HBr, USP 7.5 mg; Pseudoephedrine HCl, USP 15 mg

Uses: temporarily relieves these symptoms occurring with a cold: nasal congestion, cough due to minor throat and bronchial irritation

Warnings

Do not use if you are now taking a prescription monoamine oxidase inhibitor (MAOI) (certain drugs for depression, psychiatric, or emotional conditions, or Parkinson's disease), or for 2 weeks after stopping the MAOI drug. If you do not know if your prescription drug contains an MAOI, ask a doctor or pharmacist before taking this product.

Ask a doctor before use if you have: heart disease; high blood pressure; thyroid disease; diabetes; trouble urinating due to an enlarged prostate gland; cough that occurs with too much phlegm (mucus); cough that lasts or is chronic such as occurs with smoking, asthma, or emphysema

When using this product do not use more than directed

Stop use and ask a doctor if: you get nervous, dizzy, or sleepless; symptoms do not get better within 7 days or are accompanied by fever; cough lasts more than 7 days, comes back, or is accompanied by fever, rash, or persistent headache. These could be signs of a serious condition.

If pregnant or breast-feeding, ask a health professional before use

Keep out of reach of children. In case of overdose, get medical help or contact a Poison Control Center right away.

4 FL OZ (118 mL)

Robitussin®

A.H.ROBINS®

PEDIATRIC COUGH & COLD

COUGH SUPPRESSANT / NASAL DECONGESTANT

Directions: do not take more than 4 doses in any 24-hour period. Repeat every 6 hours. Choose dosage by weight (if weight is not known, choose by age)

age	weight	dose
under 2 yrs.	under 24 lbs	ask a doctor
2 to under 6 yrs.	24 - 47 lbs.	1 tsp
6 to under 12 yrs.	48 - 95 lbs.	2 tsp
12 yrs. and older	96 lbs. & over	4 tsp

Packaged with Tamper-Evident cap. Do Not Use if breakable ring is separated or missing.

Other information: store at 20-25°C (68-77°F). Dosage cup provided

Inactive ingredients: citric acid, FD&C red no. 40, flavor, glycerin, high fructose corn syrup, saccharin sodium, sodium benzoate, sodium chloride, sodium citrate, water

Questions or comments?
Call weekdays from 9 AM to 5 PM EST at
1-800-ROBINS5 (1-800-762-4675)

Whitehall-Robins Healthcare
Madison, NJ 07940 U.S.A.
©2001 Whitehall-Robins Healthcare

U8609-12-4

FIGURE 13-5 Label with dosage instructions per-pound

COMBINATION DRUGS

Some medications contain two drugs combined into one solution or suspension. To calculate the safe dosage of these medications, the nurse should consult a pediatric drug reference. Often the nurse will need to calculate the safe dosage for each of the medications combined in the solution or suspension. Combination drugs are usually ordered by the amount to give or dose volume.

EXAMPLE 1 ■

The physician orders Pediazole 6 mL p.o. q.6h for a child weighing 44 lb. The pediatric drug reference states that Pediazole is a combination drug containing 200 mg of erythromycin ethylsuccinate with 600 mg of sulfisoxazole acetyl in every 5 mL oral suspension. The usual dosage for Pediazole is 50 mg erythromycin and 150 mg sulfisoxazole/kg/day in equally divided doses administered every 6 hours. Is the order safe?

Because this is a combination drug, notice that the order is for the dose volume (6 mL). To verify that the dose is safe, you must calculate the recommended dosage and the recommended quantity to give to supply that dosage for each drug component.

1. **Convert lb to kg.** Approximate equivalent: 1 kg = 2.2 lb

$$\begin{aligned}
\text{Think: } \tfrac{1}{2} \text{ of } 44 &= 22 \\
\frac{1 \text{ kg}}{2.2 \text{ lb}} &\times \frac{X \text{ kg}}{44 \text{ lb}} \\
2.2X &= 44 \\
\frac{2.2X}{2.2} &= \frac{44}{2.2} \\
X &= 20 \text{ kg}
\end{aligned}$$

2. **Calculate the safe dosage for each drug component.**

   erythromycin per day: 50 mg/$\cancel{\text{kg}}$/day × 20 $\cancel{\text{kg}}$ = 1,000 mg/day; divided into 4 doses/day
   1,000 mg ÷ 4 doses = 250 mg/dose

   sulfisoxazole per day: 150 mg/$\cancel{\text{kg}}$/day × 20 $\cancel{\text{kg}}$ = 3,000 mg/day; divided into 4 doses/day
   3,000 mg ÷ 4 doses = 750 mg/dose

3. **Calculate the volume of medication recommended for one dose for each drug component.**

   erythromycin: 250 mg is the recommended dosage; the supply has 200 mg per 5 mL.

$$\begin{aligned}
\frac{\text{Dosage on hand}}{\text{Amount on hand}} &= \frac{\text{Dosage desired}}{\text{X Amount desired}} \\
\frac{200 \text{ mg}}{5 \text{ mL}} &\times \frac{250 \text{ mg}}{X \text{ mL}} \\
200X &= 1{,}250 \\
\frac{200X}{200} &= \frac{1{,}250}{200} \\
X &= 6.25 \text{ mL} = 6 \text{ mL recommended to deliver 250 mg erythromycin}
\end{aligned}$$

   As this is an oral dosage, it is safely and reasonably rounded to 6 mL.

   sulfisoxazole: 750 mg is the recommended dosage; 600 mg per 5 mL is the supply.

$$\begin{aligned}
\frac{\text{Dosage on hand}}{\text{Amount on hand}} &= \frac{\text{Dosage desired}}{\text{X Amount desired}} \\
\frac{600 \text{ mg}}{5 \text{ mL}} &\times \frac{750 \text{ mg}}{X \text{ mL}} \\
600X &= 3{,}750 \\
\frac{600X}{600} &= \frac{3{,}750}{600} \\
X &= 6.25 \text{ mL} = 6 \text{ mL recommended to deliver 750 mg sulfisoxazole}
\end{aligned}$$

4. **Decide if the dose ordered is safe.** The ordered dose is 6 mL, and the appropriate dose based on the recommended dosage for each component is 6 mL. The dose is safe. **Realize that because this is a combination product; 6 mL contains *both* medications delivered in this suspension.** Therefore, 6 mL is given, not 6 mL plus 6 mL.

EXAMPLE 2 ■

The physician orders **Septra suspension (co-trimoxazole) 7.5 mL ($1\frac{1}{2}$ t) p.o. q.12h** for a child who weighs 22 lb. The drug reference states that Septra is a combination drug containing trimethoprim (TMP) 40 mg and sulfamethoxazole 200 mg in 5 mL oral suspension. It further states that the usual dosage of Septra is based on the TMP component, which is 6 to 12 mg/kg/day p.o. in divided doses q.12h for a mild to moderate infection. Is this dose volume safe?

1. **Convert lb to kg.** Approximate equivalent: 1 kg = 2.2 lb

$$\begin{aligned}
\text{Think: } \tfrac{1}{2} \text{ of } 22 &= 11 \\
\frac{1\text{ kg}}{2.2\text{ lb}} &\times \frac{X\text{ kg}}{22\text{ lb}} \\
2.2X &= 22 \\
\frac{2.2X}{2.2} &= \frac{22}{2.2} \\
X &= 10\text{ kg}
\end{aligned}$$

2. **Calculate the safe dose for the TMP range.**

TMP minimum daily dosage: 6 mg/$\cancel{\text{kg}}$/day × 10 $\cancel{\text{kg}}$ = 60 mg/day

Divided into 2 doses/day: 60 mg ÷ 2 doses = 30 mg/dose

TMP maximum daily dosage: 12 mg/$\cancel{\text{kg}}$/day × 10 $\cancel{\text{kg}}$ = 120 mg/day

Divided into 2 doses/day: 120 mg ÷ 2 doses = 60 mg/dose

3. **Calculate the volume of medication for the dosage range.**

Minimum dose volume:

$$\begin{aligned}
\frac{\text{Dosage on hand}}{\text{Amount on hand}} &= \frac{\text{Dosage desired}}{\text{X Amount desired}} \\
\frac{40\text{ mg}}{5\text{ mL}} &\times \frac{30\text{ mg}}{X\text{ mL}} \\
40X &= 150 \\
\frac{40X}{40} &= \frac{150}{40} \\
X &= 3.75\text{ mL, minimum per dose}
\end{aligned}$$

Maximum dose volume:

$$\begin{aligned}
\frac{\text{Dosage on hand}}{\text{Amount on hand}} &= \frac{\text{Dosage desired}}{\text{X Amount desired}} \\
\frac{40\text{ mg}}{5\text{ mL}} &\times \frac{60\text{ mg}}{X\text{ mL}} \\
40X &= 300 \\
\frac{40X}{40} &= \frac{300}{40} \\
X &= 7.5\text{ mL, maximum per dose}
\end{aligned}$$

4. **Decide if the dose volume is safe.** Because the physician ordered 7.5 mL, the dosage falls within the safe range and is a safe dose.

What dosage of TMP did the physician actually order per dose for this child?

Use ratio-proportion: Ratio for dosage on hand = Ratio for desired dosage

Notice that the unknown X is now in the numerator; but the known is still on the left and the unknown is on the right. You are not calculating the amount of dose volume to give (mL desired); you are calculating the dosage (X) to determine if the dosage ordered is safe.

$$\begin{array}{rcl}
\dfrac{\text{Dosage on hand}}{\text{Amount on hand}} & = & \dfrac{\text{X Dosage desired}}{\text{Amount desired}} \\[2ex]
\dfrac{40\text{ mg}}{5\text{ mL}} & \times & \dfrac{\text{X mg}}{7.5\text{ mL}} \qquad \text{The unknown “X” is the desired dosage.} \\[2ex]
5\text{X} & = & 300 \\[1ex]
\dfrac{5\text{X}}{5} & = & \dfrac{300}{5} \\[2ex]
\text{X} & = & 60\text{ mg}
\end{array}$$

The patient receives 60 mg of TMP in each 7.5 mL dose.

EXAMPLE 3 ■

The pediatric oral surgeon orders **Tylenol and codeine (acetaminophen and codeine phosphate) suspension 10 mL p.o. q.4–6h p.r.n., pain** for a child weighing 42 lb, who had two teeth repaired. The drug reference states that Tylenol and codeine is a combination drug containing 120 mg of acetaminophen and 12 mg of codeine phosphate per 5 mL. Safe dosage is based on the codeine component, which is 0.5–1 mg/kg/dose every 4 to 6 hours as needed. Is this dose volume safe?

1. **Convert lb to kg.** Approximate equivalent: 1 kg = 2.2 lb

$$\begin{array}{rcl}
\text{Think: } \frac{1}{2} \text{ of } 42 & = & 21 \\[2ex]
\dfrac{1\text{ kg}}{2.2\text{ lb}} & \times & \dfrac{\text{X kg}}{42\text{ lb}} \\[2ex]
2.2\text{X} & = & 42 \\[1ex]
\dfrac{2.2\text{X}}{2.2} & = & \dfrac{42}{2.2} \\[2ex]
\text{X} & = & 19.1\text{ kg}
\end{array}$$

2. **Calculate the safe dosage range for the codeine.**

codeine minimum per dose: $0.5\text{ mg/}\cancel{\text{kg}}\text{/dose} \times 19.1\ \cancel{\text{kg}} = 9.55\text{ mg/dose} = 9.6\text{ mg/dose}$

codeine maximum per dose: $1\text{ mg/}\cancel{\text{kg}}\text{/dose} \times 19.1\ \cancel{\text{kg}} = 19.1\text{ mg/dose}$

3. **Calculate the volume of medication for the minimum and maximum dose.**

Minimum dose volume:

$$\begin{array}{rcl}
\dfrac{\text{Dosage on hand}}{\text{Amount on hand}} & = & \dfrac{\text{Dosage desired}}{\text{X Amount desired}} \\[2ex]
\dfrac{12\text{ mg}}{5\text{ mL}} & \times & \dfrac{9.6\text{ mg}}{\text{X mL}} \\[2ex]
12\text{X} & = & 48 \\[1ex]
\dfrac{12\text{X}}{12} & = & \dfrac{48}{12} \\[2ex]
\text{X} & = & 4\text{ mL, minimum per dose}
\end{array}$$

Maximum dose volume:

$$\begin{array}{rcl}
\dfrac{\text{Dosage on hand}}{\text{Amount on hand}} & = & \dfrac{\text{Dosage desired}}{\text{X Amount desired}} \\[2ex]
\dfrac{12\text{ mg}}{5\text{ mL}} & \times & \dfrac{19.1\text{ mg}}{\text{X mL}} \\[2ex]
12\text{X} & = & 95.5 \\[1ex]
\dfrac{12\text{X}}{12} & = & \dfrac{95.5}{12} \\[2ex]
\text{X} & = & 7.95\text{ mL} = 8\text{ mL, maximum per dose}
\end{array}$$

4. **Decide if the dose volume is safe.** The ordered dose of 10 mL exceeds the maximum safe dose range; the dose is not safe. Contact the physician to discuss the order.

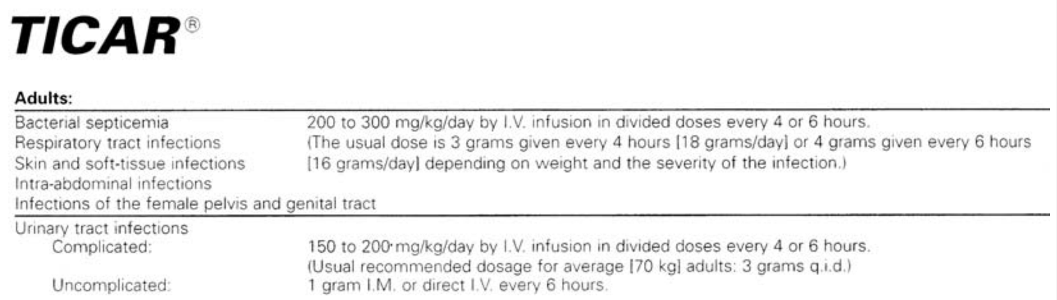
Be sure to take the time to double-check pediatric dosage. The health care provider who administers the medication has the last opportunity to ensure safe drug therapy.

ADULT DOSAGES BASED ON BODY WEIGHT

Some adult dosage recommendations are based on body weight, too, although less frequently than for children. The information you learned about calculating and verifying children's body weight dosages can be applied to adults. It is important that you become familiar and comfortable with reading labels, drug inserts, and drug reference books to check any order that appears questionable.

Let's look at information found in a drug insert about the adult dosage recommendations for the drug Ticar (ticaricillin) (Figure 13-6). Notice that the adult dosage is recommended by body weight.

FIGURE 13-6 Section of Ticar package insert



TICAR®

Adults:	
Bacterial septicemia Respiratory tract infections Skin and soft-tissue infections Intra-abdominal infections Infections of the female pelvis and genital tract	200 to 300 mg/kg/day by I.V. infusion in divided doses every 4 or 6 hours. (The usual dose is 3 grams given every 4 hours [18 grams/day] or 4 grams given every 6 hours [16 grams/day] depending on weight and the severity of the infection.)
Urinary tract infections	
Complicated:	150 to 200 mg/kg/day by I.V. infusion in divided doses every 4 or 6 hours. (Usual recommended dosage for average [70 kg] adults: 3 grams q.i.d.)
Uncomplicated:	1 gram I.M. or direct I.V. every 6 hours.

BODY WEIGHT DOSAGE CALCULATION WORKSHEET

Some students find the following worksheet helpful when calculating dosage ranges based on body weight for either adults or children. First convert the weight in lb to kg.

EXAMPLE ■

Order: Ticar 4 g IV q.6h for a patient with bacterial septicemia

Supply: Ticar 200 mg/mL

Recommended adult dosage from package insert: 200–300 mg/kg/day q.4–6h

Patient's weight: 150 lb

Convert lb to kg. Approximate equivalent: 1 kg = 2.2 lb.

Think: $\frac{1}{2}$ of 150 = 75

$$\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{150\text{ lb}}$$

$$2.2X = 150$$

$$\frac{2.2X}{2.2} = \frac{150}{2.2}$$

$$X = 68.2\text{ kg}$$

	Minimum Dosage		Maximum Dosage
Body Weight (kg) × Recommended Dosage	68.2 kg × 200 mg/kg/day		68.2 kg × 300 mg/kg/day
Total Daily Dosage ÷ # Doses/Day	13,640 mg/kg/day ÷ 4 doses/day		20,460 mg/kg/day ÷ 4 doses/day
Dosage Range/Dose	3,410 mg/dose q.6h	to	5,115 mg/dose q.6h

The ordered dosage of Ticar 4 g (or 4,000 mg) is within the recommended range and is safe.

Calculate the amount to give for 1 dose.

Step 1 **Convert** 4 g = 4,000 mg

Step 2 **Think** 4,000 mg is 20 times 200 mg, so you want to give 20 mL.

Step 3 **Calculate**

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{200 \text{ mg}}{1 \text{ mL}} = \frac{4{,}000 \text{ mg}}{\text{X mL}}$$

$$200\text{X} = 4{,}000$$

$$\frac{200\text{X}}{200} = \frac{4{,}000}{200}$$

$$\text{X} = 20 \text{ mL given intravenously every 6 hours}$$

QUICK REVIEW

To use the body weight method to verify the safety of pediatric and adult dosages:

- Convert body weight from pounds and ounces to kilograms: 1 kg = 2.2 lb; 1 lb = 16 oz.
- Calculate the recommended safe dosage in mg/kg.
- Compare the ordered dosage with the recommended dosage to decide if the dosage is safe.
- If the dosage is safe, calculate the amount to give for one dose; if not safe, notify the prescriber.
- Combination drugs are ordered by dose volume. Check a reputable drug reference to be sure the dose ordered contains the safe amount of each drug as recommended.

Review Set 30

Calculate one dose of safe pediatric dosages.

1. Order: **Pathocil 125 mg p.o. q.6h** for a child who weighs 55 lb. The recommended dosage of Pathocil (dicloxacillin sodium) for children weighing less than 40 kg is 12.5–25 mg/kg/day p.o. in equally divided doses q.6h for moderate to severe infections.

   Child's weight: __________ kg

   Recommended minimum daily dosage for this child: __________ mg/day

   Recommended minimum single dosage for this child: __________ mg/dose

   Recommended maximum daily dosage for this child: __________ mg/day

   Recommended maximum single dosage for this child: __________ mg/dose

   Is the dosage ordered safe? __________

2. Dicloxacillin sodium is available as an oral suspension of 62.5 mg per 5 mL. If the dosage ordered in question 1 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____

3. Order: **Chloromycetin 55 mg IV q.12h** for an 8-day-old infant who weighs 2,200 g. The recommended dosage of Chloromycetin (chloramphenicol) for neonates less than 2 kg is 25 mg/kg once daily; and for neonates more than 2 kg and over 7 days of age is 50 mg/kg/day divided q.12h.

   Child's weight: ________ kg

   Recommended daily dosage for this child: ________ mg/day

   Recommended single dosage for this child: ________ mg/dose

   Is the dosage ordered safe? ________

4. Chloramphenicol is available as a solution for injection of 1 g per 10 mL. If the dosage ordered in question 3 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____

5. Order: **Suprax 120 mg p.o. daily** for a child who weighs 33 lb. The recommended dosage of Suprax (cefixime) for children under 50 kg is 8 mg/kg p.o. once daily or 4 mg/kg q.12h.

   Child's weight: ________ kg

   Recommended single dosage for this child: ________ mg/dose

   Is the dosage ordered safe? ________

6. Suprax is available as a suspension of 100 mg per 5 mL in a 50 mL bottle. If the dosage ordered in question 5 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____

   How many doses are available in the bottle of Suprax? ________ dose(s)

7. Order: **Panadol 480 mg p.o. q.4h p.r.n. for temperature 101.6°F or greater.** The child's weight is 32 kg. The recommended child's dosage of Panadol (acetaminophen) is 10–15 mg/kg/dose p.o. q.4h p.r.n. for fever.

   Child's weight: ________ kg

   Recommended minimum single dosage for this child: ________ mg/dose

   Recommended maximum single dosage for this child: ________ mg/dose

   Is the dosage ordered safe? ________

8. Panadol is available as a suspension of 160 mg per 5 mL. If the dosage ordered in question 7 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____

9. Order: **Keflex 125 mg p.o. q.6h** for a child who weighs 44 lb. The recommended pediatric dosage of Keflex (cephalexin) is 25–50 mg/kg/day in 4 equally divided doses.

   Child's weight: ________ kg

   Recommended minimum daily dosage for this child: ________ mg/day

   Recommended minimum single dosage for this child: ________ mg/dose

Recommended maximum daily dosage for this child: ________ mg/day

Recommended maximum single dosage for this child: ________ mg/dose

Is the dosage ordered safe? ________

10. Keflex is available in a suspension of 125 mg per 5 mL. If the dosage ordered in question 9 is safe, give ________ mL. If not safe, explain why not and describe what you should do.

____

____

The labels provided represent the drugs available to answer questions 11 through 25. Verify safe dosages, indicate the amount to give, and draw an arrow on the accompanying measuring device. Explain unsafe dosages and describe the appropriate action to take.

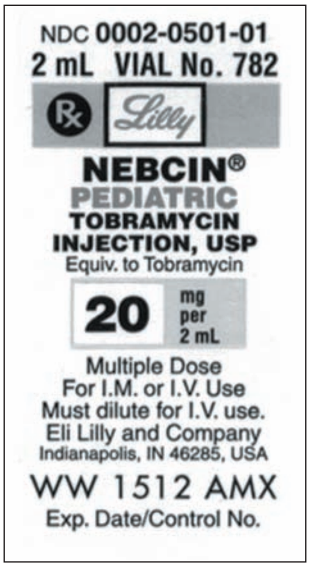
11. Order: **Nebcin 8 mg IM q.6h** for an infant who weighs 5,000 g. The recommended pediatric dosage of Nebcin (tobramycin) is 2–2.5 mg/kg q.8h or 1.5–1.9 mg/kg q.6h.

Infant's weight: ________ kg

Recommended minimum single dosage for this infant:
________ mg/dose

Recommended maximum singe dosage for this infant:
________ mg/dose

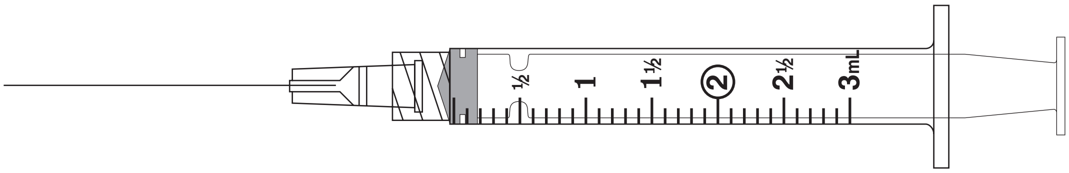
Is the dosage ordered safe? ________



NDC 0002-0501-01
2 mL VIAL No. 782
℞ Lilly
NEBCIN®
PEDIATRIC
TOBRAMYCIN
INJECTION, USP
Equiv. to Tobramycin
20 mg per 2 mL
Multiple Dose
For I.M. or I.V. Use
Must dilute for I.V. use.
Eli Lilly and Company
Indianapolis, IN 46285, USA
WW 1512 AMX
Exp. Date/Control No.

12. If the dosage ordered in question 11 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____



13. Order: **Kantrex 34 mg IV q.8h** for an infant who weighs 7 lb 8 oz. The recommended dosage of Kantrex (kanamycin sulfate) for adults and children is 15 mg/kg/day in 2 or 3 equal doses, not to exceed 1.5 g/day.

Child's weight: ________ kg

Recommended daily dosage for this child:
________ mg/day

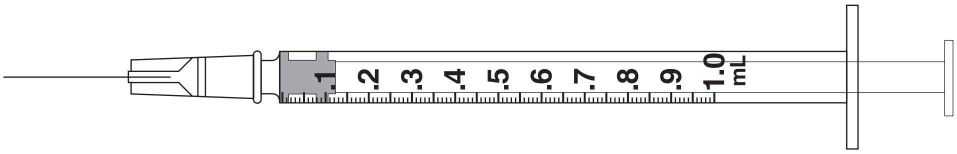
Recommended single dosage for this child:
________ mg/dose

Is the dosage ordered safe? ________

NDC 0015-3512-20
EQUIVALENT TO NSN 6505-00-926-9202
75 mg KANAMYCIN per 2 mL
KANTREX®
Kanamycin Sulfate
Injection, USP
Pediatric Injection
FOR I.M. OR I.V. USE
CAUTION: Federal law prohibits dispensing without prescription.
0.099% sodium bisulfite added as an antioxidant, buffered with 0.33% sodium citrate. • Adjusted to pH 4.5 with H_2SO_4. • Kantrex Pediatric Injection should not be physically mixed with other antibacterial agents.
READ ACCOMPANYING CIRCULAR
Distributed by APOTHECON®
A Bristol-Myers Squibb Co.
Princeton, NJ 08540
Made in USA 351220DRL-1
MAXIMUM DOSE: 15 MG/KG/DAY
Cont:
Exp. Date:

14. If the dosage ordered in question 13 is safe, give __________ mL. If not safe, explain why not and describe what you should do. ____

____



15. Order: **Bactrim pediatric suspension 7.5 mL p.o. q.12h** for a child who weighs 15 kg and has an urinary tract infection. The recommended dosage of Bactrim (trimethoprim and sulfamethoxazole) for such infections in children is based on the trimethoprim at 8 mg/kg/day in 2 equal doses.

    Recommended daily trimethoprim dosage for this child: __________ mg/day

    Recommended single trimethoprim dosage for this child: __________ mg/dose

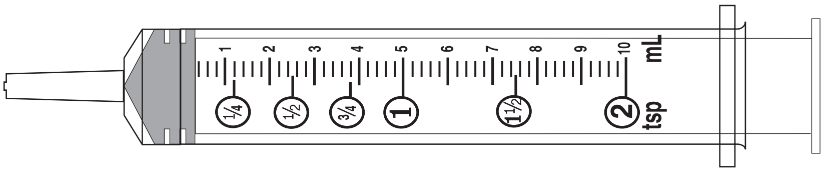
    Recommended single dose for this child: __________ mL/dose

    Is the dose ordered safe? __________

16. If the dose ordered in question 15 is safe, give __________ mL. If not safe, explain why not and describe what you should do. ____

____

The dose ordered is equivalent to __________ teaspoons.



17. Order: **gentamicin 40 mg IV q.8h** for a premature neonate who is 5 days old and weighs 1,800 g. The recommended dosage of gentamicin for children is 2–2.5 mg/kg q.8h; for neonates, it is 2.5 mg/kg q.8h; and for premature neonates less than 1 week of age, it is 2.5 mg/kg q.12h.

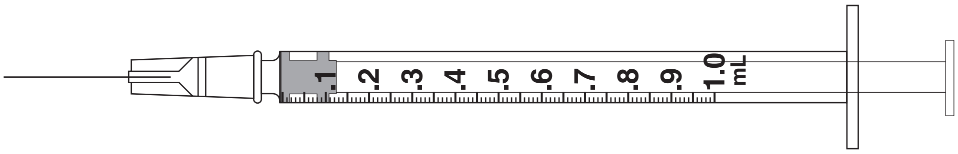
    Neonate's weight: __________ kg

    Recommended single dosage for this neonate: __________ mg/dose

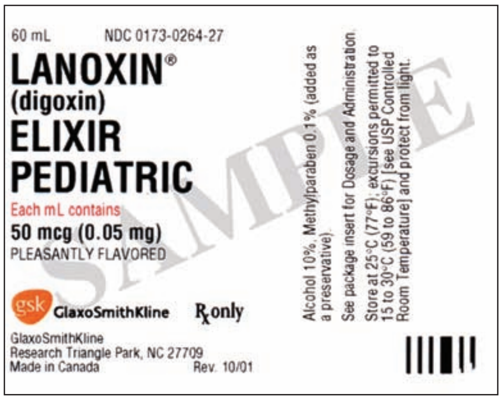
    Is the ordered dosage safe? __________

18. If the dosage ordered in question 17 is safe, give __________ mL. If not safe, explain why not and describe what you should do. ____

____



19. Order: **Lanoxin 0.15 mg p.o. q.12h** for a maintenance dose for a 9-year-old child who weighs 70 lb. The recommended maintenance pediatric dosage of Lanoxin (digoxin) tablets and elixir is 7–10 mcg/kg/day divided and given in 2 to 3 equal doses per day.


60 mL NDC 0173-0264-27

LANOXIN®
(digoxin)
ELIXIR
PEDIATRIC

Each mL contains
50 mcg (0.05 mg)
PLEASANTLY FLAVORED

GlaxoSmithKline ℞ only

GlaxoSmithKline
Research Triangle Park, NC 27709
Made in Canada Rev. 10/01

Alcohol 10%, Methylparaben 0.1% (added as a preservative).

See package insert for Dosage and Administration.

Store at 25°C (77°F); excursions permitted to 15 to 30°C (59 to 86°F) [see USP Controlled Room Temperature] and protect from light.

Child's weight: __________ kg

Recommended minimum daily dosage for this child: __________ mg/day

Recommended minimum single dosage for this child: __________ mg/dose

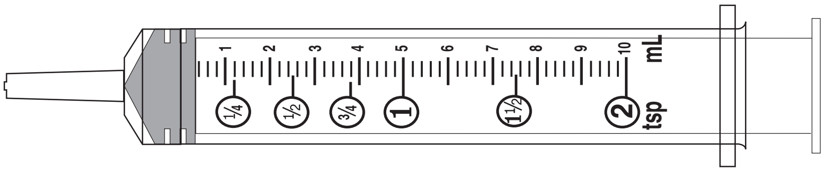
Recommended maximum daily dosage for this child: __________ mg/day

Recommended maximum single dosage for this child: __________ mg/dose

Is the dosage ordered safe? __________

20. If the dosage ordered in question 19 is safe, give __________ mL. If not safe, explain why not and describe what you should do. ______________________________

____



21. Order: **Amoxil oral suspension 100 mg p.o. q.8h** for a child who weighs 39 lb. Recommended dosage: See label.

Child's weight: __________ kg

Recommended minimum daily dosage for this child: __________ mg/day

Recommended minimum single dosage for this child: __________ mg/dose

Recommended maximum daily dosage for this child: __________ mg/day

Recommended maximum single dosage for this child: __________ mg/dose

Is the dosage ordered safe? __________


AMOXIL®
125mg/5mL

Directions for mixing: Tap bottle until all powder flows freely. Add approximately 1/3 total amount of water for reconstitution (total=116 mL); shake vigorously to wet powder. Add remaining water; again shake vigorously. Each 5 mL (1 teaspoonful) will contain amoxicillin trihydrate equivalent to 125 mg amoxicillin.
Usual Adult Dosage: 250 to 500 mg every 8 hours.
Usual Child Dosage: 20 to 40 mg/kg/day in divided doses every 8 hours, depending on age, weight and infection severity. See accompanying prescribing information.

Keep tightly closed.
Shake well before using.
Refrigeration preferable but not required.
Discard suspension after 14 days.

125mg/5mL
NDC 0029-6008-22

AMOXIL®
AMOXICILLIN
FOR ORAL
SUSPENSION

℞ only

150mL
(when reconstituted)

GlaxoSmithKline

Net contents: Equivalent to 3.75 grams amoxicillin.
Store dry powder at room temperature.

GlaxoSmithKline
Research Triangle Park, NC 27709

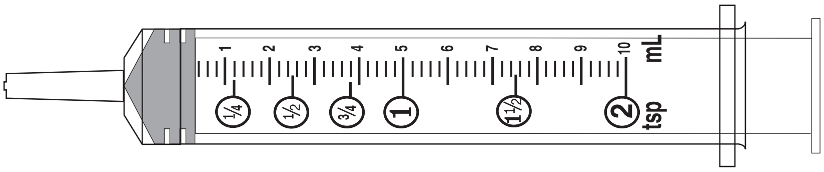
LOT
EXP.

3 0029-6008-22 4

9405813-G

22. If the dosage ordered in question 21 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____



23. Order: **Terramycin 100 mg IM q.8h** for a 9-year-old child who weighs 55 lb. Recommended pediatric dosage: See label.


Rx only

8885

DOSAGE
ADULTS: The usual daily dose is 250 mg administered once every 24 hours or 300 mg given in divided doses at 8 to 12 hour intervals.
CHILDREN ABOVE EIGHT YEARS OF AGE: 15-25 mg/kg body weight up to a maximum of 250 mg per single daily injection. Dosage may be divided and given at 8 to 12 hour intervals.

SEE ACCOMPANYING PRESCRIBING INFORMATION.

10 mL Vial NDC 0049-0750-77

Terramycin®
(oxytetracycline)

Intramuscular Solution*
contains 2% lidocaine
50 mg/mL

Pfizer Roerig
Division of Pfizer Inc, NY, NY 10017

Store below 86°F (30°C).
FOR INTRAMUSCULAR USE ONLY.
Each mL contains (w/v) 50 mg oxytetracycline, 2% lidocaine, 2.5% magnesium chloride hexahydrate, 0.3% sodium formaldehyde sulfoxylate, 1% α-monothioglycerol, approx. 2.6% monoethanolamine, 0.02% propyl gallate, 1% citric acid, 74.1% propylene glycol and 18.5% water.
*U.S. Pat. Nos. 3,017,323 and 3,026,248

MADE IN USA

05-1051-32-4

Child's weight: ________ kg

Recommended minimum daily dosage for this child: ________ mg/day

Recommended minimum single dosage for this child: ________ mg/dose

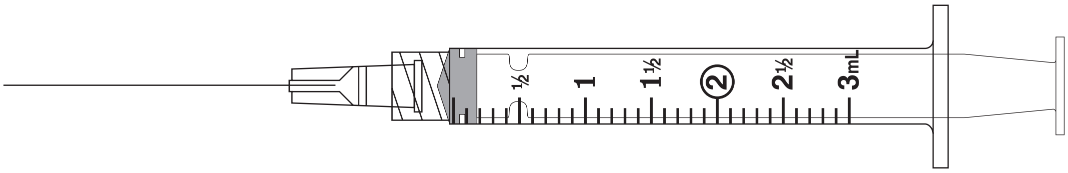
Recommended maximum daily dosage for this child: ________ mg/day

Recommended maximum single dosage for this child: ________ mg/dose

Is the dosage ordered safe? ________

24. If the dosage ordered in question 23 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____

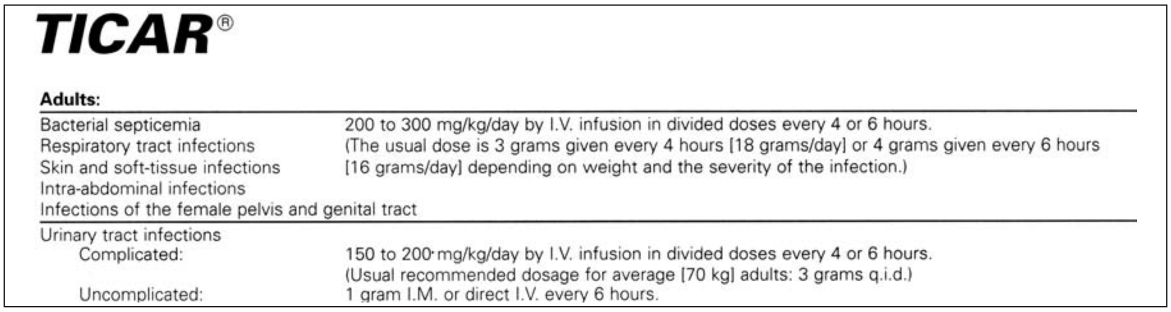


25. Order: **Terramycin 275 mg IM daily** for a 7-year-old child who weighs 21 kg. Recommended pediatric dosage: See label for question 23.

Is the ordered dosage safe? ________ Explain: ____

____

Refer to the following information from the package insert for Ticar to answer questions 26 through 30.


TICAR®

Adults:	
Bacterial septicemia Respiratory tract infections Skin and soft-tissue infections Intra-abdominal infections Infections of the female pelvis and genital tract	200 to 300 mg/kg/day by I.V. infusion in divided doses every 4 or 6 hours. (The usual dose is 3 grams given every 4 hours [18 grams/day] or 4 grams given every 6 hours [16 grams/day] depending on weight and the severity of the infection.)
Urinary tract infections	
Complicated:	150 to 200 mg/kg/day by I.V. infusion in divided doses every 4 or 6 hours. (Usual recommended dosage for average [70 kg] adults: 3 grams q.i.d.)
Uncomplicated:	1 gram I.M. or direct I.V. every 6 hours.

26. What is the recommended adult dosage of Ticar (ticaricillin) for bacterial septicemia?

____

27. What is the recommended adult dosage of Ticar for a complicated urinary tract infection?

____

28. What daily dosage range of Ticar should you expect for an adult with a complicated urinary tract infection who weighs 130 lb? __________ g to __________ g/day

29. What single dosage range of Ticar administered q.4h should you expect for the adult described in question 28? __________ g to __________ g/dose

30. What single dosage range of Ticar administered q.6h should you expect for the adult described in question 28? __________ g to __________ g/dose

After completing these problems, see pages 504-507 to check your answers.

CRITICAL THINKING SKILLS

Medication errors in pediatrics often occur when the nurse fails to properly identify the child before administering the dose.

ERROR

Failing to identify the child before administering a medication.

Possible Scenario

Suppose the physician ordered **ampicillin 500 mg IV q.6h** for a child with pneumonia. The nurse calculated the dosage to be safe, checked to be sure the child had no allergies, and prepared the medication. The child had been assigned to a semiprivate room. The nurse entered the room and noted only one child in the room and administered the IV ampicillin to that child, without checking the identification of the child. Within an hour of the administered ampicillin the child began to break out in hives and had signs of respiratory distress. The nurse asked the child's mother, "Does Johnny have any known allergies?" The mother replied, "This is James, not Johnny, and yes, James is allergic to penicillin. His roommate, Johnny, is in the playroom." At this point the nurse realized the ampicillin was given to the wrong child, who was allergic to penicillin.

Potential Outcome

James's physician would have been notified, and he would likely have ordered epinephrine subcut stat (given for anaphylactic reactions), followed by close monitoring of the child. Anaphylactic reactions can range from mild to severe. Ampicillin is a derivative of penicillin and would not have been prescribed for a child such as James.

Prevention

This error could easily have been avoided had the nurse remembered the cardinal rule of *identifying the child* before administering *any* medication. Children are mobile, and you cannot assume the identity of a child simply because he or she is in a particular room. The correct method of identifying the child is to check the wrist or ankle band and compare it to the medication administration record with the child's name, room number, physician, and account number. Finally, remember that the first of the *Six Rights* of medication administration is the *right patient.*

PRACTICE PROBLEMS—CHAPTER 13

Convert the following weights to kilograms. Round to one decimal place.

1. 12 lb = __________ kg
2. 8 lb 4 oz = __________ kg
3. 1,570 g = __________ kg
4. 2,300 g = __________ kg
5. 34 lb = __________ kg
6. 6 lb 10 oz = __________ kg
7. 52 lb = __________ kg
8. 890 g = __________ kg
9. The recommended dosage of tobramycin for adults with serious infections that are not life-threatening is 3 mg/kg/day in 3 equally divided doses q.8h. What should you expect the total daily dosage of tobramycin to be for an adult with a serious infection who weighs 80 kg? __________ mg/day
10. What should you expect the single dosage of tobramycin to be for the adult described in question 9? __________ mg/dose

The labels provided represent the drugs available to answer questions 11 through 42. Verify safe dosages and indicate the amount to give and draw an arrow on the accompanying measuring device. Explain unsafe dosages and describe the appropriate action to take.

11. Order: **gentamicin 40 mg IV q.8h** for a child who weighs 43 lb. The recommended dosage for children is 2–2.5 mg/kg q.8h.

    Child's weight: __________ kg

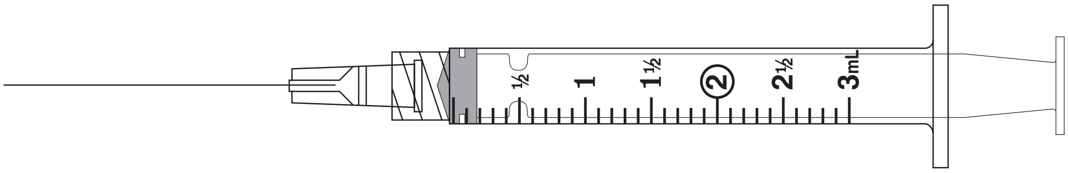
    Recommended minimum single dosage for this child: __________ mg/dose

    Recommended maximum single dosage for this child: __________ mg/dose

    Is the ordered dosage safe? __________

12. If the dosage ordered in question 11 is safe, give __________ mL. If not safe, explain why not and describe what you should do. ______________________________

    ____



13. Order: **furosemide oral solution 10 mg p.o. b.i.d.** for a child who weighs 16 lb. The recommended pediatric dosage is 0.5–2 mg/kg b.i.d.

    Child's weight: __________ kg

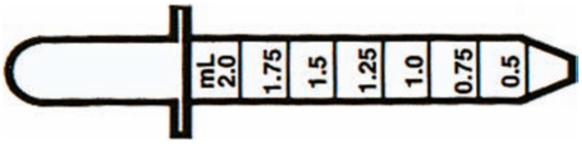
    Recommended minimum single dosage for this child: __________ mg/dose

    Recommended maximum single dosage for this child: __________ mg/dose

    Is the ordered dosage safe? __________

14. If the dosage ordered in question 13 is safe, give _________ mL. If not safe, explain why not and describe what you should do. ____

____



15. Order: **carbamazepine 150 mg p.o. b.i.d.** for a child who is 5 years old and weighs 40 lb. The recommended dosage for children under 6 years of age is 10–20 mg/kg/day in 2–4 divided doses per day, not to exceed 400 mg/day.

Child's weight: _________ kg

Recommended minimum daily dosage for this child: _________ mg/day

Recommended minimum single dosage for this child: _________ mg/dose

Recommended maximum daily dosage for this child: _________ mg/day

Recommended maximum single dosage for this child: _________ mg/dose

Is the dosage ordered safe? _________


NDC 0083-0019-76 FSC 1841
6505-01-302-4467

Tegretol®
carbamazepine USP
Suspension
100 mg/5 mL

IMPORTANT: Shake well before using.

Each 5 mL contains 100 mg carbamazepine USP.

450 mL

Dispense in tight, light-resistant container (USP).

Caution: Federal law prohibits dispensing without prescription.

ciba

Keep this and all drugs out of the reach of children.
Dosage: See package insert.
Do not store above 86°F (30°C).

Mfd. by:
Ciba-Geigy Canada, Ltd.
Dorval, Quebec, Canada

Dist. by:
Ciba-Geigy Corporation
Pharmaceuticals Division
Summit, NJ 07901

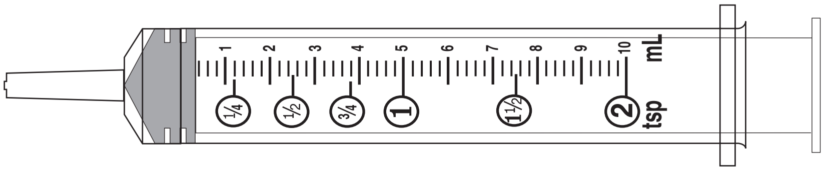
893972

P550831

N 3 0083-0019-76 1

16. If the dosage ordered in question 15 is safe, give _________ mL. If not safe, explain why not and describe what you should do. ____

____



17. Order: **Depakene 150 mg p.o. b.i.d.** for a child who is 10 years old and weighs 64 lb. The recommended dosage for adults and children 10 years and older is 10–15 mg/kg/day up to a maximum of 60 mg/kg/day. If the total daily dosage exceeds 250 mg, divide the dose.

Child's weight: _________ kg

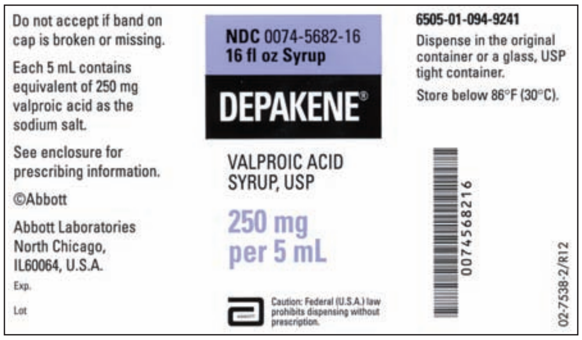
Recommended minimum daily dosage for this child: _________ mg/day

Recommended minimum single dosage for this child: _________ mg/dose

Recommended maximum daily dosage for this child: _________ mg/day

Recommended maximum single dosage for this child: _________ mg/dose

Is the dosage ordered safe? _________


Do not accept if band on cap is broken or missing.

Each 5 mL contains equivalent of 250 mg valproic acid as the sodium salt.

See enclosure for prescribing information.

©Abbott

Abbott Laboratories
North Chicago,
IL60064, U.S.A.

Exp.

Lot

NDC 0074-5682-16
16 fl oz Syrup

DEPAKENE®

VALPROIC ACID
SYRUP, USP

250 mg
per 5 mL

Caution: Federal (U.S.A.) law prohibits dispensing without prescription.

6505-01-094-9241

Dispense in the original container or a glass, USP tight container.

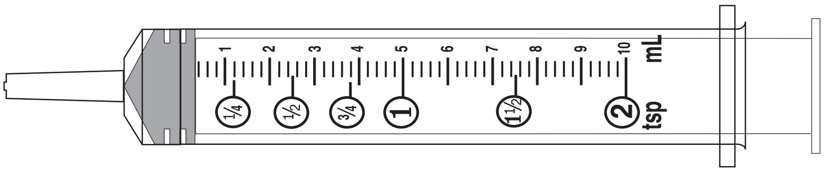
Store below 86°F (30°C).

0074568216

02-7538-2/R12

18. If the dosage ordered in question 17 is safe, give __________ mL. If not safe, explain why not and describe what you should do. __________

____



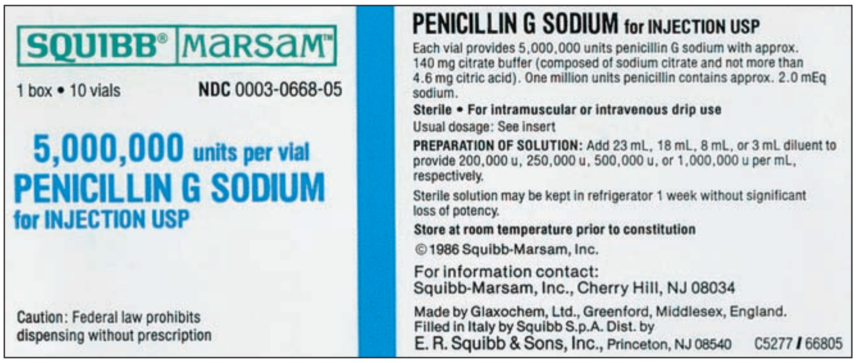
19. Order: **penicillin G sodium 125,000 units I.M. daily** for an infant who weighs 2,500 g. The recommended dosage for infants is 50,000 units/kg/day in a single dose.

Child's weight: __________ kg

Recommended daily dosage for this child: __________ units/day

Recommended single dosage for this child: __________ units/dose

Is the ordered dosage safe? __________



SQUIBB® MARSAM™

1 box • 10 vials NDC 0003-0668-05

5,000,000 units per vial

PENICILLIN G SODIUM

for INJECTION USP

Caution: Federal law prohibits dispensing without prescription

PENICILLIN G SODIUM for INJECTION USP

Each vial provides 5,000,000 units penicillin G sodium with approx. 140 mg citrate buffer (composed of sodium citrate and not more than 4.6 mg citric acid). One million units penicillin contains approx. 2.0 mEq sodium.

Sterile • For intramuscular or intravenous drip use

Usual dosage: See insert

PREPARATION OF SOLUTION: Add 23 mL, 18 mL, 8 mL, or 3 mL diluent to provide 200,000 u, 250,000 u, 500,000 u, or 1,000,000 u per mL, respectively.

Sterile solution may be kept in refrigerator 1 week without significant loss of potency.

Store at room temperature prior to constitution

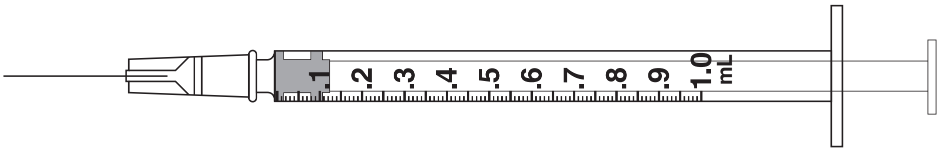
©1986 Squibb-Marsam, Inc.

For information contact:
Squibb-Marsam, Inc., Cherry Hill, NJ 08034

Made by Glaxochem, Ltd., Greenford, Middlesex, England.
Filled in Italy by Squibb S.p.A. Dist. by
E. R. Squibb & Sons, Inc., Princeton, NJ 08540 C5277 / 66805

20. If the dosage ordered in question 19 is safe, reconstitute with __________ mL diluent for a total solution volume of __________ mL with a concentration of __________ units/mL. Give __________ mL. If not safe, explain why not and describe what you should do. __________

____



21. Order: **Amoxil oral suspension 150 mg p.o. q.8h** for a child who weighs 41 lb. Recommended dosage: See label on next page.

Child's weight: __________ kg

Recommended minimum daily dosage for this child: __________ mg/day

Recommended minimum single dosage for this child: __________ mg/dose

Recommended maximum daily dosage for this child: __________ mg/day

Recommended maximum single dosage for this child: __________ mg/dose

Is the dosage ordered safe? __________

AMOXIL®
125mg/5mL

Directions for mixing: Tap bottle until all powder flows freely. Add approximately 1/3 total amount of water for reconstitution **(total=116 mL);** shake vigorously to wet powder. Add remaining water; again shake vigorously. Each 5 mL (1 teaspoonful) will contain amoxicillin trihydrate equivalent to 125 mg amoxicillin.
Usual Adult Dosage: 250 to 500 mg every 8 hours.
Usual Child Dosage: 20 to 40 mg/kg/day in divided doses every 8 hours, depending on age, weight and infection severity. See accompanying prescribing information.

Keep tightly closed.
Shake well before using.
Refrigeration preferable but not required.
Discard suspension after 14 days.

125mg/5mL
NDC 0029-6008-22

AMOXIL®
AMOXICILLIN
FOR ORAL
SUSPENSION

℞ only

150mL
(when reconstituted)

gsk GlaxoSmithKline

Net contents: Equivalent to 3.75 grams amoxicillin.
Store dry powder at room temperature.

GlaxoSmithKline
Research Triangle Park, NC 27709

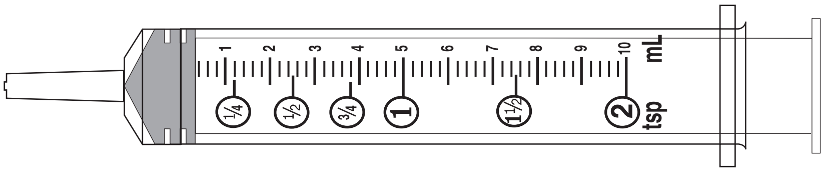
3 0029-6008-22 4

LOT
EXP.
9405813-G

SAMPLE

22. If the dosage ordered in question 21 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ______________________________

____



23. Order: **Ceclor oral suspension 187 mg p.o. b.i.d.** for a child with otitis media who weighs $20\frac{1}{2}$ lb. Recommended dosage: See label.

Child's weight: ________ kg

Recommended daily dosage for this child: ________ mg/day

Recommended single dosage for this child: ________ mg/dose

Is the dosage ordered safe? ________

NDC 0002-5130-87
50 mL (When Mixed) M-5130

℞ Lilly

CECLOR®
CEFACLOR FOR
ORAL SUSPENSION
USP
187 mg
per 5 mL

CAUTION—Federal (USA) law prohibits dispensing without prescription.

3 N 0002-5130-87 5
PULL

Usual Dose—Pediatric patients, 20 mg per kg a day (40 mg per kg in otitis media) in two divided doses. Adults, 375 mg two times a day. See literature for complete dosage information.
Contains Cefaclor Monohydrate equivalent to 1.87 g anhydrous Cefaclor in a dry pleasantly flavored mixture.
Prior to Mixing, Store at Controlled Room Temperature 59° to 86°F (15° to 30°C)
Directions for Mixing—Add 31 mL of water in two portions to the dry mixture in the bottle. Shake well after each addition.
Each 5 mL (Approx. one teaspoonful) will then contain: Cefaclor Monohydrate equivalent to 187 mg anhydrous Cefaclor.

WV 6494 AMX

Eli Lilly and Company
Indianapolis, IN 46285, USA

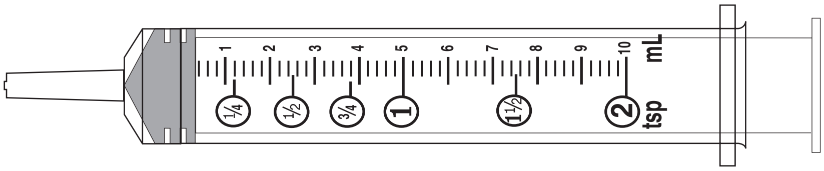
Expiration Date

50 mL CECLOR® CEFACLOR FOR ORAL SUSPENSION, USP
187 mg per 5 mL. Oversize bottle provides extra space for shaking. Store in a refrigerator. May be kept for 14 days without significant loss of potency. Keep Tightly Closed. Discard unused portion after 14 days.
SHAKE WELL BEFORE USING

Control No.

24. If the dosage ordered in question 23 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ______________________________

____



25. Order: **Narcan 100 mcg subcut stat** for a child who weighs 22 lb. Recommended pediatric dosage: 0.01 mg/kg/dose.

Child's weight: ________ kg

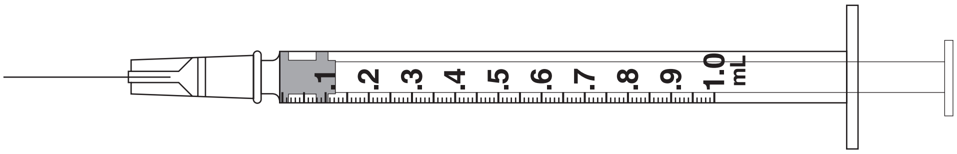
Recommended single dosage for this child: ________ mg/dose

Is the dosage ordered safe? ________

NDC 63481-358-01
NARCAN®
(Naloxone HCl
Injection, USP)
0.4 mg/mL
1 mL AMPUL
FOR IM, SC OR IV USE
Endo Pharmaceuticals Inc.
Chadds Ford, PA 19317
Lot:
Exp:
SAMPLE

26. If the dosage ordered in question 25 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____

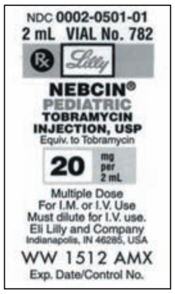


27. Order: **Nebcin 35 mg IV q.8h** for a child who weighs 14 kg. The recommended pediatric dosage of Nebcin (tobramycin) is 2–2.5 mg/kg q.8h or 1.5–1.9 mg/kg q.6h.

    Recommended minimum single dosage for this child: ________ mg/dose

    Recommended maximum single dosage for this child: ________ mg/dose

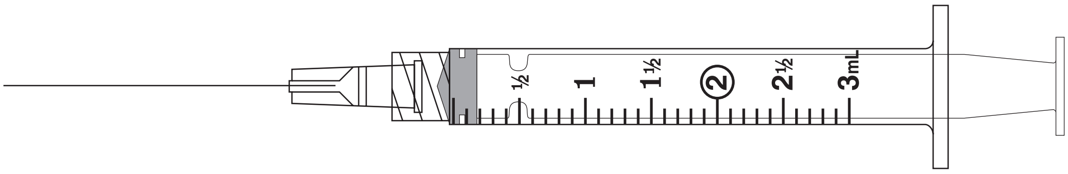
    Is the dosage ordered safe? ________

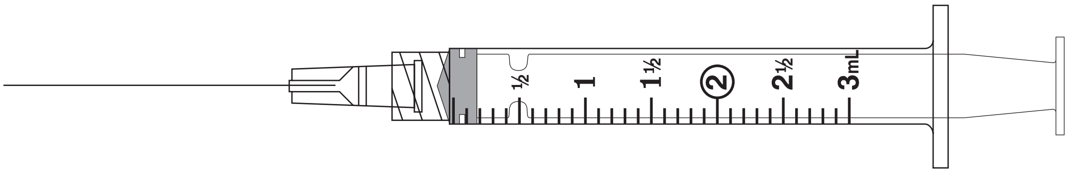


NDC 0002-0501-01
2 mL VIAL No. 782
℞ Lilly
NEBCIN®
PEDIATRIC
TOBRAMYCIN
INJECTION, USP
Equiv. to Tobramycin
20 mg per 2 mL
Multiple Dose
For I.M. or I.V. Use
Must dilute for I.V. use.
Eli Lilly and Company
Indianapolis, IN 46285, USA
WW 1512 AMX
Exp. Date/Control No.

28. If the dosage ordered in question 27 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____





29. Order: **Rocephin 1 g IV q.12h** for a child with a serious infection who weighs 20 lb. The recommended pediatric dosage of Rocephin (ceftriaxone sodium) is a total daily dosage of 50–75 mg/kg, given once a day (or in equally divided doses twice a day), not to exceed 2 g/day.

    Child's weight: ________ kg

    Recommended minimum daily dosage for this child: ________ mg/day

    Recommended minimum single dosage for this child: ________ mg/dose

    Recommended maximum daily dosage for this child: ________ mg/day

    Recommended maximum single dosage for this child: ________ mg/dose

    Is the dosage ordered safe? ________

ROCEPHIN® ROCHE® **1 g**
(ceftriaxone injection)

Galaxy®
Single Dose
Container

50 mL
Iso-osmotic

NDC 0004-2002-78
Code 2G3524
Sterile Nonpyrogenic

Each 50 mL contains: ceftriaxone sodium equivalent to 1 g ceftriaxone with approx. 1.9 g dextrose hydrous, USP, added to adjust osmolality. pH may have been adjusted with sodium hydroxide and/or hydrochloric acid. pH range 6 to 8.

Usual dosage: See accompanying literature.

Cautions: Administer IV using sterile equipment. Must not be used in series connections. Do not add supplementary medication. Check for minute leaks and solution clarity. Rx only.

Store at or below -20°C (-4°F). Thaw at room temperature (25°C/77°F) or under refrigeration (5°C/41°F). **DO NOT FORCE THAW BY IMMERSION IN WATER BATHS OR BY MICROWAVE IRRADIATION.** The thawed solution is stable for 21 days under refrigeration or 72 hours at room temperature. **Do not refreeze.**

U.S. Pat. Nos. 4,686,125; 4,779,997 PL 2040 Plastic
Roche and Rocephin are registered trademarks of Hoffmann-La Roche Inc.
Galaxy is a registered trademark of Baxter International Inc.
Manufactured for **Roche Laboratories Inc.**, Nutley, NJ 07110 7-34-2-327
By **Baxter Healthcare Corporation**, Deerfield, IL 60015 USA 7-34-2-327

30. If the dosage ordered in question 29 is safe, give __________ mL. If not safe, explain why not and describe what you should do. __________

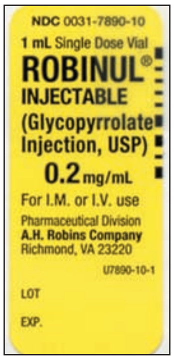
____

31. Order: **Robinul 50 mcg IM 60 minutes pre-op** for a child who weighs 11.4 kg. The recommended pediatric pre-anesthesia dosage of Robinul (glycopyrrolate) is 0.002 mg/lb of body weight given intramuscularly.

Child's weight: __________ lb

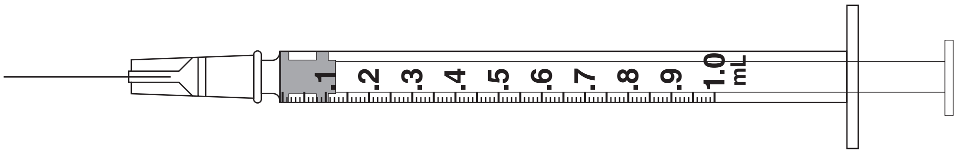
Recommended single dosage for this child: __________ mg/dose

Is the dosage ordered safe? __________



32. If the dosage ordered in question 31 is safe, give __________ mL. If not safe, explain why not and describe what you should do. __________

____



33. Order: **Tazidime 400 mg IV q.8h** for a 6-month-old infant with a serious infection who weighs 18 lb. The recommended dosage of Tazidime (ceftazidime) for infants and children 1 month–12 years is 30–50 mg/kg q.8h, not to exceed 6 g/day.

Child's weight: __________ kg

The total daily dosage ordered for this infant: __________ mg/day or __________ g/day

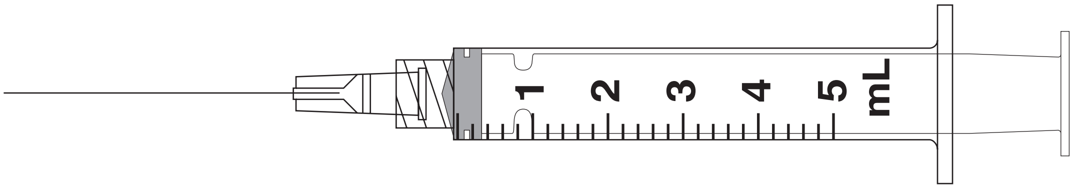
Recommended minimum single dosage for this child: __________ mg/dose

Recommended maximum single dosage for this child: __________ mg/dose

Is the dosage ordered safe? __________

34. If the dosage ordered in question 33 is safe, reconstitute with __________ mL diluent for a total solution volume of __________ mL with a concentration of __________ mg/mL. Give __________ mL. If not safe, explain why not and describe what you should do. __________

____



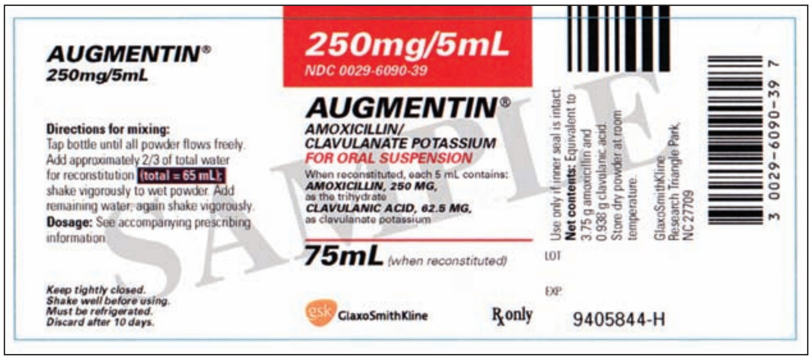
35. Order: **Augmentin 200 mg q.12h** for a 5-year-old child who weighs 45 lb. The recommended dosage of this combination drug is based on the amoxicillin at 25 mg/kg/day in divided doses q.12h or 20 mg/kg/day in divided doses q.8h.

Child's weight: __________ kg

Recommended daily dosage for this child: __________ mg/day

Recommended single dosage for this child: __________ mg/dose

Is the dosage ordered safe? __________



AUGMENTIN®
250mg/5mL

Directions for mixing:
Tap bottle until all powder flows freely. Add approximately 2/3 of total water for reconstitution (total = 65 mL); shake vigorously to wet powder. Add remaining water; again shake vigorously.
Dosage: See accompanying prescribing information.

Keep tightly closed.
Shake well before using.
Must be refrigerated.
Discard after 10 days.

250mg/5mL
NDC 0029-6090-39

AUGMENTIN®
AMOXICILLIN/
CLAVULANATE POTASSIUM
FOR ORAL SUSPENSION
When reconstituted, each 5 mL contains:
AMOXICILLIN, 250 MG,
as the trihydrate
CLAVULANIC ACID, 62.5 MG,
as clavulanate potassium

75mL (when reconstituted)

GlaxoSmithKline Rx only

Use only if inner seal is intact.
Net contents: Equivalent to 3.75 g amoxicillin and 0.938 g clavulanic acid.
Store dry powder at room temperature.

GlaxoSmithKline
Research Triangle Park,
NC 27709

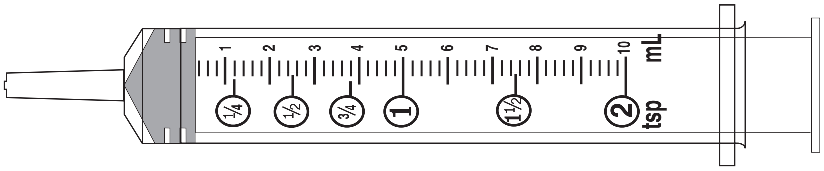
LOT
EXP
9405844-H

3 0029-6090-39 7

SAMPLE

36. If the dosage ordered in question 35 is safe, give __________ mL. If not safe, explain why not and describe what you should do. ____

____



37. Order: **Ceclor oral suspension 75 mg p.o. t.i.d.** for a child with an upper respiratory infection who weighs 18 lb. Recommended dosage: See label.

Child's weight: __________ kg

Recommended daily dosage for this child: __________ mg/day

Recommended single dosage for this child: __________ mg/dose

Is the dosage ordered safe? __________

150 mL CECLOR® CEFACLOR FOR ORAL SUSPENSION, USP
125 mg per 5 mL. Oversize bottle provides extra space for shaking. Store in a refrigerator. May be kept for 14 days without significant loss of potency. Keep Tightly Closed. Discard unused portion after 14 days.
SHAKE WELL BEFORE USING
Control No.

Usual Dose—Pediatric patients, 20 mg per kg a day (40 mg per kg in otitis media) in three divided doses. Adults, 250 mg three times a day. See literature for complete dosage information.
Contains Cefaclor Monohydrate equivalent to 3.75 g anhydrous Cefaclor in a dry pleasantly flavored mixture.
Prior to Mixing, Store at Controlled Room Temperature 59° to 86°F (15° to 30°C).
Directions for Mixing—Add 90 mL of water in two portions to the dry mixture in the bottle. Shake well after each addition.
Each 5 mL (Approx. one teaspoonful) will then contain: Cefaclor Monohydrate equivalent to 125 mg anhydrous Cefaclor.
WV 6465 AMX

Eli Lilly and Company
Indianapolis, IN 46285, USA
Expiration Date

NDC 0002-5057-68
150 mL (When Mixed) M-5057
Rx Lilly
CECLOR®
CEFACLOR FOR
ORAL SUSPENSION, USP
125 mg
per 5 mL

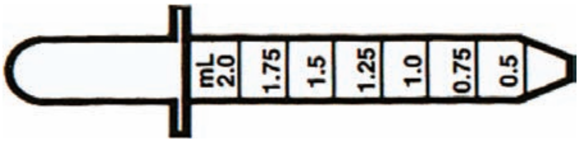
CAUTION—Federal (USA) law prohibits dispensing without prescription.

N 3 0002-5057-68 4
PULL

38. If the dosage ordered in question 37 is safe, give __________ mL. If not safe, explain why not and describe what you should do.

____

____



39. Order: **Vantin 100 mg p.o. q.i.d. × 10 days** for a 4-year-old child with tonsillitis who weighs 45 lb. Recommended dosage for children 5 months–12 years: 5 mg/kg (maximum of 100 mg/dose) q.12h (maximum daily dosage: 200 mg) for 5–10 days.

Child's weight: __________ kg

Recommended daily dosage for this child: __________ mg/day

The total daily dosage ordered for this child: __________ mg/day

Is the dosage ordered safe? __________

EXP:
LOT:

Rx only
See package insert for dosage and complete product information.
Warning: Not for injection
Store unconstituted product at controlled room temperature 20° to 25°C (68° to 77°F) [see USP]. Store constituted suspension in a refrigerator 2° to 8°C (36° to 46°F). Shake well before using. Keep container tightly closed. The mixture may be used for 14 days. Discard unused portion after 14 days.
Directions for mixing: Shake bottle to loosen granules. Add approximately 1/2 the total amount of distilled water required for constitution (total water = 29 mL). Shake vigorously to wet the granules. Add remaining water and shake vigorously.
Each 5 mL of suspension contains cefpodoxime proxetil equivalent to 100 mg cefpodoxime.
U.S. Patent Nos. 4,486,425; 4,409,215
Licensed from Sankyo Company, Ltd., Japan
Manufactured by
Pharmacia & Upjohn S.A.-N.V., Puurs - Belgium
for
Pharmacia & Upjohn Company
Kalamazoo, MI 49001, USA
817 150 101
5Q5358

NDC 0009-3615-03
50 mL (when mixed)

Vantin® For Oral Suspension
cefpodoxime proxetil
for oral suspension

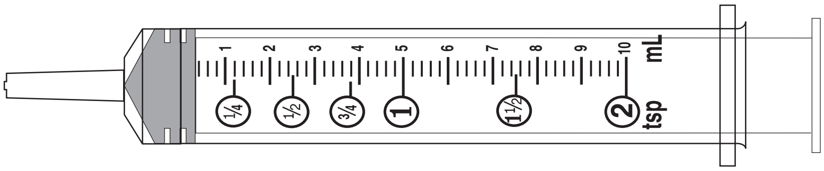
100 mg per 5 ml

Equivalent to 100 mg per 5 mL cefpodoxime when constituted

Pharmacia
&Upjohn

40. If the dosage ordered in question 39 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____



41. Order: **Biaxin 175 mg p.o. q.12h** for a child who weighs 51 lb. Recommended pediatric dosage: See label.

Child's weight: ________ kg

Recommended daily dosage for this child: ________ mg/day

Recommended single dosage for this child: ________ mg/dose

Is the dosage ordered safe? ________

May be taken before, after or with meals.
Shake well before each use. Oversize bottle provides shake space. Keep tightly closed.
After mixing, store at 15° to 30°C (59° to 86° F) and use within 14 days. DO NOT REFRIGERATE.
NDC 0074-3188-13
02-7717-R4

SPECIMEN

Lot
Exp.

TEAR PERFORATION BETWEEN ARROWS

Store granules at 15° to 30°C (59° to 86°F).
CONSTITUTING INSTRUCTIONS:
VOLUME OF WATER: 55 mL
Measure the required volume of water using a graduated cylinder. Add half the volume of water to the bottle and shake vigorously. Add the remainder of water to the bottle and shake.
Contains 5 g clarithromycin.
When mixed as directed, each teaspoonful (5 mL) contains:
Clarithromycin .... 250 mg
in a fruit punch-flavored, aqueous vehicle.
DOSAGE MAY BE ADMINISTERED WITHOUT REGARD TO MEALS.
Usual dose: Children: 15 mg/kg/day divided in 2 equal doses. See enclosure for adult dose and full prescribing information.
Abbott Laboratories
North Chicago, IL60064, U.S.A.

NDC 0074-3188-13
100 mL (when mixed)

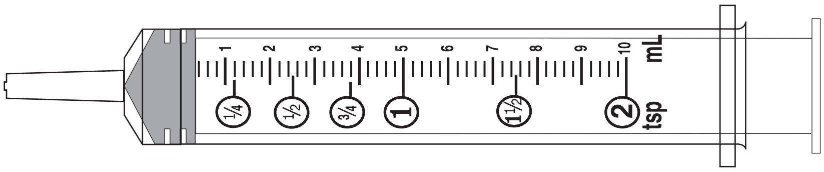
BIAXIN®
GRANULES
clarithromycin for oral suspension
250 mg per 5 mL
when reconstituted

Caution: Federal (U.S.A.) law prohibits dispensing without prescription.

0074318813

42. If the dosage ordered in question 41 is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____

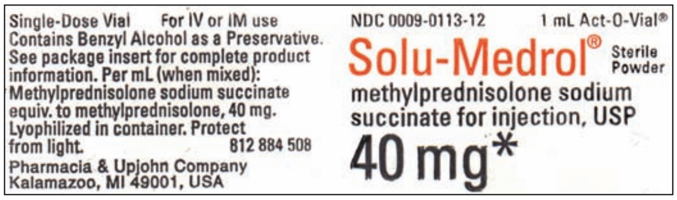


Questions 43 through 48 ask you to apply the steps on your own to determine safe dosages, just as you would do in the clinical setting. Calculate the amount to give and mark an arrow on the measuring device, or explain unsafe dosages and describe the appropriate action.

43. Order: **Solu-Medrol 10 mg IM q.6h** for a child who weighs 95 lb. Recommended pediatric dosage: Not less than 0.5 mg/kg/day.

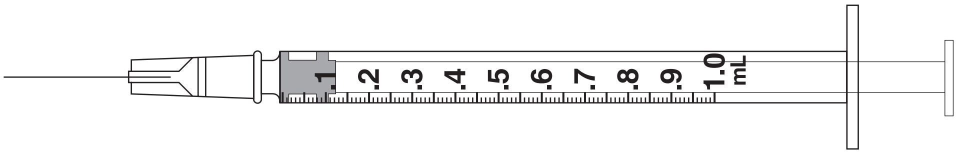
If the dosage ordered is safe, give ________ mL. If not safe, explain why not and describe what you should do. ____

____



Single-Dose Vial For IV or IM use
Contains Benzyl Alcohol as a Preservative.
See package insert for complete product information. Per mL (when mixed):
Methylprednisolone sodium succinate equiv. to methylprednisolone, 40 mg.
Lyophilized in container. Protect from light.
812 884 508
Pharmacia & Upjohn Company
Kalamazoo, MI 49001, USA

NDC 0009-0113-12 1 mL Act-O-Vial®
Solu-Medrol® Sterile Powder
methylprednisolone sodium succinate for injection, USP
40 mg*



44. Order: **albuterol 1.4 mg p.o. t.i.d.** for a 2-year-old child who weighs 31 lb. Recommended pediatric dosage: 0.1 mg/kg, not to exceed 2 mg t.i.d.

If the dosage ordered is safe, give ________ mL. If not safe, explain why not and describe what you should do. ________

____

____

SCHERING

16 fl. oz. (1 pint)

Proventil®

brand of

albuterol sulfate, USP

Syrup 2 mg* per 5 mL

*Potency expressed as albuterol.

Each teaspoonful (5 mL) contains: 2 mg albuterol as the sulfate.

Store between 2° and 30°C (36° and 86°F).

Usual Dose: See package insert.

Read accompanying directions carefully.

Caution: Federal law prohibits dispensing without prescription.

Copyright © 1992, 1995, Schering Corporation, Kenilworth, NJ 07033 USA. All rights reserved.

17359312 Rev. 11/94

6505-01-256-4997

NDC 0085-0315-02

16 fl. oz. (1 pint)

Proventil®

brand of

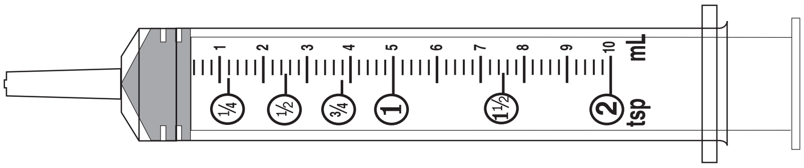
albuterol sulfate, USP

Syrup 2 mg* per 5 mL

*Potency expressed as albuterol.

N 3 0085-0315-02 7

SCHERING



45. Order: **penicillin G potassium 450,000 units IM q.6h** for a child with a streptococcal infection who weighs 12 kg. Recommended pediatric dosage for streptococcal infections is 150,000 units/kg/day given in equal doses q.4–6h.

If the dosage ordered is safe, reconstitute to a dosage supply of ________ units/mL and give ________ mL. If not safe, explain why not and describe what you should do. ________

READ ACCOMPANYING PROFESSIONAL INFORMATION

RECOMMENDED STORAGE IN DRY FORM

STORE BELOW 86°F (30°C)

Sterile solution may be kept in refrigerator for one (1) week without significant loss of potency.

MADE IN U.S.A. 05-4242-00-3

6505-00-664-7116

NDC 0049-0510-83

Buffered

Pfizerpen®

penicillin G potassium

For Injection

ONE MILLION UNITS

CAUTION: Federal law prohibits dispensing without prescription.

ROERIG Pfizer

A division of Pfizer Inc., N.Y., N.Y. 10017

USUAL DOSAGE

Average single intramuscular injection: 200,000-400,000 units. Intravenous: Additional information about the use of this product intravenously can be found in the package insert.

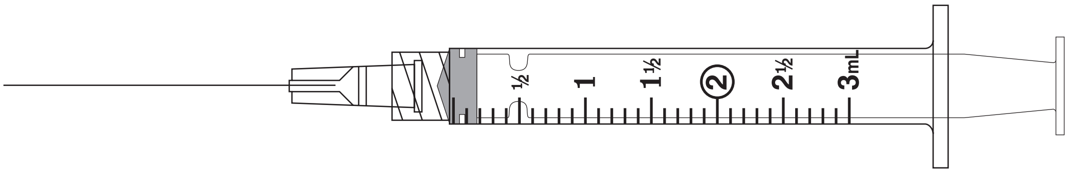
ml diluent added	Units per ml of solution
20.0 ml	50,000
10.0 ml	100,000
4.0 ml	250,000
1.8 ml	500,000

Buffered with sodium citrate and citric acid to optimum pH.

PATIENT: ________

ROOM NO.: ________

DATE DILUTED: ________



46. Order: **Klonopin 1 mg p.o. b.i.d.** for a 9-year-old child on initial therapy who weighs 56 lb. The recommended initial pediatric dosage of Klonopin (clonazepam) for children up to 10 years or 30 kg is 0.01–0.03 mg/kg/day in 2–3 divided doses up to a maximum of 0.05 mg/kg/day.

If the dosage ordered is safe, give ________ tablet(s). If not safe, explain why not and describe what you should do. ________

____

Bulk Package - Not Intended for Dispensing

Dispense in tight, light-resistant containers as defined in USP/NF.

STORE AT 59° TO 86° F (15° TO 30° C).

LOT

EXPIRES

26154893-0996

NDC 0004-0068-01

Roche

KLONOPIN® CIV

(clonazepam)

0.5 mg

CAUTION: Federal law prohibits dispensing without prescription.

100 Tablets

Each tablet contains 0.5 mg clonazepam.

USUAL DOSAGE: For dosage recommendations and other important prescribing information, read accompanying insert.

Distr. by: **ROCHE LABORATORIES INC.** Nutley, New Jersey 07110

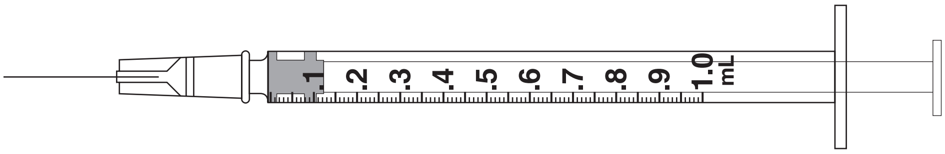
Mfd. by: **ROCHE PHARMA, INC.** Manati, Puerto Rico 00674

0004-0068-01

47. Order: **meperidine 20 mg subcut q.4h p.r.n. pain** for a child who weighs 18 lb. Recommended pediatric dosage: 1.1–1.8 mg/kg q.3–4h p.r.n.; do not exceed adult dosage of 50–100 mg/dose.

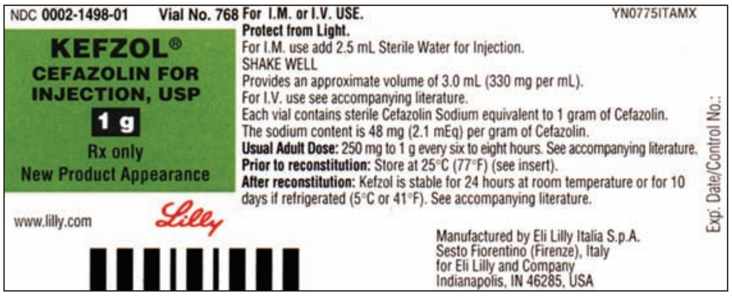
If the dosage ordered is safe, give ________ mL. If not safe, explain why not and describe what you should do. ________

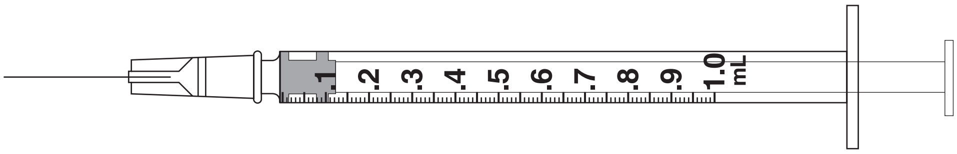

NDC 10019-151-44
Meperidine
HCl Injection, USP
25 mg/mL
FOR IM, SC OR SLOW IV USE
DO NOT USE IF PRECIPITATED
1 mL
DOSETTE® Vial
Mfd. for an affiliate of
Baxter Healthcare Corporation
by: Elkins-Sinn
Cherry Hill, NJ 08003
400-841-00
Lot:
Exp.:



48. Order: **Kefzol 250 mg IM q.8h** for a 3-year-old child who weighs 35 lb. The recommended pediatric dosage of Kefzol (cefazolin sodium) for children over 1 month: 25–50 mg/kg/day in 3–4 divided doses.

If the dosage ordered is safe, give ________ mL. If not safe, explain why not and describe what you should do. ________


NDC 0002-1498-01 Vial No. 768
KEFZOL®
CEFAZOLIN FOR INJECTION, USP
1 g
Rx only
New Product Appearance
www.lilly.com
Lilly
For I.M. or I.V. USE.
YN0775ITAMX
Protect from Light.
For I.M. use add 2.5 mL Sterile Water for Injection.
SHAKE WELL
Provides an approximate volume of 3.0 mL (330 mg per mL).
For I.V. use see accompanying literature.
Each vial contains sterile Cefazolin Sodium equivalent to 1 gram of Cefazolin.
The sodium content is 48 mg (2.1 mEq) per gram of Cefazolin.
Usual Adult Dose: 250 mg to 1 g every six to eight hours. See accompanying literature.
Prior to reconstitution: Store at 25°C (77°F) (see insert).
After reconstitution: Kefzol is stable for 24 hours at room temperature or for 10 days if refrigerated (5°C or 41°F). See accompanying literature.
Manufactured by Eli Lilly Italia S.p.A.
Sesto Fiorentino (Firenze), Italy
for Eli Lilly and Company
Indianapolis, IN 46285, USA
Exp. Date/Control No.:



49. Refer to questions 43 through 48. Identify which drugs require a reconstitution label.

50. Describe the strategy or strategies you would implement to prevent this medication error.

Possible Scenario

Suppose the family practice resident ordered **tobramycin 110 mg IV q.8h** for a child with cystic fibrosis who weighs 10 kg. The pediatric reference guide states that the safe dosage of tobramycin for a child with severe infections is 7.5 mg/kg/day in 3 equally divided doses. The nurse received five admissions the evening of this order and thought, "I'm too busy to calculate the safe dosage this time." The pharmacist prepared and labeled the medication in a syringe and the nurse administered the first dose of the medication. An hour later the resident arrived on the pediatric unit and inquired if the nurse had given the first dose. When the nurse replied "yes," the resident became pale and stated, "I just realized that I ordered an adult dose of tobramycin. I had hoped you hadn't given the medication yet."

Potential Outcome

The resident's next step would likely have been to discontinue the tobramycin and order a stat tobramycin level. The level would most likely have been elevated, and the child would have required close monitoring for renal damage and hearing loss.

Prevention

____

____

After completing these problems, see pages 501-513 to check your answers.

SECTION 3 SELF-EVALUATION

Chapter 10—Oral Dosage of Drugs

The following labels (A–N) represent the drugs you have available on your medication cart for the orders in questions 1 through 10. Select the correct label and identify the letter that corresponds to fill these medication orders. Calculate the amount to give.

1. Order: Toprol-XL 0.2 g p.o. daily

   Select label __________ and give __________ tablet(s)

2. Order: Nexium 40 mg p.o. daily

   Select label __________ and give __________ capsule(s)

3. Order: Aricept 10 mg p.o. daily

   Select label __________ and give __________ tablet(s)

4. Order: ondansetron hydrochloride 6 mg p.o. b.i.d. X 2 days

   Select label __________ and give __________ mL

5. Order: potassium chloride 16 mEq p.o. daily

   Select label __________ and give __________ mL

6. Order: nitroglycerin 13 mg p.o. t.i.d.

   Select label __________ and give __________ capsule(s)

7. Order: Synthroid 0.05 mg p.o. daily

   Select label __________ and give __________ tablet(s)

8. Order: codeine gr $\frac{1}{4}$ p.o. q.6h p.r.n., cough

   Select label __________ and give __________ tablet(s)

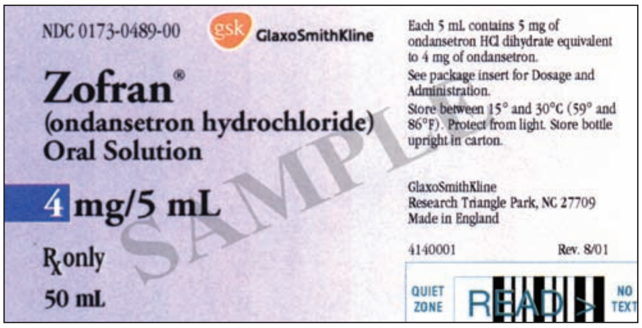
9. Order: furosemide 12.5 mg p.o. b.i.d.

   Select label __________ and give __________ mL

10. Order: Proventil 3 mg p.o. t.i.d.

    Select label __________ and give __________ mL

A



B

* Each tablet contains 95 mg metoprolol succinate equivalent to 100 mg metoprolol tartrate, USP.
DOSAGE: See package insert.
WARNING: As with all medications, keep out of the reach of children. Store at 25°C (77°F). Excursions permitted to 15-30°C (59-86°F) [see USP].
TOPROL-XL is a trademark of the AstraZeneca group of companies.

XXXXX-XX

LOT
EXP

NDC 0186-1092-05 100 tablets

TOPROL-XL®
(metoprolol succinate)
extended-release tablets

100 mg *

Rx only

Mfd. for: AstraZeneca LP
Wilmington, DE 19850
By: AstraZeneca AB
S-151 85 Södertälje, Sweden
Made in Sweden

CAUTION
Verify Product Dispensed

AstraZeneca

N3 0186-1092-05 1

F.P.O.

C

N 3 58177-006-04 3

Each extended-release capsule contains:
Nitroglycerin. . . . . 9 mg

KEEP THIS AND ALL DRUGS OUT OF THE REACH OF CHILDREN.

Manufactured by
Time-Cap Labs Inc. for
ETHEX Corporation
St. Louis, MO 63043-2413

NDC 58177-006-04

Nitroglycerin

Extended-release Capsules

9 mg

℞ Only

100 Capsules

Dispense in a tight container as defined in the USP/NF.

Store at controlled room temperature 15°-30°C (59°-86°F).

USUAL DOSAGE: See package insert for dosage, including nitrate-free intervals.

P2105-7 7/01

ETHEX ETHEX ETHEX ETHEX ETHEX

D

3 0048-1020-05 5

NDC 0048-1020-05
Code 3P1025

SYNTHROID®
(Levothyroxine Sodium Tablets, USP)

25 mcg (0.025 mg)

1000 TABLETS

Rx only

BASF Pharma knoll

See full prescribing information for dosage and administration.

Dispense in a tight, light-resistant container as described in USP.

Store at 25°C (77°F); excursions permitted to 15°-30°C (59°-86°F). [See USP Controlled Room Temperature].

Knoll Pharmaceutical Company
Mount Olive, NJ 07828
USA

7897-03

E

3 0186-5040-31 7

NDC 0186-5040-31

Nexium™
(esomeprazole magnesium)

30 Delayed-Release Capsules

Rx only

40 mg*

*Each delayed-release capsule contains 40 mg esomeprazole

AstraZeneca

Keep container tightly closed.
Store at 25°C (77°F); excursions permitted to 15–30°C (59–86°F). [See USP Controlled Room Temperature].
USUAL ADULT DOSAGE:
See package insert.
All trademarks are the property of the AstraZeneca group
© AstraZeneca 2000
Manufactured for: AstraZeneca LP
Wilmington, DE 19850
By: AstraZeneca AB
S-151 85 Södertälje, Sweden
Product of France

Lot

9388500
301 No.5040 620506-04

F

Store at controlled room temperature 59° to 86°F (15° to 30°C).
Dispense in tight containers (USP).

DOSAGE AND USE
See accompanying prescribing information.

Each tablet contains 5 mg donepezil hydrochloride.

200316

NDC 62856-245-90
ARICEPT® ⑤
(donepezil HCl tablets)

5 mg

90 Tablets

Manufactured and Marketed by
Eisai Inc.
Teaneck, NJ 07666

Marketed by
Pfizer Inc
NY, NY 10017

3 N 62856-245-90 2

7012

Rx only

©2003 Eisai Inc.

G

Delivers **15 mL**
NDC 0121-0465-15
POTASSIUM CHLORIDE
ORAL SOLUTION USP 10%
20 mEq per 15 mL
Sugar Free Alcohol 5%
DILUTE BEFORE USING
(01) 0 03 01210 46515 4
Rx ONLY
FOR INSTITUTIONAL USE ONLY
PHARMACEUTICAL ASSOCIATES, INC.
GREENVILLE, SC 29605
SEE INSERT

H

N 3 58177-005-04 6

Each extended-release capsule contains:

Nitroglycerin .... 6.5 mg

KEEP THIS AND ALL DRUGS OUT OF THE REACH OF CHILDREN.

Manufactured by
Time-Cap Labs Inc. for
ETHEX Corporation
St. Louis, MO 63043-2413

NDC 58177-005-04

Nitroglycerin

Extended-release Capsules

6.5 mg

℞ Only

100 Capsules

Dispense in a tight container as defined in the USP/NF.

Store at controlled room temperature 15°-30°C (59°-86°F).

USUAL DOSAGE: See package insert for dosage, including nitrate-free intervals.

P3808 12/01

ETHEX ETHEX ETHEX ETHEX ETHEX

I

Store at controlled room temperature 59° to 86°F (15° to 30°C).

Dispense in tight containers (USP).

DOSAGE AND USE

See accompanying prescribing information.

Each tablet contains 10 mg donepezil hydrochloride.

200317

NDC 62856-246-90

ARICEPT® ⑩

(donepezil HCl tablets)

10 mg

90 Tablets

Manufactured and Marketed by
Eisai Inc.
Teaneck,NJ 07666

Marketed by
Pfizer Inc
NY, NY 10017

3 N 62856-246-90 2

[redacted]

7013

Rx only

©2003 Eisai Inc.

J

See Package Insert for Complete Prescribing Information.

Store at Controlled Room Temperature 15°-30°C (59°-86°F).

PROTECT FROM MOISTURE.

Dispense in a well-closed container as defined in the USP/NF.

TABLETS IDENTIFIED 54 783
(Side One) (Side Two)
DO NOT USE UNLESS TABLETS CARRY THIS IDENTIFICATION

NDC 0054-4156-25

100 Tablets

30 mg

C II

CODEINE
Sulfate
Tablets USP

Each tablet contains
Codeine Sulfate 30 mg
℞ only.

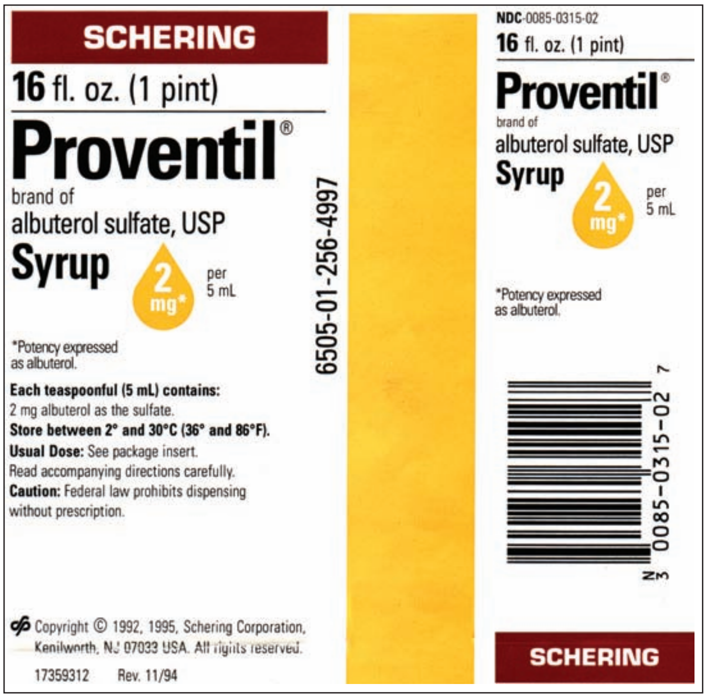
Roxane
Laboratories, Inc.
Columbus, Ohio 43216

EXP. LOT

4151001
039
© RLI, 1999

N 3 0054-4156-25 7

K



SCHERING

16 fl. oz. (1 pint)

Proventil®

brand of
albuterol sulfate, USP

Syrup

2 mg* per 5 mL

*Potency expressed as albuterol.

Each teaspoonful (5 mL) contains:
2 mg albuterol as the sulfate.
Store between 2° and 30°C (36° and 86°F).
Usual Dose: See package insert.
Read accompanying directions carefully.
Caution: Federal law prohibits dispensing without prescription.

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17359312 Rev. 11/94

6505-01-256-4997

NDC-0085-0315-02

16 fl. oz. (1 pint)

Proventil®

brand of
albuterol sulfate, USP

Syrup

2 mg* per 5 mL

*Potency expressed as albuterol.

N 3 0085-0315-02 7

SCHERING

L

PHARMACIST/ NURSE/PATIENT:
Please note diagram to the right. ←
Fill the dropper to the level of the prescribed dose.
Discard opened bottle after 90 days.
PROTECT FROM LIGHT.

Furosemide
Oral Solution
10 mg per mL

NDC 0054-3294-46

60 mL

FUROSEMIDE
Oral Solution

10 mg per mL

Each mL contains:
Furosemide 10 mg
SUGAR FREE
℞ only
See Package Insert For Complete Prescribing Information.
PROTECT FROM LIGHT

Roxane
Laboratories, Inc.
Columbus, Ohio 43216

4117540//02

© RLI, 2001

Dispense only in this bottle and only with the calibrated dropper provided. Store at Controlled Room Temperature 15°-30°C (59°-86°F).

EXP. LOT

M

3 0048-1070-03 6

NDC 0048-1070-03
NSN 6505-01-340-0152
Code 3P1073

SYNTHROID®

(Levothyroxine Sodium Tablets, USP)

100 mcg (0.1 mg)

100 TABLETS

Rx only

BASF Pharma

knoll

See full prescribing information for dosage and administration.

Dispense in a tight, light-resistant container as described in USP.

Store at 25°C (77°F); excursions permitted to 15°-30°C (59°-86°F). [See USP Controlled Room Temperature].

Knoll Pharmaceutical Company
Mount Olive, NJ 07828
USA

7885-04

N

Chapter 11—Parenteral Dosage of Drugs

The following labels (A–H) represent the drugs you have available on your medication cart for the orders in questions 11 through 18. Select the correct label and identify the letter that corresponds to fill these parenteral medication orders. Calculate the amount to give.

11. Order: clindamycin 0.6 g IV q.12h

Select label ________ and give ________ mL

How many vials will you need to administer this dose? ________

12. Order: Dilantin 175 mg IV stat

Select label ________ and give ________ mL

13. Order: epinephrine 200 mcg subcut stat

Select label ________ and give ________ mL

14. Order: furosemide 8 mg IM daily

Select label ________ and give ________ mL

15. Order: gentamicin 60 mg IV q.8h

Select label ________ and give ________ mL

16. Order: heparin 750 units subcut stat

Select label ________ and give ________ mL

17. Order: morphine gr $\frac{1}{10}$ subcut q.4h p.r.n., pain

Select label ________ and give ________ mL

18. Order: Narcan 0.3 mg IM stat

Select label ________ and give ________ mL


NDC 63323-280-04 28004
FUROSEMIDE
INJECTION, USP
40 mg/4 mL
(10 mg/mL)
For IM or IV Use Rx only
4 mL Single Dose Vial

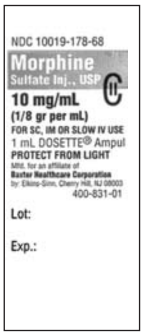
Sterile, Nonpyrogenic
Preservative Free
Discard unused portion.
Each mL contains: Furosemide 10 mg; Water for Injection q.s. Sodium chloride to adjust isotonicity. pH adjusted with sodium hydroxide and if necessary hydrochloric acid.
Usual Dosage: See insert.
PROTECT FROM LIGHT. Do not use if discolored. Use only if solution is clear and seal intact. Store at controlled room temperature 15°-30°C (59°-86°F).

American Pharmaceutical Partners, Inc.
Los Angeles, CA 90024

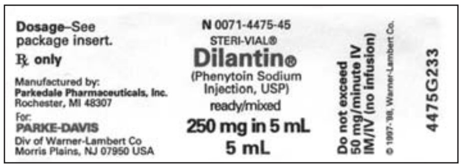
401736A

LOT
EXP
SAMPLE

A


NDC 10019-178-68
Morphine
Sulfate Inj., USP
C II
10 mg/mL
(1/8 gr per mL)
FOR SC, IM OR SLOW IV USE
1 mL DOSETTE® Ampul
PROTECT FROM LIGHT
Mfd. for an affiliate of
Baxter Healthcare Corporation
by: Elkins-Sinn, Cherry Hill, NJ 08003
400-831-01
Lot:
Exp.:

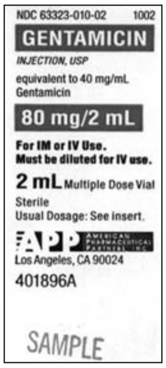
B


Dosage–See package insert.
℞ only
Manufactured by:
Parkedale Pharmaceuticals, Inc.
Rochester, MI 48307
For:
PARKE-DAVIS
Div of Warner-Lambert Co
Morris Plains, NJ 07950 USA

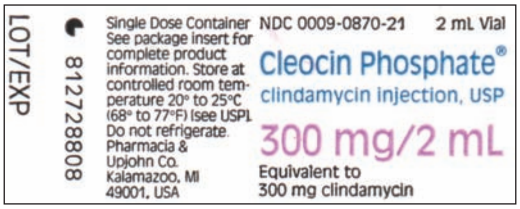
N 0071-4475-45
STERI-VIAL®
Dilantin®
(Phenytoin Sodium Injection, USP)
ready/mixed
250 mg in 5 mL
5 mL

Do not exceed 50 mg/minute IV
IM/IV (no infusion)
© 1997-'98, Warner-Lambert Co.
4475G233

C


NDC 63323-010-02 1002
GENTAMICIN
INJECTION, USP
equivalent to 40 mg/mL Gentamicin
80 mg/2 mL
For IM or IV Use.
Must be diluted for IV use.
2 mL Multiple Dose Vial
Sterile
Usual Dosage: See insert.
APP AMERICAN PHARMACEUTICAL PARTNERS, INC.
Los Angeles, CA 90024
401896A
SAMPLE

D


LOT/EXP
812728808

Single Dose Container
See package insert for complete product information. Store at controlled room temperature 20° to 25°C (68° to 77°F) [see USP].
Do not refrigerate.
Pharmacia & Upjohn Co.
Kalamazoo, MI
49001, USA

NDC 0009-0870-21 2 mL Vial
Cleocin Phosphate®
clindamycin injection, USP
300 mg/2 mL
Equivalent to
300 mg clindamycin

E


Each mL contains heparin sodium 1000 USP units, sodium chloride 8.6 mg and benzyl alcohol 0.01 mL in Water for Injection. pH 5.0-7.5; sodium hydroxide and/or hydrochloric acid added, if needed, for pH adjustment.
USUAL DOSAGE: See package insert for complete prescribing information.

30 mL MULTIPLE DOSE Vial
NDC 0641-2450-41 ℞ only
HEPARIN
SODIUM INJECTION, USP
1000 units / 1 mL
FOR INTRAVENOUS OR
DEEP SUBCUTANEOUS USE

esi® ELKINS-SINN, INC. Cherry Hill, NJ 08003

DERIVED FROM PORCINE INTESTINES
Store at controlled room temperature 20° to 25°C (68° to 77°F) [see USP].
U2450-41-2
LOT
EXP

F


NDC 0517-1071-25
EPINEPHRINE
INJECTION, USP
1:1000 (1mg/mL)
CONTAINS NO SULFITES
PRESERVATIVE FREE
FOR IV, IM OR SC USE
1mL AMPULE
Rx Only
AMERICAN REGENT LABORATORIES, INC.
SHIRLEY, NY 1196

Store between 15°-25°C (59°-77°F).
Directions: See Package Insert.
Rev. 5/99

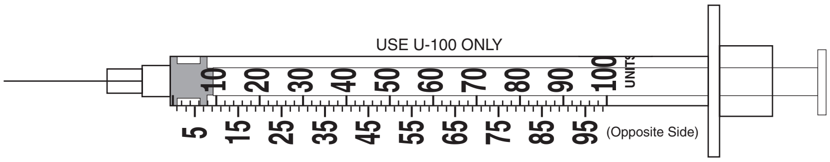
G

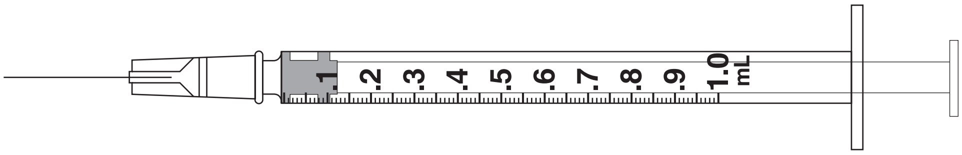

NDC 63481-358-01
NARCAN®
(Naloxone HCl Injection, USP)
0.4 mg/mL
1 mL AMPUL
FOR IM, SC OR IV USE
Endo Pharmaceuticals Inc.
Chadds Ford, PA 19317
Lot:
Exp:
SAMPLE

H

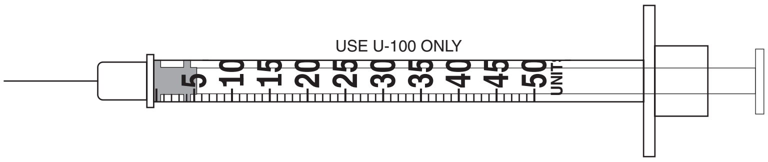
For questions 19 and 20, select and mark the amount to give on the correct syringe.

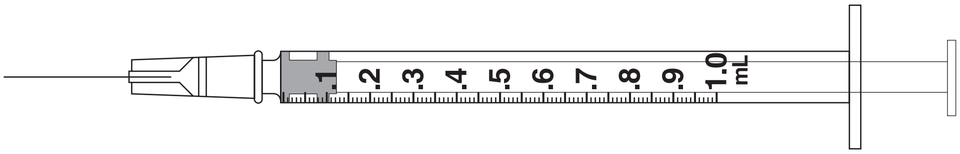
19. Order: **Humulin-N NPH U-100 insulin 48 units subcut 30 min ā breakfast**





20. Order: **Novolin R Regular U-100 insulin 12 units c̄ Novolin N NPH U-100 insulin 28 units subcut 30 min ā dinner**





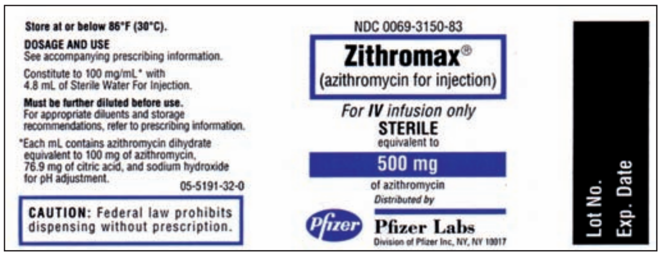
Chapter 12—Reconstitution of Solutions

For questions 21 through 26, specify the amount of diluent to add and the resulting solution concentration. Calculate the amount to give and indicate the dose with an arrow on the accompanying syringe. Finally, make a reconstitution label, if required.

21. Order: **Zithromax 500 mg IV daily**

Reconstitute with _________ mL diluent for a total solution volume of _________ mL with a concentration of _________ mg/mL.

Give: _________ mL



Store at or below 86°F (30°C).

DOSAGE AND USE
See accompanying prescribing information.

Constitute to 100 mg/mL* with
4.8 mL of Sterile Water For Injection.

Must be further diluted before use.
For appropriate diluents and storage recommendations, refer to prescribing information.

*Each mL contains azithromycin dihydrate equivalent to 100 mg of azithromycin, 76.9 mg of citric acid, and sodium hydroxide for pH adjustment.

05-5191-32-0

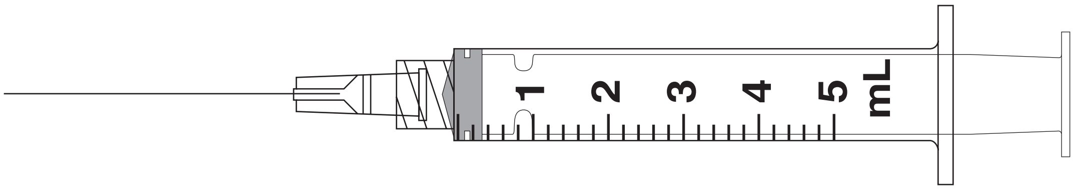
CAUTION: Federal law prohibits dispensing without prescription.

NDC 0069-3150-83

Zithromax®
(azithromycin for injection)

*For **IV** infusion only*
STERILE
equivalent to
500 mg
of azithromycin
Distributed by
Pfizer
Pfizer Labs
Division of Pfizer Inc, NY, NY 10017

Lot No.
Exp. Date

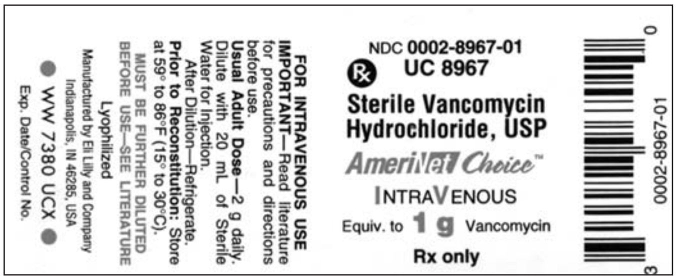


22. Order: **vancomycin 500 mg IV q.6h**

Package Insert Instructions: For IV use, dilute each 500 mg with 10 mL sterile water. Prior to administration, dilute further with 200 mL of dextrose or saline solution and infuse over 60 min. Aqueous solution is stable for 2 weeks.

Reconstitute with ________ mL diluent for a total solution volume of ________ mL with a concentration of ________ g/________ mL.

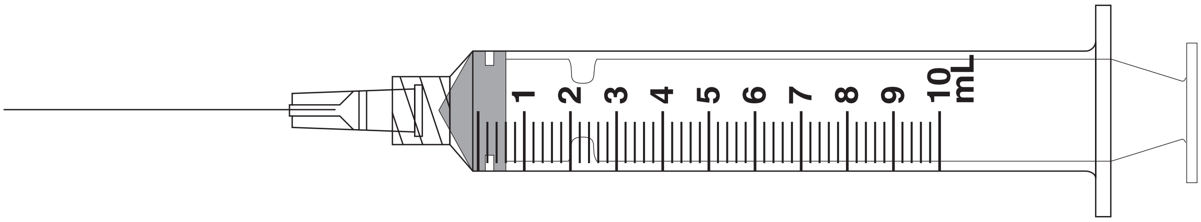
Give: ________ mL



FOR INTRAVENOUS USE
IMPORTANT—Read literature for precautions and directions before use.
Usual Adult Dose—2 g daily. Dilute with 20 mL of Sterile Water for Injection.
After Dilution—Refrigerate.
Prior to Reconstitution: Store at 59° to 86°F (15° to 30°C).
MUST BE FURTHER DILUTED BEFORE USE—SEE LITERATURE
Lyophilized
Manufactured by Eli Lilly and Company
Indianapolis, IN 46285, USA
● WW 7380 UCX ●
Exp. Date/Control No.

NDC 0002-8967-01
℞ UC 8967
Sterile Vancomycin Hydrochloride, USP
AmeriNet Choice™
INTRAVENOUS
Equiv. to 1 g Vancomycin
Rx only

0002-8967-01



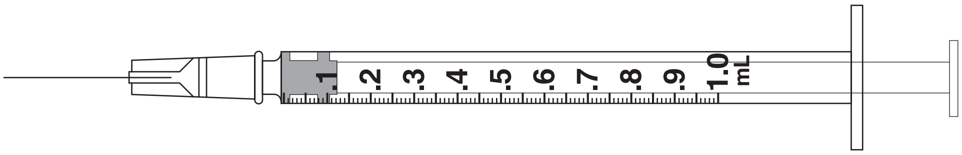
23. Order: **Tazidime 200 mg IM q.6h**

Reconstitute with ________ mL diluent for a total solution volume of ________ mL with a concentration of ________ mg/mL.

Give: ________ mL

For I.M. or I.V. Use
CAUTION: Addition of diluent generates pressure within the vial. Vent slowly.
For I.V. solution—Dilute with at least 5 ml Sterile Water for Injection or other approved diluent. SHAKE WELL TO DISSOLVE. See literature.
For I.M. solution—Add 1.5 ml of an approved diluent. SHAKE WELL TO DISSOLVE. Provides an approximate volume of 1.8 ml (280 mg per mL). For dosage and administration see literature.
Prior to Reconstitution: Protect from light. Store at 59° to 86°F.
After Reconstitution: Store in a refrigerator and use within 7 days. If kept at room temperature, use within 24 hours. Once reconstituted, light protection is not needed.
Each vial contains: 500 mg of Ceftazidime and 59 mg of Sodium Carbonate. Sodium content: approximately 27 mg (1.2 mEq) of sodium per vial.
WV 4622 AMX
Eli Lilly & Co., Indianapolis, IN 46285, U.S.A.
Exp. Date/Control No.

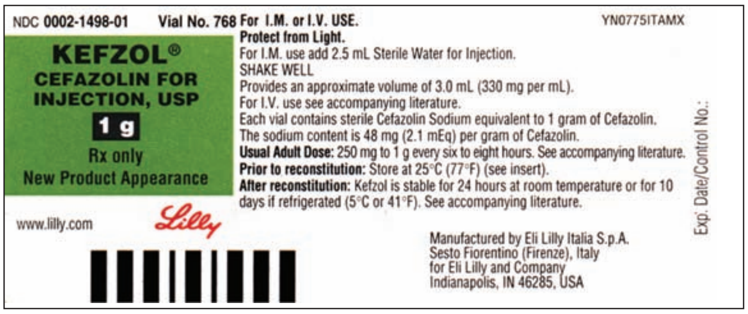
NDC 0002-7230-01
VIAL No. 7230
℞ Lilly
TAZIDIME®
CEFTAZIDIME FOR INJECTION, USP
Equivalent to
500 mg
Ceftazidime Activity



24. Order: **Kefzol 750 mg IM q.8h** (See label on next page.)

Reconstitute with ________ mL diluent for a total solution volume of ________ mL with a concentration of ________ mg/mL.

Give: ________ mL



NDC 0002-1498-01 Vial No. 768 For I.M. or I.V. USE. YN0775ITAMX

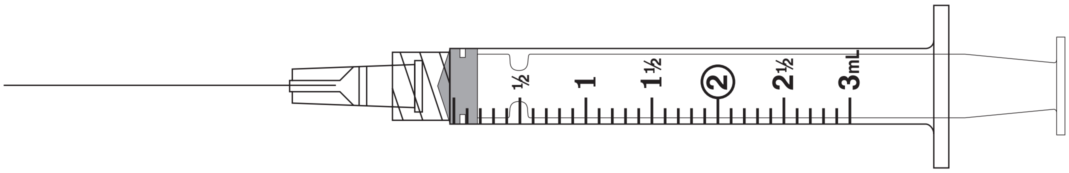
KEFZOL®
CEFAZOLIN FOR INJECTION, USP
1 g
Rx only
New Product Appearance

Protect from Light.
For I.M. use add 2.5 mL Sterile Water for Injection.
SHAKE WELL
Provides an approximate volume of 3.0 mL (330 mg per mL).
For I.V. use see accompanying literature.
Each vial contains sterile Cefazolin Sodium equivalent to 1 gram of Cefazolin.
The sodium content is 48 mg (2.1 mEq) per gram of Cefazolin.
Usual Adult Dose: 250 mg to 1 g every six to eight hours. See accompanying literature.
Prior to reconstitution: Store at 25°C (77°F) (see insert).
After reconstitution: Kefzol is stable for 24 hours at room temperature or for 10 days if refrigerated (5°C or 41°F). See accompanying literature.

www.lilly.com Lilly

Manufactured by Eli Lilly Italia S.p.A.
Sesto Fiorentino (Firenze), Italy
for Eli Lilly and Company
Indianapolis, IN 46285, USA

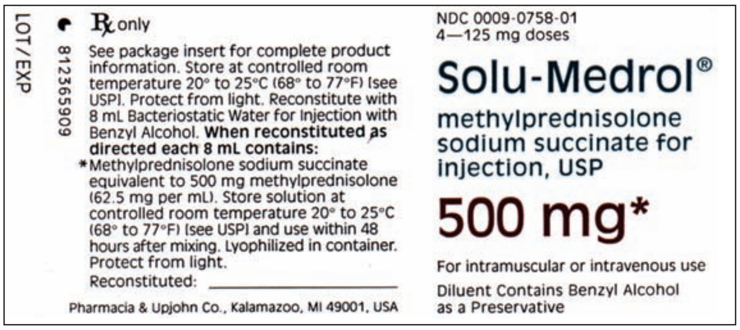
Exp. Date/Control No.:



25. Order: **Solu-Medrol 250 mg IV q.6h**

Reconstitute with _________ mL diluent for a total solution volume of _________ mL with a concentration of _________ mg/mL.

Give: _________ mL



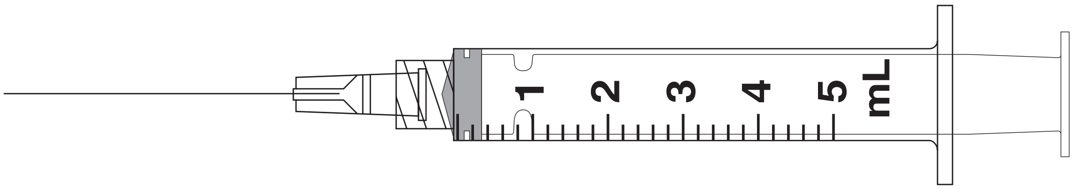
LOT / EXP

81236590 9

℞ only
See package insert for complete product information. Store at controlled room temperature 20° to 25°C (68° to 77°F) [see USP]. Protect from light. Reconstitute with 8 mL Bacteriostatic Water for Injection with Benzyl Alcohol. **When reconstituted as directed each 8 mL contains:**
*Methylprednisolone sodium succinate equivalent to 500 mg methylprednisolone (62.5 mg per mL). Store solution at controlled room temperature 20° to 25°C (68° to 77°F) [see USP] and use within 48 hours after mixing. Lyophilized in container. Protect from light.
Reconstituted: ____________
Pharmacia & Upjohn Co., Kalamazoo, MI 49001, USA

NDC 0009-0758-01
4—125 mg doses

Solu-Medrol®
methylprednisolone sodium succinate for injection, USP
500 mg*
For intramuscular or intravenous use
Diluent Contains Benzyl Alcohol as a Preservative



26. Order: **Vantin 100 mg p.o. q.12h**

Reconstitute with _________ mL diluent for a total solution volume of _________ mL with a concentration of _________ mg per _________ mL or _________ mg/mL.

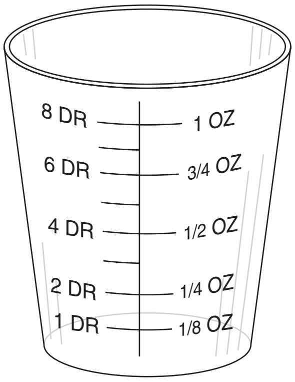
Give: _________ mL

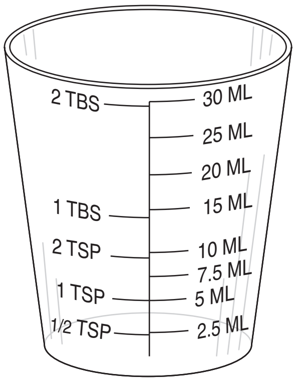
℞ only
See package insert for dosage and complete product information.
Warning: Not for injection
Store unconstituted product at controlled room temperature 20° to 25°C (68° to 77°F) [see USP]. Store constituted suspension in a refrigerator 2° to 8°C (36° to 46°F).
Shake well before using. Keep container tightly closed. The mixture may be used for 14 days. Discard unused portion after 14 days.
Directions for mixing: Shake bottle to loosen granules. Add approximately 1/2 the total amount of distilled water required for constitution (total water = 29 mL). Shake vigorously to wet the granules. Add remaining water and shake vigorously.
Each 5 mL of suspension contains cefpodoxime proxetil equivalent to 100 mg cefpodoxime.
U.S. Patent Nos. 4,486,425; 4,409,215
Licensed from Sankyo Company, Ltd., Japan
Manufactured by
Pharmacia & Upjohn S.A.-N.V., Puurs - Belgium
for
Pharmacia & Upjohn Company
Kalamazoo, MI 49001, USA
817 150 101
505358

NDC 0009-3615-03
50 mL (when mixed)

Vantin® For Oral Suspension
cefpodoxime proxetil for oral suspension
100 mg per 5 mL
Equivalent to 100 mg per 5 mL cefpodoxime when constituted

Pharmacia & Upjohn





27. How many full doses are available of the medication supplied for question 26? __________ dose(s)

28. Will the medication supplied expire before it is used up for the order in question 26? __________

    Explain: ____

Prepare the following therapeutic solutions.

29. 360 mL of $\frac{1}{3}$ strength hydrogen peroxide diluted with normal saline

    Supply: 60 mL-bottles of stock hydrogen peroxide solution

    Add __________ mL solute and __________ mL solvent

30. 240 mL $\frac{3}{4}$ strength Ensure

    Supply: 8 ounce can of Ensure

    Add __________ mL Ensure and __________ mL water

Refer to the following order for questions 31 and 32.

Order: **Give $\frac{2}{3}$ strength Ensure 240 mL via NG tube q.3h.**

Supply: Ready-to-use Ensure 8 ounce can and sterile water.

31. How much sterile water would you add to the 8 ounce can of Ensure? __________ mL

32. How many complete feedings would this make? __________ feeding(s)

Use the following information to answer questions 33 and 34.

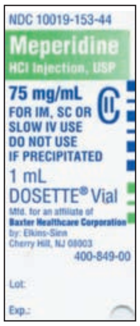
You will prepare formula to feed 9 infants in the nursery. Each infant has an order for **4 ounces of $\frac{1}{2}$ strength Isomil formula q.3h.** You have 8 ounce cans of ready-to-use Isomil and sterile water.

33. How many cans of formula will you need to open to prepare the reconstituted formula for all 9 infants for one feeding each? __________ can(s)

34. How many mL of sterile water will you add to the Isomil to reconstitute the formula for one feeding for all 9 infants? __________ mL

Medication Cart Exercise

You are to prepare medicines for patients assigned to your medication cart. The following labels represent the drugs you have available for problems 35 through 44.



NDC 10019-153-44
Meperidine
HCl Injection, USP
75 mg/mL
FOR IM, SC OR
SLOW IV USE
DO NOT USE
IF PRECIPITATED
1 mL
DOSETTE® Vial
Mfd. for an affiliate of
Baxter Healthcare Corporation
by: Elkins-Sinn
Cherry Hill, NJ 08003
400-849-00
Lot:
Exp.:

35. Order: **meperidine 60 mg IM q.4h p.r.n., pain**

    Give: __________ mL

36. Order: **methotrexate 175 mg IV stat**

    Give: __________ mL

Lot:
Exp. Date:

NDC 10019-940-28
Methotrexate
Injection, USP
PRESERVATIVE FREE ℞ only
200 mg (25 mg/mL)
Sterile Isotonic Liquid
8 mL Single Dose Vial
Mfd. for Baxter Healthcare Corp. affiliate
by: Bigmar Pharmaceuticals SA
Barbengo, Switzerland

See package insert for routes of administration.
Usual Dosage: Consult package insert for dosage and full prescribing information.
Each mL contains methotrexate sodium equivalent to 25 mg methotrexate.
Inactive ingredients: Sodium Chloride 0.490% w/v and Water for Injection. Sodium hydroxide and/or hydrochloric acid may be added to adjust pH to 8.5-8.7 during manufacture.
Store at controlled room temperature 15°-30°C (59°-86°F). PROTECT FROM LIGHT. Retain in carton until time of use. Discard any unused portion.
10-1047A 460-226-00

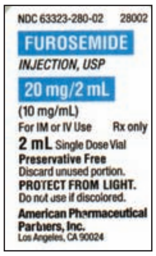
37. Order: Phenergan 15 mg IM q.4h p.r.n., nausea

Give: ________ mL

1 mL Ampul
PHENERGAN®
INJECTION
(PROMETHAZINE HCl
INJECTION, USP)
50 mg/mL
DEEP INTRAMUSCULAR
USE ONLY
PROTECT FROM LIGHT
WYETH® PHILA.
EL 25-1

38. Order: furosemide 15 mg IM stat

Give: ________ mL



NDC 63323-280-02 28002
FUROSEMIDE
INJECTION, USP
20 mg/2 mL
(10 mg/mL)
For IM or IV Use Rx only
2 mL Single Dose Vial
Preservative Free
Discard unused portion.
PROTECT FROM LIGHT.
Do not use if discolored.
American Pharmaceutical
Partners, Inc.
Los Angeles, CA 90024

39. Order: Thorazine 15 mg IM stat

Give: ________ mL

THORAZINE®
CHLORPRO-
MAZINE HCl
25mg/mL
Manufactured by
GlaxoSmithKline
Research Triangle Park,
NC 27709
LOT
EXP
693110-R
SAMPLE

40. Order: vancomycin 350 mg IV q.6h

Give: ________ mL

NDC 0002-8969-01
UC 8969
Sterile Vancomycin
Hydrochloride, USP
AmeriNet Choice™
INTRAVENOUS
Equiv. to 500 mg Vancomycin
Rx only

FOR INTRAVENOUS USE
IMPORTANT—Read literature for precautions and directions before use.
Usual Adult Dose—2 g daily. Dilute with 10 mL of Sterile Water for Injection.
After Dilution—Refrigerate.
Prior to Reconstitution: Store at 59° to 86°F (15° to 30°C).
MUST BE FURTHER DILUTED BEFORE USE—SEE LITERATURE
Manufactured by Eli Lilly and Company
Indianapolis, IN 46285, USA
WW 7370 UCX
Exp. Date/Control No.

41. Order: Nitrostat gr $\frac{1}{100}$ SL p.r.n., angina

Give: ________ tablet(s)

N 0071-0417-24
Nitrostat®
(Nitroglycerin
Tablets, USP)
0.3 mg (1/200 gr)
℞ only
100 SUBLINGUAL TABLETS
PARKE-DAVIS

Usual Dosage–0.3 to 0.6 mg sublingually as needed.
See package insert for full prescribing information.
Keep this and all drugs out of the reach of children.
Dispense in original, unopened container.
Store at Controlled Room Temperature 20°-25°C (68°-77°F) [see USP].
Manufactured by: Parke Davis Pharmaceuticals, Ltd. Vega Baja, PR 00694
Distributed by: PARKE-DAVIS Div of Warner-Lambert Co Morris Plains, NJ 07950 USA
© 1999, PDPL

Warning–To prevent loss of potency, keep these tablets in the original container. Close tightly immediately after each use.

6505-00-687-3662
0417G020

42. Order: Procanbid 1 g p.o. b.i.d.

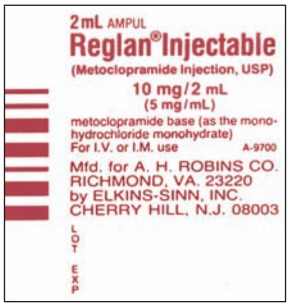
Give: ________ tablet(s)

NDC 61570-071-60
Procanbid®
(Procainamide HCl
Extended-Release Tablets*)
1000 mg
℞ Only
60 TABLETS
Monarch
Pharmaceuticals®
SAMPLE

Exp. date and lot
0564G061

43. Order: **Reglan 15 mg IV q.3h × 3 doses**

Give: _________ mL



44. Order: **levothyroxine 0.15 mg IV daily**

Give: _________ mL

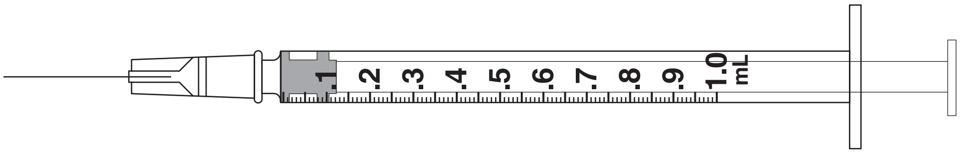
Chapter 13—Pediatric and Adult Dosages Based on Body Weight

Calculate and assess the safety of the following dosages. Mark safe dosages on the measuring device supplied.

45. Order: **morphine gr $\frac{1}{10}$ subcut q.4h p.r.n. severe pain** for a child who weighs 67 lb. Recommended pediatric dosage: 100–200 mcg/kg q.4h, up to a maximum of 15 mg/dose.

If the dosage ordered is safe, give _________ mL. If not safe, explain why not and describe what you should do. ____

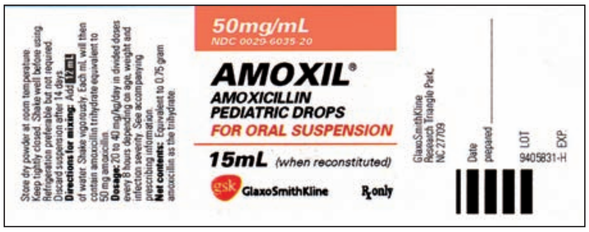
____

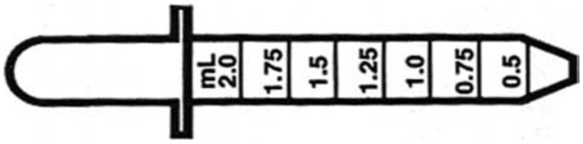


46. Order: **Amoxil pediatric drops 75 mg p.o. q.8h** for a 15 lb infant. Recommended dosage: See label.

If the dosage ordered is safe, reconstitute with _________ mL diluent for a total solution volume of _________ mL and a concentration of _________ mg/mL and give _________ mL. If not safe, explain why not and describe what you should do. _________________________

____





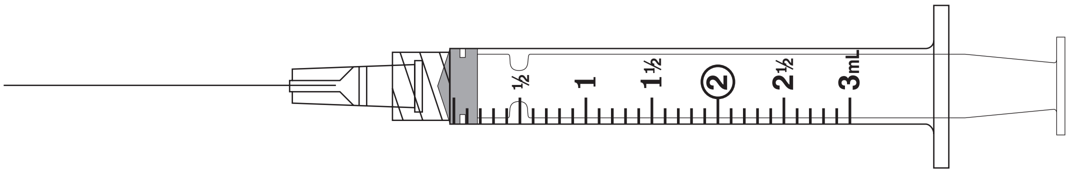
47. Order: **Dilantin 100 mg IV t.i.d.** for a child who weighs 20 kg. Recommended pediatric dosage: 5 mg/kg/day in 2–3 divided doses. If the dosage ordered is safe, give ______ mL. If not safe, explain why not and describe what you should do. ______________________________

____

Dosage–See package insert.
℞ only
Manufactured by:
Parkedale Pharmaceuticals, Inc.
Rochester, MI 48307
For:
PARKE-DAVIS
Div of Warner-Lambert Co
Morris Plains, NJ 07950 USA

N 0071-4475-45
STERI-VIAL®
Dilantin®
(Phenytoin Sodium Injection, USP)
ready/mixed
250 mg in 5 mL
5 mL

Do not exceed 50 mg/minute IV
IM/IV (no infusion)
© 1997-'98, Warner-Lambert Co.
4475G233



48. Order: **Ceclor 187 mg p.o. q.i.d.** for a child with otitis media who weighs 16 lb. Recommended dosage: See label.

If the dosage ordered is safe, reconstitute with ______ mL diluent for a total solution volume of ______ mL and a concentration of ______ mg/mL. Give ______ mL. If not safe, explain why not and describe what you should do. ______________________________

____

NDC 0002-5132-48
100 mL (When Mixed) M-5132
℞ Lilly
CECLOR®
CEFACLOR
FOR ORAL
SUSPENSION, USP
375 mg
per 5 mL
CAUTION—Federal (USA) law prohibits dispensing without prescription.

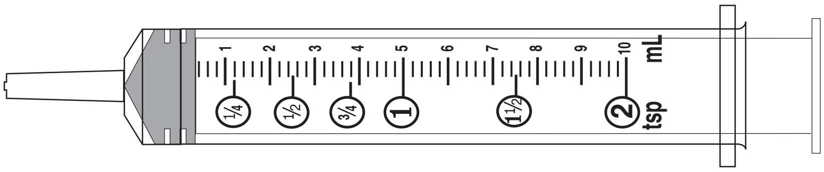
0002-5132-48
PULL

Usual Dose—Pediatric patients, 20 mg per kg a day (40 mg per kg in otitis media) in two divided doses. Adults, 375 mg two times a day. See literature for complete dosage information. Contains Cefaclor Monohydrate equivalent to 7.5 g anhydrous Cefaclor in a dry pleasantly flavored mixture. **Prior to Mixing**, Store at Controlled Room Temperature 59° to 86°F (15° to 30°C) **Directions for Mixing**—Add 62 mL of water in two portions to the dry mixture in the bottle. Shake well after each addition. **Each 5 mL (Approx. one teaspoonful) will then contain:** Cefaclor Monohydrate equivalent to 375 mg anhydrous Cefaclor.

WV 6525 AMX

Mfd. by Eli Lilly Industries, Inc., Carolina, Puerto Rico 00985
a subsidiary of Eli Lilly & Co., Indianapolis, IN, USA
Expiration Date

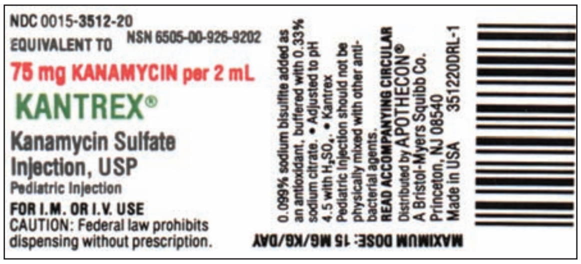
100 mL CECLOR® CEFACLOR FOR ORAL SUSPENSION, USP
375 mg per 5 mL. Oversize bottle provides extra space for shaking. Store in a refrigerator. May be kept for 14 days without significant loss of potency. Keep Tightly Closed. Discard unused portion after 14 days.
SHAKE WELL BEFORE USING
Control No.



49. a) Order: **Kantrex 60 mg IM q.8h** for a child who weighs 16 lb. The recommended dosage of Kantrex for adults and children is 15 mg/kg/day in 2–3 divided doses, not to exceed 1.5 g/day.

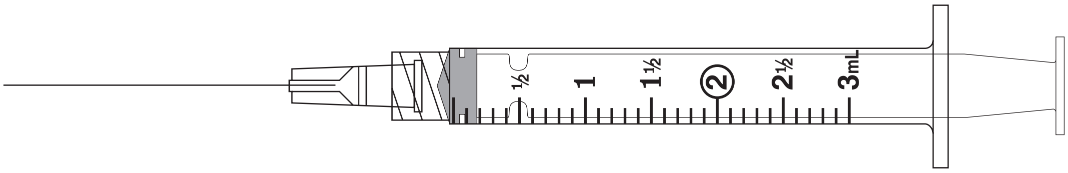
If the ordered dosage is safe, give ______ mL. If not safe, explain why not and describe what you should do. ______________________________

____



NDC 0015-3512-20
EQUIVALENT TO NSN 6505-00-926-9202
75 mg KANAMYCIN per 2 mL
KANTREX®
Kanamycin Sulfate Injection, USP
Pediatric Injection
FOR I.M. OR I.V. USE
CAUTION: Federal law prohibits dispensing without prescription.

0.099% sodium bisulfite added as an antioxidant, buffered with 0.33% sodium citrate. • Adjusted to pH 4.5 with H_2SO_4. • Kantrex Pediatric Injection should not be physically mixed with other antibacterial agents.
READ ACCOMPANYING CIRCULAR
Distributed by APOTHECON®
A Bristol-Myers Squibb Co.
Princeton, NJ 08540
Made in USA 351220DRL-1
MAXIMUM DOSE: 15 MG/KG/DAY



b) Refer to the recommended dosage of Kantrex. What would you expect the single q.8h dosage of Kantrex to be for an adult who weighs 275 lb?

__________ mg/dose

50. Describe the strategy you would implement to prevent this medication error.

Possible Scenario

The physician ordered **Amoxil 50 mg p.o. q.i.d.** for a child with an upper respiratory infection. Amoxil is supplied in an oral suspension with 125 mg per 5 mL. The nurse calculated the dose this way:

$$\frac{125\text{ mg}}{50\text{ mg}} = \frac{X\text{ mL}}{5\text{ mL}}$$

$$50X = 625$$

$$\frac{50X}{50} = \frac{625}{50}$$

$$X = 12.5\text{ mL}$$

Potential Outcome

The patient received a large overdose and should have received only 2 mL. The child would likely develop complications from the overdose of amoxicillin. When the physician was notified of the error, she would likely have ordered the medication discontinued and had extra blood lab work done. An incident report would be filed and the family notified of the error.

Prevention

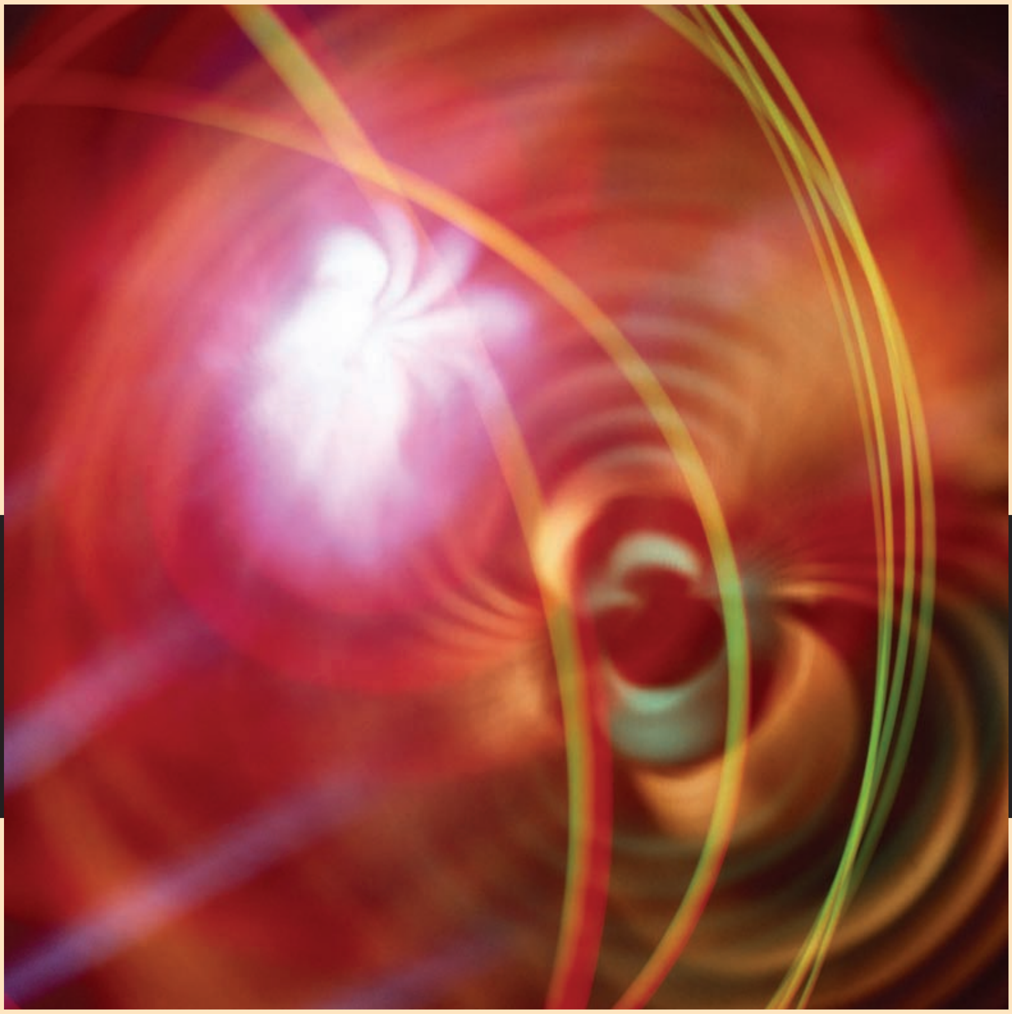
____

____

After completing these problems, see pages 513-518 to check your answers. Give yourself two points for each correct answer.

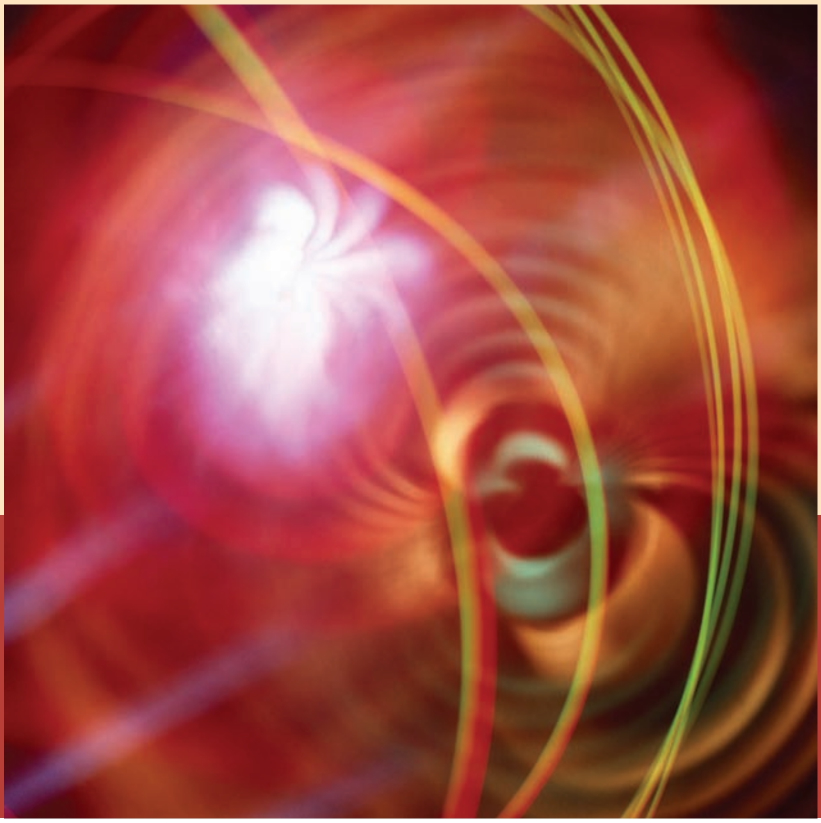
Perfect score = 100 My score = __________

Minimum mastery score = 86 (43 correct)



SECTION
4

Advanced Calculations



14

Intravenous Solutions, Equipment, and Calculations

OBJECTIVES

Upon mastery of Chapter 14, you will be able to calculate intravenous (IV) solution flow rate for electronic or manual infusion systems. To accomplish this you will also be able to:

- Identify common IV solutions and equipment.
- Calculate the amount of specific components in common IV fluids.
- Define the following terms: IV, peripheral line, central line, primary IV, secondary IV, saline/heparin locks, IV piggyback (IV PB), and IV push.
- Calculate milliliters per hour: mL/h.
- Recognize the calibration or drop factor in gtt/mL as stated on the IV tubing package.
- Apply the formula method to calculate IV flow rate in gtt/min:

$$\frac{\text{V (volume)}}{\text{T (time in min)}} \times \text{C (drop factor calibration)} = \text{R (rate of flow)}$$

- Apply the shortcut method to calculate IV flow rate in gtt/min:

$$\frac{\text{mL/h}}{\text{drop factor constant}} = \text{gtt/min}$$

- Recalculate the flow rate when the IV is off schedule.
- Calculate small-volume IV PB.
- Calculate rate for IV push medications.
- Calculate IV infusion time.
- Calculate IV infusion volume.

Intravenous (IV) means the administration of fluids or medication through a vein. IV fluids are ordered for a variety of reasons. They may be ordered for replacement of lost fluids, to maintain fluid and electrolyte balance, or to administer IV medications. *Replacement fluids* are often ordered because of losses that may occur from hemorrhage, vomiting, or diarrhea. *Maintenance fluids* sustain normal fluid and electrolyte balance. They may be used for the patient who is not yet depleted but is beginning to show symptoms of depletion. They may also be ordered for the patient who has the potential to become depleted, such as the patient who is allowed nothing by mouth (NPO) for surgery.

IV fluids and drugs may be administered by two methods: *continuous* and *intermittent* infusion. Continuous IV infusions replace or maintain fluid and electrolytes and serve as a vehicle for drug administration. Intermittent, such as IV PB and IV push, infusions are used for IV administration of drugs and supplemental fluids. Intermittent peripheral infusion devices, also known as saline or heparin locks, are used to maintain venous access without continuous fluid infusion.

IV therapy is an important and challenging nursing role. This chapter covers the essential information and presents step-by-step calculations to help you gain a thorough understanding and mastery of this subject. Let's begin by analyzing IV solutions.

IV SOLUTIONS

IV solutions are ordered by a physician or prescribing practitioner; however, they are administered and monitored by the nurse. It is the responsibility of the nurse to ensure that the correct IV fluid is administered to the correct patient at the prescribed rate. IV fluids can be supplied in plastic solution bags or glass bottles with the volume of the IV fluid container typically varying from 50 mL to 1,000 mL. Some IV bags may even contain more then 1,000 mL. Solutions used for total parenteral nutrition usually contain 2,000 mL or more in a single bag. The IV solution bag or bottle will be labeled with the exact components and amount of the IV solution. Health care practitioners often use abbreviations when communicating about the IV solution. Therefore, it is important for the nurse to know the common IV solution components and the solution concentration strengths represented by such abbreviations.

Solution Components

Glucose (dextrose), water, saline (sodium chloride or NaCl), and selected electrolytes and salts are found in IV fluids. Dextrose and sodium chloride are the two most common solute components. Learn these common IV component abbreviations.

REMEMBER

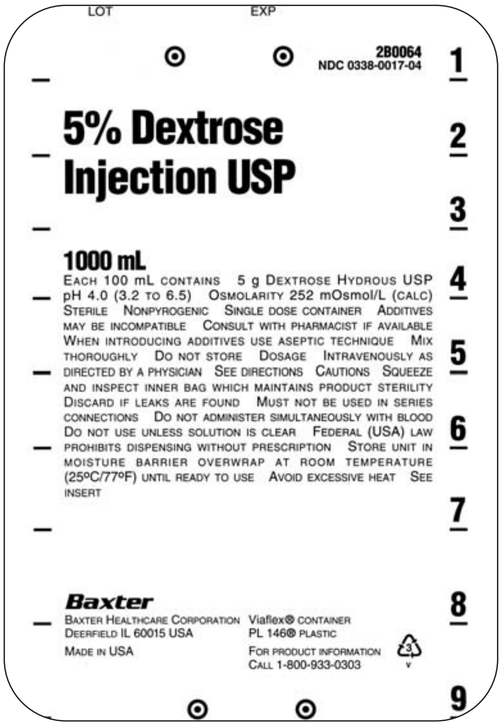
Common IV Component Abbreviations

Abbreviation	Solution Component
D	Dextrose
W	Water
S	Saline
NS	Normal Saline (0.9% NaCl)
NaCl	Sodium Chloride
RL	Ringer's Lactate
LR	Lactated Ringer's

Solution Strength

The abbreviation letters indicate the solution components, and the numbers indicate the solution strength or concentration of the components (as shown in the examples that follow, e.g., D_5W). The numbers may be written as subscripts in the medical order.

FIGURE 14-1 IV solution label: D_5W (Courtesy of Baxter Healthcare Corporation)



LOT EXP

2B0064
NDC 0338-0017-04

5% Dextrose Injection USP

1000 mL

EACH 100 mL CONTAINS 5 g DEXTROSE HYDROUS USP pH 4.0 (3.2 TO 6.5) OSMOLARITY 252 mOsmol/L (CALC) STERILE NONPYROGENIC SINGLE DOSE CONTAINER ADDITIVES MAY BE INCOMPATIBLE CONSULT WITH PHARMACIST IF AVAILABLE WHEN INTRODUCING ADDITIVES USE ASEPTIC TECHNIQUE MIX THOROUGHLY DO NOT STORE DOSAGE INTRAVENOUSLY AS DIRECTED BY A PHYSICIAN SEE DIRECTIONS CAUTIONS SQUEEZE AND INSPECT INNER BAG WHICH MAINTAINS PRODUCT STERILITY DISCARD IF LEAKS ARE FOUND MUST NOT BE USED IN SERIES CONNECTIONS DO NOT ADMINISTER SIMULTANEOUSLY WITH BLOOD DO NOT USE UNLESS SOLUTION IS CLEAR FEDERAL (USA) LAW PROHIBITS DISPENSING WITHOUT PRESCRIPTION STORE UNIT IN MOISTURE BARRIER OVERWRAP AT ROOM TEMPERATURE (25°C/77°F) UNTIL READY TO USE AVOID EXCESSIVE HEAT SEE INSERT

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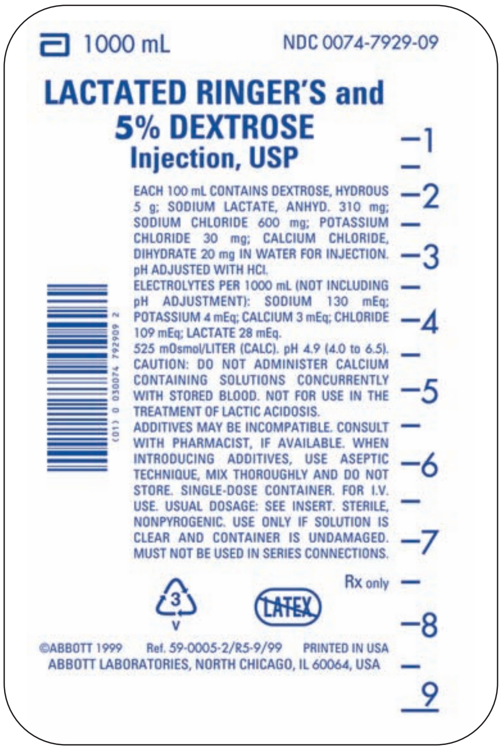
FIGURE 14-2 IV solution label: D_5LR (Courtesy of Abbott Laboratories, Inc.)



1000 mL NDC 0074-7929-09

LACTATED RINGER'S and 5% DEXTROSE Injection, USP

EACH 100 mL CONTAINS DEXTROSE, HYDROUS 5 g; SODIUM LACTATE, ANHYD. 310 mg; SODIUM CHLORIDE 600 mg; POTASSIUM CHLORIDE 30 mg; CALCIUM CHLORIDE, DIHYDRATE 20 mg IN WATER FOR INJECTION. pH ADJUSTED WITH HCl.
ELECTROLYTES PER 1000 mL (NOT INCLUDING pH ADJUSTMENT): SODIUM 130 mEq; POTASSIUM 4 mEq; CALCIUM 3 mEq; CHLORIDE 109 mEq; LACTATE 28 mEq.
525 mOsmol/LITER (CALC). pH 4.9 (4.0 to 6.5).
CAUTION: DO NOT ADMINISTER CALCIUM CONTAINING SOLUTIONS CONCURRENTLY WITH STORED BLOOD. NOT FOR USE IN THE TREATMENT OF LACTIC ACIDOSIS.
ADDITIVES MAY BE INCOMPATIBLE. CONSULT WITH PHARMACIST, IF AVAILABLE. WHEN INTRODUCING ADDITIVES, USE ASEPTIC TECHNIQUE, MIX THOROUGHLY AND DO NOT STORE. SINGLE-DOSE CONTAINER. FOR I.V. USE. USUAL DOSAGE: SEE INSERT. STERILE, NONPYROGENIC. USE ONLY IF SOLUTION IS CLEAR AND CONTAINER IS UNDAMAGED. MUST NOT BE USED IN SERIES CONNECTIONS.

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EXAMPLE 1 ■

Suppose an order includes D_5W. This abbreviation means "Dextrose 5% in Water" and is supplied as 5% Dextrose Injection, as in Figure 14-1. This means that the solution strength of the solute (dextrose) is 5%. The solvent is water. Recall from Chapter 8 that parenteral solutions expressed in a percent indicate X g per 100 mL. Read the IV bag label and notice that "each 100 mL contains 5 g dextrose. . . ." For every 100 mL of solution, there are 5 g of dextrose.

EXAMPLE 2 ■

Suppose a nurse writes D_5LR in the nurse's notes. This abbreviation means "Dextrose 5% in Lactated Ringer's" and is supplied as Lactated Ringer's and 5% Dextrose Injection, as in Figure 14-2.

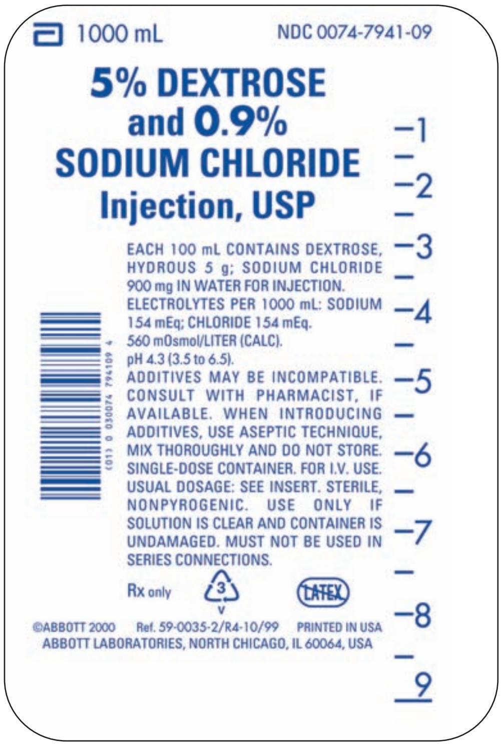
EXAMPLE 3 ■

An order states, D_5NS 1,000 mL IV q.8h. This order means "administer 1,000 mL 5% dextrose in normal saline intravenously every 8 hours" and is supplied as 5% Dextrose and 0.9% Sodium Chloride, as in Figure 14-3. *Normal saline* is the common term for 0.9% Sodium Chloride. Another name is *physiologic saline*. The concentration of sodium chloride in normal saline is 0.9 g (or 900 mg) per 100 mL of solution.

Another common saline IV concentration is 0.45% Sodium Chloride (NaCl), as in Figure 14-4. Notice that 0.45% NaCl is $\frac{1}{2}$ the strength of 0.9% NaCl, which is normal saline. Thus, it is typically written as $\frac{1}{2}$ NS for $\frac{1}{2}$ normal saline. Another saline solution strength is 0.225% NaCl (also abbreviated as $\frac{1}{4}$ *NS*).

The goal of intravenous therapy, achieved through fluid infusion, is to maintain or regain fluid and electrolyte balance. When dextrose or saline (*solute*) is diluted in water for injection (*solvent*), the result

FIGURE 14-3 IV solution label: D_5NS (Courtesy of Abbott Laboratories, Inc.)



1000 mL NDC 0074-7941-09

5% DEXTROSE and 0.9% SODIUM CHLORIDE Injection, USP

EACH 100 mL CONTAINS DEXTROSE, HYDROUS 5 g; SODIUM CHLORIDE 900 mg IN WATER FOR INJECTION. ELECTROLYTES PER 1000 mL: SODIUM 154 mEq; CHLORIDE 154 mEq. 560 mOsmol/LITER (CALC). pH 4.3 (3.5 to 6.5). ADDITIVES MAY BE INCOMPATIBLE. CONSULT WITH PHARMACIST, IF AVAILABLE. WHEN INTRODUCING ADDITIVES, USE ASEPTIC TECHNIQUE, MIX THOROUGHLY AND DO NOT STORE. SINGLE-DOSE CONTAINER. FOR I.V. USE. USUAL DOSAGE: SEE INSERT. STERILE, NONPYROGENIC. USE ONLY IF SOLUTION IS CLEAR AND CONTAINER IS UNDAMAGED. MUST NOT BE USED IN SERIES CONNECTIONS.

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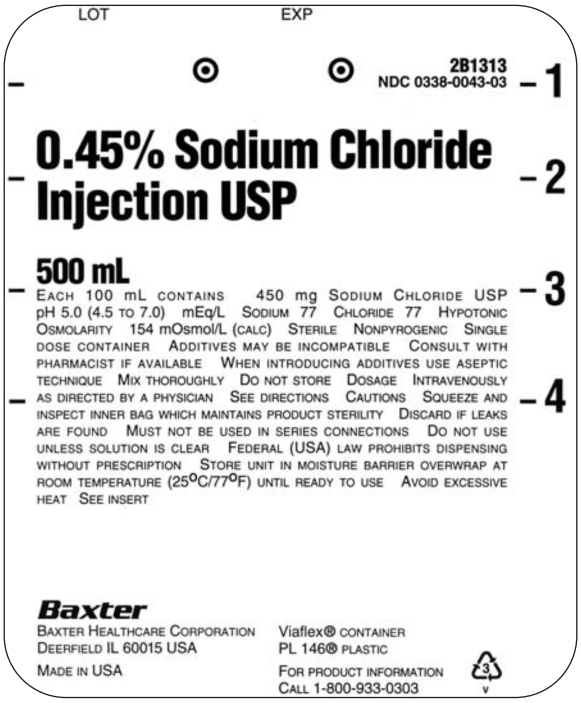
FIGURE 14-4 IV solution label: 0.45% NaCl (Courtesy of Baxter Healthcare Corporation)



LOT EXP

2B1313
NDC 0338-0043-03

0.45% Sodium Chloride Injection USP

500 mL

EACH 100 mL CONTAINS 450 mg SODIUM CHLORIDE USP pH 5.0 (4.5 TO 7.0) mEq/L SODIUM 77 CHLORIDE 77 HYPOTONIC OSMOLARITY 154 mOsmol/L (CALC) STERILE NONPYROGENIC SINGLE DOSE CONTAINER ADDITIVES MAY BE INCOMPATIBLE CONSULT WITH PHARMACIST IF AVAILABLE WHEN INTRODUCING ADDITIVES USE ASEPTIC TECHNIQUE MIX THOROUGHLY DO NOT STORE DOSAGE INTRAVENOUSLY AS DIRECTED BY A PHYSICIAN SEE DIRECTIONS CAUTIONS SQUEEZE AND INSPECT INNER BAG WHICH MAINTAINS PRODUCT STERILITY DISCARD IF LEAKS ARE FOUND MUST NOT BE USED IN SERIES CONNECTIONS DO NOT USE UNLESS SOLUTION IS CLEAR FEDERAL (USA) LAW PROHIBITS DISPENSING WITHOUT PRESCRIPTION STORE UNIT IN MOISTURE BARRIER OVERWRAP AT ROOM TEMPERATURE (25°C/77°F) UNTIL READY TO USE AVOID EXCESSIVE HEAT SEE INSERT

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is a *solution* that can be administered to maintain or approximate the normal blood plasma. Blood or serum concentration is called *tonicity* or *osmolarity* and is measured in milliOsmols per liter or mOsm/L. IV fluids are concentrated and classified as *isotonic* (the same tonicity or osmolarity as blood and other body serums), *hypotonic* (lower tonicity or osmolarity than blood and other body serums), or *hypertonic* (higher tonicity or osmolarity than blood and other body serums). Normal saline (0.9% NaCl or physiologic saline) is an isotonic solution. The osmolarity of a manufactured solution is detailed on the printed label. Look for the mOsm/L in the fine print under the solution name in Figures 14-1 through 14-4.

Figure 14-5 compares the three solution concentrations to normal serum osmolarity. Parenteral therapy is determined by unique patient needs, and these basic factors must be considered when ordering and infusing IV solutions.

FIGURE 14-5 Comparison of IV solution concentrations by osmolarity

Normal Serum Osmolarity
(Normal Average Tonicity—All Ages)
280–320 mOsm/L

Hypotonic (< 250 mOsm/L)	**Isotonic** (250–375 mOsm/L)	**Hypertonic** (> 375 mOsm/L)
Solvent exceeds solute—used to dilute excess serum electrolytes, as in hyperglycemia	*Solvent and solutes are balanced*—used to expand volume and maintain normal tonicity	*Solutes exceed solvent*—used to correct electrolyte imbalances, as in loss from excess vomiting and diarrhea
Example of IV solution: *0.45% Saline* (154 mOsm/L)	Examples of IV solution: *0.9% Saline* (308 mOsm/L) *Lactated Ringer's* (273 mOsm/L) *5% Dextrose in Water* (252 mOsm/L)	Example of IV solution: *5% Dextrose and 0.9% NaCl* (560 mOsm/L) *5% Dextrose and Lactated Ringer's* (525 mOsm/L)

Solution Additives

Electrolytes also may be added to the basic IV fluid. Potassium chloride (KCl) is a common IV additive and is measured in *milliequivalents* (mEq). The order is usually written to indicate the amount of milliequivalents per liter (1,000 mL) to be added to the IV fluid.

EXAMPLE ■

The physician orders **D_5NS 1,000 mL IV $\bar{c}$ 20 mEq KCl/L q.8h.** This means to infuse 1,000 mL 5% dextrose and 0.9% sodium chloride IV solution with 20 milliequivalents potassium chloride added per liter every 8 hours.

QUICK REVIEW

- Pay close attention to IV abbreviations: *letters* indicate the solution components and *numbers* indicate the concentration or solution strength.
- Dextrose and sodium chloride (NaCl) are common IV solutes.
- Solution strength expressed as a percent (%) indicates the number of g per 100 mL.
- Normal Saline is 0.9% sodium chloride: 0.9 g NaCl per 100 mL solution.
- IV solution tonicity or osmolarity is measured in mOsm/L.
- D_5W and normal saline are common isotonic solutions.

Review Set 31

For each of the following IV solutions labeled A through H:

a. Specify the *letter* of the illustration corresponding to the fluid abbreviation.

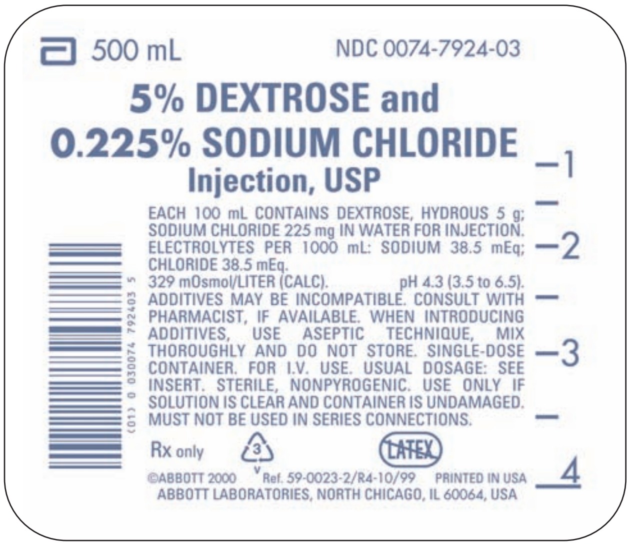
b. List the *solute(s)* of each solution, and identify the *strength (g/mL)* of each solute.

c. Identify the *osmolarity (mOsm/L)* of each solution.

d. Identify the *tonicity (isotonic, hypotonic, or hypertonic)* of each solution.

	a. Letter of matching illustration	b. Components and strength	c. Osmolarity (mOsm/L)	d. Tonicity
1. NS	________	________	________	________
2. D_5W	________	________	________	________
3. D_5NS	________	________	________	________
4. $D_5\frac{1}{2}$NS	________	________	________	________
5. $D_5\frac{1}{4}$NS	________	________	________	________
6. D_5LR	________	________	________	________
7. $D_5\frac{1}{2}$NS $\bar{c}$ 20 mEq KCl/L	________	________	________	________
8. $\frac{1}{2}$NS	________	________	________	________

After completing these problems, see page 518 to check your answers.



500 mL NDC 0074-7924-03

5% DEXTROSE and
0.225% SODIUM CHLORIDE
Injection, USP

EACH 100 mL CONTAINS DEXTROSE, HYDROUS 5 g; SODIUM CHLORIDE 225 mg IN WATER FOR INJECTION. ELECTROLYTES PER 1000 mL: SODIUM 38.5 mEq; CHLORIDE 38.5 mEq.
329 mOsmol/LITER (CALC). pH 4.3 (3.5 to 6.5).
ADDITIVES MAY BE INCOMPATIBLE. CONSULT WITH PHARMACIST, IF AVAILABLE. WHEN INTRODUCING ADDITIVES, USE ASEPTIC TECHNIQUE, MIX THOROUGHLY AND DO NOT STORE. SINGLE-DOSE CONTAINER. FOR I.V. USE. USUAL DOSAGE: SEE INSERT. STERILE, NONPYROGENIC. USE ONLY IF SOLUTION IS CLEAR AND CONTAINER IS UNDAMAGED. MUST NOT BE USED IN SERIES CONNECTIONS.

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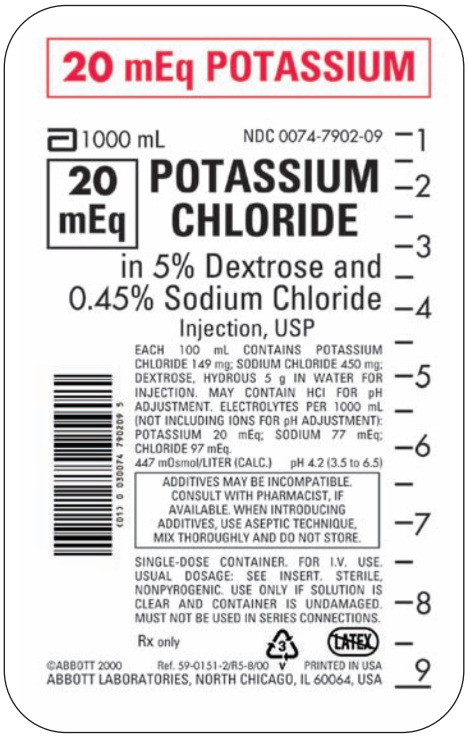
A



20 mEq POTASSIUM

1000 mL NDC 0074-7902-09

20 mEq **POTASSIUM CHLORIDE**
in 5% Dextrose and
0.45% Sodium Chloride
Injection, USP

EACH 100 mL CONTAINS POTASSIUM CHLORIDE 149 mg; SODIUM CHLORIDE 450 mg; DEXTROSE, HYDROUS 5 g IN WATER FOR INJECTION. MAY CONTAIN HCl FOR pH ADJUSTMENT. ELECTROLYTES PER 1000 mL (NOT INCLUDING IONS FOR pH ADJUSTMENT): POTASSIUM 20 mEq; SODIUM 77 mEq; CHLORIDE 97 mEq.
447 mOsmol/LITER (CALC.) pH 4.2 (3.5 to 6.5)

ADDITIVES MAY BE INCOMPATIBLE. CONSULT WITH PHARMACIST, IF AVAILABLE. WHEN INTRODUCING ADDITIVES, USE ASEPTIC TECHNIQUE, MIX THOROUGHLY AND DO NOT STORE.

SINGLE-DOSE CONTAINER. FOR I.V. USE. USUAL DOSAGE: SEE INSERT. STERILE, NONPYROGENIC. USE ONLY IF SOLUTION IS CLEAR AND CONTAINER IS UNDAMAGED. MUST NOT BE USED IN SERIES CONNECTIONS.

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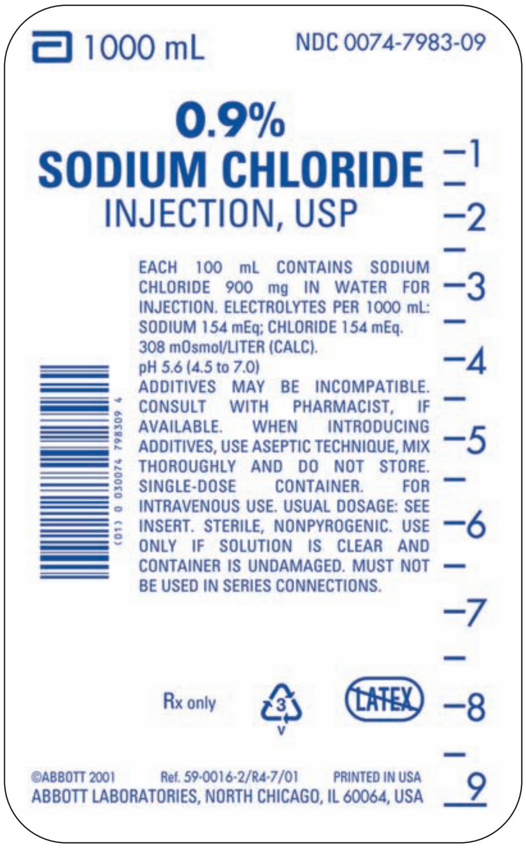
B



1000 mL NDC 0074-7983-09

0.9%
SODIUM CHLORIDE
INJECTION, USP

EACH 100 mL CONTAINS SODIUM CHLORIDE 900 mg IN WATER FOR INJECTION. ELECTROLYTES PER 1000 mL: SODIUM 154 mEq; CHLORIDE 154 mEq.
308 mOsmol/LITER (CALC).
pH 5.6 (4.5 to 7.0)
ADDITIVES MAY BE INCOMPATIBLE. CONSULT WITH PHARMACIST, IF AVAILABLE. WHEN INTRODUCING ADDITIVES, USE ASEPTIC TECHNIQUE, MIX THOROUGHLY AND DO NOT STORE. SINGLE-DOSE CONTAINER. FOR INTRAVENOUS USE. USUAL DOSAGE: SEE INSERT. STERILE, NONPYROGENIC. USE ONLY IF SOLUTION IS CLEAR AND CONTAINER IS UNDAMAGED. MUST NOT BE USED IN SERIES CONNECTIONS.

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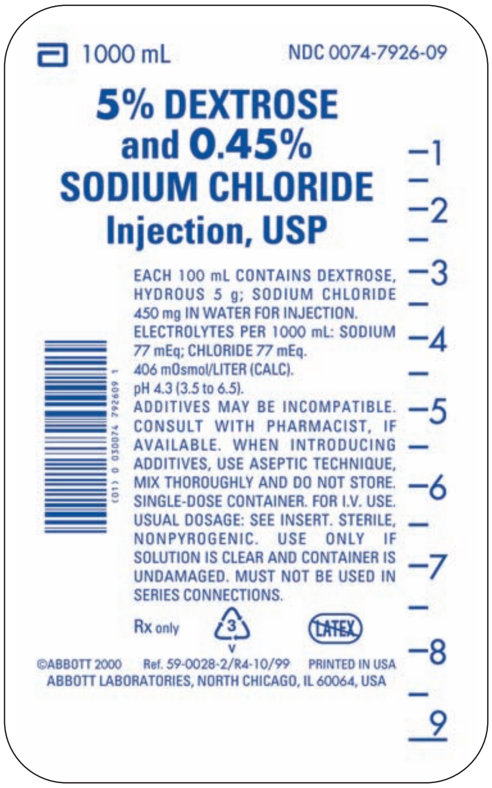

1000 mL NDC 0074-7926-09

5% DEXTROSE
and 0.45%
SODIUM CHLORIDE
Injection, USP

EACH 100 mL CONTAINS DEXTROSE, HYDROUS 5 g; SODIUM CHLORIDE 450 mg IN WATER FOR INJECTION. ELECTROLYTES PER 1000 mL: SODIUM 77 mEq; CHLORIDE 77 mEq.
406 mOsmol/LITER (CALC).
pH 4.3 (3.5 to 6.5).
ADDITIVES MAY BE INCOMPATIBLE. CONSULT WITH PHARMACIST, IF AVAILABLE. WHEN INTRODUCING ADDITIVES, USE ASEPTIC TECHNIQUE, MIX THOROUGHLY AND DO NOT STORE. SINGLE-DOSE CONTAINER. FOR I.V. USE. USUAL DOSAGE: SEE INSERT. STERILE, NONPYROGENIC. USE ONLY IF SOLUTION IS CLEAR AND CONTAINER IS UNDAMAGED. MUST NOT BE USED IN SERIES CONNECTIONS.

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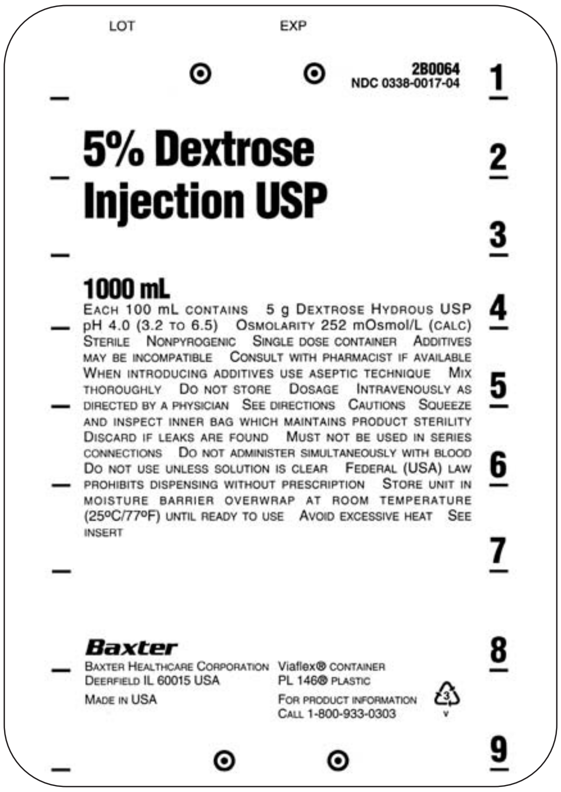

LOT EXP

2B0064
NDC 0338-0017-04

5% Dextrose Injection USP

1000 mL

EACH 100 mL CONTAINS 5 g DEXTROSE HYDROUS USP pH 4.0 (3.2 TO 6.5) OSMOLARITY 252 mOsmol/L (CALC) STERILE NONPYROGENIC SINGLE DOSE CONTAINER ADDITIVES MAY BE INCOMPATIBLE CONSULT WITH PHARMACIST IF AVAILABLE WHEN INTRODUCING ADDITIVES USE ASEPTIC TECHNIQUE MIX THOROUGHLY DO NOT STORE DOSAGE INTRAVENOUSLY AS DIRECTED BY A PHYSICIAN SEE DIRECTIONS CAUTIONS SQUEEZE AND INSPECT INNER BAG WHICH MAINTAINS PRODUCT STERILITY DISCARD IF LEAKS ARE FOUND MUST NOT BE USED IN SERIES CONNECTIONS DO NOT ADMINISTER SIMULTANEOUSLY WITH BLOOD DO NOT USE UNLESS SOLUTION IS CLEAR FEDERAL (USA) LAW PROHIBITS DISPENSING WITHOUT PRESCRIPTION STORE UNIT IN MOISTURE BARRIER OVERWRAP AT ROOM TEMPERATURE (25ºC/77ºF) UNTIL READY TO USE AVOID EXCESSIVE HEAT SEE INSERT

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Viaflex® CONTAINER
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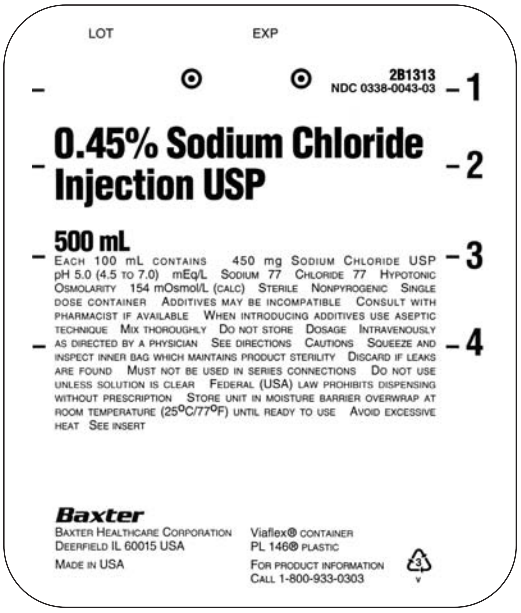
E



LOT EXP

2B1313
NDC 0338-0043-03

0.45% Sodium Chloride Injection USP

500 mL

EACH 100 mL CONTAINS 450 mg SODIUM CHLORIDE USP pH 5.0 (4.5 TO 7.0) mEq/L SODIUM 77 CHLORIDE 77 HYPOTONIC OSMOLARITY 154 mOsmol/L (CALC) STERILE NONPYROGENIC SINGLE DOSE CONTAINER ADDITIVES MAY BE INCOMPATIBLE CONSULT WITH PHARMACIST IF AVAILABLE WHEN INTRODUCING ADDITIVES USE ASEPTIC TECHNIQUE MIX THOROUGHLY DO NOT STORE DOSAGE INTRAVENOUSLY AS DIRECTED BY A PHYSICIAN SEE DIRECTIONS CAUTIONS SQUEEZE AND INSPECT INNER BAG WHICH MAINTAINS PRODUCT STERILITY DISCARD IF LEAKS ARE FOUND MUST NOT BE USED IN SERIES CONNECTIONS DO NOT USE UNLESS SOLUTION IS CLEAR FEDERAL (USA) LAW PROHIBITS DISPENSING WITHOUT PRESCRIPTION STORE UNIT IN MOISTURE BARRIER OVERWRAP AT ROOM TEMPERATURE (25ºC/77ºF) UNTIL READY TO USE AVOID EXCESSIVE HEAT SEE INSERT

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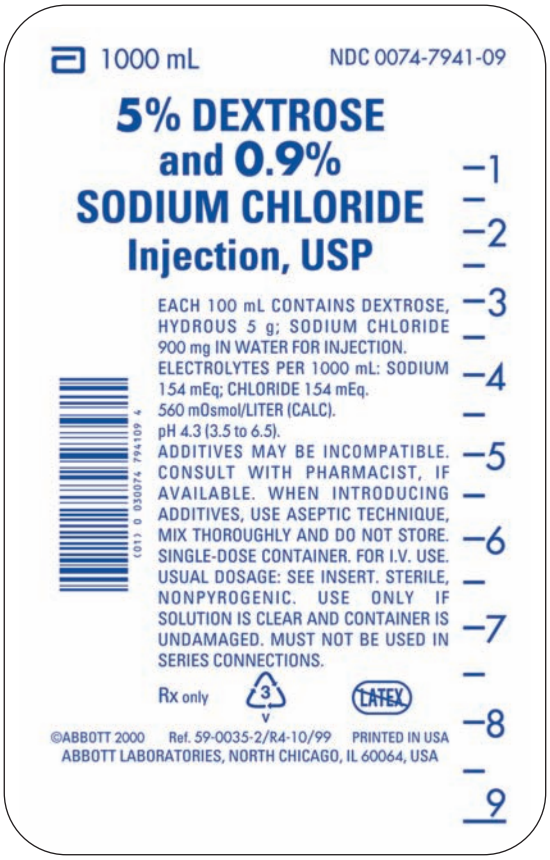

1000 mL NDC 0074-7941-09

5% DEXTROSE and 0.9% SODIUM CHLORIDE Injection, USP

EACH 100 mL CONTAINS DEXTROSE, HYDROUS 5 g; SODIUM CHLORIDE 900 mg IN WATER FOR INJECTION.
ELECTROLYTES PER 1000 mL: SODIUM 154 mEq; CHLORIDE 154 mEq.
560 mOsmol/LITER (CALC).
pH 4.3 (3.5 to 6.5).
ADDITIVES MAY BE INCOMPATIBLE. CONSULT WITH PHARMACIST, IF AVAILABLE. WHEN INTRODUCING ADDITIVES, USE ASEPTIC TECHNIQUE, MIX THOROUGHLY AND DO NOT STORE. SINGLE-DOSE CONTAINER. FOR I.V. USE. USUAL DOSAGE: SEE INSERT. STERILE, NONPYROGENIC. USE ONLY IF SOLUTION IS CLEAR AND CONTAINER IS UNDAMAGED. MUST NOT BE USED IN SERIES CONNECTIONS.

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G

500 mL NDC 0074-7929-03

LACTATED RINGER'S and 5% DEXTROSE Injection, USP

EACH 100 mL CONTAINS DEXTROSE, HYDROUS 5 g; SODIUM LACTATE, ANHYD. 310 mg; SODIUM CHLORIDE 600 mg; POTASSIUM CHLORIDE 30 mg; CALCIUM CHLORIDE, DIHYDRATE 20 mg IN WATER FOR INJECTION. pH ADJUSTED WITH HCl. ELECTROLYTES PER 1000 mL (NOT INCLUDING pH ADJUSTMENT): SODIUM 130 mEq; POTASSIUM 4 mEq; CALCIUM 3 mEq; CHLORIDE 109 mEq; LACTATE 28 mEq. 525 mOsmol/LITER (CALC). pH 4.9 (4.0 to 6.5). CAUTION: DO NOT ADMINISTER CALCIUM CONTAINING SOLUTIONS CONCURRENTLY WITH STORED BLOOD. NOT FOR USE IN THE TREATMENT OF LACTIC ACIDOSIS. ADDITIVES MAY BE INCOMPATIBLE. CONSULT WITH PHARMACIST, IF AVAILABLE. WHEN INTRODUCING ADDITIVES, USE ASEPTIC TECHNIQUE, MIX THOROUGHLY AND DO NOT STORE. SINGLE-DOSE CONTAINER. FOR I.V. USE. USUAL DOSAGE: SEE INSERT. STERILE, NONPYROGENIC. USE ONLY IF SOLUTION IS CLEAR AND CONTAINER IS UNDAMAGED. MUST NOT BE USED IN SERIES CONNECTIONS.

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(A, B, C, D, G, and H Courtesy of Abbott Laboratories, Inc. E and F Courtesy of Baxter International, Inc., I.V. Systems Division)

CALCULATING COMPONENTS OF IV SOLUTIONS WHEN EXPRESSED AS A PERCENT

Recall from Chapter 8 that solution strength expressed as a percent (%) indicates the number of g per 100 mL. Understanding this concept allows you to calculate the total amount of solute per IV order.

EXAMPLE 1 ■

Order: D_5W 1,000 mL IV q.8h

Calculate the amount of dextrose in 1,000 mL D_5W.

This can be calculated using ratio-proportion.

Recall that % indicates g per 100 mL; therefore, D_5 5% dextrose or 5 g dextrose per 100 mL of solution.

$$\frac{5\text{ g}}{100\text{ mL}} \times \frac{\text{X g}}{1{,}000\text{ mL}}$$

$$\begin{aligned} 100\text{X} &= 5{,}000 \\ \frac{100\text{X}}{100} &= \frac{5{,}000}{100} \\ \text{X} &= 50\text{ g} \end{aligned}$$

1,000 mL of D_5W contains 50 g of dextrose.

EXAMPLE 2 ■

Order: $D_5 \frac{1}{4}$NS 500 mL IV q.6h

Calculate the amount of dextrose and sodium chloride in 500 mL.

D_5 = Dextrose 5% = 5 g dextrose per 100 mL

$$\frac{5\text{ g}}{100\text{ mL}} \times \frac{\text{X g}}{500\text{ mL}}$$

$$\begin{aligned} 100\text{X} &= 2{,}500 \\ \frac{100\text{X}}{100} &= \frac{2{,}500}{100} \\ \text{X} &= 25\text{ g dextrose} \end{aligned}$$

$\frac{1}{4}$NS = 0.225% NaCl = 0.225 g NaCl per 100 mL

(Recall that NS or normal saline is 0.9% NaCl; therefore, $\frac{1}{4}$ NS is $\frac{1}{4} \times 0.9\% = 0.225\%$ NaCl.)

$$\frac{0.225\text{ g}}{100\text{ mL}} \times \frac{\text{X g}}{500\text{ mL}}$$

$$\begin{aligned} 100\text{X} &= 112.5 \\ \frac{100\text{X}}{100} &= \frac{112.5}{100} \\ \text{X} &= 1.125\text{ g NaCl} \end{aligned}$$

500 mL $D_5 \frac{1}{4}$ NS contains 25 g dextrose and 1.125 g sodium chloride.

This concept is important, because it helps you understand that IV solutions provide much more than fluid. They also provide other components. For example, now you know what you are administering to your patient when the IV order prescribes D_5W. Think, "I am hanging D_5W intravenous solution. Do I know what this fluid contains? Yes, it contains dextrose as the solute and water as the solvent in the concentration of 5 g of dextrose in every 100 mL of solution." Regular monitoring and careful understanding of intravenous infusions cannot be stressed enough.

QUICK REVIEW

- Solution concentration expressed as a percent is the number of g of solute per 100 mL solution.

Review Set 32

Calculate the amount of dextrose and/or sodium chloride in each of the following IV solutions.

1. 1,000 mL of D_5NS

   dextrose ________ g

   sodium chloride ________ g

2. 500 mL of $D_5 \frac{1}{2}NS$

   dextrose ________ g

   sodium chloride ________ g

3. 250 mL of $D_{10}W$

   dextrose ________ g

4. 750 mL of NS

   sodium chloride ________ g

5. 500 mL of D_5 0.225% NaCl

   dextrose ________ g

   sodium chloride ________ g

6. 3 L of D_5NS

   dextrose ________ g

   sodium chloride ________ g

7. 0.5 L of $D_{10} \frac{1}{4}NS$

   dextrose ________ g

   sodium chloride ________ g

8. 300 mL of D_{12} 0.9% NaCl

   dextrose ________ g

   sodium chloride ________ g

9. 2 L of D_5 0.225% NaCl

   dextrose ________ g

   sodium chloride ________ g

10. 0.75 L of 0.45% NaCl

    sodium chloride ________ g

After completing these problems, see pages 518-519 to check your answers.

IV SITES

IV fluids may be ordered via a *peripheral line,* such as a vein in the arm, leg, or sometimes a scalp vein for infants, if other sites are inaccessible. Blood flowing through these veins can usually dilute the components in IV fluids. Glucose or dextrose is usually concentrated between 5% and 10% for short-term IV therapy. Peripheral veins can accommodate a maximum glucose concentration of 12%. The rate of infusion in peripheral veins should not exceed 200 mL in one hour.

IV fluids that are transparent flow smoothly into relatively small peripheral veins. When blood transfusion or replacement is needed, a larger vein is preferred to facilitate ease of blood flow. Whole blood or its components, especially packed cells, can be viscous and must be infused within a short period of time.

IV fluids may also be ordered via a *central line,* in which a special catheter is inserted to access a large vein in the chest. The subclavian vein, for example, may be used for a central line. Central lines may be accessed either directly through the chest wall or indirectly via a neck vein or peripheral vein in the arm. If a peripheral vein is used to access a central vein, you may see the term *peripherally inserted central catheter* or *PICC line.* Larger veins can accommodate higher concentrations of glucose (up to 35%) and other nutrients, and faster rates of IV fluids (greater than 200 mL in one hour). They are often utilized if the patient is expected to need IV therapy for an extended period of time.

MONITORING IVs

The nurse is responsible for monitoring the patient regularly during an IV infusion.

CAUTION

Generally the IV site and infusion should be checked at least every 30 minutes to one hour (according to hospital policy) for volume of remaining fluids, correct infusion rate, and signs of complications.

The major complications associated with IV therapy are phlebitis, infiltration, and infection at the IV site. *Phlebitis* occurs when the vein becomes irritated, red, or painful. (Think: *warm and cordlike vein.*) *Infiltration* is when the IV catheter becomes dislodged from the vein and IV fluid escapes into the subcutaneous tissue. (Think: *cool and puffy skin.*) Should phlebitis or infiltration occur, the IV is discontinued and another IV site is chosen to restart the IV. The patient should be instructed to notify the nurse of any pain or swelling.

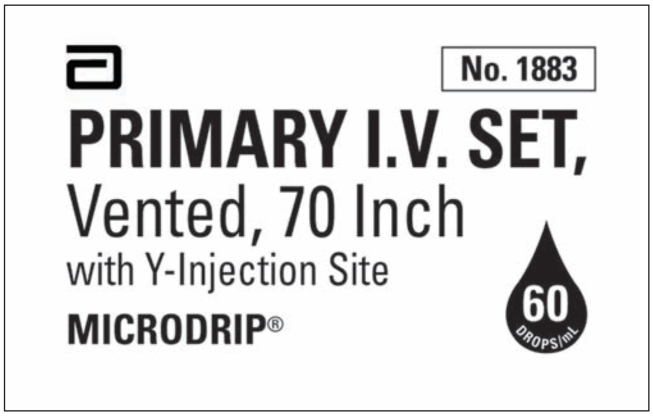
PRIMARY AND SECONDARY IVs

Primary IV tubing packaging and set are shown in Figures 14-6 and 14-7(a). This IV set is used to set up a typical or *primary IV*. Primary IV tubing includes a drip chamber, one or more injection ports, and a roller clamp, and is long enough to be attached to the hub of the IV catheter positioned in the patient's vein. The drip chamber is squeezed until it is half full of IV fluid, and IV fluid is run through the tubing prior to attaching it to the IV catheter to ensure that no air is in the tubing. The nurse can either regulate the rate manually using the roller clamp (Figure 14-7a) or place the tubing in an electronic infusion pump (Figures 14-12 through 14-15).

IV bags are often labeled with an infusion label (Figure 14-7b) that gives the nurse a visual check to monitor if the IV infusion is infusing on time as prescribed. These labels are attached to the IV bag and indicate the start and stop times of the infusion, as well as how the IV should be progressing, such as at 25 gtt/min. Each hour, from the start time to the stop time, the nurse should mark the label at the level where the solution should be.

Secondary IV tubing is used when giving medications. Secondary tubing is "piggybacked" into the primary line (Figure 14-8). This type of tubing generally is shorter and also contains a drip chamber and roller clamp. This gives access to the primary IV catheter without having to start another IV. You will notice that in this type of setup, the *secondary IV* set or *piggyback* is hung higher than the primary IV, to allow the secondary set of medication to infuse first. When administering primary IV fluids, choose primary IV tubing; when hanging piggybacks, select secondary IV tubing. IV piggybacks are discussed further at the end of this chapter.

FIGURE 14-6 Primary intravenous infusion set (Courtesy of Abbott Laboratories, Inc.)

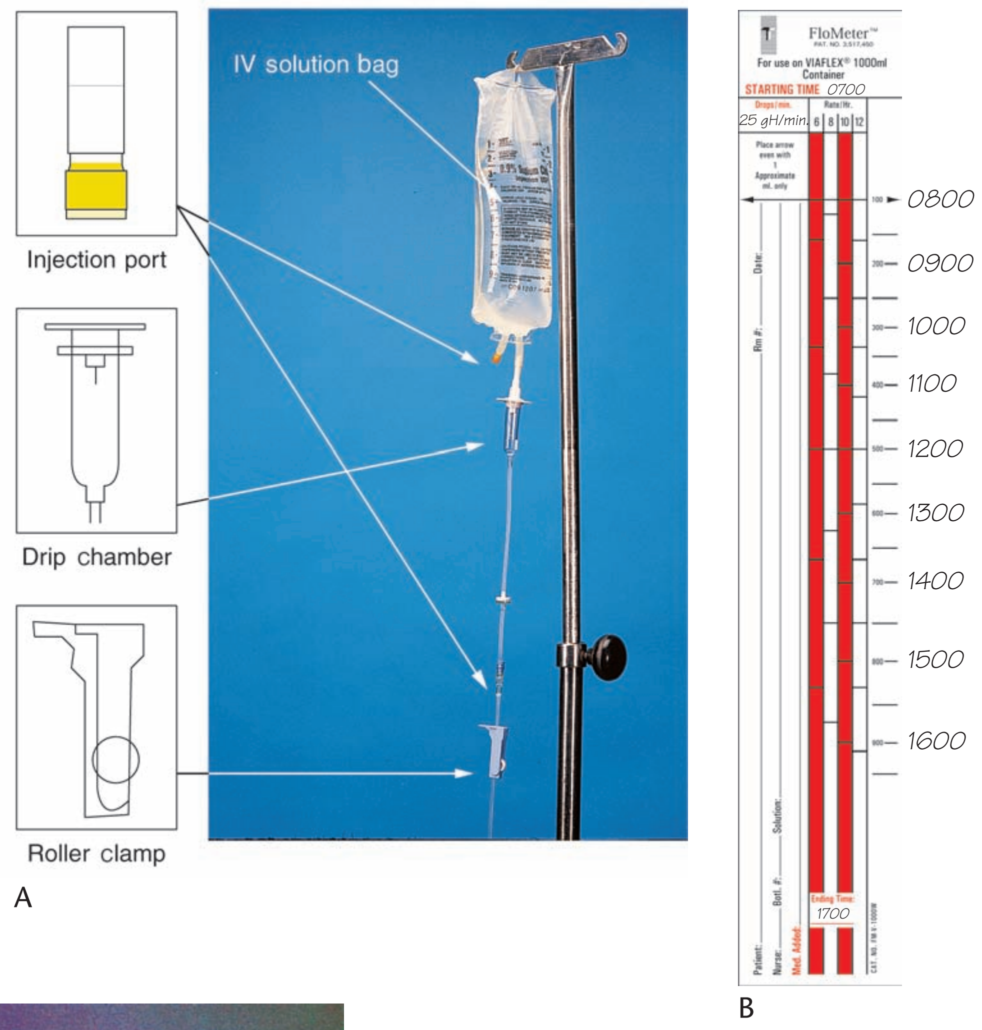


No. 1883

PRIMARY I.V. SET,
Vented, 70 Inch
with Y-Injection Site
MICRODRIP®

60 DROPS/mL

FIGURE 14-7 (a) Standard straight gravity flow IV system and (b) infusion label



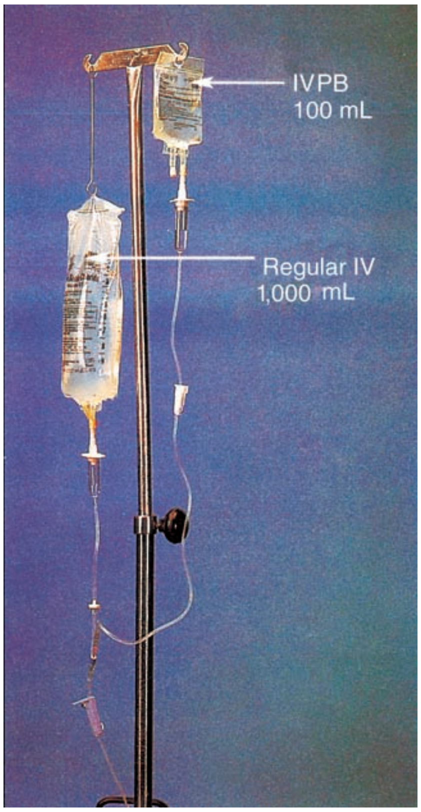


FIGURE 14-8 IV with piggyback (IV PB)

BLOOD ADMINISTRATION TUBING

When blood is administered, a standard blood set (Figure 14-9) or a Y-type blood set (Figure 14-10) is commonly used. The “Y” refers to the two spikes that are attached above the drip chamber. One spike is attached to the blood container, and the other spike is attached to normal saline. Normal saline is used to dilute packed cells and to flush the IV tubing at the beginning and at the end of the transfusion. Blood is usually infused manually by gravity, and the roller clamp on the line is used to adjust the rate. Some electronic pumps may also be used for infusion of blood. In such cases, the nurse would program the pump in mL/h and then the pump would regulate the blood infusion. Blood infusion is calculated the same as any other IV fluid.

IV FLOW RATE

The *flow rate* of an IV infusion is ordered by the physician. It is the nurse’s responsibility to regulate, monitor, and maintain this flow rate. Regulation of intravenous therapy is a critical skill in nursing. Because the fluids administered are infusing directly into the patient’s circulatory system, careful monitoring is essential to be sure the patient does not receive too much or too little IV fluid and medication. It is also important for the nurse to accurately set and maintain the flow rate to administer the prescribed volume of the IV solution within the specified time period. The nurse records the IV fluids administered and IV flow rates on the IV administration record (IVAR) (Figure 14-11).

IV solutions are usually ordered for a certain volume to run for a stated period of time, such as *125 mL/h* or *1,000 mL per 8 h.* The nurse will use electronic or manual regulating equipment to monitor the flow rate. The calculations you must perform to set the flow rate will depend on the equipment used to administer the IV solutions.

ELECTRONICALLY REGULATED IVs

Frequently, IV solutions are regulated electronically by an infusion device, such as a controller or pump. The use of an electronic infusion device will be determined by the need to strictly regulate the IV. Manufacturers supply special volumetric tubing that must be used with their infusion devices. This special tubing ensures accurate, consistent IV infusions. Each device can be set for a specific flow rate and will set off an alarm if this rate is interrupted. Electronic units today are powered by direct current (from a wall outlet) as well as an internal rechargeable battery. The battery takes over when the unit is unplugged, to allow for portability and patient ambulation.

Controllers (Figure 14-12) depend on gravity to maintain the desired flow rate by a compression/decompression mechanism that pinches the IV tubing, rather than forcing IV fluid into the system. They are often referred to as electronic flow clamps because they monitor the selected rate of infusion by either drop counting (drops per minute) or volumetric delivery (milliliters per hour).

Infusion pumps (Figure 14-13) do not rely on gravity but maintain the flow by displacing fluid at the prescribed rate. Resistance to flow within the system causes positive pressure in relation to the flow rate. The nurse or other user may preset a pressure alarm threshold. When the pressure sensed by the device reaches this threshold, the device stops pumping and sets off an alarm. The amount of change in pressure that results from infiltration or phlebitis may be insufficient to reach the alarm threshold. Therefore, users should not expect the device to stop infusing in the presence of these conditions.

A *syringe pump* (Figure 14-14) is a type of electronic infusion pump. It is used to infuse fluids or medications directly from a syringe. It is most often used in the neonatal and pediatric areas when small volumes of medication are delivered at low rates. It is also used in anesthesia, labor and delivery, and in critical care when the drug cannot be mixed with other solutions or medications, or to reduce the volume of diluent fluid delivered to the patient. Syringe pumps can deliver in up to 16 different modes, including mL/h, volume/time, dose or body weight modes, mass modes such as units/h, and other specialty modes.

FIGURE 14-9 Standard blood set

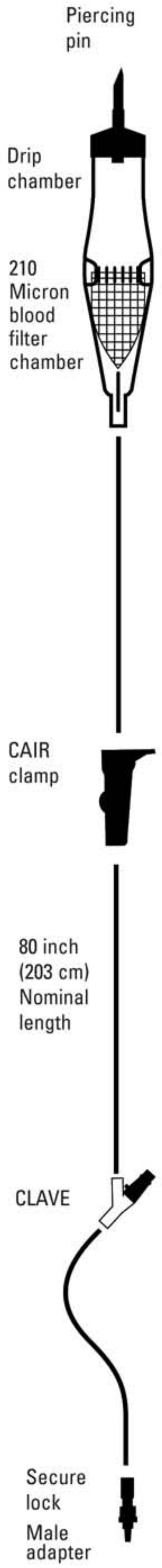


FIGURE 14-10 Y-type blood set

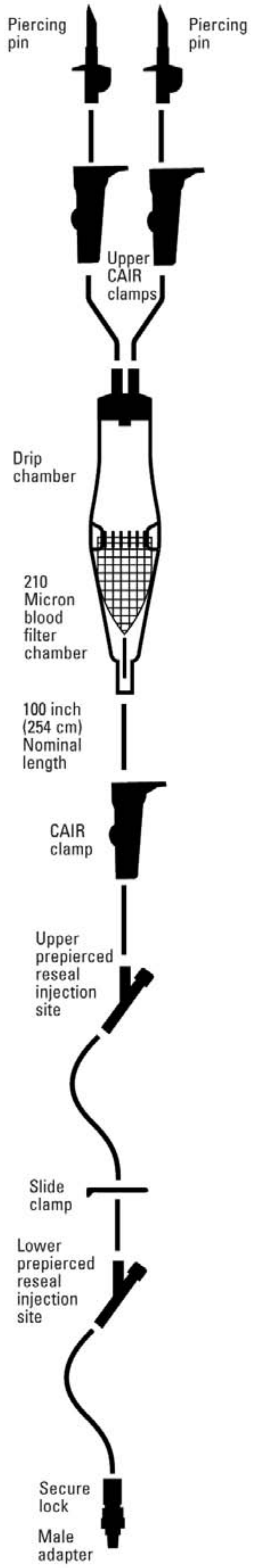
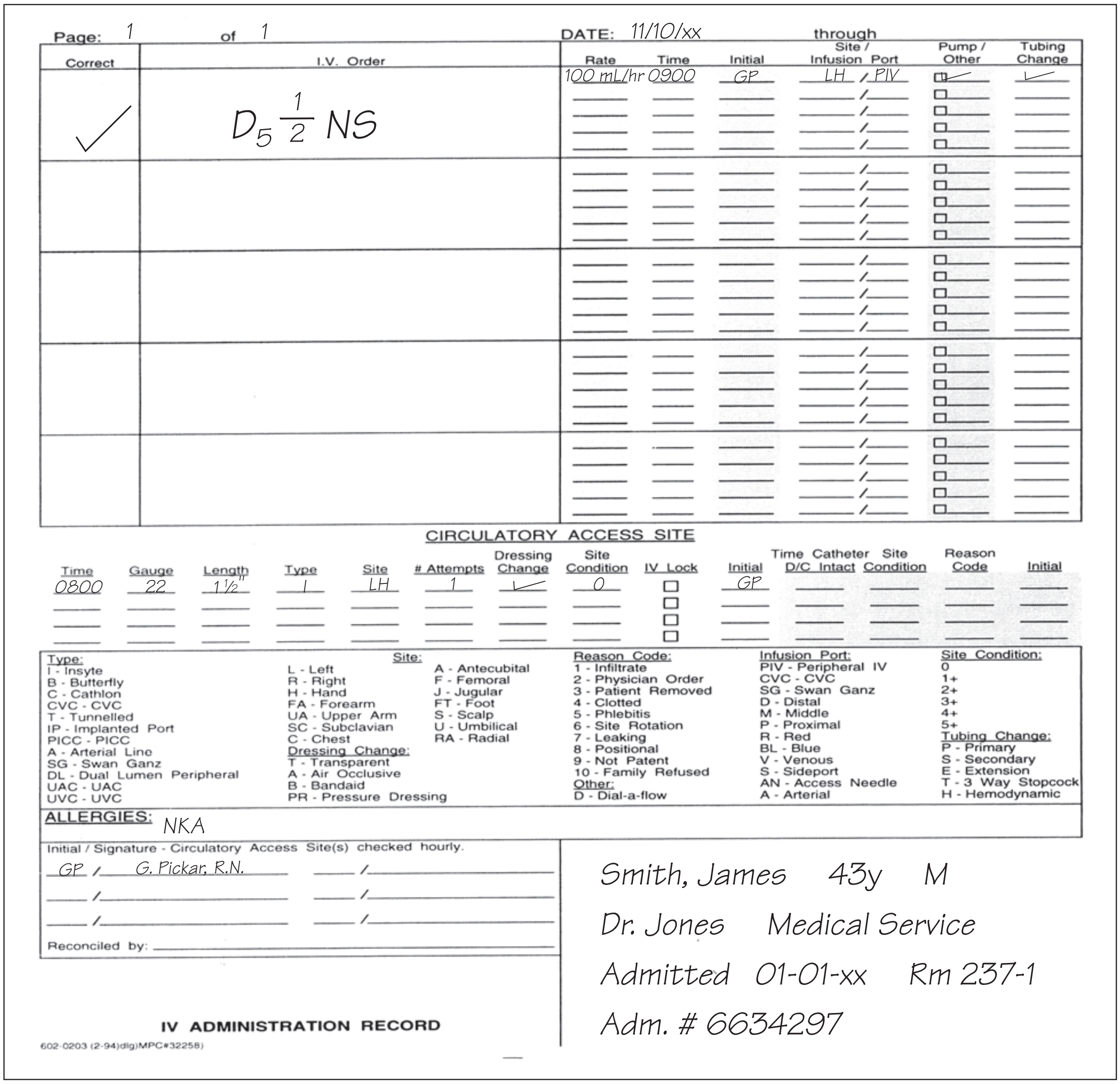


FIGURE 14-11 Intravenous Administration Record



Page: 1 of 1

DATE: 11/10/xx through

Correct	I.V. Order	Rate	Time	Initial	Site / Infusion Port	Pump / Other	Tubing Change
✓	$D_5 \frac{1}{2}$ NS	100 mL/hr	0900	GP	LH / PIV	☑	✓
					/	☐	
					/	☐	
					/	☐	
					/	☐	

CIRCULATORY ACCESS SITE

Time	Gauge	Length	Type	Site	# Attempts	Dressing Change	Site Condition	IV Lock	Initial	Time D/C	Catheter Intact	Site Condition	Reason Code	Initial
0800	22	1½"	I	LH	1	✓	0	☐	GP					
								☐						
								☐						
								☐						

Type:
I - Insyte
B - Butterfly
C - Cathlon
CVC - CVC
T - Tunnelled
IP - Implanted Port
PICC - PICC
A - Arterial Line
SG - Swan Ganz
DL - Dual Lumen Peripheral
UAC - UAC
UVC - UVC

Site:
L - Left
R - Right
H - Hand
FA - Forearm
UA - Upper Arm
SC - Subclavian
C - Chest
A - Antecubital
F - Femoral
J - Jugular
FT - Foot
S - Scalp
U - Umbilical
RA - Radial

Dressing Change:
T - Transparent
A - Air Occlusive
B - Bandaid
PR - Pressure Dressing

Reason Code:
1 - Infiltrate
2 - Physician Order
3 - Patient Removed
4 - Clotted
5 - Phlebitis
6 - Site Rotation
7 - Leaking
8 - Positional
9 - Not Patent
10 - Family Refused

Other:
D - Dial-a-flow

Infusion Port:
PIV - Peripheral IV
CVC - CVC
SG - Swan Ganz
D - Distal
M - Middle
P - Proximal
R - Red
BL - Blue
V - Venous
S - Sideport
AN - Access Needle
A - Arterial

Site Condition:
0
1+
2+
3+
4+
5+

Tubing Change:
P - Primary
S - Secondary
E - Extension
T - 3 Way Stopcock
H - Hemodynamic

ALLERGIES: NKA

Initial / Signature - Circulatory Access Site(s) checked hourly.

GP / G. Pickar, R.N.

Reconciled by:

Smith, James 43y M
Dr. Jones Medical Service
Admitted 01-01-xx Rm 237-1
Adm. # 6634297

IV ADMINISTRATION RECORD

602-0203 (2-94)dlg)MPC#32258)

FIGURE 14-12 Volumetric infusion controller/pump (Photo courtesy of Cardinal Health)

FIGURE 14-13 Infusion pump (Photo courtesy of Cardinal Health)

FIGURE 14-14 Syringe pump (Photo courtesy of Smiths Medical)

A *patient-controlled analgesia (PCA) pump* (Figure 14-15) is used to allow the patient to self-administer IV medication to control postoperative and other types of severe pain. The physician or other prescribing practitioner orders the pain medication, which is contained in a prefilled syringe locked securely in the IV pump. The patient presses the control button and receives the pain medication immediately rather than waiting for someone to bring it. The dose, frequency, and a safety "lock out" time are ordered and programmed into the pump, which delivers an individual therapeutic dose. The pump stores information about the frequency and dosage of the drug requested by and delivered to the patient. The nurse can display this information to document and evaluate pain management effectiveness. The nurse can also use such a pump to administer other IV push medications.

CAUTION

All electronic infusion devices must be monitored frequently (at least every 30 minutes to one hour) to ensure proper and safe functioning. Check the policy in your facility.

FIGURE 14-15 Syndeo PCA (patient-controlled analgesia) syringe pump (Photo courtesy of Baxter Medication Delivery)

CALCULATING FLOW RATES FOR ELECTRONIC REGULATORS IN mL/h

When an electronic infusion regulator is used, the IV volume is ordered by the physician and programmed into the device by the nurse. These devices are regulated in mL/h. Usually the physician orders the IV volume to be delivered in mL/h. If not, the nurse must calculate it.

MATH TIP

Several calculations for IV rates are simple formulas. We will consider both formulas and ratio-proportion to solve these problems.

RULE

To regulate an IV volume by electronic infusion pump or controller calibrated in mL/h, calculate:

$$\frac{\text{Total mL ordered}}{\text{Total h ordered}} = \text{mL/h (rounded to a whole number)}$$

or use ratio-proportion: $\frac{\text{Total mL}}{\text{Total h}} = \frac{\text{X mL}}{\text{1 h}}$

EXAMPLE ■

Order reads: D_5W 250 mL IV over the next 2 h by infusion pump

Step 1 Think. The pump is set by the rate of mL per hour. So, if 250 mL is to be infused in two hours, how much will be infused in one hour? Yes, 125 mL will be infused in one hour. You would set the pump at 125 mL per hour.

Step 2 Use the formula:

$$\frac{\text{Total mL ordered}}{\text{Total h ordered}} = \text{mL/h}$$

$$\frac{\overset{125}{\cancel{250}}\text{ mL}}{\underset{1}{\cancel{2}}\text{ h}} = \frac{125\text{ mL}}{1\text{ h}}$$

Therefore, set the pump at 125 mL per hour (125 mL/h).

This can also be solved using a ratio-proportion. In fact, the formula *is* a ratio-proportion. Let's look at this more closely.

The ratio-proportion to calculate mL/h looks almost the same as the formula.

$$\frac{\text{Total mL}}{\text{Total h}} = \frac{\text{X mL}}{\text{1 h}}$$

$$\frac{250\text{ mL}}{2\text{ h}} \times \frac{\text{X mL}}{1\text{ h}}$$

$$2X = 250$$

$$\frac{2X}{250} = \frac{250}{250}$$

$$X = 125\text{ mL}$$

But, the formula to divide *total mL* by *total h* is quite simple. You can use either formula or ratio-proportion.

In most cases it is easy to calculate mL/h by dividing total mL by total h. However, an IV with medication added or an IV PB may be ordered to be administered in *less than one hour* by an electronic infusion device, but the pump or controller must still be set in mL/h.

RULE

$$\frac{\text{Total mL ordered}}{\text{Total min ordered}} = \frac{\text{X mL/h}}{\text{60 min/h}}$$

X = mL/h (rounded to a whole number)

EXAMPLE ■

Order: **Ampicillin 500 mg IV in 50 mL $D_5\frac{1}{2}$NS in 30 min by controller**

Step 1 Think. The controller is set by the rate of mL per hour. If 50 mL is to be infused in 30 minutes, then 100 mL will be infused in 60 minutes, because 100 mL is twice as much as 50 mL and 60 minutes is twice as much as 30 minutes. Set the rate of the controller at 100 mL/h to infuse 50 mL per 30 min.

Step 2

$$\frac{\text{Total mL ordered}}{\text{Total min ordered}} = \frac{\text{X mL/h}}{\text{60 min/h}}$$

$$\frac{\text{50 mL}}{\text{30 min}} \times \frac{\text{X mL/h}}{\text{60 min/h}}$$

$$30X = 3{,}000$$

$$\frac{30X}{30} = \frac{3{,}000}{30}$$

$$X = 100 \text{ mL/h}$$

CAUTION

Typical values of mL/h to expect in calculations are in the range of 50-200 mL/h. Use this guideline as part of checking for reasonable answers.

QUICK REVIEW

For electronic infusion regulators:

- $\frac{\text{Total mL ordered}}{\text{Total h ordered}} = \text{mL/h}$
- If the infusion time is less than one hour, then

  $$\frac{\text{Total mL ordered}}{\text{Total min ordered}} = \frac{\text{X mL/h}}{\text{60 min/h}}$$

- Round mL/h to a whole number.

Review Set 33

Calculate the flow rate at which you will program the electronic infusion regulator for the following IV orders.

1. **D_5W 1 L IV to infuse in 10 h by infusion pump**

   Flow rate: ________ mL/h

2. **NS 1,800 mL IV to infuse in 15 h by controller**

   Flow rate: ________ mL/h

3. **D_5W 2,000 mL IV in 24 h by controller**

   Flow rate: ________ mL/h

4. **NS 100 mL IV PB in 30 min by infusion pump**

   Flow rate: ________ mL/h

5. 30 mL antibiotic in D_5W IV in 15 min by infusion pump

   Flow rate: __________ mL/h

6. NS 2.5 L IV in 20 h by controller

   Flow rate: __________ mL/h

7. 500 mL D_5LR IV in 4 h by controller

   Flow rate: __________ mL/h

8. 0.45% NaCl 600 mL IV in 3 h by infusion pump

   Flow rate: __________ mL/h

9. 150 mL antibiotic in D_5W IV in 2 h by infusion pump

   Flow rate: __________ mL/h

10. NS 3 L IV in 24 h by controller

    Flow rate: __________ mL/h

11. LR Injection 1.5 L IV in 24 h by infusion pump

    Flow rate: __________ mL/h

12. $D_{10}W$ 240 mL IV in 10 h by controller

    Flow rate: __________ mL/h

13. D_5W 750 mL IV in 5 h by infusion pump

    Flow rate: __________ mL/h

14. D_5NS 1.5 L IV in 12 h by controller

    Flow rate: __________ mL/h

15. D_5 0.45% NaCl 380 mL IV in 9 h by infusion pump

    Flow rate: __________ mL/h

After completing these problems, see page 519 to check your answers.

MANUALLY REGULATED IVs

When an electronic infusion device is not used, the nurse manually regulates the IV rate. To do this, the nurse must calculate the ordered IV rate based on a certain *number of drops per minute (gtt/min)*. This actually represents the ordered milliliters per hour, as you will shortly see in the calculation.

The number of drops dripping per minute into the IV drip chamber (Figures 14-7a and 14-16) are counted and regulated by opening or closing the roller clamp. You actually place your watch at the level of the drip chamber and count the drops as they fall during a one-minute period or fraction thereof (referred to as the *watch count*). This manual, gravity flow rate depends on the IV tubing calibration called the *drop factor*.

RULE

Drop factor = gtt/mL

The drop factor is the number of drops per milliliter (gtt/mL) a particular IV tubing set will deliver. It is stated on the IV tubing package (Figure 14-6) and varies according to the manufacturer of the IV equipment. Standard or *macrodrop* IV tubing sets have a drop factor of 10, 15, or 20 gtt/mL. All microdrip (or minidrip) IV tubing has a drop factor of 60 gtt/mL. Hospitals typically stock one macrodrop tubing for routine adult IV administration and the microdrip tubing for situations requiring more exact measurement.

Figure 14-16 compares macrodrops and microdrops. Figure 14-17 illustrates the size and number of drops in 1 mL for each drop factor. Notice that the fewer the number of drops per milliliter, the larger the actual drop size.

QUICK REVIEW

- Drop factor = gtt/mL
- The drop factor is stated on the IV tubing package.
- Macrodrop factors: 10, 15, or 20 gtt/mL
- Microdrop factor: 60 gtt/mL

FIGURE 14-16 Intravenous drip chambers; Comparison of (a) macrodrops and (b) microdrops

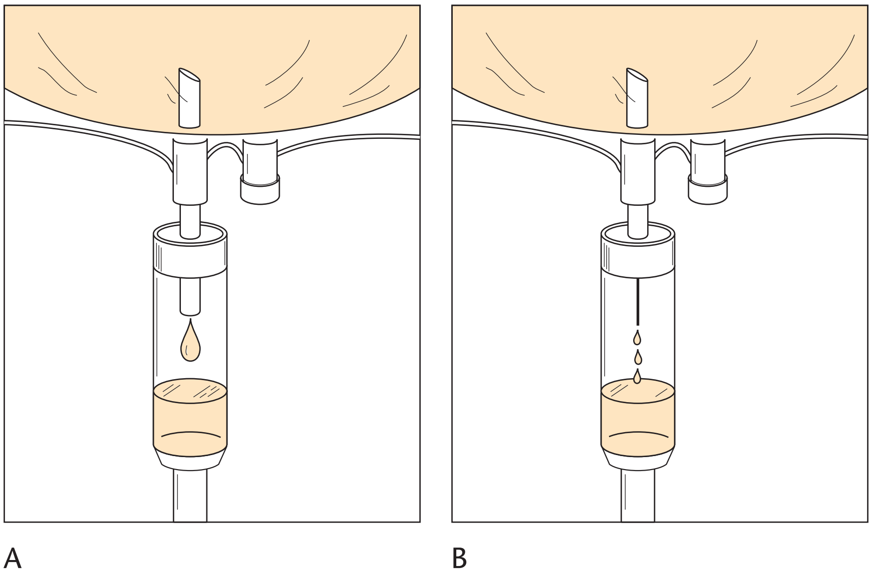
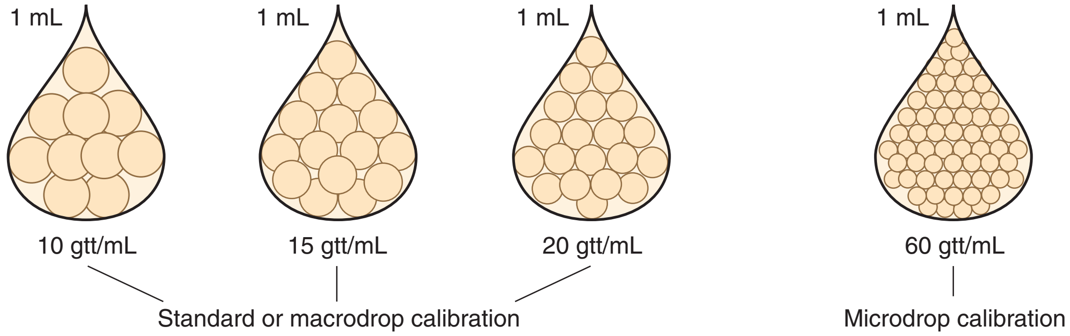


FIGURE 14-17 Comparison of calibrated drop factors



Review Set 34

Identify the drop factor calibration of the IV tubing pictured.

LATEX-FREE

No. 4967

PRIMARY I.V. SET,
Convertible Pin, 80 Inch
with Backcheck Valve
and 2 Injection Sites
Piggyback

15 DROPS/mL

(Courtesy of Abbott Laboratories, Inc.)

1. ________ gtt/mL

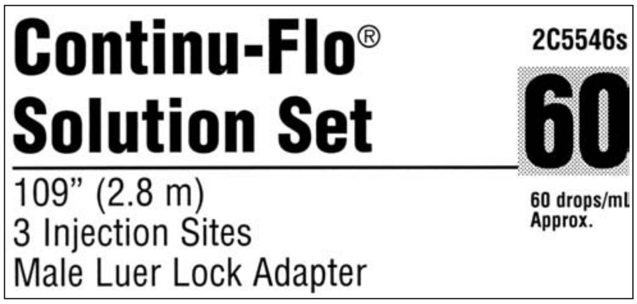
LifeShield® LATEX-FREE No. 11409

HEMA® II Y-TYPE BLOOD SET,
Nonvented, 100 Inch
with 2 Prepierced Injection Sites
and Secure Lock

10 DROPS/mL

(Courtesy of Abbott Laboratories, Inc.)

2. ________ gtt/mL



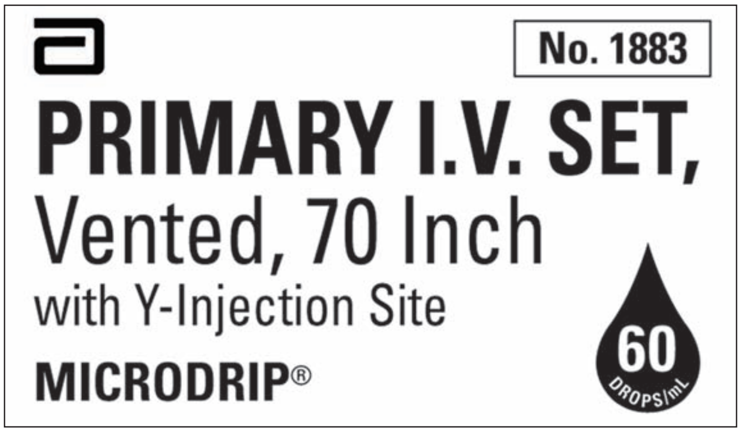
Continu-Flo® Solution Set 2C5546s

109” (2.8 m)
3 Injection Sites
Male Luer Lock Adapter

60
60 drops/mL
Approx.

(Courtesy of Abbott Laboratories, Inc.)

3. ________ gtt/mL



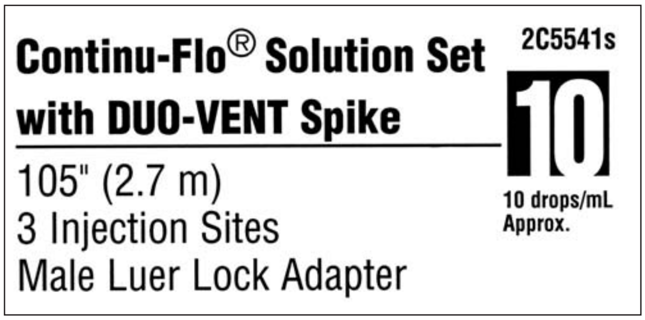
No. 1883

PRIMARY I.V. SET,
Vented, 70 Inch
with Y-Injection Site
MICRODRIP®

60 DROPS/mL

(Courtesy of Abbott Laboratories, Inc.)

4. ________ gtt/mL



Continu-Flo® Solution Set 2C5541s
with DUO-VENT Spike

105" (2.7 m)
3 Injection Sites
Male Luer Lock Adapter

10
10 drops/mL
Approx.

(Courtesy of Baxter Healthcare Corporation)

5. ________ gtt/mL

After completing these problems, see page 519 to check your answers.

CALCULATING FLOW RATES FOR MANUALLY REGULATED IVs IN gtt/min

In this section you will learn two methods to calculate IV flow rate for manually regulated IVs: the formula method and the shortcut method.

Formula Method

The formula method can be used to determine the flow rate in drops per minute (gtt/min).

RULE

The formula method to calculate IV flow rate for manually regulated IVs ordered in mL/h or for a prescribed number of minutes is:

$$\frac{V}{T} \times C = R$$

$$\frac{\text{Volume (mL)}}{\text{Time (min)}} \times \text{Calibration or drop factor (gtt/mL)} = \text{Rate (gtt/min)}$$

In this formula:

V = *volume to be infused* designated in mL; ordered by the prescriber.

C = *calibration of tubing* (drop factor) in gtt/mL.

T = *time required for V,* converted to minutes; ordered by the prescriber or pharmacy.

R = *rate of flow* in gtt/min. Think: The unknown is the watch count.

IV fluid and medication orders are written as a specific volume to be infused in a certain time period. Most IV fluid orders are written as X mL/h, which means X mL in 60 minutes. However, some IV medications are to be administered in less than one hour; for example, over 30 minutes.

MATH TIP

Carry calculations to one decimal place. Round gtt/min to the nearest whole number, because you can watch-count only whole drops.

Let's look at some examples of how to calculate the flow rate or watch count in gtt/min.

EXAMPLE 1 ■

The physician orders **D_5W IV at 125 mL/h**. The infusion set is calibrated for a drop factor of 10 gtt/mL. Calculate the IV flow rate in gtt/min. Notice that the mL cancel out, leaving gtt/min.

$$\frac{V}{T} \times C = \frac{125 \text{ mL}}{60 \text{ min}} \times 10 \text{ gtt/mL} = \frac{125 \cancel{\text{mL}}}{\underset{6}{\cancel{60}} \text{ min}} \times \frac{\overset{1}{\cancel{10}} \text{ gtt}}{1 \cancel{\text{mL}}} = \frac{125 \text{ gtt}}{6 \text{ min}} = 20.8 \text{ gtt/min} = 21 \text{ gtt/min}$$

Use your watch to count the drops and adjust the roller clamp to deliver 21 gtt/min.

EXAMPLE 2 ■

Order: **Lactated Ringer's IV at 150 mL/h.** The drop factor is 15 gtt/mL.

$$\frac{V}{T} \times C = \frac{150 \cancel{\text{mL}}}{\underset{4}{\cancel{60}} \text{ min}} \times \overset{1}{\cancel{15}} \text{ gtt/}\cancel{\text{mL}} = \frac{150 \text{ gtt}}{4 \text{ min}} = 37.5 \text{ gtt/min} = 38 \text{ gtt/min}$$

EXAMPLE 3 ■

Order: **Ampicillin 500 mg IV in 100 mL of NS, infuse over 45 min**

The drop factor is 20 gtt/mL. Notice that the time is less than one hour. Also notice that the 500 mg does not figure into the calculations because it is the dosage of ampicillin dissolved in the IV fluid. Only the *total volume of 100 mL* is needed to complete the calculations.

$$\frac{V}{T} \times C = \frac{100\ \cancel{mL}}{45\ min} \times 20\ gtt/\cancel{mL} = \frac{2{,}000\ gtt}{45\ min} = 44.4\ gtt/min = 44\ gtt/min$$

MATH TIP

When the IV drop factor is 60 gtt/mL (microdrip sets), then the flow rate in gtt/min is the same as the volume ordered in mL/h.

EXAMPLE 4 ■

Order: **D_5W NS IV at 50 mL/h.** The drop factor is 60 gtt/mL.

$$\frac{V}{T} \times C = \frac{50\ \cancel{mL}}{\cancel{60}\ min} \times \cancel{60}\ gtt/\cancel{mL} = 50\ gtt/min$$

Notice that the order of 50 mL/h is the *same* as the flow rate of 50 gtt/min when the drop factor is 60 gtt/mL. This will always be the rule when the drop factor is 60 gtt/mL.

Sometimes the prescriber will order a total IV volume to be infused over a total number of hours. In such cases, first calculate the mL/h (rounded to tenths), then calculate gtt/min (rounded to a whole number).

RULE

The formula method to calculate IV flow rate for manually regulated IVs ordered in total volume and total hours is:

STEP 1 $\frac{\text{Total mL}}{\text{Total hours}} = \text{mL/h}$ (round result to tenths)

STEP 2 $\frac{V}{T} \times C = R$ (round result to a whole number)

EXAMPLE ■

Order: **NS IV 3,000 mL per 24 h.** Drop factor is 15 gtt/min.

Step 1 $\frac{\text{Total mL}}{\text{Total h}} = \frac{3{,}000\ mL}{24\ h} = 125\ mL/h$

Step 2 $\frac{V}{T} \times C = R: \frac{125\ mL}{60\ min} \times 15\ gtt/mL = \frac{125\ \cancel{mL}}{\underset{4}{\cancel{60}}\ min} \times \frac{\overset{1}{\cancel{15}}\ gtt}{1\ \cancel{mL}} = \frac{125\ gtt}{4\ min} = 31.2\ gtt/min = 31\ gtt/min$

CAUTION

Typical values of gtt/min to expect in calculations are in the range of 20-100 gtts/min. Use this guideline as part of checking for reasonable answers.

QUICK REVIEW

- The formula method to calculate the flow rate, or watch count, in gtt/min for manually regulated IV rates ordered in mL/h or mL/minutes is:

$$\frac{\text{Volume (mL)}}{\text{Time (min)}} \times \text{Calibration or drop factor (gtt/mL)} = \text{Rate (gtt/min)}$$

- When total volume and total hours are ordered, first calculate mL/h.
- When the drop factor calibration is 60 (microdrop sets), then the flow rate in gtt/min is the same as the ordered volume in mL/h.
- Round gtt/min to a whole number.

Review Set 35

1. State the rule for the formula method to calculate IV flow rate in gtt/min when mL/h are known.

____

Calculate the flow rate or watch count in gtt/min.

2. Order: D_5W 3,000 mL IV at 125 mL/h

Drop factor: 10 gtt/mL

__________ gtt/min

3. Order: LR 250 mL IV at 50 mL/h

Drop factor: 60 gtt/mL

__________ gtt/min

4. Order: NS 100 mL bolus IV to infuse in 60 min

Drop factor: 20 gtt/mL

__________ gtt/min

5. Order: $D_5 \frac{1}{2}$ NS IV with 20 mEq KCl per liter to run at 25 mL/h

Drop factor: 60 gtt/mL

__________ gtt/min

6. Order: Two 500 mL units of whole blood IV to be infused in 4 h

Drop factor V 20 gtt/mL.

__________ gtt/min

7. Order: Hyperalimentation solution 1,240 mL IV to infuse in 12 h

Drop factor: 15 gtt/mL

__________ gtt/min

8. Order: D_5NS IV at 150 mL/h

Drop factor: 20 gtt/mL

__________ gtt/min

9. Order: NS 150 mL bolus IV to infuse in 45 min

Drop factor: 15 gtt/mL

__________ gtt/min

10. Order: D_5W antibiotic solution 80 mL IV to infuse in 60 min

Drop factor: 60 gtt/mL

__________ gtt/min

11. Order: Packed red blood cells 480 mL IV to infuse in 4 h

Drop factor: 10 gtt/mL

__________ gtt/min

12. Order: D_5W IV at 120 mL/h

Drop factor: 15 gtt/mL

__________ gtt/min

13. Order: D_5 0.45% NaCl IV at 50 mL/h

Drop factor: 20 gtt/mL

__________ gtt/min

14. Order: LR 2,500 mL IV at 165 mL/h

Drop factor: 20 gtt/mL

__________ gtt/min

15. Order: D_5LR 3,500 mL IV to run at 160 mL/h

Drop factor: 15 gtt/mL

__________ gtt/min

After completing these problems, see pages 519-520 to check your answers.

Shortcut Method

By converting the volume and time in the formula method to mL per h (or mL per 60 min), you can use a shortcut to calculate flow rate. This shortcut is derived from the drop factor (C), which cancels out each time and reduces the 60 minutes (T). You are left with the *drop factor constant*. Look at these examples.

EXAMPLE 1 ■

Administer **Normal Saline 1,000 mL IV at 125 mL/h** with a microdrop infusion set calibrated for 60 gtt/mL. Use the formula $\frac{V}{T} \times C = R$.

$$\frac{V}{T} \times C = \frac{125\ \cancel{mL}}{\underset{1}{\cancel{60}}\ min} \times \overset{1}{\cancel{60}}\ gtt/\cancel{mL} = \frac{125\ gtt}{\textcircled{1}\ min} = 125\ gtt/min$$

The drop factor constant for an infusion set with 60 gtt/mL is 1. Therefore, to administer 125 mL/h, set the flow rate at 125 gtt/min. Recall that when the drop factor is 60, then gtt/min = mL/h.

EXAMPLE 2 ■

Administer **NS 1,000 mL IV at 125 mL/h IV** with 20 gtt/mL infusion set.

$$\frac{V}{T} \times C = \frac{125\ \cancel{mL}}{\underset{3}{\cancel{60}}\ min} \times \overset{1}{\cancel{20}}\ gtt/\cancel{mL} = \frac{125\ gtt}{\textcircled{3}\ min} = 41.6\ gtt/min = 42\ gtt/min$$

Drop factor constant = 3

Each drop factor constant is obtained by dividing 60 by the drop factor calibration from the infusion set.

REMEMBER

Drop Factor	Drop Factor Constant
10 gtt/mL	$\frac{60}{10} = 6$
15 gtt/mL	$\frac{60}{15} = 4$
20 gtt/mL	$\frac{60}{20} = 3$
60 gtt/mL	$\frac{60}{60} = 1$

Most hospitals consistently use infusion equipment manufactured by one company. Each manufacturer typically supplies one macrodrop and one microdrop system. You will become familiar with the supplier used where you work; therefore, the shortcut method is practical, quick, and simple to use.

RULE

The shortcut method to calculate IV flow rate is:

$$\frac{\text{mL/h}}{\text{Drop factor constant}} = \text{gtt/min}$$

Let's examine four examples using the shortcut method.

EXAMPLE 1 ■

The IV order reads: **D_5W 1,000 mL IV at 125 mL/h.** The infusion set is calibrated for a drop factor of 10 gtt/mL. Drop factor constant: 6

$$\frac{\text{mL/h}}{\text{Drop factor constant}} = \text{gtt/min}$$

$$\frac{125\ \text{mL/h}}{6} = 20.8\ \text{gtt/min} = 21\ \text{gtt/min}$$

EXAMPLE 2 ■

Order reads: **LR 1,000 mL IV at 150 mL/h.** The drop factor is 15 gtt/mL. Drop factor constant: 4

$$\frac{\text{mL/h}}{\text{Drop factor constant}} = \text{gtt/min}$$

$$\frac{150 \text{ mL/h}}{4} = 37.5 \text{ gtt/min} = 38 \text{ gtt/min}$$

EXAMPLE 3 ■

Order reads: **$D_5 \frac{1}{2}$NS 200 mL IV in 2 h.** The drop factor is 20 gtt/mL. Drop factor constant: 3

Step 1 $$\frac{\text{Total mL}}{\text{Total h}} = \text{mL/h}$$

$$\frac{200}{2} = 100 \text{ mL/h}$$

Step 2 $$\frac{\text{mL/h}}{\text{Drop factor constant}} = \text{gtt/min}$$

$$\frac{100 \text{ mL/h}}{3} = 33.3 \text{ gtt/min} = 33 \text{ gtt/min}$$

EXAMPLE 4 ■

Order reads: **D_5W NS 500 mL IV at 50 mL/h.** The drop factor is 60 gtt/mL. Drop factor constant: 1

$$\frac{\text{mL/h}}{\text{Drop factor constant}} = \text{gtt/min}$$

$$\frac{50 \text{ mL/h}}{1} = 50 \text{ gtt/min}$$

Remember, when the drop factor is 60 (microdrop), set the flow rate at the same gtt/min as the mL/h.

CAUTION

For the shortcut method to work, the rate has to be written in mL/h. The shortcut method will not work if the time is less than one hour or is calculated in minutes, such as 15 or 30 minutes.

QUICK REVIEW

- The drop factor constant is 60 divided by the drop factor.

Drop Factor	Drop Factor Constant
10 gtt/mL	6
15 gtt/mL	4
20 gtt/mL	3
60 gtt/mL	1 → Set the flow rate at the same gtt/min as the mL/h.

- $\frac{\text{mL/h}}{\text{Drop factor constant}} = \text{gtt/min}$

Review Set 36

1. The drop factor constant is derived by dividing __________ by the drop factor calibration.

Determine the drop factor constant for each of the following infusion sets.

2. 60 gtt/mL __________

3. 20 gtt/mL __________

4. 15 gtt/mL __________

5. 10 gtt/mL __________

6. State the rule for the shortcut method to calculate the IV flow rate in gtt/min. ________________

____

Calculate the IV flow rate in gtt/min using the shortcut method.

7. Order: D$_5$W 1,000 mL IV to infuse at 200 mL/h

   Drop factor: 15 gtt/mL

   Flow rate: ________ gtt/min

8. Order: D$_5$W 750 mL IV to infuse at 125 mL/h

   Drop factor: 20 gtt/mL

   Flow rate: ________ gtt/min

9. Order: D$_5$W 0.45% Saline 500 mL IV to infuse at 165 mL/h

   Drop factor: 10 gtt/mL

   Flow rate: ________ gtt/min

10. Order: NS 2 L IV to infuse at 60 mL/h $\bar{c}$ microdrop infusion set of 60 gtt/mL

    Flow rate: ________ gtt/min

11. Order: D$_5$W 400 mL IV to infuse at 50 mL/h

    Drop factor: 10 gtt/mL

    Flow rate: ________ gtt/min

12. Order: NS 3 L IV to infuse at 125 mL/h

    Drop factor: 15 gtt/mL

    Flow rate: ________ gtt/min

13. Order: D$_5$LR 500 mL IV to infuse in 6 h

    Drop factor: 20 gtt/mL

    Flow rate: ________ gtt/min

14. Order: 0.45% NaCl 0.5 L IV to infuse in 20 h

    Drop factor: 60 gtt/mL

    Flow rate: ________ gtt/min

15. Order: D$_5$ 0.9% NaCl 650 mL IV to infuse in 10 h

    Drop factor: 10 gtt/mL

    Flow rate: ________ gtt/min

After completing these problems, see page 520 to check your answers.

SUMMARY

Calculating mL/h to program infusion devices and gtt/min to watch-count manually regulated IVs are two major IV calculations you need to know. Further, you have learned to calculate the supply dosage of certain IV solutes. These important topics warrant additional reinforcement and review.

QUICK REVIEW

- Solution strength expressed as a percent (%) indicates the number of g of solute per 100 mL of solution.
- When regulating IV flow rate for an electronic infusion device, calculate mL/h.
- When calculating IV flow rate to regulate an IV manually, calculate mL/h, find the drop factor, and calculate gtt/min by using the:

  Formula Method

  $\frac{V}{T} \times C = R$

  or Shortcut Method: $\frac{\text{mL/h}}{\text{Drop factor constant}} = \text{gtt/min}$
- Carefully monitor patients receiving IV fluids at least hourly.
  - Check remaining IV fluids.
  - Check IV flow rate.
  - Observe IV site for complications.

Review Set 37

Calculate the IV flow rate for these manually regulated IV administrations.

1. Order: 0.45% NaCl 3,000 mL IV for 24 h

   Drop factor: 15 gtt/mL

   Flow rate: __________ mL/h

   Flow rate: __________ gtt/min

2. Order: D_5W 200 mL IV to run at 100 mL/h

   Drop factor: Microdrop, 60 gtt/mL

   Flow rate: __________ gtt/min

3. Order: $D_5 \frac{1}{2}$ NS 800 mL IV for 8 h

   Drop factor: 20 gtt/mL

   Flow rate: __________ mL/h

   Flow rate: __________ gtt/min

4. Order: NS 1,000 mL IV at 50 mL/h

   Drop factor: 60 gtt/mL

   Flow rate: __________ gtt/min

5. Order: D_5W 1,500 mL IV for 12 h

   Drop factor: 15 gtt/mL

   Flow rate: __________ mL/h

   Flow rate: __________ gtt/min

6. Order: theophylline 0.5 g IV in 250 mL D_5W to run for 2 h by infusion pump

   Drop factor: 60 gtt/mL

   Flow rate: __________ mL/h

   Flow rate: __________ gtt/min

7. Order: D_5 0.45% NaCl 2,500 mL IV at 105 mL/h

   Drop factor: 20 gtt/mL

   Flow rate: __________ gtt/min

8. Order: D_5 0.45% NaCl 500 mL IV at 100 mL/h

   Drop factor: 10 gtt/mL

   Flow rate: __________ gtt/min

9. Order: NS 1,200 mL IV at 150 mL/h

   Drop factor: 10 gtt/mL

   Flow rate: __________ gtt/min

Calculate the IV flow rate for these electronically regulated IV administrations.

10. Order: D_5 0.45% NaCl 1,000 mL IV to infuse over 8 h

    Drop factor: On electronic infusion pump

    Flow rate: __________ mL/h

11. Order: D_5NS 2,000 mL IV to infuse over 24 h

    Drop factor: On electronic infusion controller

    Flow rate: __________ mL/h

12. Order: LR 500 mL IV to infuse over 4 h

    Drop factor: On electronic infusion controller

    Flow rate: __________ mL/h

13. Order: 100 mL IV antibiotic to infuse in 30 min via electronic infusion pump

    Flow rate: __________ mL/h

14. Order: 50 mL IV antibiotic to infuse in 20 min via electronic infusion pump

    Flow rate: __________ mL/h

15. Order: 150 mL IV antibiotic to infuse in 45 min via electronic infusion pump

    Flow rate: __________ mL/h

What is the total dosage of the solute(s) the patient will receive for each of the following orders?

16. 3,000 mL $\frac{1}{2}$ NS IV NaCl: __________ g
17. 200 mL D_{10} NS IV D: __________ g NaCl: __________ g
18. 2,500 mL NS IV NaCl: __________ g

19. 650 mL D_5 0.45% NaCl IV D: ________ g NaCl: ________ g

20. 1,000 mL D_5 $\frac{1}{4}$ NS IV D: ________ g NaCl: ________ g

After completing these problems, see pages 520-521 to check your answers.

ADJUSTING IV FLOW RATE

IV fluids, especially those with medicines added (called additives), are viewed as medications with specific dosages (rates of infusion, in this case). It is the responsibility of the nurse to maintain this rate of flow through careful calculations and close observation at regular intervals. Various circumstances, such as gravity, condition, and movement of the patient, can alter the set flow rate of an IV, causing the IV to run ahead of or behind schedule.

CAUTION

It is not the discretion of the nurse to arbitrarily speed up or slow down the flow rate to catch up the IV. This practice can result in serious conditions of overhydration or underhydration and electrolyte imbalance. Avoid off-schedule IV flow rates by regularly monitoring IVs at least every 30 minutes to one hour. Check your agency policy.

During your regular monitoring of the IV, if you find that the rate is not progressing as scheduled or is significantly ahead of or behind schedule, the physician may need to be notified as warranted by the patient's condition, hospital policy, or good nursing judgment. Some hospital policies allow the flow rate per minute to be adjusted a certain percentage of variation. A rule of thumb is that the flow rate per minute may be adjusted by *up to 25 percent more or less* than the original prescribed rate depending on the condition of the patient. In such cases, assess the patient. If the patient is stable, recalculate the flow rate to administer the total milliliters remaining over the number of hours remaining of the original order.

RULE

- Check for institutional policy regarding correcting off-schedule IV rates and the percentage of variation allowed. This variation should not exceed 25 percent.
- If adjustment is permitted, use the following formula to recalculate the mL/h and gtt/min for the time remaining and the percentage of variation.

Step 1 $$\frac{\text{Remaining volume}}{\text{Remaining hours}} = \text{Recalculated mL/h}$$

Step 2 $$\frac{V}{T} \times C = \text{gtt/min}$$

Step 3 $$\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \text{\% variation}$$

The percent variation will be positive (+) if the administration is slow and the rate has to be increased, and negative (–) if the administration is too fast and the rate has to be decreased.

EXAMPLE 1 ■

The order reads **D_5W 1,000 mL IV at 125 mL/h for 8 h.** The drop factor is 10 gtt/mL, and the IV is correctly set at 21 gtt/min. You would expect that after 4 hours, one-half of the total, or 500 mL, of the solution would be infused ($125 \text{ mL}/\cancel{\text{h}} \times 4 \cancel{\text{h}} = 500 \text{ mL}$). However, when you check the IV bag the fourth hour after starting the IV, you find 600 milliliters remaining. The rate of flow is *behind schedule*, and the hospital allows a 25% IV flow variation with careful patient assessment and if the patient's condition is stable. The patient is stable, so you decide to compute a new flow rate for the remaining 600 milliliters to complete the IV fluid order in the remaining 4 hours.

Step 1 $\frac{\text{Remaining volume}}{\text{Remaining hours}} = \text{Recalculated mL/h}$

$$\frac{600\ \text{mL}}{4\text{h}} = 150\ \text{mL/h}$$

Step 2 $\frac{V}{T} \times C = \frac{150\ \cancel{\text{mL}}}{\underset{6}{\cancel{60}}\ \text{min}} \times \overset{1}{\cancel{10}}\ \text{gtt}/\cancel{\text{mL}} = \frac{150\ \text{gtt}}{6\ \text{min}} = 25\ \text{gtt/min}$ (Adjusted flow rate)

You could also use the shortcut method.

$$\frac{\text{mL/h}}{\text{Drop factor constant}} = \text{gtt/min}$$

$$\frac{150\ \text{mL/h}}{6} = 25\ \text{gtt/min}$$

Step 3 $\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%\ \text{of variation}$

$\frac{25 - 21}{21} = \frac{4}{21} = 0.19 = 19\%$; within the acceptable 25% of variation depending on policy and patient's condition

Compare 25 gtt/min (in the last example) with the starting flow rate of 21 gtt/min. You can see that adjusting the total remaining volume over the total remaining hours changes the flow rate only 4 gtt/min. Most patients can tolerate this small amount of increase per minute over several hours. However, trying to catch up the lost 100 milliliters in one hour can be dangerous. To infuse an extra 100 milliliters in one hour, with a drop factor of 10, you would need to speed up the IV to a much faster rate. Let's see what that rate would be.

$\frac{V}{T} \times C = \frac{100\ \cancel{\text{mL}}}{\underset{6}{\cancel{60}}\ \text{min}} \times \overset{1}{\cancel{10}}\ \text{gtt}/\cancel{\text{mL}} = \frac{100\ \text{gtt}}{6\ \text{min}} = 16.6\ \text{gtt/min} = 17\ \text{gtt/min}$ more than the original rate

To catch up the IV over the next hour, the flow rate would have to be 17 drops per minute faster than the original 21 drops per minute rate. The infusion would have to be set at $17 + 21 = 38$ gtt/min for one hour and then slowed to the original rate. Such an increase would be $\frac{38-21}{21} = \frac{17}{21} = 81\%$ greater than the ordered rate. This could present a serious problem. **Do not do it! If permitted by hospital policy, the flow rate for the remainder of the order must be recalculated when the IV is off-schedule and should never exceed a 25 percent adjustment.**

EXAMPLE 2 ■

The order reads: **LR 500 mL IV to run over 10 h at 50 mL/h.** The drop factor is 60 gtt/mL and the IV is correctly infusing at 50 gtt/min. After $2\frac{1}{2}$ hours, you find 300 mL remaining. Almost half of the total volume has already infused in about one-quarter the time. This IV infusion is *ahead of schedule*. You would compute a new flow rate of 300 mL to complete the IV fluid order in the remaining $7\frac{1}{2}$ hours. The patient would require close assessment for fluid overload.

Step 1 $\frac{\text{Remaining volume}}{\text{Remaining hours}} = \text{Recalculated mL/h}$

$$\frac{300\ \text{mL}}{7.5\ \text{h}} = 40\ \text{mL/h}$$

Time remaining is $7\frac{1}{2}$ h $(10\ \text{h} - 2\frac{1}{2}\ \text{h})$

Step 2 $\frac{V}{T} \times C = \frac{40\ \cancel{\text{mL}}}{\cancel{60}\ \text{min}} \times \cancel{60}\ \text{gtt}/\cancel{\text{mL}} = 40\ \text{gtt/min}$ (Adjusted flow rate)

Or, you know when drop factor is 60, then mL/h = gtt/min.

Step 3 $\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%\ \text{of variation}$

$\frac{40 - 50}{50} = \frac{-10}{50} = -0.2 = -20\%$ within the acceptable 25% of variation

Remember, the negative percent of variation (–20%) indicates that the adjusted flow rate will be decreased.

RULE

Shortcut for IV Rate Adjustment Check (Step 3):

Ordered IV Rate ± (Ordered IV Rate ÷ 4) = Acceptable IV Adjustment Range

You know that you can adjust the flow rate by as much as ±25 percent, and you know that $25\% = \frac{1}{4}$. Therefore, after recalculating the adjusted flow rate, you can check the safety of the recalculated rate by using a shortcut that does not include percents. To do this you divide the ordered rate by 4 and add or subtract the result from the ordered rate to determine the acceptable range of adjustment.

In the *first* example, the ordered rate is 21 gtt/min, and the recalculated rate is 25 gtt/min. Is this within the safe range? Use the shortcut to calculate the acceptable range.

$$\text{Ordered IV Rate} \pm (\text{Ordered IV Rate} \div 4) = \text{Acceptable IV Adjustment Range}$$

$$21 + (21 \div 4) = 21 + 5.25 = 26.25 = 26 \text{ gtt/min}$$

$$21 + (21 \div 4) = 21 - 5.25 = 15.75 = 16 \text{ gtt/min}$$

The safe range is 16-26 gtt/min. Yes, 25 gtt/min is within the safe ± 25% range.

This may be an easier calculation for you than working with percents. Let's look at the *second* example. The ordered rate is 50 gtt/min and the recalculated rate is 40 gtt/min. What is the acceptable range?

$$\text{Ordered IV Rate} \pm (\text{Ordered IV Rate} \div 4) = \text{Acceptable IV Adjustment Range}$$

$$50 + (50 \div 4) = 50 + 12.5 = 62.5 = 63 \text{ gtt/min}$$

$$50 - (50 \div 4) = 50 - 12.5 = 37.5 = 38 \text{ gtt/min}$$

The safe range is 38-63 gtt/min. Yes, it is safe to slow the rate to 40 gtt/min, which is within the safe ± 25% range.

A good rule of thumb is that the recalculated flow rate should not vary from the ordered rate by more than 25 percent. If the recalculated rate does vary from the ordered by more than 25 percent, contact your supervisor or the doctor for further instructions. The original order may have to be revised. Regular monitoring helps to prevent or minimize this problem.

Patients who require close monitoring for IV fluids will most likely have the IV regulated by an electronic infusion device. Because of the nature of their condition, "catching up" these IVs, if off schedule, is not recommended. If an IV regulated by an infusion pump or controller is off-schedule or inaccurate, suspect that the infusion pump may need recalibration. Consult with your supervisor, as appropriate.

QUICK REVIEW

- Regular IV monitoring and patient assessment at least every 30 minutes to one hour is important to maintain prescribed IV flow rate.
- Do not arbitrarily speed up or slow down IV flow rates that are off-schedule.
- Check hospital policy regarding adjustment of off-schedule IV flow rates and the percentage of variation allowed. If permitted, a rule of thumb is a maximum 25 percent variation for patients in stable condition.
- Use the remaining time and the remaining IV fluid volume to recalculate off-schedule IV flow rate:

Step 1 $\frac{\text{Remaining volume}}{\text{Remaining hours}} = \text{Recalculated mL/h}$

Step 2 $\frac{V}{T} \times C = \text{gtt/min}$

Step 3 $\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%\text{ variation}$

- Contact the prescribing health care professional for a new IV fluid order if the recalculated IV flow rate variation exceeds the allowed variation or if the patient's condition is unstable.

Review Set 38

Compute the flow rate in drops per minute. Hospital policy permits recalculation of IVs when off-schedule, with a maximum variation in rate of 25 percent for stable patients. Compute the percent of variation.

1. Order: **Lactated Ringer's 1,500 mL IV for 12 h at 125 mL/h**

   Drop factor: 20 gtt/mL

   Original flow rate: ________ gtt/min

   After 6 hours, there are 850 mL remaining; describe your action now.

   Time remaining: ________ h

   Recalculated flow rate: ________ mL/h

   Recalculated flow rate: ________ gtt/min

   Variation: ________ %

   Action: ____

2. Order: **Lactated Ringer's 1,000 mL IV for 6 h at 167 mL/h**

   Drop factor: 15 gtt/mL

   Original flow rate: ________ gtt/min

   After 4 hours, there are 360 mL remaining; describe your action now.

   Time remaining: ________ h

   Recalculated flow rate: ________ mL/h

   Recalculated flow rate: ________ gtt/min

   Variation: ________ %

   Action: ____

3. Order: **D_5W 1,000 mL IV for 8 h at 125 mL/h**

   Drop factor: 20 gtt/mL

   Original flow rate: ________ gtt/min

   After 4 hours, there are 800 mL remaining; describe your action now.

   Time remaining: ________ h

   Recalculated flow rate: ________ mL/h

   Recalculated flow rate: ________ gtt/min

   Variation: ________ %

   Action: ____

4. Order: **NS 2,000 mL IV for 12 h at 167 mL/h**

Drop factor: 10 gtt/mL

Original flow rate: ________ gtt/min

After 8 hours, there are 750 mL remaining; describe your action now.

Time remaining: ________ h

Recalculated flow rate: ________ mL/h

Recalculated flow rate: ________ gtt/min

Variation: ________ %

Action: ____

5. Order: **NS 1,000 mL IV for 8 h at 125 mL/h**

Drop factor: 10 gtt/mL

Original flow rate: ________ gtt/min

After 4 hours, there are 750 mL remaining; describe your action now.

Time remaining: ________ h

Recalculated flow rate: ________ mL/h

Recalculated flow rate: ________ gtt/min

Variation: ________ %

Action: ____

6. Order: **NS 2,000 mL IV for 16 h at 125 mL/h**

Drop factor: 15 gtt/mL

Original flow rate: ________ gtt/min

After 6 hours, 650 mL of fluid have infused; describe your action now.

Solution remaining: ________ mL Time remaining: ________ h

Recalculated flow rate: ________ mL/h

Recalculated flow rate: ________ gtt/min

Variation: ________ %

Action: ____

7. Order: **NS 900 mL IV for 6 h at 150 mL/h**

Drop factor: 20 gtt/mL

Original flow rate: ________ gtt/min

After 3 hours, there are 700 mL remaining; describe your action now.

Time remaining: ________ h

Recalculated flow rate: ________ mL/h

Recalculated flow rate: ________ gtt/min

Variation: ________ %

Action: ____

8. Order: D_5NS 500 mL IV for 5 h at 100 mL/h

   Drop factor: 20 gtt/mL

   Original flow rate: ________ gtt/min

   After 2 hours, there are 250 mL remaining; describe your action now.

   Time remaining: ________ h

   Recalculated flow rate: ________ mL/h

   Recalculated flow rate: ________ gtt/min

   Variation: ________ %

   Action: ____

9. Order: NS 1 L IV for 20 h at 50 mL/h

   Drop factor: 15 gtt/mL

   Original flow rate: ________ gtt/min

   After 10 hours, there are 600 mL remaining; describe your action now.

   Time remaining: ________ h

   Recalculated flow rate: ________ mL/h

   Recalculated flow rate: ________ gtt/min

   Variation: ________ %

   Action: ____

10. Order: D_5W 1,000 mL IV for 10 h at 100 mL/h

   Drop factor: 60 gtt/mL

   Original flow rate: ________ gtt/min

   After 5 hours, there are 500 mL remaining; describe your action now.

   Time remaining: ________ h

   Recalculated flow rate: ________ mL/h

   Recalculated flow rate: ________ gtt/min

   Variation: ________ %

   Action: ____

After completing these problems, see pages 521-522 to check your answers.

INTERMITTENT IV INFUSIONS

Sometimes the patient needs to receive supplemental fluid therapy and/or IV medications but does not need continuous replacement or maintenance IV fluids. Several intermittent IV infusion systems are available to administer IV drugs. These include IV PB, IV locks for IV push drugs, the ADD-Vantage system, and volume control sets (such as Buretrol). Volume control sets are discussed in Chapter 15.

IV Piggybacks

A medication may be ordered to be dissolved in a small amount of IV fluid (usually 50 to 100 mL) and run piggyback to the regular IV fluids (Figure 14-8). Recall that the IV PB (or secondary IV) requires a secondary IV set.

The IV PB medication may come premixed by the manufacturer or pharmacy, or the nurse may need to prepare it. Whichever the case, it is always the responsibility of the nurse to accurately and safely administer the medication. The infusion time may be less than 60 minutes, so it is important to carefully read the order and recommended infusion time.

Sometimes the physician's order for the IV PB medication will not include an infusion time or rate. It is understood, when this is the case, that the nurse will follow the manufacturer's guidelines for infusion rates, keeping in mind the amount of fluid accompanying the medication and any standing orders that limit fluid amounts or rates. Appropriate infusion times are readily available in many drug reference books. Reference books are usually available on most nursing units, or you can consult with a hospital pharmacist.

EXAMPLE 1 ■

Order: Kefzol 0.5 g in 100 mL D_5W IV PB to run over 30 min

Drop factor: 20 gtt/mL

What is the flow rate in gtt/min?

$$\frac{V}{T} \times C = \frac{100\ \cancel{\text{mL}}}{\underset{3}{\cancel{30}}\ \text{min}} \times \overset{2}{\cancel{20}}\ \text{gtt}/\cancel{\text{mL}} = \frac{200\ \text{gtt}}{3\ \text{min}} = 66.6\ \text{gtt/min} = 67\ \text{gtt/min}$$

EXAMPLE 2 ■

If an infusion pump or controller is used to administer the same order as in Example 1, remember that you would need to program the device in mL/h.

Step 1 **Think** If 100 mL will be administered in 30 minutes or one-half hour, then 200 mL will be administered in twice this time or 60 minutes.

Step 2 **Calculate** Use ratio-proportion to calculate mL/h.

$$\frac{100\ \text{mL}}{30\ \text{min}} \times \frac{X\ \text{mL/h}}{60\ \text{min/h}}$$

$$30X = 6{,}000$$

$$\frac{30X}{30} = \frac{6{,}000}{30}$$

$$X = 200\ \text{mL/h}$$

Set the electronic IV PB regulator to 200 mL/h

Saline and Heparin IV Locks for IV Push Drugs

IV locks can be attached to the hub of the IV catheter that is positioned in the vein. The lock may be referred to as a *saline lock*, meaning that saline is used to flush or maintain the IV catheter patency, or a *heparin lock* if heparin is used to maintain the IV catheter patency. Sometimes a more general term, such as *intermittent peripheral infusion device*, may be used. Medications can be given *IV push*, meaning that a syringe is attached to the lock and medication is pushed in. An *IV bolus*, usually a quantity of IV fluid, can be run in over a specified period of time through an IV setup that is attached to the lock. Using either a saline or heparin lock allows for intermittent medication and fluid infusion. Heparin and saline locks are also being used for outpatient and home care medication therapy. Refer to the policy at your hospital or health care agency regarding the frequency, volume, and concentration of saline or heparin to be used to maintain the IV lock.

CAUTION

Heparin lock flush solution is usually concentrated to 10 units/mL or 100 units/mL. Much higher concentrations of heparin are given IV or subcut, so carefully check the concentration.

Dosage calculations for IV push injections are the same as calculations for intramuscular (IM) injections. The IV push route of administration is often preferred when immediate onset of action is desired for persons with small or wasted muscle mass, poor circulation, or for drugs that have limited absorption from body tissues.

Drug literature and institutional guidelines recommend an acceptable rate (per minute or per incremental amount of time) for IV push drug administration. Most timed IV push administration recommendations are for 1–5 minutes or more. For smooth manual administration of IV push drugs, calculate the incremental volume to administer over 15-second intervals. You should time the administration with a digital or sweep second-hand watch or clock.

CAUTION

IV drugs are potent and rapid acting. Never infuse IV push drugs more rapidly than recommended by agency policy or pharmacology literature. Some drugs require further dilution after reconstitution for IV push administration. Carefully read package inserts and reputable drug resources for minimum dilution and minimum time for IV administration.

EXAMPLE 1 ■

Order: **Ativan 3 mg IV Push 20 min preoperatively**

Supply: Ativan 4 mg/mL with drug literature guidelines of *IV infusion not to exceed 2 mg/min*

How much Ativan should you prepare?

Step 1 Convert No conversion is necessary.

Step 2 Think You want to give less than 1 mL.

Step 3 Calculate $\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$

$$\frac{4\text{ mg}}{1\text{ mL}} \times \frac{3\text{ mg}}{\text{X mL}}$$

$$4\text{ X} = 3$$

$$\frac{4\text{ X}}{4} = \frac{3}{4}$$

$$\text{X} = 0.75\text{ mL}$$

What is a safe infusion time?

Use ratio-proportion to calculate the time required to administer the drug as ordered.

$$\frac{2\text{ mg}}{1\text{ min}} \times \frac{3\text{ mg}}{\text{X min}}$$

$$2\text{X} = 3$$

$$\frac{2\text{X}}{2} = \frac{3}{2}$$

$$\text{X} = 1\tfrac{1}{2}\text{ min}$$

Administer 0.75 mL over $1\frac{1}{2}$ min.

How much should you infuse every 15 seconds?

Convert: 1 min = 60 sec; $1\frac{1}{2}$ min = $1\frac{1}{2} \times 60 = 90$ sec

$$\frac{0.75\text{ mL}}{90\text{ sec}} \times \frac{X\text{ mL}}{15\text{ sec}}$$

$$90X = 11.25$$

$$\frac{90X}{90} = \frac{11.25}{90}$$

X = 0.125 mL = 0.13 mL of Ativan 4 mg/mL infused IV push every 15 seconds will deliver 3 mg of Ativan.

This is a small amount. Use a 1 mL syringe to prepare 0.75 mL and slowly administer 0.13 mL every 15 seconds.

EXAMPLE 2 ■

Order: **Cefizox 1,500 mg IV push q.8h**

Supply: Cefizox 2 g powder with directions, *For direct IV administration, reconstitute each 1 g in 10 mL sterile water and give slowly over 3–5 minutes.*

How much Cefizox should you prepare?

Step 1 Convert 2 g = 2,000 mg

Step 2 Think If 1 g (or 1,000 mg) requires 10 mL for dilution, then 2 g (or 2,000 mg) requires twice this amount or 20 mL for dilution. Therefore, to administer 1,500 mg, you will prepare more than 10 mL and less than 20 mL.

Step 3 Calculate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{2{,}000\text{ mg}}{20\text{ mL}} \times \frac{1{,}500\text{ mg}}{X\text{ mL}}$$

$$2{,}000X = 30{,}000$$

$$\frac{2{,}000X}{2{,}000} = \frac{30{,}000}{2{,}000}$$

$$X = 15\text{ mL}$$

What is a safe infusion time?

This amount is larger than the Ativan dosage from Example 1, so you should use the longer infusion time recommendation (1 g per 5 min). Remember the unknown X is the time to infuse the dosage desired.

$$\frac{\text{Dosage recommended}}{\text{Time recommended}} = \frac{\text{Dosage desired}}{\text{X Time desired}}$$

$$\frac{1{,}000\text{ mg}}{5\text{ min}} \times \frac{1{,}500\text{ mg}}{X\text{ min}}$$

$$\frac{1{,}000X}{1{,}000} = \frac{7{,}500}{1{,}000}$$

$$X = 7.5\text{ min}$$

Administer 15 mL over 7.5 min.

How much should you infuse every 15 seconds?

Convert: 1 min = 60 sec

7.5 min = 7.5 × 60 = 450 sec

$$\frac{15\text{ mL}}{450\text{ sec}} \times \frac{X\text{ mL}}{15\text{ sec}}$$

$$450\text{ X} = 225$$

$$\frac{450X}{450} = \frac{225}{450}$$

X = 0.5 mL of Cefizox 2 g per 20 mL infused IV push every 15 seconds to deliver 1,500 mg of Cefizox

Use a 20 mL syringe to prepare 15 mL and slowly infuse 0.5 mL every 15 seconds.

ADD-Vantage System

Another type of IV medication setup commonly used in hospitals is the ADD-Vantage system by Abbott Laboratories (Figure 14-18). This system uses a specially designed IV bag with a medication vial port. The medication vial comes with the ordered dosage and medication prepared in a powder form. The medication vial is attached to the special IV bag, and together they become the IV PB container. The powder is dissolved by the IV fluid and used within a specified time. This system maintains asepsis and eliminates the extra time and equipment (syringe and diluent vials) associated with reconstitution of powdered medications. Several drug manufacturers market many common IV antibiotics using products similar to the ADD-Vantage system.

QUICK REVIEW

- Intermittent IV infusions typically require more or less than 60 minutes of infusion time.
- Calculate IV PB flow rate in gtt/min: $\frac{V}{T} \times C = R$.
- Use a proportion to calculate IV PB flow rate in mL/h for an electronic infusion device.
- Use the three-step dosage calculation method to calculate the amount to give for IV push medications: convert, think, calculate.
- Use ratio-proportion to calculate safe IV push time in minutes and seconds as recommended by reputable drug reference.

Review Set 39

Calculate the IV PB or IV push flow rate.

1. Order: Ancef 1 g in 100 mL D_5W IV PB to be infused over 45 min

   Drop factor: 60 gtt/mL

   Flow rate: ________ gtt/min

2. Order: Ancef 1 g in 100 mL D_5W IV PB to be administered by electronic infusion controller to infuse in 45 min

   Flow rate: ________ mL/h

3. Order: Kefzol 2 g IV PB diluted in 50 mL D_5W to infuse in 15 min

   Drop factor: 15 gtt/mL

   Flow rate: ________ gtt/min

4. Order: Kefzol 2 g IV PB diluted in 50 mL D_5W to infuse in 15 min by an electronic infusion pump

   Flow rate: ________ mL/h

5. Order: 50 mL IV PB antibiotic solution to infuse in 30 min

   Drop factor: 60 gtt/mL

   Flow rate: ________ gtt/min

6. Order: Zosyn 3 g in 100 mL D_5W IV PB to be infused over 40 min

   Drop factor: 10 gtt/mL

   Flow rate: ________ gtt/min

7. Order: Unasyn 1.5 g in 50 mL D_5W IV PB to be infused over 15 min

   Drop factor: 15 gtt/mL

   Flow rate: ________ gtt/min

8. Order: Merrem 1 g in 100 mL D_5W IV PB to be infused over 30 min

   Use infusion pump.

   Flow rate: ________ mL/h

9. Order: Keflin 750 mg in 50 mL NS IV PB to be infused over 20 min

   Use infusion pump.

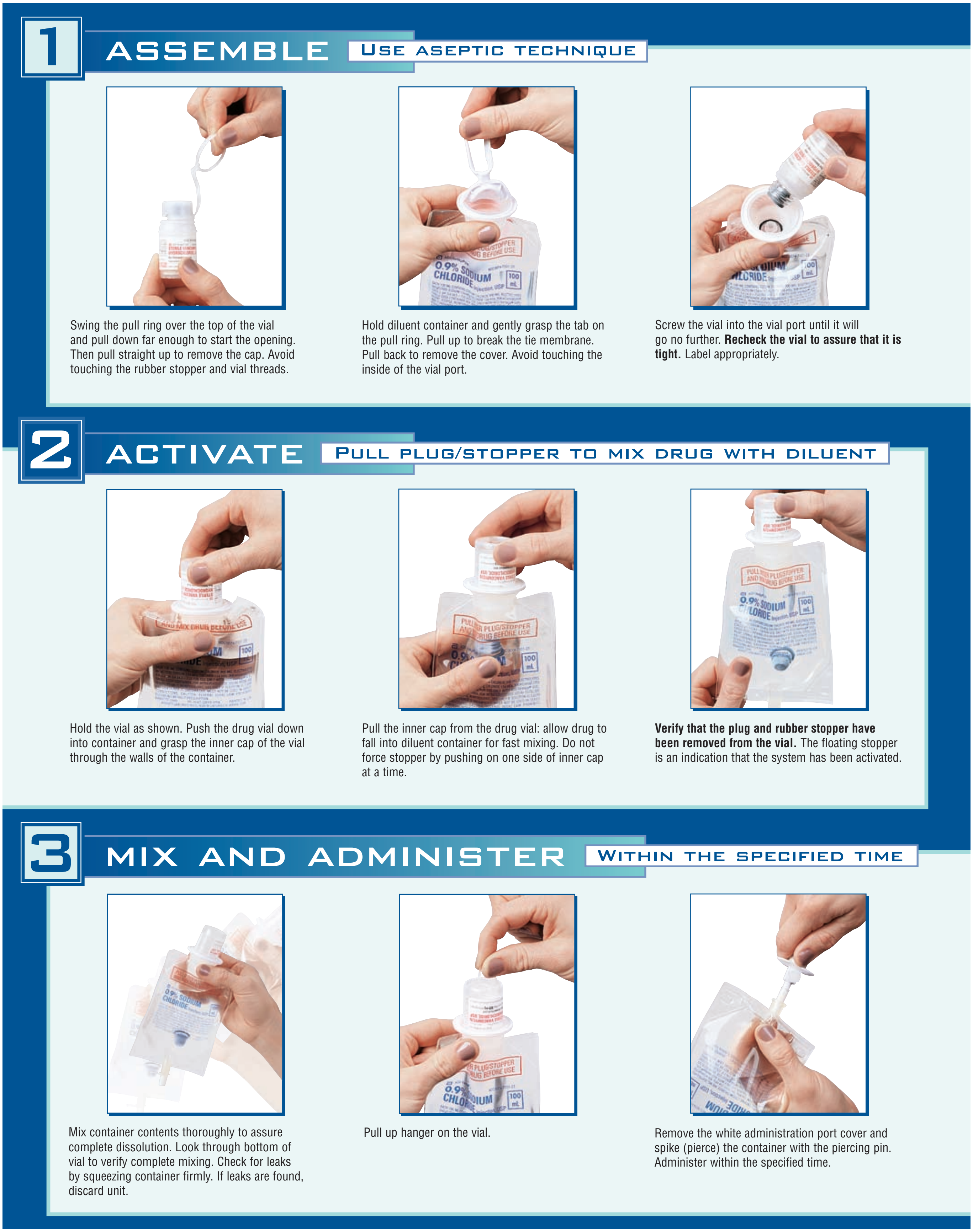
   Flow rate: ________ mL/h

10. Order: oxacillin Sodium 900 mg in 125 mL D_5W IV PB to be infused over 45 min

    Use infusion pump.

    Flow rate: ________ mL/h

FIGURE 14-18 ADD-Vantage system: Medications can be added to another solution being infused (Reproduced with permission of Abbott Laboratories, Inc.)



1 ASSEMBLE USE ASEPTIC TECHNIQUE

Swing the pull ring over the top of the vial and pull down far enough to start the opening. Then pull straight up to remove the cap. Avoid touching the rubber stopper and vial threads.

Hold diluent container and gently grasp the tab on the pull ring. Pull up to break the tie membrane. Pull back to remove the cover. Avoid touching the inside of the vial port.

Screw the vial into the vial port until it will go no further. **Recheck the vial to assure that it is tight.** Label appropriately.

2 ACTIVATE PULL PLUG/STOPPER TO MIX DRUG WITH DILUENT

Hold the vial as shown. Push the drug vial down into container and grasp the inner cap of the vial through the walls of the container.

Pull the inner cap from the drug vial: allow drug to fall into diluent container for fast mixing. Do not force stopper by pushing on one side of inner cap at a time.

Verify that the plug and rubber stopper have been removed from the vial. The floating stopper is an indication that the system has been activated.

3 MIX AND ADMINISTER WITHIN THE SPECIFIED TIME

Mix container contents thoroughly to assure complete dissolution. Look through bottom of vial to verify complete mixing. Check for leaks by squeezing container firmly. If leaks are found, discard unit.

Pull up hanger on the vial.

Remove the white administration port cover and spike (pierce) the container with the piercing pin. Administer within the specified time.

11. Order: **Unasyn 0.5 g in 100 mL D_5W IV PB to be infused over 15 min**

    Drop factor: 20 gtt/mL

    Flow rate: ________ gtt/min

12. Order: **Keflin 500 mg in 50 mL NS IV PB to be infused over 20 min**

    Drop factor: 10 gtt/mL

    Flow rate: ________ gtt/min

13. Order: **Merrem 1 g in 100 mL D_5W IV PB to be infused over 50 min**

    Use infusion pump.

    Flow rate: ________ mL/h

14. Order: **oxacillin sodium 900 mg in 125 mL D_5W IV PB to be infused over 45 min**

    Drop factor: 20 gtt/mL

    Flow rate: ________ gtt/min

15. Order: **Zosyn 1.3 g in 100 mL D_5W IV PB to be infused over 30 min**

    Drop factor: 60 gtt/mL

    Flow rate: ________ gtt/min

16. Order: **Lasix 120 mg IV push stat**

    Supply: Lasix 10 mg/mL with drug insert, which states, *IV injection not to exceed 40 mg/min.*

    Give: ________ mL/________ min or ________ mL per 15 sec

17. Order: **Dilantin 150 mg IV push stat**

    Supply: Dilantin 250 mg per 5 mL with drug insert, which states, *IV infusion not to exceed 50 mg/min.*

    Give: ________ mL per ________ min or ________ mL per 15 sec

18. Order: **morphine sulfate 6 mg IV push q.3h p.r.n., pain**

    Supply: Morphine sulfate 10 mg/mL with drug reference recommendation, which states, *IV infusion not to exceed 2.5 mg/min.*

    Give: ________ mL per ________ min and ________ seconds or ________ mL per 15 sec

19. Order: **cimetidine 300 mg IV push stat**

    Supply: Tagamet (cimetidine) 300 mg per 2 mL

    Package insert instructions: *For direct IV injection, dilute 300 mg in 0.9% NaCl to a total volume of 20 mL. Inject over at least 2 minutes.*

    Prepare ________ mL Tagamet

    Dilute with ________ mL 0.9% NaCl for a total of 20 mL of solution.

    Administer ________ mL/min or ________ mL per 15 sec

20. Order: **Versed 1.5 mg IV push stat**

    Supply: Versed 1 mg/mL

    Instructions: *Slowly titrate to the desired effect using no more than 1.5 mg initially given over 2-min period.*

    Prepare ________ mL Versed

    Give ________ mL/min or ________ mL per 15 sec

After completing these problems, see pages 522-523 to check your answers.

CALCULATING IV INFUSION TIME

Intravenous solutions are usually ordered to be administered at a prescribed number of milliliters per hour, such as *1,000 mL Lactated Ringer's IV to run at 125 mL per hour*. You may need to calculate the total infusion time so that you can anticipate when to add a new bag or bottle or when to discontinue the IV.

RULE

To calculate IV infusion time:

$$\frac{\text{Total volume}}{\text{mL/h}} = \text{Total hours}$$

Or use ratio-proportion: Ratio for prescribed flow rate in mL/h = Ratio for total mL per X total hours:

$$\frac{\text{mL}}{\text{h}} = \frac{\text{Total mL}}{\text{X Total h}}$$

EXAMPLE 1 ■

LR 1,000 mL IV to run at 125 mL/h. How long will this IV last?

$$\frac{\overset{8}{\cancel{1{,}000}}\ \cancel{\text{mL}}}{\underset{1}{\cancel{125}}\ \cancel{\text{mL}}/\text{h}} = 8 \text{ h}$$

Or, use ratio-proportion.

$$\frac{125 \text{ mL}}{1 \text{ h}} \times \frac{1{,}000 \text{ mL}}{\text{X h}}$$

$$125\text{X} = 1{,}000$$

$$\frac{125\text{X}}{125} = \frac{1{,}000}{125}$$

$$\text{X} = 8 \text{ h}$$

MATH TIP

Use fractions for hours that are not whole numbers. They are more exact than decimals, which often have to be rounded. Rounded decimals are harder to use.

EXAMPLE 2 ■

1,000 mL D_5W IV to infuse at 60 mL/h to begin at 0600. At what time will this IV be complete?

$$\frac{1{,}000\ \cancel{\text{mL}}}{60\ \cancel{\text{mL}}/\text{h}} = 16.6 \text{ h} = 16\frac{2}{3} \text{ h}; \frac{2}{3} \text{ h} = \frac{2}{3} \times 60 = 40 \text{ min; Total time: 16 h and 40 min}$$

Or, use ratio-proportion:

$$\frac{60 \text{ mL}}{1 \text{ h}} \times \frac{1{,}000 \text{ mL}}{\text{X h}}$$

$$60\text{ X} = 1{,}000$$

$$\frac{60\text{X}}{60} = \frac{1{,}000}{60}$$

$$\text{X} = 16.6 \text{ h} = 16\frac{2}{3}\text{h} = 16 \text{ h and 40 min}$$

The IV will be complete at 0600 + 1640 = 2240 (or 10:40 PM).

You can also determine the infusion time if you know the volume, flow rate in gtt/min, and drop factor. Calculate the infusion time by using the $\frac{V}{T} \times C = R$ formula; T, time in minutes, is unknown.

RULE

Use the formula method to calculate time (T):

$$\frac{V}{T} \times C = R$$

EXAMPLE ■

D_5W 80 mL IV at 20 microdrops/min

The drop factor is 60 gtt/mL. Calculate the infusion time.

Step 1 $\frac{V}{T} \times C = R: \frac{80 \text{ mL}}{T \text{ min}} \times 60 \text{ gtt/mL} = 20 \text{ gtt/min}$

$$\frac{80\ \cancel{mL}}{T \text{ min}} \times \frac{60 \text{ gtt}}{1\ \cancel{mL}} = \frac{20 \text{ gtt}}{1 \text{ min}}$$

$$\frac{4{,}800 \text{ gtt}}{T \text{ min}} = \frac{20 \text{ gtt}}{1 \text{ min}}$$

Then you apply ratio-proportion.

$$\frac{4{,}800}{T} \times \frac{20}{1}$$

$$\begin{aligned} 20T &= 4{,}800 \\ \frac{20T}{20} &= \frac{4{,}800}{20} \\ T &= 240 \text{ min} \end{aligned}$$

Step 2 Convert: minutes to hours

$$\begin{aligned} \frac{1 \text{ h}}{60 \text{ min}} &= \frac{X \text{ h}}{240 \text{ min}} \\ 60\ X &= 240 \\ \frac{60\ X}{60} &= \frac{240}{60} \\ X &= 4 \text{ h} \end{aligned}$$

Or, simply divide 240 by 60.

$240 \text{ min} = \frac{240}{60} = 4 \text{ h}$

CALCULATING IV FLUID VOLUME

If you have an IV that is regulated at a particular flow rate (gtt/min) and you know the drop factor (gtt/mL) and the amount of time, you can determine the volume to be infused.

Apply the flow rate formula; V, volume, is unknown.

RULE

To calculate IV volume (V):

$\frac{V}{T} \times C = R$

EXAMPLE ■

When you start your shift at 7 AM, there is an IV bag of D_5W infusing at the rate of 25 gtt/min. The infusion set is calibrated for a drop factor of 15 gtt/mL. How much can you anticipate that the patient will receive during your 8-hour shift?

$8 \text{ h} = 8 \times 60 = 480 \text{ min}$

$\frac{V}{T} \times C = R: \frac{V \text{ mL}}{480 \text{ min}} \times 15 \text{ gtt/mL} = 25 \text{ gtt/min}$

$$\frac{V\ \cancel{mL}}{480 \text{ min}} \times \frac{15 \text{ gtt}}{1\ \cancel{mL}} = \frac{25 \text{ gtt}}{1 \text{ min}}$$

$$\frac{15V\text{ gtt}}{480\text{ min}} = \frac{25\text{ gtt}}{1\text{ min}}$$

$$\frac{15V}{480} \times \frac{25}{1}$$

$$15V = 12{,}000$$

$$\frac{15V}{15} = \frac{12{,}000}{15}$$

V = 800 mL to be infused in 8 h

If the IV is regulated in mL/h, you can also calculate the total volume that will infuse over a specific time.

RULE

To calculate IV volume:
Total hours × mL/h = Total volume
Or use ratio-proportion:
Ratio for ordered mL/h = Ratio for X total volume per total hours

$$\frac{\text{mL}}{\text{h}} = \frac{\text{X Total mL}}{\text{Total h}}$$

EXAMPLE ■

Your patient's IV is running on an infusion pump set at the rate of 100 mL/h. How much will be infused during the next 8 hours?

$$8\ \cancel{\text{h}} \times 100\text{ mL}/\cancel{\text{h}} = 800\text{ mL}$$

Or, use ratio-proportion:

$$\frac{100\text{ mL}}{1\text{ h}} \times \frac{\text{X mL}}{8\text{ h}}$$

$$X = 800\text{ mL}$$

QUICK REVIEW

- The formula to calculate IV infusion time, when mL is known:

  $$\frac{\text{Total volume}}{\text{mL/h}} = \text{Total hours}$$

  or use ratio-proportion: $\frac{\text{mL}}{\text{h}} = \frac{\text{Total mL}}{\text{X total h}}$

- The formula to calculate IV infusion time, when flow rate in gtt/min, drop factor, and volume are known: $\frac{V}{T} \times C = R$; T is the unknown.

- The formula to calculate total infusion volume, when mL/h are known:

  Total hours × mL/h = Total volume

  Or, use ratio-proportion: $\frac{\text{mL}}{\text{h}} = \frac{\text{X total mL}}{\text{Total h}}$

- The formula to calculate IV volume, when flow rate (gtt/min), drop factor, and time are known:

  $\frac{V}{T} \times C = R$; V is the unknown.

Review Set 40

Calculate the infusion time and rate (as requested) for the following IV orders:

1. Order: D_5W 500 mL IV at 30 gtt/min

   Drop factor: 20 gtt/mL

   Time: ________ h and ________ min

2. Order: Lactated Ringer's 1,000 mL IV at 25 gtt/min

   Drop factor: 10 gtt/mL

   Time: ________ h and ________ min

3. Order: D_5 Lactated Ringer's 800 mL IV at 25 gtt/min

   Drop factor: 15 gtt/mL

   Time: ________ h

4. Order: Normal Saline 120 mL IV to run at 20 mL/h

   Drop factor: 60 microdrops/mL

   Time: ________ h

   Flow rate: ________ gtt/min

5. Order: D_5W 80 mL IV to run at 20 mL/h

   Drop factor: 60 microdrops/mL

   Time: ________ h

   Flow rate: ________ gtt/min

Calculate the completion time for the following IVs.

6. At 1600 hours the nurse started an IV of 1,200 mL D_5W at 27 gtt/min. The infusion set used is calibrated for a drop factor of 15 gtt/mL.

   Infusion time: ________ h

   Completion time: ________

7. At 1530 hours the nurse starts 2,000 mL of D_5W to run at 125 mL/h. The infusion set used is calibrated for a drop factor of 10 gtt/mL.

   Infusion time: ________ h

   Completion time: ________

Calculate the total volume (mL) to be infused per 24 hours.

8. An IV of D_5 Lactated Ringer's is infusing on an electronic infusion pump at 125 mL/h.

   Total volume: ________ mL/24 h

9. An IV is flowing at 12 gtt/min and the infusion set has a drop factor of 15 gtt/mL.

   Total volume: ________ mL/24 h

10. An IV of D_5W is flowing at 21 gtt/min and has a drop factor of 10 gtt/mL.

    Total volume: ________ mL/24 h

Calculate IV volume for the following IV orders.

11. Order: 0.9% sodium chloride IV infusing at 65 mL/h for 4 h

    Volume: ________ mL

12. Order: D_5W IV infusing at 150 mL/h for 2 h

    Volume: ________ mL

13. Order: D_5LR IV at 75 mL/h for 8 h

    Volume: ________ mL

14. Order: **D_5 0.225% NaCl IV at 40 gtt/min for 8 h**

    Drop factor: 60 gtt/mL

    Infusion time: __________ min

    Volume: __________ mL

15. Order: **0.45% NaCl IV at 45 gtt/min for 4 h**

    Drop factor: 20 gtt/mL

    Infusion time: __________ min

    Volume: __________ mL

After completing these problems, see pages 523-524 to check your answers.

CRITICAL THINKING SKILLS

It is important to know the equipment you are using. Let's look at an example in which the nurse was unfamiliar with the IV PB setup.

ERROR

Failing to follow manufacturer's directions when using a new IV PB system.

Possible Scenario

Suppose the physician ordered **Rocephin 1 g IV q.12h** for an elderly patient with streptococcus pneumonia. The medication was sent to the unit by pharmacy utilizing the ADD-Vantage system. Rocephin 1 gram was supplied in a powder form and attached to a 50 mL IV bag of D_5W. The directions for preparing the medication were attached to the label. The nurse, assigned to the day shift, who was unfamiliar with the new ADD-Vantage system, hung the IV medication, calculated the drip rate, and infused the 50 mL of fluid. The nurse cared for the patient for three days. During walking rounds on the third day, the oncoming nurse noticed that the Rocephin powder remained in the vial and never was diluted in the IV bag. The nurse realized that the vial stopper inside of the IV bag was not open. Therefore, the medication powder was not mixed in the IV fluid during this shift for the past three days.

Potential Outcome

The omission by the nurse resulted in the patient missing three doses of the ordered IV antibiotic. The delay in the medication administration could have serious consequences for the patient, such as worsening of the pneumonia, septicemia, and even death, especially in the elderly. The patient received only one-half of the daily dose ordered by the physician for three days. The physician would be notified of the error and likely order additional diagnostic studies, such as chest X-ray, blood cultures, and an additional one-time dose of Rocephin.

Prevention

This error could easily have been avoided had the nurse read the directions for preparing the medication or consulted with another nurse who was familiar with the system.

PRACTICE PROBLEMS—CHAPTER 14

Compute the flow rate in drops per minute or milliliters per hour as requested. For these situations, hospital policy permits recalculating IVs when off-schedule with a maximum variation in rate of 25 percent.

1. Order: **Ampicillin 500 mg dissolved in 200 mL D_5W IV to run for 2 h**

   Drop factor: 10 gtt/mL

   Flow rate: ________ gtt/min

2. Order: **D_5W 1,000 mL IV per 24h**

   Drop factor: 60 gtt/mL

   Flow rate: ________ gtt/min

3. Order: **D_5LR 1,500 mL IV to run for 12 h**

   Drop factor: 20 gtt/mL

   Flow rate: ________ gtt/min

4. Order: **D_5RL 200 mL IV for 24 h**

   Drop factor: 60 gtt/mL

   Flow rate: ________ gtt/min

5. Order: **$D_{10}W$ 1 L IV to run from 1000 to 1800**

   Drop factor: On electronic infusion pump

   Flow rate: ________ mL/h

6. See question 5. At 1100 there are 800 mL remaining. Describe your nursing action now. ________

   ____

7. Order: **NS 1,000 mL followed by D_5W 2,000 mL IV to run for 24 h**

   Drop factor: 15 gtt/mL

   Flow rate: ________ gtt/min

8. Order: **NS 2.5 L IV to infuse at 125 mL/h**

   Drop factor: 20 gtt/mL

   Flow rate: ________ gtt/min

9. Order: **D_5W 1,000 mL IV for 6 h**

   Drop factor: 15 gtt/mL

   After 2 hours, 800 mL remain. Describe your nursing action now. ________

   ____

The IV tubing package in the accompanying figure is the IV system available in your hospital for manually regulated, straight gravity flow IV administration with macrodrop. The patient has an order for **D_5W 500 mL IV q.4h** written at 1515, and you start the IV at 1530. Questions 10 through 20 refer to this situation.

LATEX-FREE

No. 4967

PRIMARY I.V. SET,

Convertible Pin, 80 Inch

with Backcheck Valve

and 2 Injection Sites

Piggyback

15 DROPS/mL

Abbott Laboratories, Inc.

10. How much IV fluid will the patient receive in 24 hours? ________ mL

11. Who is the manufacturer of the IV infusion set tubing? ________

12. What is the drop factor calibration for the IV infusion set tubing? ________

13. What is the drop factor constant for the IV infusion set tubing? ________

14. Using the shortcut (drop factor constant) method, calculate the flow rate of the IV as ordered. Show your work.

    Shortcut method calculation: ____

    Flow rate: ________ gtt/min

15. Using the formula method, calculate the flow rate of the IV as ordered. Show your work.

    Formula method calculation: ____

    Flow rate: ________ gtt/min

16. At what time should you anticipate the first IV bag of 500 mL D_5W will be completely infused? ________

17. How much IV fluid should be infused by 1730? ________ mL

18. At 1730 you notice that the IV has 210 mL remaining. After assessing your patient and confirming that his or her condition is stable, what should you do? ________________________

    ____

19. After consulting the physician, you decide to use an electronic controller to better regulate the flow rate. The physician orders that the controller be set to infuse 500 mL every 4 hours. You should set the controller for ________ mL/h

20. The next day the physician adds the order **Amoxicillin 250 mg in 50 mL D_5W IV PB to infuse in 30 min q.i.d.** The patient is still on the IV controller. To infuse the IV PB, set the controller for ________ mL/h

21. List the components and concentration strengths of the fluid IV $D_{2.5}\frac{1}{2}$ NS.

    ____

22. Calculate the amount of dextrose and sodium chloride in D_5NS 500 mL.

    dextrose ________ g

    NaCl ________ g

23. Define a central line. ____

24. Define a primary line. ____

25. Describe the purpose of a saline or heparin lock. ____

26. A safe IV push infusion rate of protamine sulfate is 5 mg/min. What is a safe infusion time to administer 50 mg? ________ min

    Protamine sulfate is available in a supply dosage of 10 mg/mL. To administer 50 mg IV push, prepare ________ mL and inject slowly IV at the rate of ________ mL/min or ________ mL per 15 sec.

27. Describe the purpose of the PCA pump. ____

28. Identify two advantages of the syringe pump. ____

29. List two complications of IV sites. ____

30. How often should the IV site be monitored? ____

31. Describe the purpose of the Y-set IV system. ____

For each IV order in questions 32 through 47, use the drop factor to calculate the flow rate in gtt/min.

Order: Hyperalimentation solution 1 L IV to infuse in 12 h

32. Drop factor 10 gtt/mL Flow rate: ________ gtt/min

33. Drop factor 15 gtt/mL Flow rate: ________ gtt/min

34. Drop factor 20 gtt/mL Flow rate: ________ gtt/min

35. Drop factor 60 gtt/mL Flow rate: ________ gtt/min

Order: D_5NS 2 L IV to infuse in 20 h

36. Drop factor 10 gtt/mL Flow rate: ________ gtt/min

37. Drop factor 15 gtt/mL Flow rate: ________ gtt/min

38. Drop factor 20 gtt/mL Flow rate: ________ gtt/min

39. Drop factor 60 gtt/mL Flow rate: ________ gtt/min

Order: 0.45% NaCl 1,000 mL IV at 200 mL/h

40. Drop factor 10 gtt/mL Flow rate: ________ gtt/min

41. Drop factor 15 gtt/mL Flow rate: ________ gtt/min

42. Drop factor 20 gtt/mL Flow rate: ________ gtt/min

43. Drop factor 60 gtt/mL Flow rate: ________ gtt/min

Order: **D_5 0.9% NaCl 540 mL IV at 45 mL/h**

44. Drop factor 10 gtt/mL Flow rate: ______ gtt/min

45. Drop factor 15 gtt/mL Flow rate: ______ gtt/min

46. Drop factor 20 gtt/mL Flow rate: ______ gtt/min

47. Drop factor 60 gtt/mL Flow rate: ______ gtt/min

48. You make rounds before your lunch break and find that a patient has 150 mL of IV fluid remaining. The flow rate is 25 gtt/min. The drop factor is 10 gtt/mL. What volume will be infused during the hour that you are at lunch? ______ mL
What should you alert your relief nurse to watch for while you are off the unit? ______

______

49. Your shift is 0700–1500. You make rounds at 0730 and find an IV of D_5 0.45% NaCl is regulated on an electronic infusion pump at the ordered rate of 75 mL/h with 400 mL remaining. The order specifies a continuous infusion. At what time should you anticipate hanging the next IV bag?
______

50. Describe the strategy you would implement to prevent this medication error.

Possible Scenario
Suppose the physician ordered **D_5LR 1,000 mL IV at 125 mL/h** for an elderly patient just returning from the OR following abdominal surgery. The nurse gathered the IV solution and IV tubing, which had a drop factor of 20 gtt/mL. The nurse did not check the package for the drop factor and assumed it was 60 gtt/mL. The manual rate was calculated this way:

$$\frac{125\ \cancel{\text{mL}}}{\cancel{60}\ \text{min}} \times \cancel{60}\ \text{gtt}/\cancel{\text{mL}} = 125\ \text{gtt/min}$$

The nurse infused the D_5LR at 125 gtt/min for 8 hours. During shift report, the patient called for the nurse, complaining of shortness of breath. On further assessment the nurse heard crackles in the patient's lungs and noticed that the patient's third 1,000 mL bottle of D_5LR this shift was nearly empty already. At this point the nurse realized the IV rate was in error. The nurse was accustomed to using the 60 gtt/mL IV set up and therefore calculated the drip rate using the 60 gtt/mL (microdrop) drop factor. However, the tubing used delivered 20 gtt/mL (macrodrop) drop factor. The nurse never looked at the drop factor on the IV set package and assumed it was a 60 gtt/mL set.

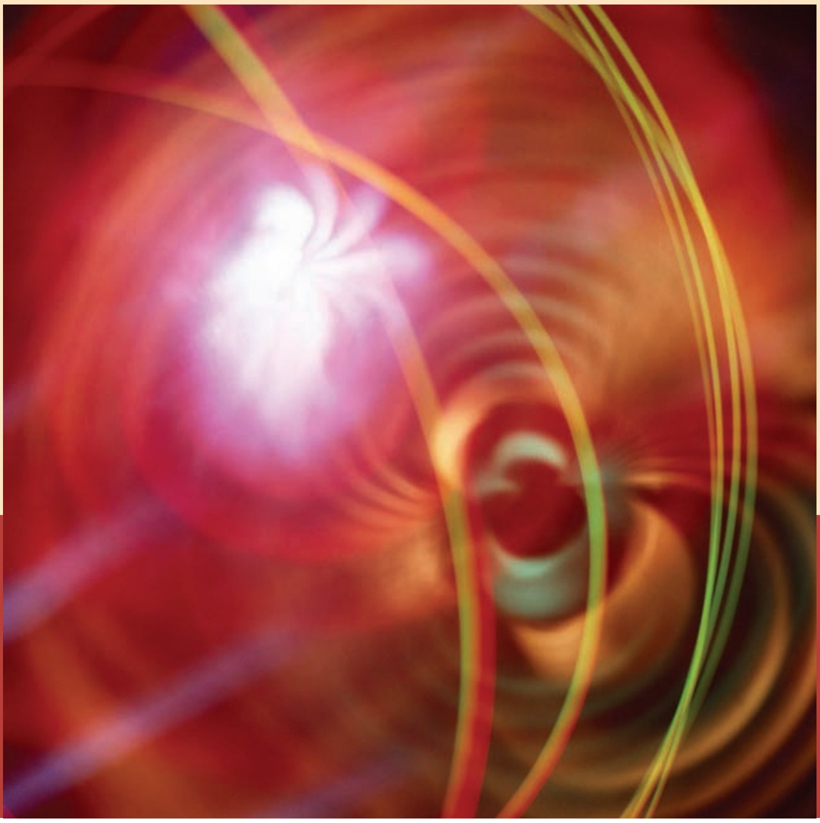
Potential Outcome
The patient developed signs of fluid overload and could have developed congestive heart failure due to the excessive IV rate. The physician would have been notified and likely ordered Lasix (a diuretic) to help eliminate the excess fluid. The patient likely would have been transferred to the ICU for closer monitoring.

Prevention

______

______

Upon completion of these problems, see pages 524-526 to check your answers.



15

Body Surface Area and Advanced Pediatric Calculations

OBJECTIVES

Upon mastery of Chapter 15, you will be able to perform advanced calculations for children and apply these advanced concepts across the life span. To accomplish this you will also be able to:

- Determine the body surface area (BSA) using a calculation formula or a nomogram scale.
- Compute the safe amount of drug to be administered when ordered according to the BSA.
- Calculate intermittent intravenous (IV) medications administered with IV infusion control sets.
- Calculate the amount to mix proportionate IV additive medications into small volume IV solutions.
- Calculate the minimal and maximal dilution in which an IV medication can be safely prepared and delivered, such as via a syringe pump.
- Calculate pediatric IV maintenance fluids.

This chapter will focus on additional and more advanced calculations used frequently by pediatric nurses. It will help you understand the unique drug and fluid management required by a growing child. Further, these concepts, which are most commonly related to children, are also applied to adults in special situations. Let's start by looking at the BSA method of calculating a dosage and checking for accuracy and safety of a particular drug order.

BODY SURFACE AREA METHOD

The BSA is an important measure in calculating dosages for infants and children. BSA is also used for selected adult populations, such as those undergoing open-heart surgery or radiation therapy, severe burn victims, and those with renal disease. Regardless of age, antineoplastic agents (chemotherapy drugs) and an increasing number of other highly potent drug classifications are being prescribed based on BSA.

BSA is a mathematical estimate using the patient's *height* and *weight*. BSA is expressed in square meters (**m²**). BSA can be determined by formula calculation or by using a chart, referred to as a *nomogram*, that estimates the BSA. Because drug dosages recommended by BSA measurement are potent, and because the formula calculation is the most accurate, we will begin with the formulas. In most situations, the prescribing practitioner will compute the BSA for drugs ordered by this method. However, the nurse who administers the drug is responsible for verifying safe dosage, which may require calculating the BSA.

BSA Formula

One BSA formula is based on metric measurement of height in centimeters and weight in kilograms. The other is based on household measurement of height in inches and weight in pounds. Either is easy to compute using the square root function on a calculator.

RULE

To calculate BSA in m² based on metric measurement of height and weight:

- $\text{BSA (m}^2\text{)} = \sqrt{\dfrac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}}$

To calculate BSA in m² based on household measurement of height and weight:

- $\text{BSA (m}^2\text{)} = \sqrt{\dfrac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}}$

Let's apply both formulas, and see how the BSA measurements compare.

MATH TIP

Notice that in addition to metric versus household measurement, the other difference between the two BSA formulas is in the denominators of the fraction within the square root sign.

EXAMPLE 1 ■

Use the metric formula to calculate the BSA of an infant whose length is 50 cm (20 in) and weight is 3.2 kg (7 lb).

$$\text{BSA (m}^2\text{)} = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} = \sqrt{\frac{50 \times 3.2}{3{,}600}} = \sqrt{\frac{160}{3{,}600}} = \sqrt{0.044\ldots} = 0.210\ldots = 0.21 \text{ m}^2$$

MATH TIP

To perform BSA calculations using the metric formula on most calculators, follow this sequence: multiply height in cm by weight in kg, divide by 3600, press =, then press $\sqrt{}$ to arrive at m². Round m² to hundredths (two decimal places). For Example 1, enter 50 × 3.2 ÷ 3600 = 0.044..., and press $\sqrt{}$ to arrive at 0.210..., rounded to 0.21 m².

Or use the BSA formula based on household measurement.

$$\text{BSA (m}^2\text{)} = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} = \sqrt{\frac{20 \times 7}{3{,}131}} = \sqrt{\frac{140}{3{,}131}} = \sqrt{0.044\ldots} = 0.211\ldots = 0.21 \text{ m}^2$$

MATH TIP

To use the calculator, follow this sequence: multiply height in inches by weight in pounds, divide by 3131, press =, then press $\sqrt{\ }$ to arrive at the m^2. Round m^2 to hundredths (two decimal places). For Example 1, enter 20 × 7 ÷ 3131 = 0.044..., and press $\sqrt{\ }$ to arrive at 0.211..., rounded to 0.21 m^2.

EXAMPLE 2 ■

Calculate the BSA of a child whose height is 105 cm (42 inches) and weight is 31.8 kg (70 lb).

Metric:

$$\text{BSA (m}^2\text{)} = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} = \sqrt{\frac{105 \times 31.8}{3{,}600}} = \sqrt{\frac{3{,}339}{3{,}600}} = \sqrt{0.927} = 0.963 \text{ m}^2 = 0.96 \text{ m}^2$$

Household:

$$\text{BSA (m}^2\text{)} = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} = \sqrt{\frac{42 \times 70}{3{,}131}} = \sqrt{\frac{2{,}940}{3{,}131}} = \sqrt{0.938} = 0.969 \text{ m}^2 = 0.97 \text{ m}^2$$

MATH TIP

There is a slight variation in m^2 calculated by the metric and household methods because of the rounding used to convert centimeters and inches; 1 in = 2.54 cm, which is rounded to 2.5 cm. The results of the two methods are approximate equivalents.

EXAMPLE 3 ■

Calculate the BSA of an adult whose height is 173 cm (69 inches) and weight is 88.6 kg (195 lb).

Metric:

$$\text{BSA (m}^2\text{)} = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} = \sqrt{\frac{173 \times 88.8}{3{,}600}} = \sqrt{\frac{15{,}362.4}{3{,}600}} = \sqrt{4.267\ldots} = 2.07 \text{ m}^2$$

Household:

$$\text{BSA (m}^2\text{)} = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} = \sqrt{\frac{69 \times 195}{3{,}131}} = \sqrt{\frac{13{,}455}{3{,}131}} = \sqrt{4.297} = 2.07 \text{ m}^2$$

These examples show that either metric or household measurements of height and weight result in essentially the same calculated BSA value.

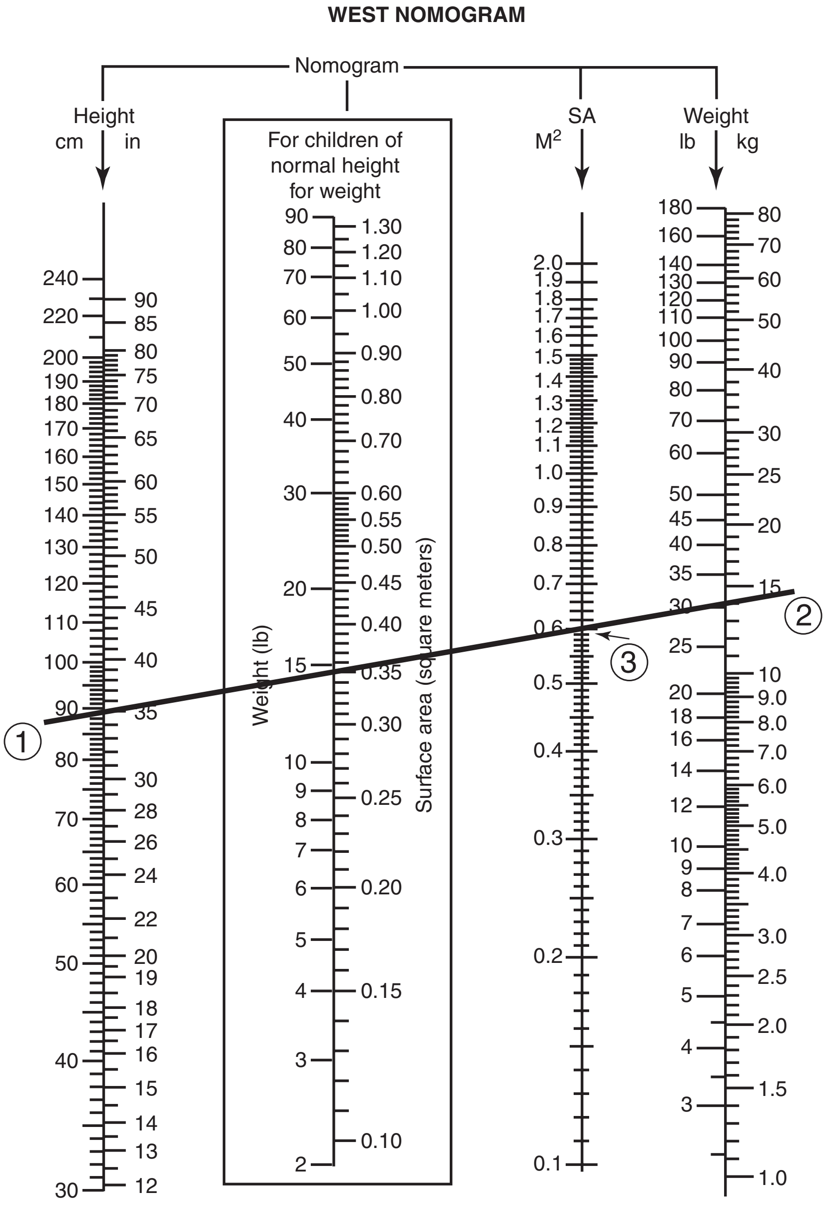
BSA Nomogram

Some practitioners use a chart called a *nomogram* that *estimates* the BSA by plotting the height and weight and simply connecting the dots with a straight line. Figure 15-1 shows the most well-known BSA chart, the West Nomogram. It is used for both children and adults for heights up to 240 cm (95 inches) and weights up to 80 kg (180 lb).

CAUTION

Notice that the increments of measurement and the spaces on the BSA nomogram are not consistent. Be sure you correctly read the numbers and the calibration values between them.

FIGURE 15-1 Body surface area (BSA) is determined by drawing a straight line from the patient's height (1) in the far left column to his or her weight (2) in the far right column. Intersection of the line with surface area (SA) column (3) is the estimated BSA (m^2). For infants and children of normal height and weight, BSA may be estimated from weight alone by referring to the enclosed area. (From *Nelson Textbook of Pediatrics* (17th ed) by R. E. Behrman, R. M. Kliegman, & H. B. Jenson, 2004, Philadelphia: Saunders. Reprinted with permission.)



For a child of normal height and weight, the BSA can be determined on the West Nomogram using the weight alone. Notice the enclosed column to the center left. Normal height and weight standards can be found on pediatric growth and development charts.

CAUTION

To use the normal column on the West Nomogram, you must be familiar with normal height and weight standards for children. If you are unsure, use both height and weight to estimate BSA. Do not guess.

QUICK REVIEW

- BSA is used to calculate select dosages across the life span, most often for children.
- BSA is calculated by height and weight and expressed in m^2.
- The following metric and household formulas are the preferred methods of calculating BSA:

  Metric: $\text{BSA } (m^2) = \sqrt{\dfrac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}}$

  Household: $\text{BSA } (m^2) = \sqrt{\dfrac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}}$

- Nomograms can be used to estimate BSA, by correlating height and weight measures to m^2.

Review Set 41

Use the formula method to determine the BSA. Round to 2 decimal places.

1. A child measures 36 inches tall and weighs 40 lb. __________ m^2
2. An adult measures 190 cm tall and weighs 105 kg. __________ m^2
3. A child measures 94 cm tall and weighs 18 kg. __________ m^2
4. A teenager measures 153 cm tall and weighs 46 kg. __________ m^2
5. An adult measures 175 cm tall and weighs 85 kg. __________ m^2
6. A child measures 41 inches tall and weighs 76 lb. __________ m^2
7. An adult measures 62 inches tall and weighs 140 lb. __________ m^2
8. A child measures 28 inches tall and weighs 18 lb. __________ m^2
9. A teenager measures 160 cm tall and weighs 64 kg. __________ m^2
10. A child measures 65 cm tall and weighs 15 kg. __________ m^2
11. A child measures 55 inches tall and weighs 70 lb. __________ m^2
12. A child measures 92 cm tall and weighs 24 kg. __________ m^2

Find the BSA on the West Nomogram (Figure 15-1) for a child of normal height and weight.

13. 4 lb __________ m^2 14. 42 lb __________ m^2 15. 17 lb __________ m^2

Find the BSA on the West Nomogram (Figure 15-1) for children with the following height and weight.

16. 41 inches and 32 lb __________ m^2
17. 21 inches and 8 lb __________ m^2
18. 140 cm and 30 kg __________ m^2
19. 80 cm and 11 kg __________ m^2
20. 106 cm and 25 kg __________ m^2

After completing these problems, see page 526 to check your answers.

BSA Dosage Calculations

Once the BSA is obtained, the drug dosage can be verified by consulting a reputable drug resource for the recommended dosage. Package inserts, the *Hospital Formulary*, or other dosage handbooks contain pediatric and adults dosages. Remember to carefully read the reference to verify if the drug dosage is calculated in m^2 *per dose* or m^2 *per day.*

RULE

To verify safe pediatric dosage based on BSA:

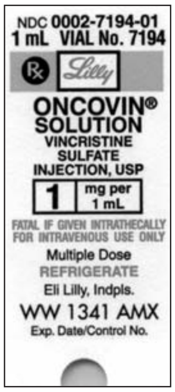
1. Determine BSA in m^2.
2. Calculate the safe dosage based on **BSA: $mg/m^2 \times m^2 = X$ mg**
3. Compare the ordered dosage to the recommended dosage, and decide if the dosage is safe.
4. If the dosage is safe, calculate the amount to give and administer the dose. If the dosage seems unsafe, consult with the ordering practitioner before administering the drug.

Note: Recommended dosage may specify mg/m^2, mcg/m^2, g/m^2, units/m^2, milliunits/m^2, or mEq/m^2.

EXAMPLE 1 ■

A child is 126 cm tall and weighs 23 kg. The drug order reads: **Oncovin 1.8 mg IV at 10 AM.** Is this dosage safe for this child? The recommended dosage as noted on the package insert is 2 mg/m^2. Supply: See label, Figure 15-2.

FIGURE 15-2 Oncovin label



1. **Determine BSA.** The child's BSA is 0.9 m^2 (using the metric BSA formula).

$$\text{BSA (m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} = \sqrt{\frac{126 \times 23}{3{,}600}} = \sqrt{\frac{2{,}898}{3{,}600}} = \sqrt{0.805} = 0.897 \text{ m}^2 = 0.9 \text{ m}^2$$

2. **Calculate recommended dosage.** $\text{mg/m}^2 \times \text{m}^2 = 2 \text{ mg/}\cancel{\text{m}^2} \times 0.9 \cancel{\text{m}^2} = 1.8 \text{ mg}$

3. **Decide if the dosage is safe.** The dosage ordered is 1.8 mg and 1.8 mg is the amount recommended by BSA. The dosage is safe. How much should you give?

4. **Calculate one dose.**

Step 1 Convert No conversion is necessary.

Step 2 Think You want to give more than 1 mL and less than 2 mL.

Step 3 Calculate
$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{1 \text{ mg}}{1 \text{ mL}} \times \frac{1.8 \text{ mg}}{\text{X mL}}$$

$$\text{X} = 1.8 \text{ mL}$$

EXAMPLE 2 ■

A 2-year-old child with herpes simplex is 35 inches tall and weighs 30 lb. The drug order reads **acyclovir 100 mg IV b.i.d.** Is this order safe? The drug reference recommends 250 mg/m^2 q.8h for children less than 12 years and more than 6 months. Acyclovir is supplied as Zovirax 500 mg injection with directions to reconstitute with 10 mL sterile water for injection for a concentration of 50 mg/mL.

1. **Determine BSA.** The child's BSA is 0.6 m^2 (using the West Nomogram, Figure 15-1).
2. **Calculate recommended dosage.** $\text{mg/m}^2 \times \text{m}^2 = 250\ \text{mg/}\cancel{\text{m}^2} \times 0.6\ \cancel{\text{m}^2} = 150\ \text{mg}$
3. **Decide if the dosage is safe.** The dosage of 100 mg b.i.d. is not safe—the single dosage is too low. Further, the drug should be administered 3 times per day q.8h, not b.i.d. or 2 times per day.
4. **Confer with the prescriber.**

QUICK REVIEW

Safe dosage based on BSA: $\text{mg/m}^2 \times \text{m}^2$, compared to recommended dosage.

Review Set 42

1. What is the dosage of one dose of interferon alpha-2b required for a child with a BSA of 0.82 m^2 if the recommended dosage is 2 million units/m^2? __________ units
2. What is the total daily dosage range of mitomycin required for a child with a BSA of 0.59 m^2 if the recommended dosage range is 10 to 20 mg/m^2/day? __________ mg/day to __________ mg/day
3. What is the dosage of calcium EDTA required for an adult with a BSA of 1.47 m^2 if the recommended dosage is 500 mg/m^2? __________ mg
4. What is the total daily dosage of Thioplex required for a adult with a BSA of 2.64 m^2 if the recommended dosage is 6 mg/m^2/day? __________ mg. After 4 full days of therapy, this patient will have received a total of __________ mg of Thioplex.
5. What is the dosage of acyclovir required for a child with a BSA of 1 m^2, if the recommended dosage is 250 mg/m^2? __________ mg
6. Child is 30 inches tall and weighs 25 pounds.

   Order: **Zovirax 122.5 mg IV q.8h**

   Supply: Zovirax 500 mg with directions to reconstitute with 10 mL sterile water for injection for a final concentration of 50 mg/mL.

   Recommended dosage from drug insert: 250 mg/m^2

   BSA = __________ m^2

   Recommended dosage for this child: __________ mg

   Is the ordered dosage safe? __________

   If safe, give __________ mL

   If not safe, what should you do? ____

7. Child is 45 inches tall and weighs 55 pounds.

   Order: **methotrexate 2.9 mg IV daily**

Supply: methotrexate 2.5 mg/mL

Recommended dosage from drug insert: 3.3 mg/m^2

BSA = ________ m^2

Recommended dosage for this child: ________ mg

Is the ordered dosage safe? ________

If safe, give ________ mL

If not safe, what should you do? ____

8. Order: **Benoject 22 mg IV q.8h.** Child has BSA of 0.44 m^2. Recommended safe dosage of Benoject is 150 mg/m^2/day in divided dosages every 6 to 8 hours.

   Recommended daily dosage for this child: ________ mg/day

   Recommended single dosage for this child: ________ mg/dose

   Is the ordered dosage safe? ________

   If not safe, what should you do? ____

9. Order: **quinidine 198 mg p.o. daily for 5 days.** Child has BSA of 0.22 m^2. Recommended safe dosage of quinidine is 900 mg/m^2/day given in 5 daily doses.

   Recommended dosage for this child: ________ mg/dose

   Is the dosage ordered safe? ________

   If not safe, what should you do? ____

   How much quinidine would this child receive over 5 days of therapy? ________ mg

10. Order: **deferoxamine mesylate IV per protocol.** Child has BSA of 1.02 m^2.

    Protocol: 600 mg/m^2 initially followed by 300 mg/m^2 at 4-hour intervals for 2 doses; then give 300 mg/m^2 q.12 h for 2 days. Calculate the total dosage received.

    Initial dosage: ________ mg

    Two q.4h dosages: ________ mg

    Two days of q.12h dosages: ________ mg

    Total dosage child would receive: ________ mg

11. Protocol: **Fludara 10 mg/m^2 bolus over 15 minutes followed by a continuous IV infusion of 30.5 mg/m^2/day.** Child has BSA of 0.81 m^2. The bolus dosage is ________ mg, and the continuous 24-hour IV infusion will contain ________ mg of Fludara.

12. Order: **Accutane 83.75 mg IV q.12h** for a child with a BSA of 0.67 m^2. The recommended dosage range is 100 to 250 mg/m^2/day in 2 divided doses.

    Recommended daily dosage range for this child: ________ mg/day to ________ mg/day

    Recommended single dosage range for this child: ________ mg/dose to ________ mg/dose

    Is the ordered dosage safe? ________

    If not, what should you do? ____

13. Order: **Cerubidine 9.6 mg IV on day 1 and day 8 of cycle.**

    Protocol: 25 to 45 mg/m^2 on days 1 and 8 of cycle. Child has BSA of 0.32 m^2.

    Recommended dosage range for this child: ________ mg/dose to ________ mg/dose

    Is the ordered dosage safe? ________

If not safe, what should you do? ____

Answer questions 14 and 15 based on the following information.

The recommended dosage of Oncaspar is 2,500 units/m^2/dose IV daily × 14 days for adults and children with a BSA > 0.6 m^2.

Supply: Oncaspar 750 units/mL with directions to dilute in 100 mL D_5W and give over 2 hours. You will administer the drug via infusion pump.

14. Order: **Give Oncaspar 2,050 units IV today at 1600.** Child is 100 cm tall and weighs 24 kg. The child's BSA is __________ m^2.

    The recommended dosage for this child is __________ units. Is the ordered dosage of Oncaspar safe? __________

    If yes, add __________ mL of Oncaspar for a total IV fluid volume of __________ mL. Set the IV infusion pump at __________ mL/h.

    If the order is not safe, what should you do? __________

15. Order: **Oncaspar 4,050 units IV stat** for an adult patient who is 162 cm tall and weighs 58.2 kg. The patient's BSA is __________ m^2. The recommended dosage of Oncaspar for this adult is __________ units.

    Is the ordered dosage of Oncaspar safe? __________

    If safe, you would add __________ mL of Oncaspar for a total IV fluid volume of __________ mL. Set the infusion pump at __________ mL/h.

    If the order is not safe, what should you do? ____________________________________

After completing these problems, see page 527 to check your answers.

PEDIATRIC VOLUME CONTROL SETS

Volume control sets, Figure 15-3, are most frequently used to administer hourly fluids and intermittent IV medications to children. The fluid chamber will hold 100 to 150 milliliters of fluid to be infused in a specified time period as ordered, usually 60 minutes or less. The medication is added to the IV fluid in the chamber for a prescribed dilution volume.

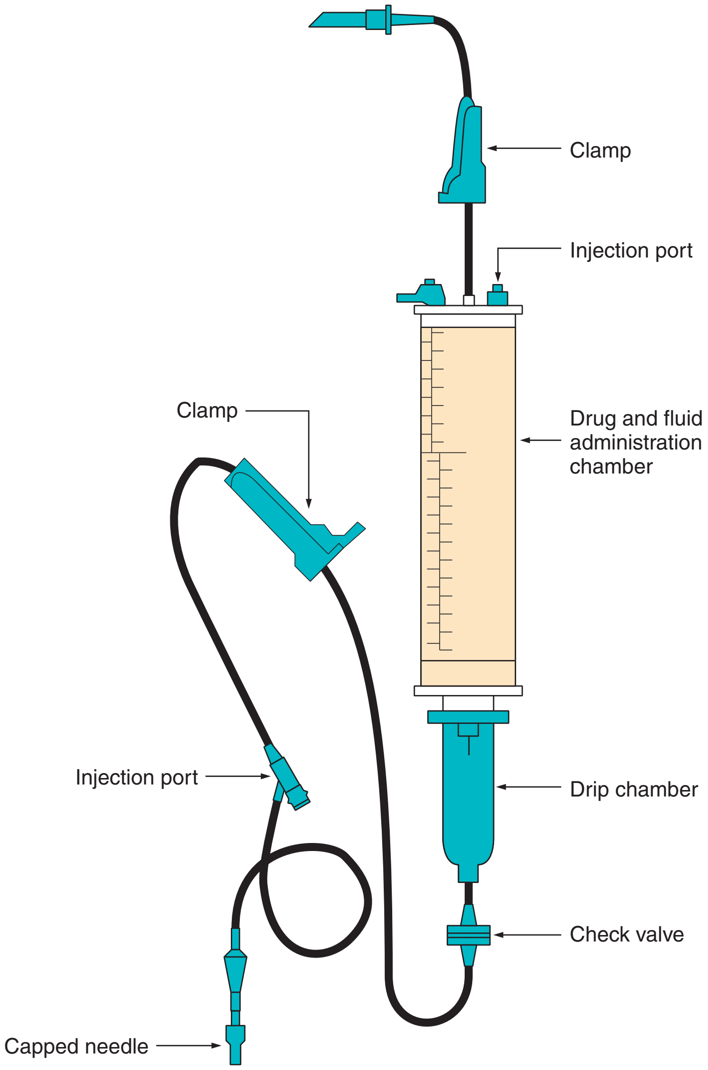
The volume of fluid in the chamber is filled by the nurse every 1 to 2 hours or as needed. Only small, ordered quantities of fluid are added, and the clamp above the chamber is fully closed. The IV bag acts only as a reservoir to hold future fluid infusions. The patient is protected from receiving more volume than intended. This is especially important for children, because they can tolerate only a narrow range of fluid volume. This differs from standard IV infusions that run directly from the IV bag through the drip chamber and IV tubing into the patient's vein.

Volume control sets may also be used to administer intermittent IV medications to adults with fluid restrictions, such as for heart or kidney disease. An electronic controller or pump may also be used to regulate the flow rate. When used, the electronic device will alarm when the chamber empties.

Intermittent IV Medication Infusion via Volume Control Set

Children receiving IV medications may have a saline or heparin lock in place of a continuous IV infusion. The nurse will inject the medication into the volume control set chamber, add an appropriate volume of IV fluid to dilute the drug, and attach the IV tubing to the child's IV lock to infuse over a specified period of time. After the chamber has emptied and the medication has infused, a flush of IV fluid is given to be sure all the medication has cleared the tubing. Realize that when the chamber empties, some medication still remains in the drip chamber, IV tubing, and the IV lock above the child's vein. There is no standard amount of fluid used to flush peripheral or central IV lines. Because tubing varies

FIGURE 15-3 Volume control set



by manufacturer, the flush can vary from 15 mL to as much as 50 mL, according to the overall length of the tubing and extra extensions added. Verify your hospital policy on the correct volume to flush peripheral and central IV lines in children. For the purpose of sample calculations, this text uses a 15 mL volume to flush a peripheral IV line, unless specified otherwise.

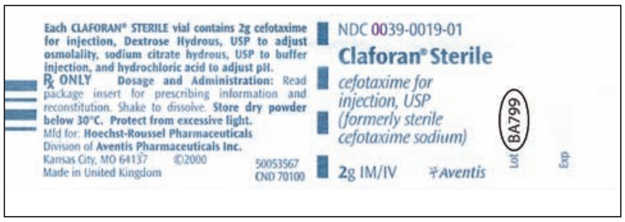
To calculate the IV flow rate for the volume control set, you must consider the total fluid volume of the medication, the IV fluid used for dilution, and the volume of IV flush fluid. Volume control sets are microdrip sets with a drop factor of 60 gtt/mL.

EXAMPLE ■

Order: Claforan 250 mg IV q.6h in 50 mL $D_5\frac{1}{4}$NS to infuse in 30 min followed by a 15 mL flush. Child has a saline lock.

Supply: See label

Instructions from package insert for IV use:
Add 10 mL diluent for a total volume of 11 mL with a concentration of 180 mg/mL.



Each CLAFORAN® STERILE vial contains 2g cefotaxime for injection, Dextrose Hydrous, USP to adjust osmolality, sodium citrate hydrous, USP to buffer injection, and hydrochloric acid to adjust pH.
℞ ONLY Dosage and Administration: Read package insert for prescribing information and reconstitution. Shake to dissolve. Store dry powder below 30°C. Protect from excessive light.
Mfd for: Hoechst-Roussel Pharmaceuticals
Division of Aventis Pharmaceuticals Inc.
Kansas City, MO 64137 ©2000
Made in United Kingdom
50053567
CND 70100

NDC 0039-0019-01
Claforan® Sterile
cefotaxime for injection, USP (formerly sterile cefotaxime sodium)
2g IM/IV
Aventis
Lot BA799
Exp

Step 1 Calculate the total volume of the intermittent IV medication and the IV flush.
50 mL + 15 mL = 65 mL

Step 2 Calculate the flow rate of the IV medication and the IV flush. Remember: The drop factor is 60 gtt/mL.

$$\frac{V}{T} \times C = \frac{65\ \cancel{\text{mL}}}{\underset{1}{\cancel{30}}\ \text{min}} \times \overset{2}{\cancel{60}}\ \text{gtt}/\cancel{\text{mL}} = 130\ \text{gtt/min}$$

Step 3 Calculate the volume of the medication to be administered.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{180\text{ mg}}{1\text{ mL}} \times \frac{250\text{ mg}}{\text{X mL}}$$

$$180\text{X} = 250$$

$$\frac{180\text{X}}{180} = \frac{250}{180}$$

$$\text{X} = 1.4\text{ mL}$$

Step 4 Add 1.4 mL Claforan 2 g to the chamber and fill with IV fluid to a volume of 50 mL. This provides the prescribed total volume of 50 mL in the chamber.

Step 5 Set the flow rate of the 50 mL of intermittent IV medication for 130 gtt/min. Follow with the 15 mL flush also set at 130 gtt/min. When complete, detach IV tubing, and follow saline lock policy.

The patient may also have an intermittent medication ordered as part of a continuous infusion at a prescribed IV volume per hour. In such cases the patient is to receive the same fluid volume each hour, regardless of the addition of intermittent medications. This means that the total prescribed fluid volume must include the intermittent IV medication volume.

EXAMPLE ■

Order: D_5NS IV at 30 mL/h for continuous infusion and gentamicin 30 mg IV q.8h over 30 min

Supply: See label, Figure 15-4

An infusion controller is in use with the volume control set.

FIGURE 15-4 Gentamicin label

Step 1 Calculate the dilution volume required to administer the gentamicin at the prescribed continuous flow rate of 30 mL/h.

Think If 30 mL infuses in 1 h, then $\frac{1}{2}$ of 30, or 15 mL, will infuse in $\frac{1}{2}$ h or 30 min.

Calculate Use ratio-proportion to verify your estimate.

$$\frac{30\text{ mL}}{60\text{ min}} \times \frac{\text{X mL}}{30\text{ min}}$$

$$60\text{X} = 900$$

$$\frac{60\text{X}}{60} = \frac{900}{60}$$

$$\text{X} = 15\text{ mL in 30 min}$$

Therefore, the IV fluid dilution volume required to administer 30 mg of gentamicin in 30 minutes is 15 mL to maintain the prescribed, continuous infusion rate of 30 mL/h.

Step 2 Determine the volume of gentamicin and IV fluid to add to the volume control chamber.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{40 \text{ mg}}{1 \text{ mL}} \times \frac{30 \text{ mg}}{\text{X mL}}$$

$$40\text{X} = 30$$

$$\frac{40\text{X}}{40} = \frac{30}{40}$$

$$\text{X} = 0.75 \text{ mL}$$

Add 0.75 mL gentamicin and fill the chamber with D_5NS to the total volume of 15 mL.

Step 3 Set the controller to 30 mL/h in order to deliver 15 mL of intermittent IV gentamicin solution in 30 minutes. Resume the regular IV, which will also flush out the tubing. The continuous flow rate will remain at 30 mL/h.

QUICK REVIEW

- Volume control sets have a drop factor of 60 gtt/mL.
- The total volume of the medication, IV dilution fluid, and the IV flush fluid must be considered to calculate flow rates when using volume control sets.
- Use ratio-proportion to calculate flow rates for intermittent medications when a continuous IV rate in mL/h is prescribed.

Review Set 43

Calculate the IV flow rate to administer the following IV medications by using a volume control set, and determine the amount of IV fluid and medication to be added to the chamber. The ordered time includes the flush volume.

1. Order: **Antibiotic X 60 mg IV q.8h in 50 mL D_5NS over 45 min. Flush with 15 mL.**

   Supply: Antibiotic X 60 mg per 2 mL

   Flow rate: __________ gtt/min

   Add __________ mL medication and __________ mL IV fluid to the chamber.

2. Order: **Medication Y 75 mg IV q.6h in 60 mL $D_5\frac{1}{4}$NS over 60 min. Flush with 15 mL.**

   Supply: Medication Y 75 mg per 3 mL

   Flow rate: __________ gtt/min

   Add __________ mL medication and __________ mL IV fluid to the chamber.

3. Order: **Antibiotic Z 15 mg IV b.i.d. in 25 mL 0.9% NaCl over 20 min. Flush with 15 mL.**

   Supply: Antibiotic Z 15 mg per 3 mL

   Flow rate: __________ gtt/min

   Add __________ mL medication and __________ mL IV fluid to the chamber.

4. Order: **Ancef 0.6 g IV q.12h in 50 mL D_5NS over 60 min on an infusion pump. Flush with 30 mL.**

   Supply: Ancef 1 g per 10 mL

   Flow rate: __________ mL/h

   Add __________ mL medication and __________ mL IV fluid to the chamber.

5. Order: **Cleocin 150 mg IV q.8h in 32 mL D_5NS over 60 min on an infusion pump. Flush with 28 mL.**

   Supply: Cleocin 150 mg/mL

   Flow rate: ________ mL/h

   Add ________ mL medication and ________ mL IV fluid to the chamber.

   Total IV Volume after 3 doses are given is ________ mL.

Calculate the amount of IV fluid to be added to the volume control chamber.

6. Order: **0.9% NaCl at 50 mL/h for continuous infusion with Ancef 250 mg IV q.8h to be infused over 30 min by volume control set.**

   Supply: Ancef 125 mg/mL

   Add ________ mL medication and ________ mL IV fluid to the chamber.

7. Order: **D_5W at 30 mL/h for continuous infusion with Medication × 60 mg q.6h to be infused over 20 min by volume control set.**

   Supply: Medication X 60 mg per 2 mL

   Add ________ mL medication and ________ mL IV fluid to the chamber.

8. Order: **D_5 0.225% NaCl IV at 85 mL/h with erythromycin 600 mg IV q.6h to be infused over 40 min by volume control set.**

   Supply: erythromycin 50 mg/mL

   Add ________ mL medication and ________ mL IV fluid to the chamber.

9. Order: **D_5NS IV at 66 mL/h with Fortaz 720 mg IV q.8h to be infused over 40 min by volume control set.**

   Supply: Fortaz 1 g per 10 mL

   Add ________ mL medication and ________ mL IV fluid to the chamber.

10. Order: **D_5 0.45% NaCl IV at 48 mL/h with Vibramycin 75 mg IV q.12h to be infused over 2 h by volume control set.**

    Supply: Vibramycin 100 mg per 10 mL

    Add ________ mL medication and ________ mL IV fluid to the chamber.

After completing these problems, see pages 527–528 to check your answers.

PREPARING PEDIATRIC IVs

The physician may order a medication such as potassium chloride (KCl) to be added to each liter of IV fluid for continuous infusion. The volume of the IV solution bag selected for children is usually smaller than that for adults, because the total volume required per 24 hours is less. Therefore, the amount of medication to be added must be adjusted proportionately to the total volume of the IV bag. Use ratio-proportion to determine the appropriate amount of medication to add to the prescribed dilution.

EXAMPLE ■

Order: $D_5 \frac{1}{2}$ NS IV $\bar{c}$ KCl 20 mEq per L to infuse at 30 mL/h

The child's length is 64 cm and weight is 7.2 kg.

1. Should you choose a 1 liter (1,000 mL) or 500 mL bag of IV fluid?

   $30\text{ mL}/\cancel{\text{h}} \times 24\ \cancel{\text{h}} = 720\text{ mL}$

   At the rate of 30 mL/h, the child would receive only 720 mL in 24 hours, so you should choose a 500 mL bag of $D_5 \frac{1}{2}$ NS rather than a 1 liter or 1,000 mL bag. Otherwise, the same 1,000 mL bag of IV fluid would be infusing for more than 24 hours, which is unsafe.

2. How many mEq of KCl should you add to the 500 mL bag?

Step 1 **Convert** 1 L = 1,000 mL

Step 2 **Think** 500 mL is $\frac{1}{2}$ of 1,000 mL, so you would need $\frac{1}{2}$ of the 20 mEq of KCl or 10 mEq.

Step 3 **Calculate**

$$\begin{aligned}\frac{20\text{ mEq}}{1{,}000\text{ mL}} &\times \frac{X\text{ mEq}}{500\text{ mL}}\\ 1{,}000X &= 10{,}000\\ \frac{1{,}000X}{1{,}000} &= \frac{10{,}000}{1{,}000}\\ X &= 10\text{ mEq}\end{aligned}$$

3. Potassium chloride is available in 2 mEq per mL. How much KCl should you add to the *500 mL* IV bag? Remember that you will add 10 mEq to 500 mL IV solution.

Step 1 **Convert** No conversions are needed.

Step 2 **Think** You want to give more than 1 mL. In fact, you want to give 5 times 1 mL or 5 mL.

Step 3 **Calculate**

$$\begin{aligned}\frac{\text{Dosage on hand}}{\text{Amount on hand}} &= \frac{\text{Dosage desired}}{X\text{ Amount desired}}\\ \frac{2\text{ mEq}}{1\text{ mL}} &\times \frac{10\text{ mEq}}{X\text{ mL}}\\ 2X &= 10\\ \frac{2X}{2} &= \frac{10}{2}\\ X &= 5\text{ mL}\end{aligned}$$

4. How many mEq of potassium chloride would the child receive per hour?

   Total IV volume: 500 mL + 5 mL = 505 mL

$$\begin{aligned}\frac{10\text{ mEq}}{505\text{ mL}} &\times \frac{X\text{ mEq}}{30\text{ mL}}\\ 505X &= 300\\ \frac{505\ X}{505} &= \frac{300}{505}\\ X &= 0.59\text{ mEq or }0.6\text{ mEq of KCl per hour}\end{aligned}$$

5. The recommended dosage for children is *up to* 3 mEq/kg/day or 40 mEq/m²/day. Based on the child's BSA, is the dosage ordered safe?

   First determine the amount of potassium chloride the child will receive per day.

   $0.6\text{ mEq}/\cancel{\text{h}} \times 24\ \cancel{\text{h}}/\text{day} = 14.4\text{ mEq/day}$

   Then determine the maximum allowed per day according to the child's weight.

   $3\text{ mEq}/\cancel{\text{kg}} \times 7.2\ \cancel{\text{kg}} = 21.6\text{ mEq}$; so the 14.4 mEq dosage is safe.

Then determine the child's BSA and how many mEq the child should receive as recommended.

$$\text{BSA (m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} = \sqrt{\frac{64 \times 7.2}{3{,}600}} = \sqrt{\frac{460.8}{3{,}600}} = \sqrt{0.128} = 0.357\ \text{m}^2 = 0.36\ \text{m}^2$$

$40\ \text{mEq}/\cancel{\text{m}^2}/\text{day} \times 0.36\ \cancel{\text{m}^2} = 14.4\ \text{mEq/day}$ is recommended and 14.4 mEq/day will be infused.

Yes, the dosage ordered is safe. Add 5 mL of KCl 2 mEq/mL to each 500 mL of IV fluid to infuse 0.6 mEq/h or 14.4 mEq/day.

QUICK REVIEW

To determine the drug dosage required to prepare a prescribed dilution:

- use ratio-proportion

Review Set 44

Use the following information to answer questions 1 through 7.

Order: $D_5W\frac{1}{2}$ NS IV $\bar{c}$ 20 mEq KCl per L to infuse at 15 mL/h

Supply: 250 mL and 500 mL bags of $D_5W\ \frac{1}{2}$ NS and KCl 2 mEq/mL

The infant is 18 in long and weighs 5 lb.

1. At the rate ordered, how many mL of IV fluid will this child receive per day? ________ mL/day
2. What volume IV solution bag (250 mL or 500 mL) should you select? ________ mL

   Explain. ____
3. How many mEq of KCl should be added to the 250 mL bag? ________ mEq
4. How many mL of KCl should be added to the 250 mL bag to fill the order? ________ mL
5. How many mEq of KCl would the infant receive per hour? ________ mEq/h
6. How many mEq of KCl would this infant receive per day? ________ mEq/day
7. The recommended dosage of KCl is up to 40 $\text{mEq/m}^2\text{/day}$.

   Child's BSA: ________ m^2

   Recommended maximum daily dosage for this infant: ________ mEq/day

   Is the ordered dosage safe? ________

   If not safe, what should you do? ________________________________

Calculate the amount of medication and the volume to administer for each of the following IV bags to achieve the ordered concentration. Supply: KCl 2 mEq/mL

8. Order: Add 10 mEq KCl per L of IV fluid

   Supply: 480 mL IV solution. Add: ________ mEq; ________ mL
9. Order: Add 30 mEq KCl per L of IV fluid

   Supply: 600 mL IV solution. Add: ________ mEq; ________ mL
10. Order: Add 15 mEq KCl per L of IV fluid

    Supply: 850 mL IV solution. Add: ________ mEq; ________ mL

After completing these problems, see pages 528-529 to check your answers.

MINIMAL DILUTIONS FOR IV MEDICATIONS

IV medications in infants and young children (or adults on limited fluids) are often ordered to be given in the smallest volume or *maximal safe concentration* to prevent fluid overload. Consult a pediatric reference, *Hospital Formulary*, or drug insert to assist you in problem solving. These types of medications are usually given via an electronic pump.

Many pediatric IV medications allow a dilution *range* or a minimum and maximum allowable concentration. A solution of *lower* concentration may be given if the patient can tolerate the added volume (called *minimal safe concentration, maximal dilution,* or *largest volume*). A solution of *higher* concentration (called *maximal safe concentration, minimal dilution,* or *smallest volume*) must not exceed the recommended dilution instructions. Recall that the greater the volume of diluent or solvent, the less concentrated the resulting solution. Likewise, less volume of diluent or solvent results in a more concentrated solution.

CAUTION

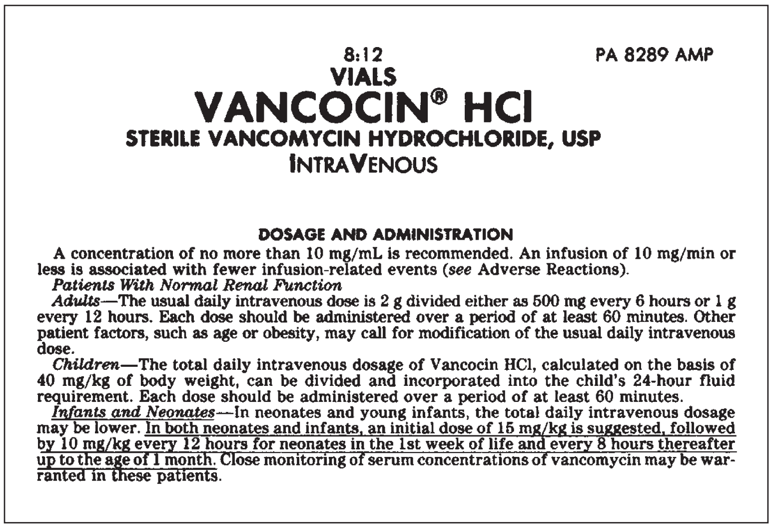
An excessively high concentration of an IV drug can cause vein irritation and potentially life-threatening toxic effects. Dilution calculations are critical skills.

Let's examine how to follow the drug reference recommendations for a minimal IV drug dilution, when a minimal and maximal range is given for an IV drug dilution.

RULE

Ratio for recommended drug dilution equals ratio for desired drug dilution.

FIGURE 15-5 Portion of Vancocin package insert



8:12 PA 8289 AMP
VIALS
VANCOCIN® HCl
STERILE VANCOMYCIN HYDROCHLORIDE, USP
INTRAVENOUS

DOSAGE AND ADMINISTRATION

A concentration of no more than 10 mg/mL is recommended. An infusion of 10 mg/min or less is associated with fewer infusion-related events (*see* Adverse Reactions).

Patients With Normal Renal Function

Adults—The usual daily intravenous dose is 2 g divided either as 500 mg every 6 hours or 1 g every 12 hours. Each dose should be administered over a period of at least 60 minutes. Other patient factors, such as age or obesity, may call for modification of the usual daily intravenous dose.

Children—The total daily intravenous dosage of Vancocin HCl, calculated on the basis of 40 mg/kg of body weight, can be divided and incorporated into the child's 24-hour fluid requirement. Each dose should be administered over a period of at least 60 minutes.

Infants and Neonates—In neonates and young infants, the total daily intravenous dosage may be lower. In both neonates and infants, an initial dose of 15 mg/kg is suggested, followed by 10 mg/kg every 12 hours for neonates in the 1st week of life and every 8 hours thereafter up to the age of 1 month. Close monitoring of serum concentrations of vancomycin may be warranted in these patients.

EXAMPLE 1 ■

The physician orders **Vancocin 40 mg IV q.12h** for an infant who weighs 4,000 g. What is the minimal amount of IV fluid in which the Vancocin can be safely diluted? The package insert is provided for your reference (Figure 15-5). It states that a *concentration of no more than 10 mg/mL is recommended.* This is the *maximal safe concentration*.

$$\frac{10 \text{ mg}}{1 \text{ mL}} \times \frac{40 \text{ mg}}{X \text{ mL}}$$

$$\begin{aligned} 10X &= 40 \\ \frac{10X}{10} &= \frac{40}{10} \\ X &= 4 \text{ mL (This is the minimal amount of IV fluid.)} \end{aligned}$$

EXAMPLE 2 ■

The physician orders **Claforan 1.2 g IV q.8h** for a child who weighs 36 kg. The recommended safe administration of Claforan for intermittent IV administration is a final concentration of 20 to 60 mg/mL to infuse over 15 to 30 minutes. What is the minimal amount of IV fluid to safely dilute this dosage? (Remember this represents the **maximal safe concentration.**)

Step 1 **Convert** 1.2 g = 1,200 mg

Step 2 **Think** 1,200 is more than 10 times 60, in fact it is 20 times 60. So you need at least 20 mL to dilute the drug.

Step 3 **Calculate**

$$\frac{60 \text{ mg}}{1 \text{ mL}} \times \frac{1{,}200 \text{ mg}}{X \text{ mL}}$$

$$\begin{aligned} 60X &= 1{,}200 \\ \frac{60X}{60} &= \frac{1{,}200}{60} \\ X &= 20 \text{ mL (minimal dilution for maximal safe concentration)} \end{aligned}$$

What is the maximal amount of IV fluid recommended to safely dilute this drug to the minimal safe concentration?

Step 1 **Convert** 1.2 g = 1,200 mg

Step 2 **Think** 1,200 is more than 50 times 20; in fact, it is 60 times 20. So you can use up to 60 mL to dilute the drug.

Step 3 **Calculate**

$$\frac{20 \text{ mg}}{1 \text{ mL}} \times \frac{1{,}200 \text{ mg}}{X \text{ mL}}$$

$$\begin{aligned} 20X &= 1{,}200 \\ \frac{20X}{20} &= \frac{1{,}200}{20} \\ X &= 60 \text{ mL (maximal dilution for minimal safe concentration)} \end{aligned}$$

CALCULATION OF DAILY VOLUME FOR MAINTENANCE FLUIDS

Another common pediatric IV calculation is to calculate 24-hour maintenance IV fluids for children.

RULE

Use this formula to calculate the daily rate of pediatric maintenance IV fluids:

- 100 mL/kg/day for first 10 kg of body weight
- 50 mL/kg/day for next 10 kg of body weight
- 20 mL/kg/day for each kg above 20 kg of body weight

This formula uses the child's weight in kilograms to estimate the 24-hour total fluid need, including oral intake. It does not include replacement for losses, such as diarrhea, vomiting, or fever. This accounts only for fluid needed to maintain normal cellular metabolism and fluid turnover.

Pediatric IV solutions that run over 24 hours usually include a combination of glucose, saline, and potassium chloride and are *hypertonic* solutions (see Figure 14-5, page 332). Dextrose (glucose) for energy is usually concentrated between 5% and 12% for peripheral infusions. Sodium chloride is usually concentrated between 0.225% and 0.9% ($\frac{1}{4}$ NS up to NS). Further, 20 mEq per liter of potassium chloride (20 mEq KCl/L) are usually added to continuous pediatric infusions. Any dextrose and saline combination without potassium should be used only as an intermittent or short-term IV fluid in children. Be wary of isotonic solutions like 5% dextrose in water and 0.9% sodium chloride. They do not contribute enough electrolytes and quickly can lead to water intoxication.

CAUTION

A red flag should go up in your mind if either plain 5% dextrose in water or 0.9% sodium chloride (normal saline) are running continuously on an infant or child. Consult the ordering practitioner immediately!

Let's examine the daily rate of maintenance fluids and the hourly flow rate for the children in the following examples.

EXAMPLE 1 ■

Child who weighs 6 kg

$100\text{ mL}/\cancel{\text{kg}}/\text{day} \times 6\ \cancel{\text{kg}} = 600\text{ mL/day}$ or per 24h

$\frac{600\text{ mL}}{24\text{ h}} = 25\text{ mL/h}$

EXAMPLE 2 ■

Child who weighs 12 kg

$100\text{ mL}/\cancel{\text{kg}}/\text{day} \times 10\ \cancel{\text{kg}} = 1{,}000\text{ mL/day}$ (for first 10 kg)

$50\text{ mL}/\cancel{\text{kg}}/\text{day} \times 2\ \cancel{\text{kg}} = 100\text{ mL/day}$ (for the remaining 2 kg)

Total: $1{,}000\text{ mL/day} + 100\text{ mL/day} = 1{,}100\text{ mL/day}$ or per 24 h

$\frac{1{,}100\text{ mL}}{24\text{ h}} = 45.8\text{ mL/h} = 46\text{ mL/h}$

EXAMPLE 3 ■

Child who weighs 24 kg

$100\text{ mL}/\cancel{\text{kg}}/\text{day} \times 10\ \cancel{\text{kg}} = 1{,}000\text{ mL/day}$ (for first 10 kg)

$50\text{ mL}/\cancel{\text{kg}}/\text{day} \times 10\ \cancel{\text{kg}} = 500\text{ mL/day}$ (for next 10 kg)

$20\text{ mL}/\cancel{\text{kg}}/\text{day} \times 4\ \cancel{\text{kg}} = 80\text{ mL/day}$ (for the remaining 4 kg)

Total: $1{,}000\text{ mL/day} + 500\text{ mL/day} + 80\text{ mL/day} = 1{,}580\text{ mL/day}$ or per 24 h

$\frac{1{,}580\text{ mL}}{24\text{ h}} = 65.8\text{ mL/h} = 66\text{ mL/h}$

QUICK REVIEW

- Minimal and maximal dilution volumes for some IV drugs are recommended to prevent fluid overload and to minimize vein irritation and toxic effects.
- The ratio for recommended dilution equals the ratio for desired drug dilution.

- When mixing IV drug solutions,
  - the *smaller* the added volume, the *stronger* or *higher* the resulting *concentration* (minimal dilution).
  - the *larger* the added volume, the *weaker (more dilute)* or *lower* the resulting *concentration* (maximal dilution).
- Daily volume of pediatric maintenance IV fluids based on body weight is:
  - 100 mL/kg/day for first 10 kg.
  - 50 mL/kg/day for next 10 kg.
  - 20 mL/kg/day for each kg above 20.

Review Set 45

1. If a child is receiving chloramphenicol 400 mg IV q.6h and the maximum concentration is 100 mg/mL, what is the minimum volume of fluid in which the medication can be safely diluted? ________ mL
2. If a child is receiving gentamicin 25 mg IV q.8h and the minimal concentration is 1 mg/mL, what is the maximum volume of fluid in which the medication can be safely diluted? ________ mL
3. Calculate the total volume and hourly IV flow rate for a 25 kg child receiving maintenance IV fluids. Infuse ________ mL at ________ mL/h
4. Calculate the total volume and hourly IV flow rate for a 13 kg child receiving maintenance IV fluids. Infuse ________ mL at ________ mL/h
5. Calculate the total volume and hourly IV flow rate for a 77 lb child receiving maintenance fluids. Infuse ________ mL at ________ mL/h
6. Calculate the total volume and hourly IV flow rate for a 3,500 g infant receiving maintenance fluids. Infuse ________ mL at ________ mL/h
7. A child is receiving 350 mg IV of a certain medication, and the minimal and maximal dilution range is 30 to 100 mg/mL. What is the minimum volume (maximal concentration) and the maximum volume (minimal concentration) for safe dilution? ________ mL (minimum volume); ________ mL (maximum volume). Hint: The equipment measures whole mL; round up to the next whole mL.
8. A child is receiving 52 mg IV of a certain medication, and the minimal and maximal dilution range is 0.8 to 20 mg/mL. What is the minimum volume and the maximum volume of fluid for safe dilution? ________ mL (minimum volume); ________ mL (maximum volume).
9. A child is receiving 175 mg IV of a certain medication, and the minimal and maximal dilution range is 5 to 75 mg/mL. What is the minimum volume and the maximum volume of fluid for safe dilution? ________ mL (minimum volume); ________ mL (maximum volume).
10. You are making rounds on your pediatric patients and notice that a 2-year-old child who weighs 14 kg has 1,000 mL of normal saline infusing at the rate of 50 mL/h. You decide to question this order. What is your rationale? ____

    ____

After completing these problems, see pages 529-530 to check your answers.

CRITICAL THINKING SKILLS

Let's look at an example in which the nurse *prevents* a medication error by calculating the safe dosage of a medication before administering the drug to a child.

ERROR

Dosage that is too high for a child.

Possible Scenario

Suppose a physician ordered **KCl 25 mEq IV per 500 mL of $D_5 \frac{1}{2}$ NS to infuse at the rate of 20 mL/h.** The infant weighs 10.5 lb and is 24 in long. KCl for IV injection is supplied as 2 mEq/mL. The nurse looked up potassium chloride in a drug reference and noted that the safe dosage of potassium chloride is up to 3 mEq/kg or 40 mEq/m²/day. The nurse calculated the infant's dosage as 14.4 mEq/day based on body weight and 11.2 mEq/day based on BSA.

First convert lb to kg.

$$\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{10.5\text{ lb}}$$

$$\frac{2.2X}{2.2} = \frac{10.5}{2.2}$$

$$X = 4.8\text{ kg}$$

$$3\text{ mEq}/\cancel{\text{kg}}/\text{day} \times 4.8\ \cancel{\text{kg}} = 14.4\text{ mEq/day}$$

$$\text{BSA (m}^2) = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} = \sqrt{\frac{10.5 \times 24}{3{,}131}} = \sqrt{\frac{252}{3{,}131}} = \sqrt{0.08} = 0.283\text{ m}^2 = 0.28\text{ m}^2$$

$$40\text{ mEq}/\cancel{\text{m}^2}/\text{day} \times 0.28\ \cancel{\text{m}^2} = 11.2\text{ mEq/day}$$

The nurse further calculated that at the rate ordered, the infant would receive 480 mL of IV fluid per day, which is a reasonable daily rate of pediatric maintenance IV fluids.

$$20\text{ ml}/\cancel{\text{h}} \times \frac{24\ \cancel{\text{h}}}{\text{day}} = 480\text{ mL/day}$$

Maintenance pediatric IV fluids:
100 mL/kg/day for first 10 kg: $100\text{ mL}/\cancel{\text{kg}}/\text{day} \times 4.8\ \cancel{\text{kg}} = 480\text{ mL/day}$

But then the nurse calculated that to add 25 mEq KCl to the 500 mL IV bag would require 12.5 mL of KCl 2 mEq/mL.

PRACTICE PROBLEMS—CHAPTER 15

Calculate the volume for one dose of safe dosages. Refer to the BSA formulas or the West Nomogram on 398 as needed to answer questions 1 through 20.

1. Order: **vincristine 2 mg direct IV stat** for a child who weighs 85 pounds and is 50 inches tall.

   Recommended dosage of vincristine for children: 1.5–2 mg/m² 1 time/week; inject slowly over a period of 1 minute.

   Supply: vincristine 1 mg/mL

   BSA (per formula) of this child: ________ m²

   Recommended dosage range for this child: ________ mg to ________ mg

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{2 \text{ mEq}}{1 \text{ mL}} \times \frac{25 \text{ mEq}}{\text{X mL}}$$

$$2X = 25$$

$$\frac{2X}{2} = \frac{25}{2}$$

$$X = 12.5 \text{ mL}$$

The total volume would be 512.5 mL (500 mL IV solution + 12.5 mL KCl) and the infant would receive 0.98 or approximately 1 mEq KCl per hour.

$$\frac{25 \text{ mEq}}{512.5 \text{ mL}} \times \frac{\text{X mEq}}{20 \text{ mL}}$$

$$\frac{512.5X}{512.5} = \frac{500}{512.5}$$

$$512.5X = 500$$

$$X = 0.975 \text{ mEq} = 0.98 \text{ mEq (approximately 1 mEq per hour)}$$

Finally, the nurse calculated that at this rate the infant would receive 23.5 or 24 mEq/day, which is approximately twice the safe dosage. Therefore, the order is unsafe.

$0.98 \text{ mEq}/\cancel{\text{h}} \times 24\ \cancel{\text{h}}/\text{day} = 23.5 \text{ mEq/day (approximately 24 mEq/day)}$

The nurse notified the physician and questioned the order. The physician responded, "Thank you, you are correct. I intended to order one-half that amount of KCl or 25 mEq per L, which should have been 12.5 mEq per 500 mL. This was my error and I am glad you caught it."

Potential Outcome

If the nurse had not questioned the order, the infant would have received twice the safe dosage. The infant likely would have developed signs of hyperkalemia that could lead to ventricular fibrillation, muscle weakness progressing to flaccid quadriplegia, respiratory failure, and death.

Prevention

In this instance, the nurse prevented a medication error by checking the safe dosage and notifying the physician before administering the infusion. Let this be you!

Is the ordered dosage safe? ________

If safe, give ________ mL/min or ________ mL per 15 sec.

If not, what should you do? ____

2. Use the BSA nomogram (see next page) to calculate the safe oral dosage and amount to give of mercaptopurine for a child of normal proportions who weighs 25 pounds.

Recommended dosage: 80 mg/m^2/day once daily p.o.

Supply: mercaptopurine 50 mg/mL

BSA: ________ m^2

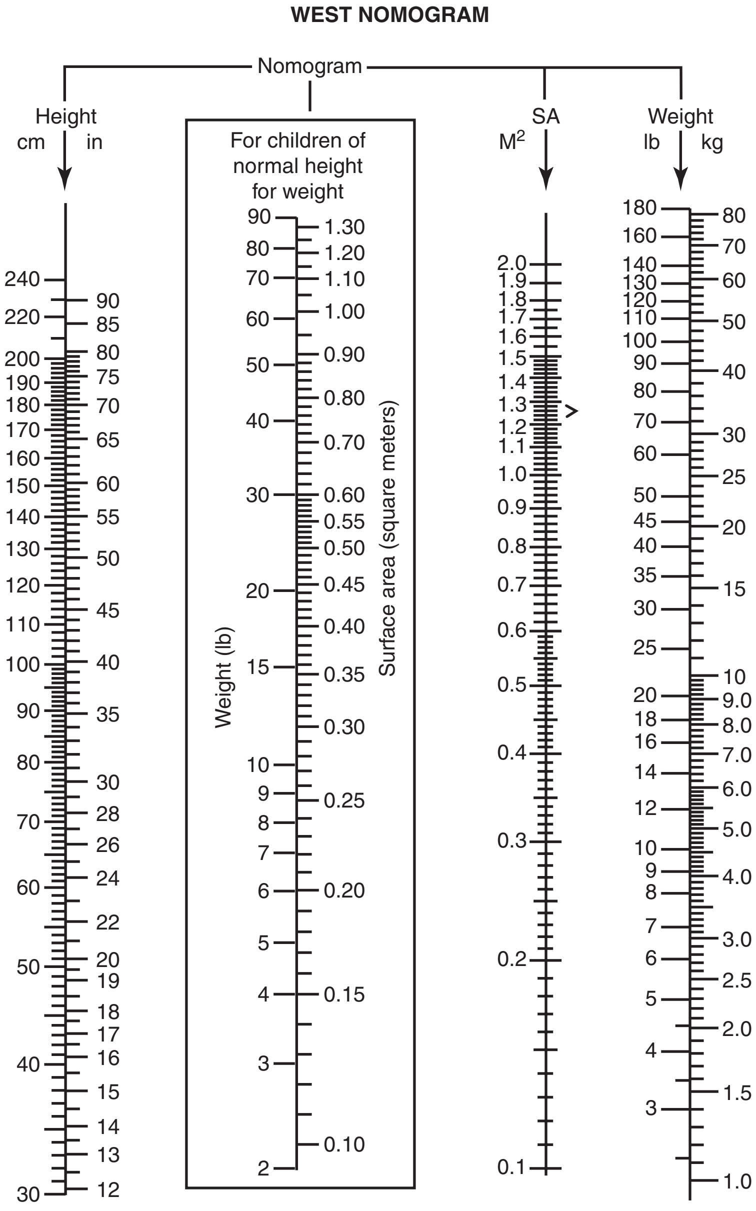
Safe dosage: ________ mg

Metric:

$$\text{BSA (m}^2\text{)} = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}}$$

Household:

$$\text{BSA (m}^2\text{)} = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}}$$



West Nomogram for estimation of body surface area. (From *Nelson Textbook of Pediatrics* (17th ed) by R. E. Behrman, R. M. Kliegman & H. B. Jenson, 2004, Philadelphia: Saunders. Reprinted with permission.)

3. Use the BSA nomogram to calculate the safe IV dosage of sargramostim for a 1-year-old child who is 25 inches tall and weighs 20 pounds.

   Recommended dosage: 250 mcg/m^2/day once daily IV

   BSA: __________ m^2

   Safe dosage: __________ mcg

4. Sargramostim is available in a solution strength of 500 mcg per 10 mL. Calculate one dose for the child in question 3.

   Give: __________ mL

5. Use the BSA nomogram to determine the BSA for a child who is 35 inches tall and weighs 40 pounds.

   BSA: _________ m^2

6. The child in question 5 will receive levodopa. The recommended oral dosage of levodopa is 0.5 g/m^2. What is the safe dosage for this child?

   Safe dosage: _________ mg

7. Levodopa is supplied in 100 mg and 250 mg capsules. Calculate one dose for the child in question 6.

   Give: _________ of the _________ mg capsule(s)

8. Use the BSA nomogram to determine the safe IM dosage of Oncaspar for a child who is 42 inches tall and weighs 45 pounds. The recommended IM dosage is 2,500 units/m^2/dose.

   BSA: _________ m^2

   Safe dosage: _________ units

9. Oncaspar is reconstituted to 750 units/mL. Calculate one dose for the child in question 8.

   Give: _________ mL

10. Should the Oncaspar in question 9 be given in one injection? _________

11. A child is 140 cm tall and weighs 43.5 kg. The recommended IV dosage of Adriamycin is 20 mg/m^2. Use the BSA formula to calculate the safe IV dosage of Adriamycin for this child.

    BSA: _________ m^2

    Safe dosage: _________ mg

12. Calculate the dose amount of Adriamycin for the child in question 11.

    Supply: Adriamycin 2 mg/mL

    Give: _________ mL

For questions 13 through 20, use the BSA formulas to calculate the BSA value.

13. Height: 5 ft 6 in Weight: 136 lb BSA: _________ m^2
14. Height: 4 ft Weight: 80 lb BSA: _________ m^2
15. Height: 60 cm Weight: 6 kg BSA: _________ m^2
16. Height: 68 in Weight: 170 lb BSA: _________ m^2
17. Height: 164 cm Weight: 58 kg BSA: _________ m^2
18. Height: 100 cm Weight: 17 kg BSA: _________ m^2
19. Height: 64 in Weight: 63 kg BSA: _________ m^2
20. Height: 85 cm Weight: 11.5 kg BSA: _________ m^2

21. What is the safe dosage of one dose of interferon alpha-2b required for a child with a BSA of 0.28 m^2 if the recommended dosage is 2 million units/m^2? _________ units

22. What is the safe dosage of calcium EDTA required for an adult with a BSA of 2.17 m^2 if the recommended dosage is 500 mg/m^2? _________ mg or _________ g

23. What is the total daily dosage range of mitomycin required for a child with a BSA of 0.19 m^2 if the recommended dosage range is 10 to 20 mg/m^2/day? _________ to _________ mg/day

24. What is the total safe daily dosage of Thioplex required for a adult with a BSA of 1.34 m^2 if the recommended dosage is 6 mg/m^2/day? _________ mg/day

25. After 5 full days of therapy receiving the recommended dosage, the patient in question 24 will have received a total of __________ mg of Thioplex.

26. Order: **Ancef 0.42 g IV q.12 h in 30 mL D_5NS over 30 min by volume control set on an infusion controller. Flush with 15 mL.**

    Supply: Ancef 500 mg per 5 mL

    Total IV fluid volume: __________ mL

    Flow rate: __________ mL/h

    Add __________ mL Ancef and __________ mL D_5NS to the chamber.

27. After 7 days of IV therapy, the patient referred to in question 26 will have received a total of __________ mL of Ancef.

28. Order: **clindamycin 285 mg IV q.8h in 45 mL D_5NS over 60 min by volume control set on an infusion controller. Flush with 15 mL.**

    Supply: clindamycin 75 mg per 0.5 mL

    Total IV fluid volume: __________ mL

    Flow rate: __________ mL/h

    Add __________ mL clindamycin and __________ mL D_5NS to the chamber.

29. When the patient in item 28 has received 4 days therapy of clindamycin, he will have received a total IV medication volume of __________ mL.

30. Order: **D_5 0.225% NaCl IV at 65 mL/h with erythromycin 500 mg IV q.6h to be infused over 40 min**

    You will use a volume control set and flush with 15 mL.

    Supply: erythromycin 50 mg/mL

    Add __________ mL of erythromycin and __________ mL D_5 NS to the chamber.

31. Order: **D_5 0.45% NaCl IV at 66 mL/h with Fortaz 620 mg IV q.8h to be infused over 40 min**

    You will use a volume control set and flush with 15 mL.

    Supply: Fortaz 0.5 g per 5 mL

    Add __________ mL Fortaz and __________ mL D_5 0.45% NaCl to the chamber.

For questions 32 through 34, calculate the ordered medication for each of the following IV bags to achieve the ordered concentration. Supply: KCl 2 mEq/mL

32. Order: **Add 30 mEq KCl per L of IV fluid**

    Supply: 360 mL IV solution Add: __________ mEq; __________ mL

33. Order: **Add 20 mEq KCl per L of IV fluid**

    Supply: 700 mL IV solution Add: __________ mEq; __________ mL

34. Order: **Add 15 mEq KCl per L of IV fluid**

    Supply: 250 mL IV solution Add: __________ mEq; __________ mL

For questions 35 through 38, to calculate the daily volume of pediatric maintenance IV fluids, allow:

100 mL/kg/day for first 10 kg of body weight

50 mL/kg/day for next 10 kg of body weight

20 mL/kg/day for each kg of body weight above 20 kg

35. Calculate the total volume and hourly IV flow rate for a 21 kg child receiving maintenance fluids.

    Infuse ________ mL at ________ mL/h

36. Calculate the total volume and hourly IV flow rate for a 78 lb child receiving maintenance fluids.

    Infuse ________ mL at ________ mL/h

37. Calculate the total volume and hourly IV flow rate for a 33 lb child receiving maintenance fluids.

    Infuse ________ mL at ________ mL/h

38. Calculate the total volume and hourly IV flow rate for a 2,400 g infant receiving maintenance fluids.

    Infuse ________ mL at ________ mL/h

For questions 39 through 49, verify the safety of the following pediatric dosages ordered. If the dosage is safe, calculate one dose and the IV volume to infuse one dose.

Order for a child weighing 15 kg:

D_5 0.45% NaCl IV at 53 mL/h $\bar{c}$ ampicillin 275 mg IV q.4h infused over 40 min by volume control set

Recommended dosage: ampicillin 100–125 mg/kg/day in 6 divided doses

Supply: ampicillin 1 g per 10 mL

39. Safe daily dosage range for this child: ________ mg/day to ________ mg/day

    Safe single dosage range for this child: ________ mg/dose to ________ mg/dose

    Is the ordered dosage safe? ________ If safe, give ________ mL/dose.

    If not safe, describe your action. ______________________________

40. IV fluid volume to be infused in 40 min: ________ mL

    Add ________ mL ampicillin and ________ mL $D_5$0.45% NaCl to the chamber.

For questions 41 and 42, order for a child who weighs 27 lb:

D_5 NS IV at 46 mL/h $\bar{c}$ oxacillin 308 mg IV q.6h to be infused over 30 min by volume control set

Recommended dosage: oxacillin 100 mg/kg/day in 4 divided doses

Supply: oxacillin 500 mg per 10 mL

41. Child's weight: ________ kg

    Safe daily dosage for this child: ________ mg/day

    Safe single dosage for this child: ________ mg/dose

    Is the ordered dosage safe? ________ If safe, give ________ mL/dose.

    If not safe, describe your action. ______________________________

42. IV fluid volume to be infused in 30 min: ________ mL

    Add ________ mL oxacillin and ________ mL D_5 NS to the chamber.

For questions 43 and 44, order for a child who weighs 22 kg:

D_5 0.225% NaCl IV at 50 mL/h $\bar{c}$ Amikin 165 mg IV q.8h to be infused over 30 min by volume control set

Recommended dosage: Amikin 15–22.5 mg/kg/day in 3 divided doses q.8h

Supply: Amikin 100 mg per 2 mL

43. Safe daily dosage range for this child: _________ mg/day to _________ mg/day

Safe single dosage range for this child: _________ mg/dose to _________ mg/dose

Is the ordered dosage safe? _________ If safe, give _________ mL/dose.

If not safe, describe your action. ____

44. IV fluid volume to be infused in 30 min: _________ mL

Add _________ mL Amikin and _________ mL $D_5$0.225% NaCl to the chamber.

For questions 45 and 46, order for a child who weighs 9 kg:

D_5 NS IV at 38 mL/h $\bar{c}$ Ticar 800 mg IV q.4h to be infused over 40 min by volume control set

Recommended dosage: Ticar 200–300 mg/kg/day in 6 divided doses every 4 hours

Supply: Ticar 200 mg/mL

45. Safe daily dosage range for this child: _________ mg/day to _________ mg/day

Safe single dosage range for this child: _________ mg/dose to _________ mg/dose

Is the ordered dosage safe? _________ If safe, give _________ mL/dose.

If not safe, describe your action. ____

46. IV fluid volume to be infused in 40 min: _________ mL

Add _________ mL Ticar and _________ mL D_5 NS to the chamber.

For questions 47 through 49, order for a child who weighs 55 lbs:

D_5NS IV at 60 mL/h $\bar{c}$ penicillin G potassium 525,000 units q.4h to be infused over 20 min by volume control set

Recommended dosage: penicillin G potassium 100,000–250,000 units/kg/day in 6 divided doses q.4h

Supply: penicillin G potassium 200,000 units/mL

47. Child's weight: _________ kg

Safe daily dosage for this child: _________ units/day to _________ units/day

Safe single dosage for this child: _________ units/dose to _________ units/dose

48. Is the ordered dosage safe? _________ If safe, give _________ mL/dose.

If not safe, describe your action. ____

49. IV fluid volume to be infused in 20 min: _________ mL

Add _________ mL penicillin G potassium and _________ mL D_5NS to the chamber.

50. Describe the strategy you would implement to prevent this medication error.

Possible Scenario

Suppose the physician came to the pediatric oncology unit to administer chemotherapy to a critically ill child whose cancer symptoms had recurred suddenly. The nurse assigned to care for the child was floated from the adult oncology unit and was experienced in administering chemotherapy to adults. The physician, recognizing the nurse, said, "Oh good, you know how to calculate and prepare chemo. Go draw up 2 mg/m^2 of Oncovin for this child so I can get his chemotherapy started quickly." The nurse consulted the child's chart and saw the following weights written on his assessment sheet: 20/.45. No height was recorded.

On the adult unit, that designation means _X_ kg or _Y_ lb. The nurse took the West Nomogram and estimated the child's BSA based on his weight of 45 lb to be 0.82 m^2. The nurse calculated

2 mg/$\cancel{m^2}$ × 0.82 $\cancel{m^2}$ = 1.64 mg. Oncovin is supplied as 1 mg/1 mL, so the nurse further calculated 1.6 mL was the dose and drew it up in a 3 mL syringe. As the nurse handed the syringe to the physician, the amount looked wrong. The physician asked the nurse how that amount was obtained. When the nurse told the physician the estimated BSA from the child's weight (45 pounds) is 0.82 m^2, and the dosage is 2 mg/m^2 × 0.82 m^2 = 1.64 mg or 1.6 mL, the physician said, "No! This child's *BSA is 0.45 m*^{2}. I wrote it myself next to his weight—20 pounds." The physician, despite the need to give the medication as soon as possible, took the necessary extra step and examined the amount of medication in the syringe. Though the physician knew and trusted the nurse, the amount of medication in the syringe did not seem right. Perhaps the physician had figured a ballpark amount of about 1 mL, and the volume the nurse brought in made the physician question what was calculated. The correct dosage calculations are:

$$2\text{ mg}/\cancel{m^2} \times 0.45\ \cancel{m^2} = 0.9\text{ mg}$$

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{1\text{ mg}}{1\text{ mL}} \times \frac{0.9\text{ mg}}{\text{X mL}}$$

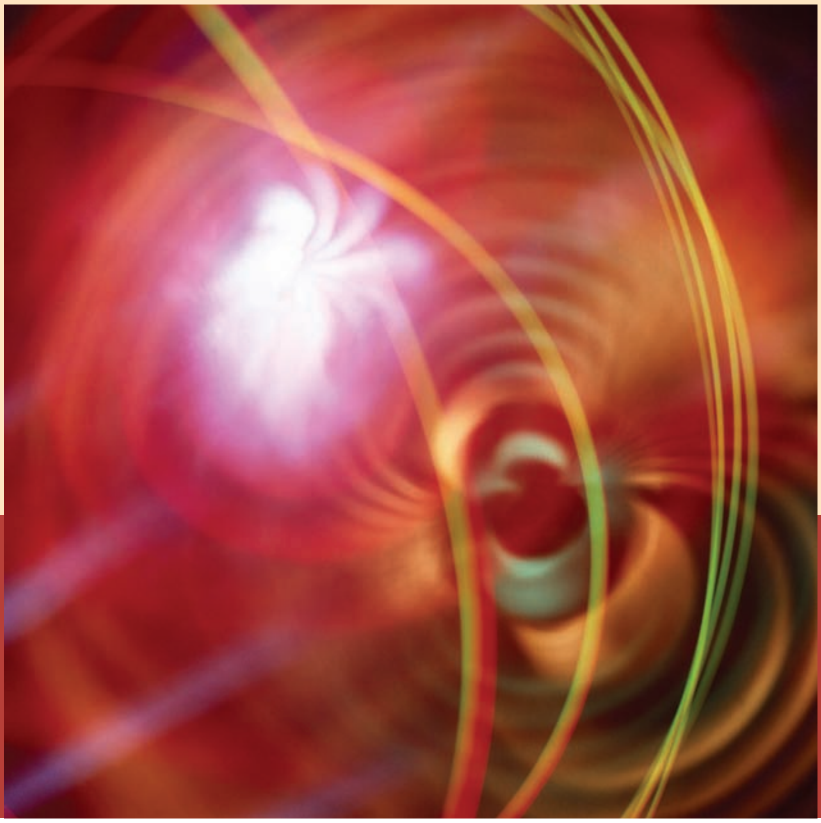
$$\text{X} = 0.9\text{ mL}$$

Potential Outcome

The child, already critically ill, could have received almost double the amount of medication had the physician rushed to give the dose calculated and prepared by someone else. This excessive amount of medication probably could have caused a fatal overdose. What should have been done to prevent this error?

Prevention

After completing these problems, see pages 530-533 to check your answers.



16

Advanced Adult Intravenous Calculations

OBJECTIVES

Upon mastery of Chapter 16, you will be able to perform advanced adult intravenous (IV) calculations and apply these skills to patients across the life span. To accomplish this you will also be able to:

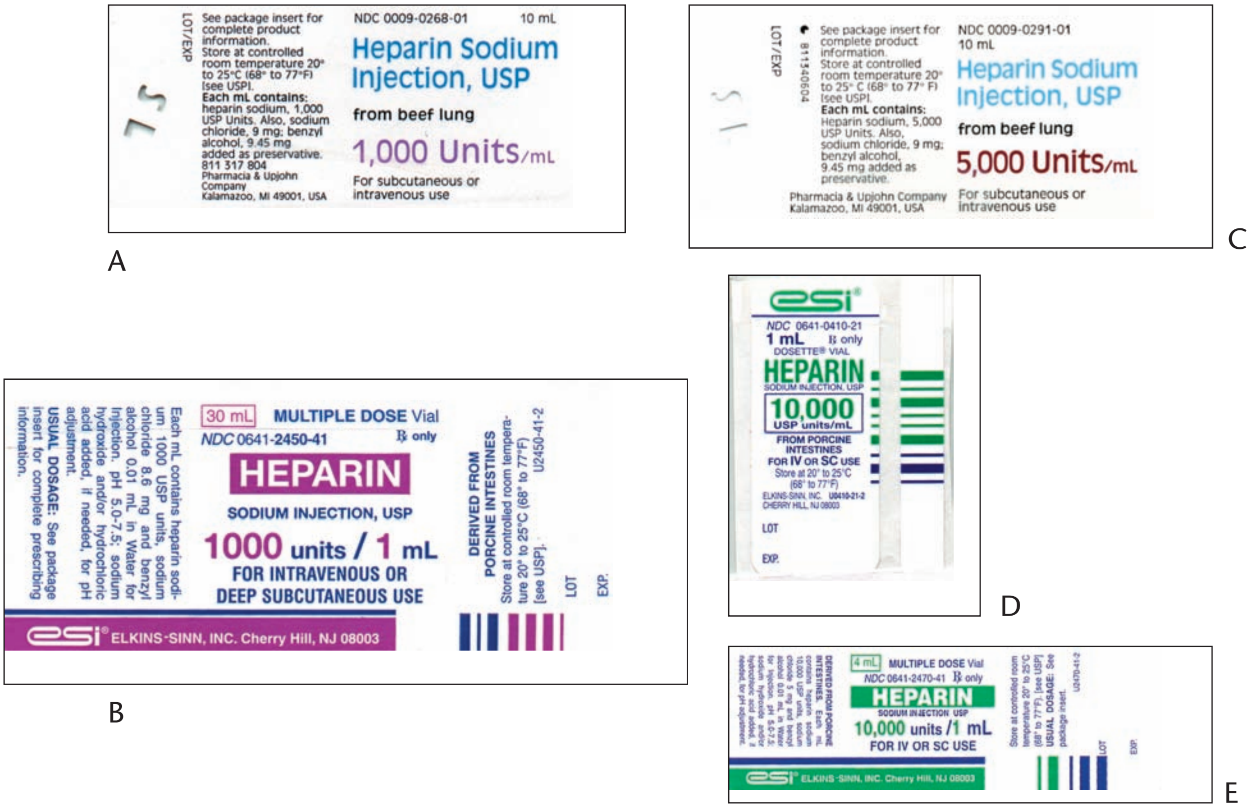
- Calculate and assess safe hourly heparin dosage.
- Calculate heparin IV flow rate.
- Calculate the flow rate and assess safe dosages for critical care IV medications administered over a specified time period.
- Calculate the flow rate for primary IV and IV piggyback (IV PB) solutions for patients with restricted fluid intake requirements.

Nurses are becoming increasingly more responsible for the administration of IV medications in the critical care areas as well as on general nursing units. Patients in life-threatening situations require thorough and timely interventions that frequently involve specialized, potent drugs. This chapter focuses on advanced adult IV calculations with special requirements that can be applied to patients across the life span.

IV HEPARIN

Heparin is an anticoagulant for the prevention of clot formation. It is measured in USP units (Figure 16-1). IV heparin is frequently ordered in *units per hour (units/h)* and as such should be administered by an electronic infusion device. Because of the potential for hemorrhage or clots with incorrect dosage, careful monitoring of patients receiving heparin is a critical nursing skill. The nurse is responsible for administering the correct dosage and for ensuring that the dosage is safe.

FIGURE 16-1 Various heparin dosage strengths and container volumes



CAUTION

Heparin order, dosage, vial, and amount to give should be checked by another nurse before administering the dose.

Calculating Safe IV Heparin Flow Rate

When IV heparin is ordered in units/h, use ratio-proportion to calculate the flow rate in mL/h.

RULE

To calculate IV heparin flow rate in mL/h:

Ratio of supply dosage on hand is equivalent to ratio of desired dosage rate

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired/h}}{\text{X Amount desired/h}}$$

Note: This rule applies to drugs ordered in units/h, milliunits/h, mg/h, mcg/h, g/h, or mEq/h.

Let's apply the rule to some examples.

EXAMPLE 1 ■

Order: **D_5W 500 mL $\bar{c}$ heparin 25,000 units IV at 1,000 units/h**

What is the flow rate in mL/h?

Calculate the flow rate in mL/h, which will administer 1,000 units/h.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired/h}}{\text{X Amount desired/h}}$$

$$\frac{25{,}000 \text{ units}}{500 \text{ mL}} \times \frac{1{,}000 \text{ units/h}}{\text{X mL/h}}$$

$$25{,}000\text{X} = 500{,}000$$

$$\frac{25{,}000\text{X}}{25{,}000} = \frac{500{,}000}{25{,}000}$$

$$\text{X} = 20 \text{ mL/h}$$

Look at the labels in Figure 16-1, representing the various supply dosages of heparin you have available. Often, IV solutions with heparin additive come premixed. But, if you have to mix the solution, what label would you select to prepare the heparin infusion as ordered? The best answer is label E: 4 mL vial of heparin 10,000 units/mL. This is necessary because to add 25,000 units of heparin to 500 mL of IV solution, you would need 2.5 mL of heparin. Let's do the calculations.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{10{,}000 \text{ units}}{1 \text{ mL}} \times \frac{25{,}000 \text{ units}}{\text{X mL}}$$

$$10{,}000\text{X} = 25{,}000$$

$$\frac{10{,}000\text{X}}{10{,}000} = \frac{25{,}000}{10{,}000}$$

$$\text{X} = 2.5 \text{ mL}$$

However, notice that you could also select label B and prepare 25 mL of heparin 1,000 units/mL, or label C and prepare 5 mL of heparin 5,000 units/mL. Labels A and D do not have sufficient volume to fill the dosage required.

EXAMPLE 2 ■

Order: **D_5W 500 mL $\bar{c}$ heparin 25,000 units IV at 850 units/h**

Calculate the flow rate in mL/h.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired/h}}{\text{X Amount desired/h}}$$

$$\frac{25{,}000 \text{ units}}{500 \text{ mL}} \times \frac{850 \text{ units/h}}{\text{X mL/h}}$$

$$25{,}000\text{X} = 425{,}000$$

$$\frac{25{,}000\text{X}}{25{,}000} = \frac{425{,}000}{25{,}000}$$

$$\text{X} = 17 \text{ mL/h}$$

EXAMPLE 3 ■

D_5W 500 mL with heparin 25,000 units IV is currently infusing at 850 units/h, or 17 mL/h. Based on laboratory results, it is determined that the patient's infusion must be increased by 120 units/h, so that it should now be infusing at 970 units/h.

Calculate the flow rate in mL/h.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired/h}}{\text{X Amount desired/h}}$$

$$\frac{25{,}000 \text{ units}}{500 \text{ mL}} \times \frac{970 \text{ units/h}}{\text{X mL/h}}$$

$$25{,}000\text{X} = 485{,}000$$

$$\frac{25{,}000\text{X}}{25{,}000} = \frac{485{,}000}{25{,}000}$$

$$\text{X} = 19.4 = 19 \text{ mL/h}$$

You would need to increase the infusion from 17 mL/h (850 units/h) to 19 mL/h (970 units/h).

IV Heparin Protocol

Because patients vary significantly in weight, the intravenous heparin dosage is individualized based on patient weight. Many hospitals have standard protocols related to intravenous heparin administration. Figure 16-2 shows a sample protocol. Note that the bolus or loading dosage and the initial infusion dosage of heparin are based on the patient's weight. Line 10 indicates that for this protocol, the standard heparin bolus dosage is 80 units/kg and the infusion rate is 18 units/kg/h. When the patient's response to heparin therapy changes, as measured by the APTT blood clotting value (activated partial thromboplastin time measured in seconds), the heparin dosage is adjusted as indicated in lines 11–15. These orders in Figure 16-2 are based on patient weight rounded to the nearest 10 kg. Some facilities use the patient's exact weight in kilograms. It is important to know the protocol for your clinical setting. Let's work through some examples of calculation of heparin dosage based on patient weight and a standardized heparin dosage protocol.

FIGURE 16-2 Sample orders for patient on heparin therapy

Standard Weight-Based Heparin Protocol

For all patients on heparin drips:

1. Weight in kilograms. Required for order to be processed: ________ kg
2. Heparin 25,000 units in 250 mL of $\frac{1}{2}$NS. Boluses to be given as 1,000 units/mL.
3. APTT q.6h or 6 hours after rate change; daily after two consecutive therapeutic APTTs.
4. CBC initially and repeat every ________ days(s).
5. Obtain APTT and PT/INR on day one prior to initiation of therapy.
6. Guaiac stool initially then every ________ day(s) until heparin discontinued. Notify if positive.
7. Neuro checks every ________ hours while on heparin. Notify physician of any changes.
8. Discontinue APTT and CBC once heparin drip is discontinued, unless otherwise ordered.
9. Notify physician of any bleeding problems.
10. Bolus with 80 units/kg. Start drip at 18 units/kg/h.
11. If APTT is less than 35 secs: Rebolus with 80 units/kg and increase rate by 4 units/kg/h
12. If APTT is 36–44 secs: Rebolus with 40 units/kg and increase rate by 2 units/kg/h
13. If APTT is 45–75 secs: Continue current rate
14. If APTT is 76–90 secs: Decrease rate by 2 units/kg/h
15. If APTT is greater than 90 secs: Hold heparin for 1 hour and decrease rate by 3 units/kg/h

EXAMPLE 1 ■

Protocol: **Bolus patient with heparin 80 units/kg body weight and start drip at 18 units/kg/h**

Patient's weight: 110 lb

How many units of heparin should the patient receive?

Step 1 Calculate patient's weight in kilograms. Conversion: 1 kg = 2.2 lb

$$\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{110\text{ lb}}$$

$$2.2X = 110$$

$$\frac{2.2X}{2.2} = \frac{110}{2.2}$$

$$X = 50\text{ kg}$$

Step 2 Calculate the heparin bolus dosage.

$$80\text{ units/}\cancel{\text{kg}} \times 50\ \cancel{\text{kg}} = 4{,}000\text{ units}$$

This patient should receive 4,000 units IV heparin as a bolus.

Step 3 Calculate the number of milliliters to administer for the bolus.

Supply: heparin 1,000 units/mL, as recommended by the protocol (see #2, Figure 16-2)

Think: You want to give 4,000 units, which is four times 1,000 units/mL, so you want to give four times 1 mL or 4 mL.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{1{,}000\text{ units}}{1\text{ mL}} \times \frac{4{,}000\text{ units}}{X\text{ mL}}$$

$$\frac{1{,}000X}{1{,}000} = \frac{4{,}000}{1{,}000}$$

$$1{,}000X = 4{,}000$$

$$X = 4\text{ mL}$$

Administer 4 mL of heparin for the bolus.

Step 4 Calculate the infusion rate for the heparin IV drip.

Protocol: **Start drip at 18 units/kg/h** (see #10, Figure 16-2)

Supply: heparin 25,000 units per 250 mL (see #2, Figure 16-2) or 100 units/mL

$$18\text{ units/}\cancel{\text{kg}}\text{/h} \times 50\ \cancel{\text{kg}} = 900\text{ units/h}$$

Think: You want to administer 9 times 1 mL or 9 mL for the IV heparin infusion.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired/h}}{\text{X Amount desired/h}}$$

$$\frac{100\text{ units}}{1\text{ mL}} \times \frac{900\text{ units/h}}{X\text{ mL/h}}$$

$$100X = 900$$

$$\frac{100X}{100} = \frac{900}{100}$$

$$X = 9\text{ mL/h}$$

Set the flow rate at 9 mL/h.

EXAMPLE 2 ■

After 6 hours, the patient in Example 1 has an APTT of 43 secs. According to the protocol, you will **rebolus with 40 units/kg and increase the amount of IV heparin by 2 units/kg/h** (see #12, Figure 16-2).

Step 1 You already know the patient's weight: 50 kg

Step 2 Calculate the heparin rebolus dosage.

$$40\text{ units/}\cancel{\text{kg}} \times 50\ \cancel{\text{kg}} = 2{,}000\text{ units}$$

Step 3 Calculate the number of milliliters to prepare.

Supply: heparin 1,000 units/mL, as recommended by the protocol

Think: You want to give 2 times 1 mL or 2 mL.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{1{,}000\text{ units}}{1\text{ mL}} \times \frac{2{,}000\text{ units}}{\text{X mL}}$$

$$1{,}000\text{X} = 2{,}000$$

$$\frac{1{,}000\text{X}}{1{,}000} = \frac{2{,}000}{1{,}000}$$

$$\text{X} = 2\text{ mL}$$

Administer 2 mL of heparin for the rebolus.

Step 4 Calculate the number of units the patient's IV heparin will be increased.

$$2\text{ units/}\cancel{\text{kg}}\text{/h} \times 50\ \cancel{\text{kg}} = 100\text{ units/h}$$

Step 5 Calculate the new infusion rate.

Supply: heparin 25,000 units per 250 mL (see #2, Figure 16-2) or 100 units/mL

Think: You want to administer 100 units/h and you have 100 units/mL, so you want to increase the infusion by 1 mL/h.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired/h}}{\text{X Amount desired/h}}$$

$$\frac{100\text{ units}}{1\text{ mL}} \times \frac{100\text{ units/h}}{\text{X mL/h}}$$

$$100\text{X} = 100$$

$$\frac{100\text{X}}{100} = \frac{100}{100}$$

$$\text{X} = 1\text{ mL/h}$$

9 mL/h + 1 mL/h = 10 mL/h

Reset the infusion rate to 10 mL/h.

QUICK REVIEW

- Use ratio-proportion to calculate mL/h when you know units/h and units/mL.
- Many hospitals use standard protocols to initiate and maintain heparin therapy.
- The protocols are based on patient weight in kilograms, and adjustments are made based on laboratory results (usually APTT).

Review Set 46

Calculate the flow rate.

1. Order: **0.45% NS 1,000 mL IV $\bar{c}$ heparin 25,000 units to infuse at 1,000 units/h.**

   Flow rate: ________ mL/h

2. Order: **D_5W 500 mL IV $\bar{c}$ heparin 40,000 units to infuse at 1,100 units/h.**

   Flow rate: ________ mL/h

3. Order: **0.45% NS 500 mL IV $\bar{c}$ heparin 25,000 units to infuse at 500 units/h.**

   Flow rate: ________ mL/h

4. Order: **D_5W 500 mL IV $\bar{c}$ heparin 40,000 units to infuse at 1,500 units/h.**

   Flow rate: ________ mL/h

5. Order: **D_5W 1 L IV $\bar{c}$ heparin 25,000 units to infuse at 1,200 units/h**. On rounds, you assess the patient and observe that the infusion pump is set at 120 mL/h.

   At what rate should the pump be set? ________ mL/h

   What should your action be? ____

6. Order: **D_5W 500 mL IV with heparin 25,000 units to infuse at 800 units/h**

   Flow rate: ________ mL/h

Questions 7 through 10 refer to a patient who weighs 165 lb and has IV heparin ordered per the following Weight Based Heparin Protocol.

Weight-Based Heparin Protocol:

Heparin IV infusion: Heparin 25,000 units in 250 mL of $\frac{1}{2}$NS

IV Boluses: Use heparin 1,000 units/mL

Calculate the patient's weight in kg. Weight: ________ kg

Bolus with heparin 80 units/kg. Then initiate heparin drip at 18 units/kg/h. Obtain APTT every 6 hours and adjust dosage and rate as follows:

If APTT is less than 35 seconds: Rebolus with 80 units/kg and increase rate by 4 units/kg/h.

If APTT is 36–44 seconds: Rebolus with 40 units/kg and increase rate by 2 units/kg/h.

If APTT is 45–75 seconds: Continue current rate.

If APTT is 76–90 seconds: Decrease rate by 2 units/kg/h.

If APTT is greater than 90 seconds: Hold heparin for 1 hour and then decrease rate by 3 units/kg/h.

7. Convert the patient's weight to kg: ________ kg

   Calculate the initial heparin bolus dosage: ________ units

   Calculate the bolus dose: ________ mL

   Calculate the initial heparin infusion rate: ________ units/h or ________ mL/h

8. At 0900, the patient's APTT is 33 seconds. According to the protocol, what will your action be?

   Rebolus with ________ units or ________ mL

   Reset infusion rate to ________ units/h or ________ mL/h

9. At 1500, the patient's APTT is 40 seconds. According to the protocol, what will your action be?

   Rebolus with ________ units or ________ mL

   Reset infusion rate to ________ units/h or ________ mL/h

10. At 2100, the patient's APTT is 60 seconds. What will your action be according to the protocol?

____

The same method can be used to calculate flow rates for other medications ordered at a specified dosage unit per hour. Calculate flow rate for questions 11 through 15.

11. Order: **0.9% NaCl 500 mL IV $\bar{c}$ Humulin R Regular U-100 insulin 500 units to infuse at 10 units/h.**

    Flow rate: ________ mL/h

12. Order: **D_5W 1 L IV $\bar{c}$ KCl 40 mEq to infuse at 2 mEq/h.**

    Flow rate: ________ mL/h

13. Order: **D_5W 100 mL IV $\bar{c}$ Cardizem 125 mg to infuse at 5 mg/h**

    Flow rate: ________ mL/h

14. Order: **NS 250 mL IV $\bar{c}$ Cardizem 125 mg to infuse at 10 mg/h**

    Flow rate: ________ mL/h

15. Order: **0.9% NaCl 500 mL IV $\bar{c}$ Humulin R Regular U-100 insulin 300 units to infuse at 5 units/h**

    Flow rate: ________ mL/h

After completing these problems, see pages 533-534 to check your answers.

CRITICAL CARE IV CALCULATIONS: CALCULATING FLOW RATE OF AN IV MEDICATION TO BE GIVEN OVER A SPECIFIED TIME PERIOD

With increasing frequency, medications are ordered for patients in critical care situations as a prescribed amount to be administered in a specified time period, such as *X mg per minute.* Such medications are usually administered by electronic infusion devices, programmed in mL/h. Careful monitoring of patients receiving life-threatening therapies is a critical nursing skill.

IV Medication Ordered Per Minute

RULE

To determine the flow rate (mL/h) for IV medications ordered per minute (such as mg/min):

Step 1 Calculate the dosage flow rate in mL/min

Ratio for supply dosage on hand is equivalent to the desired dosage flow rate. In this case it is *per minute.*

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{Dosage desired/min}}{\text{X Amount desired/min}}$$

Step 2 Calculate the flow rate in mL/h of the volume to administer per minute:

$$\frac{\text{Volume on hand}}{\text{Min to be infused}} = \frac{\text{X volume to be infused/h}}{\text{60 min/h}}$$

Or,

mL/min × 60 min/h = mL/h

Note: The order may specify mg/min, mcg/min, g/min, units/min, milliunits/min, or mEq/min.

EXAMPLE 1 ■

Order: **lidocaine 2 g IV in 500 mL D_5W at 2 mg/min via infusion pump.** You must prepare and hang 500 mL of D_5W IV solution that has 2 g of lidocaine added to it. Then, you must regulate the flow rate so the patient receives 2 mg of the lidocaine every minute. Determine the flow rate in mL/h.

Step 1 Calculate mL/min (change mg/min to mL/min)

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{Dosage desired/min}}{\text{X Amount desired/min}}$$

Dosage on hand: 2 g = 2,000 mg

Amount of solution on hand: 500 mL

Dosage desired/min: 2 mg/min

Amount desired/min: X mL/min

$$\frac{2{,}000 \text{ mg}}{500 \text{ mL}} \times \frac{2 \text{ mg/min}}{\text{X mL/min}}$$

$$2{,}000\text{X} = 1{,}000$$

$$\frac{2{,}000\text{X}}{2{,}000} = \frac{1{,}000}{2{,}000}$$

$$\text{X} = 0.5 \text{ mL/min}$$

Step 2 Determine the flow rate in mL/h (change mL/min to mL/h)

$$\frac{\text{Volume on hand}}{\text{Min to be infused}} = \frac{\text{X volume to be infused/h}}{\text{60 min/h}}$$

Now you know the following information:

Volume on hand: 0.5 mL

Min to infuse 0.5 mL: 1 min

Min per h: 60 min/h

Flow rate: X mL/h

$$\frac{0.5 \text{ mL}}{1 \text{ min}} \times \frac{\text{X mL/h}}{60 \text{ min/h}}$$

$$\text{X} = 30 \text{ mL/h}$$

Or, you know that there are 60 minutes per hour, so you can just multiply mL/min by 60 min/h. Notice that *min* cancel out so you have *mL/h* remaining.

$$\text{mL/min} \times 60 \text{ min/h} = \text{mL/h}$$

$$0.5 \text{ mL/}\cancel{\text{min}} \times 60 \text{ }\cancel{\text{min}}\text{/h} = 30 \text{ mL/h}$$

Regulate the flow rate to 30 mL/h to deliver 2 mg/min of lidocaine that is prepared at the concentration of 2 g per 500 mL of D_5W IV solution.

EXAMPLE 2 ■

Order: **nitroglycerin 125 mg IV in 500 mL D_5W to infuse at 42 mcg/min**

Calculate the flow rate in mL/h to program the infusion pump.

Step 1 Calculate mL/min (change mcg/min to mL/min)

First, convert mg to mcg: 1 mg = 1,000 mcg

$$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{125 \text{ mg}}{\text{X mcg}}$$

$$\text{X} = 125{,}000 \text{ mcg}$$

Then, calculate mL/min:

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{Dosage desired/min}}{\text{X Amount desired/min}}$$

$$\frac{125{,}000 \text{ mcg}}{500 \text{ mL}} \times \frac{42 \text{ mcg/min}}{\text{X mL/min}}$$

$$125{,}000\text{X} = 21{,}000$$

$$\frac{125{,}000\text{X}}{125{,}000} = \frac{21{,}000}{125{,}000}$$

$$\text{X} = 0.168 \text{ mL/min} = 0.17 \text{ mL/min}$$

Step 2 Determine the flow rate in mL/h (change mL/min to mL/h)

$$\frac{\text{Volume on hand}}{\text{Min to be infused}} = \frac{\text{X volume to be infused/h}}{60 \text{ min/h}}$$

$$\frac{0.17 \text{ mL}}{1 \text{ min}} \times \frac{\text{X mL/h}}{60 \text{ min/h}}$$

$$\text{X} = 10.2 \text{ mL/h} = 10 \text{ mL/h}$$

Or, you can just multiply mL/min by 60 min/h.

$\text{mL/min} \times 60 \text{ min/h} = \text{mL/h}$

$0.17 \text{ mL/}\cancel{\text{min}} \times 60 \text{ }\cancel{\text{min}}\text{/h} = 10.2 \text{ mL/h} = 10 \text{ mL/h}$

Regulate the flow rate to 10 mL/h to deliver 42 mcg/min of nitroglycerin that is prepared at the concentration of 125 mg per 500 mL of D_5W IV solution.

IV Medication Ordered Per Kilogram Per Minute

The physician may also order the amount of medication in an IV solution that a patient should receive in a specified time period per kilogram of body weight. An electronic infusion device is usually used to administer these orders.

RULE

To determine the flow rate (mL/h) for IV medications ordered per minute (such as mg/min):

Step 1 Convert to like units, such as mg to mcg or lb to kg

Step 2 Calculate desired dosage per minute: mg/kg/min × kg = mg/min

Step 3 Calculate the dosage flow rate in mL/min:

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{Dosage desired/min}}{\text{X Amount desired/min}}$$

Step 4 Calculate the flow rate in mL/h of the volume to administer per minute:

$$\frac{\text{Volume on hand}}{\text{Min to be infused}} = \frac{\text{X volume to be infused/h}}{60 \text{ min/h}}$$

Or,

$\text{mL/min} \times 60 \text{ min/h} = \text{mL/h}$

Note: The order may specify mg/min, mcg/min, g/min, units/min, milliunits/min, or mEq/min; or mg/h, mcg/h, g/h, units/h, milliunits/h, or mEq/h

EXAMPLE 1 ■

Order: **250 mL of IV solution with 225 mg of a medication to infuse at 3 mcg/kg/min via infusion pump** for a person who weighs 110 lb.

Determine the flow rate in mL/h.

Step 1 Convert mg to mcg: 1 mg = 1,000 mcg

$$\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{225\text{ mg}}{\text{X mcg}}$$

$$\text{X} = 225{,}000\text{ mcg}$$

Convert lb to kg: 1 kg = 2.2 lb

$$\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{\text{X kg}}{110\text{ lb}}$$

$$2.2\text{X} = 110$$

$$\frac{2.2\text{X}}{2.2} = \frac{110}{2.2}$$

$$\text{X} = 50\text{ kg}$$

Step 2 Calculate desired mcg/min

$$3\text{ mcg/}\cancel{\text{kg}}\text{/min} \times 50\text{ }\cancel{\text{kg}} = 150\text{ mcg/min}$$

Step 3 Calculate mL/min

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{Dosage desired/min}}{\text{X Amount desired/min}}$$

$$\frac{225{,}000\text{ mcg}}{250\text{ mL}} \times \frac{150\text{ mcg/min}}{\text{X mL/min}}$$

$$225{,}000\text{X} = 37{,}500$$

$$\frac{225{,}000\text{X}}{225{,}000} = \frac{37{,}500}{225{,}000}$$

$$\text{X} = 0.166\text{ mL/min} = 0.17\text{ mL/min}$$

Step 4 Calculate mL/h

$$\frac{\text{Volume on hand}}{\text{Min to be infused}} = \frac{\text{X volume to be infused/h}}{60\text{ min/h}}$$

$$\frac{0.17\text{ mL}}{1\text{ min}} \times \frac{\text{X mL/h}}{60\text{ min/h}}$$

$$\text{X} = 10.2\text{ mL/h} = 10\text{ mL/h}$$

Or, you can just multiply mL/min by 60 min/h.

$$\text{mL/min} \times 60\text{ min/h} = \text{mL/h}$$

$$0.17\text{ mL/}\cancel{\text{min}} \times 60\text{ }\cancel{\text{min}}\text{/h} = 10.2\text{ mL/h} = 10\text{ mL/h}$$

Regulate the flow rate to 10 mL/h to deliver 150 mcg/min (3 mcg/kg/min) of the drug that is prepared at the concentration of 225 mg per 250 mL of IV solution for a person who weighs 110 lb or 50 kg.

Titrating IV Drugs

Sometimes IV medications may be ordered to be administered at an initial dosage over a specified time period and then continued at a different dosage and time period. These situations are common in obstetrics and critical care. Medications, such as magnesium sulfate, dopamine, Isuprel, and Pitocin, are ordered to be *titrated* or *regulated* to obtain measurable physiologic responses. Dosages will be adjusted until the desired effect is achieved. In some cases, a loading or bolus dose is infused and monitored closely. Most IV medications that require titration usually start at the lowest dosage and are increased or decreased as needed. An upper titration limit is usually set and is not exceeded unless the desired response is not obtained. A new drug order is then required.

Let's look at some of these situations.

RULE

To calculate flow rate (mL/h) for IV medications ordered over a specific time period (e.g., mg/min):

Step 1 Calculate mg/mL.

Step 2 Calculate mL/h.

Note: The order may specify mg/min, mcg/min, g/min, units/min, milliunits/min, or mEq/min; or mg/h, mcg/h, g/h, units/h, milliunits/h, or mEq/h.

EXAMPLE 1 ■

Order: **RL 1,000 mL IV $\bar{c}$ magnesium sulfate 20 g. Start with bolus of 4 g for 30 min, then maintain a continuous infusion at 2 g/h.**

1. What is the flow rate in mL/h for the bolus order?

Step 1 Calculate the bolus dosage in g/mL.

There are 20 g in 1,000 mL. How many mL are necessary to infuse 4 g?

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

$$\frac{20\text{ g}}{1{,}000\text{ mL}} \times \frac{4\text{ g}}{\text{X mL}}$$

$$20X = 4{,}000$$

$$\frac{20X}{20} = \frac{4{,}000}{20}$$

$$X = 200\text{ mL}$$

Therefore, 200 mL contain 4 g, to be administered over 30 min.

Step 2 Calculate the bolus rate in mL/h.

What is the flow rate in mL/h to infuse 200 mL (which contain 4 g of magnesium sulfate)? Remember 1 h = 60 min.

$$\frac{\text{Volume on hand}}{\text{Min to be infused}} = \frac{\text{X volume to be infused/h}}{\text{60 min/h}}$$

$$\frac{200\text{ mL}}{30\text{ min}} \times \frac{\text{X mL/h}}{60\text{ min/h}}$$

$$30X = 12{,}000$$

$$\frac{30X}{30} = \frac{12{,}000}{30}$$

$$X = 400\text{ mL/h}$$

Set the infusion pump at 400 mL/h to deliver the bolus of 4 g for 30 min as ordered.

Now calculate the continuous IV rate in mL/h.

2. What is the flow rate in mL/h for the continuous infusion of magnesium sulfate of 2 g/h? You know from the bolus dosage calculation that 200 mL contain 4 g.

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{Dosage desired/h}}{\text{X Amount desired/h}}$$

$$\frac{4\text{ g}}{200\text{ mL}} \times \frac{2\text{ g/h}}{\text{X mL/h}}$$

$$4X = 400$$

$$\frac{4X}{4} = \frac{400}{4}$$

$$X = 100\text{ mL/h}$$

After the bolus has infused in the first 30 min, reset the infusion pump to 100 mL/h to deliver the continuous infusion of 2 g/h.

Let's look at an example using Pitocin (a drug used to induce or augment labor), measured in units and milliunits.

EXAMPLE 2 ■

A drug order is written to induce labor: **LR 1,000 mL IV c̄ Pitocin 20 units. Begin a continuous infusion IV at 1 milliunit/min, increase by 1 milliunit/min q.15 min to a maximum of 20 milliunits/min.**

1. What is the flow rate in mL/h to deliver 1 milliunit/min?

In this example, the medication is measured in units (instead of g or mg).

Step 1 Calculate milliunits/mL.

Convert: 1 unit = 1,000 milliunits; 20 units = 20,000 milliunits

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{Dosage desired}}{\text{X Amount desired}}$$

Dosage on hand: 20,000 milliunits

Amount of solution on hand: 1,000 mL

Dosage desired: 1 milliunit

$$\frac{20{,}000\text{ milliunits}}{1{,}000\text{ mL}} \times \frac{1\text{ milliunit}}{X\text{ mL}}$$

$$20{,}000X = 1{,}000$$

$$\frac{20{,}000X}{20{,}000} = \frac{1{,}000}{20{,}000}$$

$$X = 0.05\text{ mL}$$

Therefore, 0.05 mL contains 1 milliunit of Pitocin, or there is 1 milliunit per 0.05 mL.

Step 2 Calculate mL/h.

What is the flow rate in mL/h to infuse 0.05 mL/min (which is 1 milliunit Pitocin/min)?

$$\frac{\text{Volume on hand}}{\text{Min to be infused}} = \frac{\text{X volume to be infused/h}}{\text{60 min/h}}$$

$$\frac{0.05\text{ mL}}{1\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$$

$$X = 3\text{ mL/h}$$

Set the infusion pump at 3 mL/h to infuse Pitocin 1 milliunit/min as ordered.

2. What is the maximum flow rate in mL/h that the Pitocin infusion can be set for the titration as ordered? Notice that the order allows a maximum of 20 milliunits/min. You know from the bolus dosage calculation that there is 1 milliunit per 0.05 mL.

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{Dosage desired/min}}{\text{X Amount desired/min}}$$

Dosage on hand: 1 milliunit

Amount of solution: 0.5 mL

Dosage desired: 20 milliunits/min

$$\frac{1 \text{ milliunit}}{0.05 \text{ mL}} \times \frac{20 \text{ milliunits/min}}{\text{X mL/min}}$$

$$\text{X} = 0.05 \times 20$$

$$\text{X} = 1 \text{ mL/min}$$

Now convert mL/min to mL/h, so you can program the electronic infusion device.

$$\frac{\text{Volume on hand}}{\text{Min to be infused}} = \frac{\text{X volume to be infused/h}}{\text{60 min/h}}$$

$$\frac{1 \text{ mL}}{1 \text{ min}} \times \frac{\text{X mL/h}}{\text{60 min/h}}$$

$$\text{X} = 60 \text{ mL/h}$$

Or, you can just multiply mL/min by 60 min/h.

$\text{mL/min} \times 60 \text{ min/h} = \text{mL/h}$

$1 \text{ mL/}\cancel{\text{min}} \times 60 \text{ }\cancel{\text{min}}\text{/h} = 60 \text{ mL/h}$

You know that 1 milliunit/min is infused at 3 mL/h.

$$\frac{3 \text{ mL/h}}{1 \text{ milliunit/min}} \times \frac{\text{X mL/h}}{20 \text{ milliunits/min}}$$

$$\text{X} = 60 \text{ mL/h}$$

Rate of 60 mL/h will deliver 20 milliunits/min.

Verifying Safe IV Medication Dosage Recommended Per Minute

It is also a critical nursing skill to be sure that patients are receiving safe dosages of medications. Therefore, you must also be able to convert critical care IVs with additive medications to **mg/h** or **mg/min** to check safe or normal dosage ranges.

RULE

To check safe dosage of IV medications ordered in mL/h:

Step 1 Calculate mg/h

Step 2 Calculate mg/min

Step 3 Compare recommended dosage and ordered dosage to decide if the dosage is safe.

Note: The ordered and recommended dosages may specify mg/min, mcg/min, g/min, units/min, milliunits/min, or mEq/min.

EXAMPLE ■

The *Hospital Formulary* states that the recommended dosage of Lidocaine is 1–4 mg/min. The patient has an order for **D_5W 500 mL IV $\bar{c}$ lidocaine 1 g to infuse at 30 mL/h.** Is the lidocaine dosage within the safe range?

Step 1 Calculate mg/h.

Convert: 1 g = 1,000 mg

Remember, the unknown X is mg/h. Notice that X is in the numerator of the second ratio in this proportion.

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{X Dosage desired/h}}{\text{Amount desired/h}}$$

$$\frac{1{,}000 \text{ mg}}{500 \text{ mL}} \times \frac{\text{X mg/h}}{30 \text{ mL/h}}$$

$$500\text{X} = 30{,}000$$

$$\frac{500\text{X}}{500} = \frac{30{,}000}{500}$$

$$\text{X} = 60 \text{ mg/h}$$

60 mg are administered in one hour when the flow rate is 30 mL/h.

Step 2 Calculate mg/min. THINK: It is obvious that 60 mg/h is the same as 60 mg per 60 min or 1 mg/min.

$$\frac{60 \text{ mg}}{60 \text{ min}} \times \frac{\text{X mg}}{1 \text{ min}}$$

$$60\text{X} = 60$$

$$\frac{60\text{X}}{60} = \frac{60}{60}$$

$$\text{X} = 1 \text{ mg}$$

Rate is 1 mg/min.

Step 3 Compare ordered and recommended dosages.

1 mg/min is within the safe range of 1 to 4 mg/min. The dosage is safe.

Likewise, IV medications ordered as mL/h and recommended in mg/kg/min require verification of their safety or normal dosage range.

RULE

To check safe dosage of IV medications recommended in mg/kg/min and ordered in mL/h:

Step 1 Convert to like units, such as mg to mcg or lb to kg.

Step 2 Calculate recommended mg/min.

Step 3 Calculate ordered mg/h.

Step 4 Calculate ordered mg/min.

Step 5 Compare ordered and recommended dosages. Decide if the dosage is safe.

Note: The ordered and recommended dosages may specify mg/kg/min, mcg/kg/min, g/kg/min, units/kg/min, milliunits/kg/min, or mEq/kg/min.

EXAMPLE ■

The recommended dosage range of Nitropress for adults is 0.3–10 mcg/kg/min. The patient has an order for D_5W 100 mL IV with Nitropress 420 mg to infuse at 1 mL/h. The patient weighs 154 lb. Is the Nitropress dosage within the normal range?

Step 1 Convert lb to kg

$$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{\text{X kg}}{154 \text{ lb}}$$

$$2.2\text{X} = 154$$

$$\frac{2.2\text{X}}{2.2} = \frac{154}{2.2}$$

$$\text{X} = 70 \text{ kg}$$

Convert mg to mcg: 420 mg = 420,000 mcg

Step 2 Calculate recommended mcg/min range.

minimum: $0.3 \text{ mcg}/\cancel{\text{kg}}/\text{min} \times 70 \cancel{\text{kg}} = 21 \text{ mcg/min}$

maximum: $10 \text{ mcg}/\cancel{\text{kg}}/\text{min} \times 70 \cancel{\text{kg}} = 700 \text{ mcg/min}$

Step 3 Calculate ordered mcg/h.

$$\frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired/h}}{\text{X Amount desired/h}}$$

$$\frac{420{,}000 \text{ mcg}}{100 \text{ mL}} \times \frac{\text{X mcg/h}}{1 \text{ mL/h}}$$

$$100X = 420{,}000$$

$$\frac{100X}{100} = \frac{420{,}000}{100}$$

$$X = 4{,}200 \text{ mcg/h}$$

Step 4 Calculate ordered mcg/min

You know 1 h = 60 min; therefore, 4,200 mcg/h = 4,200 mcg per 60 min. How many mcg can be infused in 1 min?

$$\frac{4{,}200 \text{ mcg}}{60 \text{ min}} \times \frac{\text{X mcg}}{1 \text{ min}}$$

$$60X = 4{,}200$$

$$\frac{60X}{60} = \frac{4{,}200}{60}$$

$$X = 70 \text{ mcg (per minute)}$$

This is also a simple division problem.

$$\frac{4{,}200 \text{ mcg}}{60 \text{ min}} = 70 \text{ mcg/min}$$

Step 5 Compare ordered and recommended dosages. Decide if the dosage is safe. 70 mcg/min is within the allowable range of 21 to 700 mcg/min. The ordered dosage is safe.

QUICK REVIEW

- For IV medications ordered in mg/min:
  - **Step 1** Calculate mL/min
  - **Step 2** Calculate mL/h
- To check safe dosages of IV medications recommended in mg/min and ordered in mL/h:
  - **Step 1** Calculate mg/h
  - **Step 2** Calculate mg/min
  - **Step 3** Compare recommended and ordered dosages. Decide if the dosage is safe.
- To check safe dosage of IV medications recommended in mg/kg/min and ordered in mL/h:
  - **Step 1** Convert to like units, such as mg to mcg or lb to kg
  - **Step 2** Calculate recommended mg/min
  - **Step 3** Calculate ordered mg/h
  - **Step 4** Calculate ordered mg/min
  - **Step 5** Compare ordered and recommended dosages. Decide if the dosage is safe.

Review Set 47

Compute the flow rate for each of these medications administered by infusion pump.

1. Order: **lidocaine 2 g IV per 1,000 mL D_5W at 4 mg/min**

   Rate: ________ mL/min and ________ mL/h

2. Order: **Pronestyl 0.5 g IV per 250 mL D_5W at 2 mg/min**

   Rate: ________ mL/min and ________ mL/h

3. Order: **Isuprel 2 mg IV per 500 mL D_5W at 6 mcg/min**

   Rate: ________ mL/min and ________ mL/h

4. Order: **Medication X 450 mg IV per 500 mL NS at 4 mcg/kg/min**

   Weight: 198 lb

   Weight: ________ kg Give: ________ mcg/min

   Rate: ________ mL/min and ________ mL/h

5. Order: **dopamine 800 mg in 500 mL NS IV at 15 mcg/kg/min**

   Weight: 70 kg

   Give: ________ mcg/min

   Rate: ________ mL/min and ________ mL/h

Refer to this order for questions 6 through 8.

Order: **D_5W 500 mL IV $\bar{c}$ Dobutrex 500 mg to infuse at 15 mL/h.** The patient weighs 125 lb. Recommended range: 2.5–10 mcg/kg/min

6. What mcg/min range of Dobutrex should this patient receive?
   ________ to ________ mcg/min

7. What mg/min range of Dobutrex should this patient receive?
   ________ to ________ mg/min

8. Is the Dobutrex as ordered within the safe range? ________

Refer to this order for questions 9 and 10.

Order: **D_5W 500 mL IV $\bar{c}$ Pronestyl 2 g to infuse at 60 mL/h.** Normal range: 2–6 mg/min

9. How many mg/min of Pronestyl is the patient receiving? ________ mg/min

10. Is the dosage of Pronestyl within the normal range? ________

11. Order: **magnesium sulfate 20 g IV in LR 500 mL. Start with a bolus of 2 g to infuse over 30 min. Then maintain a continuous infusion at 1 g/h.**

    Rate: ________ mL/h for bolus

    ________ mL/h for continuous infusion

12. A drug order is written to induce labor as follows:

    Pitocin 15 units IV in 250 mL LR. Begin a continuous infusion at the rate of 1 milliunit/min.

    Rate: ________ mL/h

Refer to this order for questions 13 through 15.

Order: **D_5W 1,000 mL IV with Brethine 10 mg to infuse at 150 mL/h.**

Normal dosage range: 10–80 mcg/min

13. How many mg/min of Brethine is the patient receiving? ________ mg/min
14. How many mcg/min of Brethine is the patient receiving? ________ mcg/min
15. Is the dosage of Brethine within the normal range? ________

After completing these problems, see pages 534-536 to check your answers.

LIMITING INFUSION VOLUMES

Calculating IV rates to include the IV PB volume may be necessary to limit the total volume of IV fluid a patient receives. To do this, you must calculate the flow rate for both the regular IV and the piggyback IV. In such instances of restricted fluids, the piggyback IVs are to be included as part of the total prescribed IV volume and time.

RULE

Follow these six steps to calculate the flow rate of an IV, which includes IV PB.

Step 1 *IV PB flow rate:* $\frac{V}{T} \times C = R$

or use $\frac{\text{mL/h}}{\text{Drop factor constant}} = R$

Step 2 *Total IV PB time:* Time for one dose × # of doses in 24 h

Step 3 *Total IV PB volume:* Volume of one dose × # of doses in 24 h

Step 4 *Total regular IV volume:* Total volume − IV PB volume = Regular IV volume

Step 5 *Total regular IV time:* Total time − IV PB time = Regular IV time

Step 6 *Regular IV flow rate:* $\frac{V}{T} \times C = R$

or use $\frac{\text{mL/h}}{\text{Drop factor constant}} = R$

EXAMPLE 1 ■

Order: D_5LR 3,000 mL IV for 24 h with Kefzol 1 g IV PB per 100 mL D_5W q.6h to run 1 hour. Limit total fluids to 3,000 mL daily.

The drop factor is 10 gtt/mL.

NOTE: The order intends that the patient will receive a maximum of 3,000 mL in 24 hours. Remember, when fluids are restricted, the piggybacks are to be *included* in the total 24-hour intake, not added to it.

Step 1 Calculate the flow rate of the IV PB.

$$\frac{V}{T} \times C = \frac{100\ \cancel{\text{mL}}}{\underset{6}{\cancel{60}}\ \text{min}} \times \overset{1}{\cancel{10}}\ \text{gtt}/\cancel{\text{mL}} = \frac{100\ \text{gtt}}{6\ \text{min}} = 16.6\ \text{gtt/min} = 17\ \text{gtt/min}$$

or $\frac{\text{mL/h}}{\text{Drop factor constant}} = \text{gtt/min}$ (Drop factor constant is 6.)

$$\frac{100\ \text{mL/h}}{6} = 16.6\ \text{gtt/min} = 17\ \text{gtt/min}$$

Set the flow rate for the IV PB at 17 gtt/min to infuse 1 g Kefzol in 100 mL over 1 hour or 60 min.

Step 2 Calculate the total time the IV PB will be administered.

q.6h = 4 times per 24 h; 4 × 1 h = 4 h

Step 3 Calculate the total volume of the IV PB.

100 mL × 4 = 400 mL IV PB per 24 hours.

Step 4 Calculate the volume of the regular IV fluids to be administered between IV PB. Total volume of regular IV minus total volume of IV PB: 3,000 mL − 400 mL = 2,600 mL.

Step 5 Calculate the total regular IV fluid time or the time between IV PB. Total IV time minus total IV PB time: 24 h − 4 h = 20 h

Step 6 Calculate the flow rate of the regular IV.

$$\text{mL/h} = \frac{2{,}600\ \text{mL}}{20\ \text{h}} = 130\ \text{mL/h}$$

$$\frac{V}{T} \times C = \frac{130\ \cancel{\text{mL}}}{\underset{6}{\cancel{60}}\ \text{min}} \times \overset{1}{\cancel{10}}\ \text{gtt}/\cancel{\text{mL}} = \frac{130\ \text{gtt}}{6\ \text{min}} = 21.6\ \text{gtt/min} = 22\ \text{gtt/min}$$

$$\text{or}\ \frac{\text{mL/h}}{\text{Drop factor constant}} = \text{gtt/min (Drop factor constant is 6.)}$$

$$\frac{130\ \text{mL/h}}{6} = 21.6\ \text{gtt/min} = 22\ \text{gtt/min}$$

Set the regular IV of D_5LR at the flow rate of 22 gtt/min. Then after 5 hours, switch to the Kefzol IV PB at the flow rate of 17 gtt/min for 1 hour. Repeat this process four times in 24 hours.

EXAMPLE 2 ■

Order: **NS 2,000 mL IV for 24 h with 80 mg gentamycin in 80 mL IV PB q.8h to run for 30 min. Limit fluid intake to 2,000 mL daily.**

Drop factor: 15 gtt/mL

Calculate the flow rate for the regular IV and for the IV PB.

Step 1 IV PB flow rate:

$$\frac{V}{T} \times C = \frac{80\ \cancel{\text{mL}}}{\underset{2}{\cancel{30}}\ \text{min}} \times \overset{1}{\cancel{15}}\ \text{gtt}/\cancel{\text{mL}} = \frac{80\ \text{gtt}}{2\ \text{min}} = 40\ \text{gtt/min}$$

Step 2 Total IV PB time: q.8h = 3 times per 24 h; 3 × 30 min = 90 min

$$90\ \cancel{\text{min}} \div 60\ \cancel{\text{min}}/\text{h} = \frac{90}{60}\ \text{h} = 1\tfrac{1}{2}\ \text{h}$$

Step 3 Total IV PB volume: 80 mL × 3 = 240 mL

Step 4 Total regular IV volume: 2,000 mL – 240 mL = 1,760 mL

Step 5 Total regular IV time: 24 h − $1\tfrac{1}{2}$ h = $22\tfrac{1}{2}$ h = 22.5 h

Step 6 Regular IV flow rate:

$$\text{mL/h} = \frac{1{,}760\ \text{mL}}{22.5\ \text{h}} = 78.2 = 78\ \text{mL/h}$$

$$\frac{V}{T} \times C = \frac{78\ \cancel{\text{mL}}}{\underset{4}{\cancel{60}}\ \text{min}} \times \overset{1}{\cancel{15}}\ \text{gtt}/\cancel{\text{mL}} = \frac{78\ \text{gtt}}{4\ \text{min}} = 19.5\ \text{gtt/min} = 20\ \text{gtt/min}$$

$$\text{or}\ \frac{\text{mL/h}}{\text{Drop factor constant}} = \text{R (Drop factor constant is 4.)}$$

$$\frac{78\ \text{mL/h}}{4} = 19.5\ \text{gtt/min} = 20\ \text{gtt/min}$$

Set the regular IV of NS at the flow rate of 20 gtt/min. After $7\tfrac{1}{2}$ hours, switch to the gentamycin IV PB at the flow rate of 40 gtt/min for 30 minutes. Repeat this process three times in 24 hours.

Patients receiving a primary IV at a specific rate via an infusion controller or pump may require that the infusion rate be altered when a secondary (piggyback) medication is being administered. To do this, calculate the flow rate of the secondary medication in mL/h as you would for the primary IV, and reset the infusion device.

Some infusion controllers or pumps allow you to set the flow rate for the secondary IV independent of the primary IV. Upon completion of the secondary infusion, the infusion device automatically returns to the original flow rate. If this is not the case, be sure to manually readjust the primary flow rate after the completion of the secondary set.

QUICK REVIEW

- To calculate the flow rate of a regular IV with an IV PB and restricted fluids, calculate:

Step 1 IV PB flow rate

Step 2 Total IV PB time

Step 3 Total IV PB volume

Step 4 Total regular IV volume

Step 5 Total regular IV time

Step 6 Regular IV flow rate

Review Set 48

Calculate the flow rates for the IV and IV PB orders. These patients are on limited fluid volume (restricted fluids).

1. Orders: NS 3,000 mL IV for 24 h
   Limit total IV fluids to 3,000 mL daily
   penicillin G potassium 1,000,000 units IV PB q.4h in 100 mL NS to run for 30 min
   Drop factor: 10 gtt/mL
   IV PB flow rate: ________ gtt/min
   IV flow rate: ________ gtt/min
2. Orders: D_5W 1,000 mL IV for 24 h
   Limit total IV fluids to 1,000 mL daily
   Garamycin 40 mg q.i.d. in 40 mL IV PB to run 1 h
   Drop factor: 60 gtt/mL
   IV PB flow rate: ________ gtt/min
   IV flow rate: ________ gtt/min
3. Orders: D_5 LR 3,000 mL IV for 24 h
   Limit total IV fluids to 3,000 mL daily
   ampicillin 0.5 g q.6h IV PB in 50 mL D_5W to run 30 min
   Drop factor: 15 gtt/mL
   IV PB flow rate: ________ gtt/min
   IV flow rate: ________ gtt/min
4. Orders: $\frac{1}{2}$ NS 2,000 mL IV for 24 h
   Limit total IV fluids to 2,000 mL daily
   Chloromycetin 500 mg per 50 mL NS IV PB q.6h to run 1 h
   Drop factor: 60 gtt/mL

IV PB flow rate: ________ gtt/min

IV flow rate: ________ gtt/min

5. Orders: LR 1,000 mL IV for 24 h

Limit total IV fluids to 1,000 mL daily

Kefzol 250 mg IV PB per 50 mL D_5W q.8h to run 1 h

Drop factor: 60 gtt/mL

IV PB flow rate: ________ gtt/min

IV flow rate: ________ gtt/min

6. Orders: D_5 LR 2,400 mL IV for 24 h

Limit total IV fluids to 2,400 mL daily

Ancef 1 g IV PB q.6h in 50 mL D_5W to run 30 min

Drop factor: On infusion pump

IV PB flow rate: ________ mL/h

IV flow rate: ________ mL/h

7. Orders: NS 2,000 mL IV for 24 h

Limit total IV fluids to 2,000 mL daily

Garamycin 100 mg IV PB q.8h in 100 mL D_5W to run in over 30 min

Drop factor: On infusion controller

IV PB flow rate: ________ mL/h

IV flow rate: ________ mL/h

8. Orders: D_5 0.45% NS 3,000 mL IV to run 24 h

Limit total IV fluids to 3,000 mL daily

Zantac 50 mg q.6h in 50 mL D_5W to infuse 15 min

Drop factor: On infusion controller

IV PB flow rate: ________ mL/h

IV flow rate: ________ mL/h

9. Orders: D_5 NS 1,500 mL IV to run 24 h

Limit total IV fluids to 1,500 mL daily

Kefzol 500 mg IV PB per 50 mL D_5W q.8 h to run 1 h

Drop factor: 20 gtt/mL

IV PB flow rate: ________ gtt/min

IV flow rate: ________ gtt/min

10. Orders: NS 2,700 mL IV for 24 h

Limit total IV fluids to 2,700 mL per day

gentamycin 60 mg in 60 mL D_5W IV PB q.8h to run for 30 min

Drop factor: On infusion pump

IV PB flow rate: ________ mL/h

IV flow rate: ________ mL/h

After completing these problems, see pages 536-538 to check your answers.

CRITICAL THINKING SKILLS

The importance of knowing the therapeutic dosage of a given medication is a critical nursing skill. Let's look at an example in which the order was unclear, and the nurse did not verify the order with the appropriate person.

ERROR

Failing to clarify an order.

Possible Scenario

Suppose the physician ordered a heparin infusion for a patient with thrombophlebitis who weighs 100 kg. The facility uses the Standard Weight-Based Heparin Protocol as seen in Figure 16-2, page 408. The order was written this way:

heparin 25000 units in 250 mL $\frac{1}{2}$ NS IV at 18000/h.

The order was difficult to read and the nurse asked a co-worker to help her decipher it. They both agreed that it read 18,000 units per hour. The nurse calculated mL/h to be:

$$\frac{\text{Dosage on hand}}{\text{Amount of solution on hand}} = \frac{\text{Dosage desired/h}}{\text{X Amount desired/h}}$$

$$\frac{25{,}000\text{ units}}{250\text{ mL}} \times \frac{18{,}000\text{ units/h}}{\text{X mL/h}}$$

$$25{,}000\text{X} = 4{,}500{,}000$$

$$\frac{25{,}000\text{X}}{25{,}000} = \frac{4{,}500{,}000}{25{,}000}$$

$$\text{X} = 180\text{ mL/h}$$

She proceeded to start the heparin drip at 180 mL/h. The patient's APTT prior to initiation of the infusion was 37 seconds. Six hours into the infusion, an APTT was drawn according to protocol. The nurse was shocked when the results returned and were 95 seconds, which is abnormally high. She called the physician, who asked, "What is the rate of the heparin drip?" The nurse replied, "I have

PRACTICE PROBLEMS—CHAPTER 16

You are working on the day shift 0700–1500 hours. You observe that one of the patients assigned to you has an IV infusion with a volume control set. His orders include:

D_5W IV at 50 mL/h for continuous infusion

Pipracil 1 g IV q.6h

The pharmacy supplies the Pipracil in a prefilled syringe labeled *1 g per 5 mL* with instructions to *add Pipracil to volume control set, and infuse over 30 minutes.* Answer questions 1 through 5.

1. What is the drop factor of the volume control set? ________ gtt/mL
2. What amount of Pipracil will you add to the chamber? ________ mL
3. How much D_5W IV fluid will you add to the chamber with the Pipracil? ________ mL
4. To maintain the flow rate at 50 mL/h, you will time the IV Pipracil to infuse at ________ gtt/min.
5. The medication administration record indicates that the patient received his last dose of IV Pipracil at 0600. How many doses of Pipracil will you administer during your shift? ________

the infusion set at 180 mL/h so the patient receives the prescribed amount of 18,000 units per hour." The physician was astonished and replied, "I ordered the drip at 1,800 units per hour, not 18,000 units per hour."

Potential Outcome

The physician would likely have discontinued the heparin; ordered protamine sulfate, the antidote for heparin overdosage; and obtained another APTT. The patient may have started to show signs of abnormal bleeding, such as blood in the urine, bloody nose, and increased tendency to bruise.

Prevention

When the physician wrote the order for 1800 U/h, the U for looked like an 0 and the nurse misinterpreted the order as 18,000 units. The nurse missed three opportunities to prevent this error. The order as written is unclear, unsafe, and incomplete. Contacting the physician and requesting a clarification of the order are appropriate actions for several reasons. First, the writing is unclear and does not follow JCAHO guidelines, which are automatic cautions to contact the prescribing practitioner for clarification. The prescriber should have used commas to write amounts of 1,000 and greater; and the prescriber should have spelled out *units* rather than use the *U* abbreviation. Guessing about the exact meaning of an order is dangerous, as this scenario demonstrates.

Second, the Standard Weight-Based Heparin Protocol recommends a safe heparin infusion rate of 1,800 units/h or 18 mL/h (with a supply dosage of 25,000 units per 250 mL or 100 units/mL) for an individual weighing 100 kg. It is the responsibility of the individual administering a medication to be sure the Six Rights of medication administration are observed. The first three rights state that the *"**right** patient must receive the **right** drug in the **right** amount."* The order of 18,000 units as understood by the nurse was unsafe. The patient was overdosed by 10 times the recommended amount of heparin.

Third, if the nurse clearly interpreted the order as 18,000, then no unit of measure was specified, which is a medication error that requires contact with the physician for correction. An incomplete order must not be filled.

6. Order: **heparin 25,000 units in 250 mL 0.45% NS to infuse at 1,200 units/h**

   Drop factor: On infusion controller

   Flow rate: ________ mL/h.

7. Order: **thiamine 100 mg per L D_5W IV to infuse at 5 mg/h**

   Drop factor: On infusion pump

   Flow rate: ________ mL/h

8. Order: **magnesium sulfate 4 g in 500 mL D_5W at 500 mg/h**

   Drop factor: On infusion pump

   Flow rate: ________ mL/h

9. A patient is to receive **D_5W 500 mL $\bar{c}$ heparin 20,000 units at 1,400 units/h.**

   Set the infusion pump at ________ mL/h.

10. At the rate of 4 mL/min, how long will it take to administer 1.5 L of IV fluid? ________ h and ________ min

11. Order: **lidocaine 2 g in 500 mL D_5W IV to run at 4 mg/min**

Drop factor: On infusion pump

Flow rate: ________ mL/h

12. Order: **Xylocaine 1 g IV in 250 mL D_5W at 3 mg/min**

Drop factor: On infusion controller

Flow rate: ________ mL/h

13. Order: **procainamide 1 g IV in 500 mL D_5W to infuse at 2 mg/min**

Drop factor: On infusion pump

Flow rate: ________ mL/h

14. Order: **dobutamine 250 mg IV in 250 mL D_5W to infuse at 5 mcg/kg/min**

Weight: 80 kg

Drop factor: On infusion controller

Flow rate: ________ mL/h

15. Your patient has **D_5W 1 L IV with 2 g lidocaine added infusing at 75 mL/h.** The recommended continuous IV dosage of lidocaine is 1–4 mg/min. Is this dosage safe? ________

16. Order: **Restricted fluids: 3,000 mL D_5 NS IV for 24 h**

Chloromycetin 1 g IV PB in 100 mL NS q.6h to run 1 h

Drop factor: 10 gtt/mL

Flow rate: ________ gtt/min IV PB and ________ gtt/min primary IV

17. Order: **Restricted fluids: 3,000 mL D_5W IV for 24 h**

ampicillin 500 mg in 50 mL D_5W IV PB q.i.d. for 30 min

Drop factor: On infusion pump

Flow rate: ________ mL/h IV PB and ________ mL/h primary IV

18. Order: **50 mg Nitropress IV in 500 mL D_5W to infuse at 3 mcg/kg/min**

Weight: 125 lb

Drop factor: On infusion pump

Flow rate: ________ mL/h

19. Order: **KCl 40 mEq to each liter IV fluid**

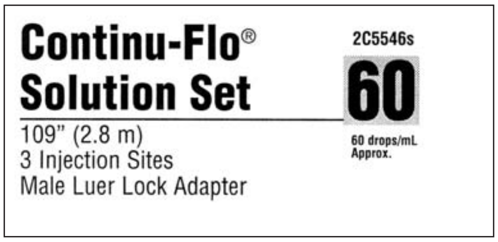
Situation: IV discontinued with 800 mL remaining

How much KCl infused? ________

20. A patient's infusion rate is 125 mL/h. The rate is equivalent to ________ mL/min

21. Order: **$\frac{1}{2}$ NS 1,500 mL IV to run at 100 mL/h.** Calculate the infusion time. ________ h

Use the infusion set that follows to calculate the information requested for questions 22 and 23.



Continu-Flo®
Solution Set
109" (2.8 m)
3 Injection Sites
Male Luer Lock Adapter

2C5546s
60
60 drops/mL
Approx.

22. Order: **KCl 40 mEq/L D_5W IV to infuse at 2 mEq/h**

Rate: ________ mL/h

Rate: ________ gtt/min

23. Order: **heparin 50,000 units/L D_5W IV to infuse at 3,750 units/h**

Rate: ________ mL/h

Rate: ________ gtt/min

24. If the minimal dilution for tobramycin is 5 mg/mL and you are giving 37 mg, what is the least amount of fluid in which you could safely dilute the dosage? ________ mL

25. Order: **oxytocin 10 units IV in 500 mL NS. Infuse 4 milliunits/min for 20 min, followed by 6 milliunits/min for 20 min. Use electronic infusion pump.**

Rate: ________ mL/h for first 20 min

Rate: ________ mL/h for next 20 min

26. Order: **magnesium sulfate 20 g IV in 500 mL of LR solution. Start with a bolus of 3 g to infuse over 30 min. Then maintain a continuous infusion at 2 g/h.**

You will use an electronic infusion pump.

Rate: ________ mL/h for bolus

Rate: ________ mL/h for continuous infusion

27. Order: **Pitocin 15 units IV in 500 mL of LR solution. Infuse at 1 milliunit/min**

You will use an electronic infusion pump.

Rate: ________ mL/h

28. Order: **heparin drip 40,000 units/L D_5W IV to infuse at 1,400 units/h**

Drop factor: On infusion pump

Flow rate: ________ mL/h

Refer to this order for questions 29 and 30.

Order: **magnesium sulfate 4 g IV in 500 mL D_5W at 500 mg/h on an infusion pump**

29. What is the solution concentration? ________ mg/mL

30. What is the hourly flow rate? ________ mL/h

Calculate the drug concentration of the following IV solutions as requested.

31. A solution containing 80 units of oxytocin in 1,000 mL of D_5W: ________ milliunits/mL

32. A solution containing 200 mg of nitroglycerin in 500 mL of D_5W: ________ mg/mL

33. A solution containing 4 mg of Isuprel in 1,000 mL of D_5W: ________ mcg/mL

34. A solution containing 2 g of lidocaine in 500 mL of D_5W: ________ mg/mL

Refer to this order for questions 35 through 37.

Order: **Norcuron IV 1 mg/kg/min** to control respirations for a ventilated patient.

35. The patient weighs 220 pounds, which is equal to ________ kg.

36. The available Norcuron 20 mg is dissolved in 100 mL NS. This available solution concentration is ________ mg/mL, which is equivalent to ________ mcg/mL.

37. The IV is infusing at the rate of 1 mcg/kg/min on an infusion pump. The hourly rate is ________ mL/h.

Refer to this order for questions 38 through 43.

Order: **Restricted fluids: 3,000 mL per 24 h. Primary IV of D_5LR running via infusion pump.**
ampicillin 3 g IV PB q.6h in 100 mL of D_5W over 30 min
gentamycin 170 mg IV PB q.8h in 50 mL of D_5W to infuse in 1 h.

38. Calculate the IV PB flow rates. ampicillin: ________ mL/h; gentamycin: ________ mL/h

39. Calculate the total IV PB time. ________ h

40. Calculate the total IV PB volume. ________ mL

41. Calculate the total regular IV volume. ________ mL

42. Calculate the total regular IV time. ________ h

43. Calculate the regular IV flow rate. ________ mL/h

44. A 190 lb patient in renal failure receives **dopamine 800 mg in 500 mL of D_5W IV at 4 mcg/kg/min.** As the patient's blood pressure drops, the nurse titrates the drip to **12 mcg/kg/min** as ordered.

    What is the initial flow rate? ________ mL/h

    After titration, what is the flow rate? ________ mL/h

Questions 45 through 49 refer to your patient who has left leg deep vein thrombosis. He has orders for IV heparin therapy. He weighs 225 lb. On admission his APTT is 25 seconds. You initiate therapy at 1130 on 5/10/xx. Follow the Standard Weight-Based Heparin Protocol on 408. Record your answers on the Standard Weight-Based Heparin Protocol Worksheet on page 431.

45. What is the patient's weight in kilograms? ________ kg (Round to the nearest 10 kg and record on the worksheet.) What does the protocol indicate for the standard bolus dosage of heparin? ________ units/kg

Standard Weight-Based Heparin Protocol

For all patients on heparin drips:

1. Weight in kilograms. Required for order to be processed: ________ kg
2. Heparin 25,000 units in 250 mL of $\frac{1}{2}$NS. Boluses to be given as 1,000 units/mL.
3. APTT q.6h or 6 hours after rate change; daily after two consecutive therapeutic APTTs.
4. CBC initially and repeat every ________ days(s).
5. Obtain APTT and PT/INR on day one prior to initiation of therapy.
6. Guaiac stool initially then every ________ day(s) until heparin discontinued. Notify if positive.
7. Neuro checks every ________ hours while on heparin. Notify physician of any changes.
8. Discontinue APTT and CBC once heparin drip is discontinued, unless otherwise ordered.
9. Notify physician of any bleeding problems.
10. Bolus with 80 units/kg. Start drip at 18 units/kg/h.
11. If APTT is less than 35 secs: Rebolus with 80 units/kg and increase rate by 4 units/kg/h
12. If APTT is 36–44 secs: Rebolus with 40 units/kg and increase rate by 2 units/kg/h
13. If APTT is 45–75 secs: Continue current rate
14. If APTT is 76–90 secs: Decrease rate by 2 units/kg/h
15. If APTT is greater than 90 secs: Hold heparin for one hour and decrease rate by 3 units/kg/h

STANDARD WEIGHT-BASED HEPARIN PROTOCOL WORKSHEET

Round Patient's Total Body Weight to Nearest 10 kg: ________ kg
DO NOT Change the Weight Based on Daily Measurements

FOUND ON THE ORDER FORM
Initial Bolus (80 units/kg) ________ units ________ mL
Initial Infusion Rate (18 units/kg/h) ________ units/h ________ mL/h

Make adjustments to the heparin drip rate as directed by the order form.
ALL DOSES ARE ROUNDED TO THE NEAREST 100 UNITS

Date	Time	APTT	Bolus	Rate Change		New Rate	RN 1	RN 2
				units/h	mL/h			

If APTT is	Then
less than 35 secs:	Rebolus with 80 units/kg and increase rate by 4 units/kg/h
36–44 secs:	Rebolus with 40 units/kg and increase rate by 2 units/kg/h
45–75 secs:	Continue current rate
76–90 secs:	Decrease rate by 2 units/kg/h
greater than 90 secs:	Hold heparin for one hour and decrease rate by 3 units/kg/h

Signatures	Initials

46. Calculate the dosage of heparin that should be administered for the bolus for this patient. ________ units (Record on the worksheet.)

    What does the protocol indicate as the required solution concentration (supply dosage) of heparin to use for the bolus? ________ units/mL

    Calculate the dose volume of heparin that should be administered for the bolus for this patient. ________ mL (Record on the worksheet.)

47. What does the protocol indicate for the initial infusion rate? ________ units/kg/h

    Calculate the dosage of heparin this patient should receive each hour. ________ units/h (Record on the worksheet.)

    What does the protocol indicate as the required solution concentration (supply dosage) of heparin to use for the initial infusion? ________ units/mL

    Calculate the heparin solution volume this patient should receive each hour to provide the correct infusion for his weight. ________ mL/h (Record on the worksheet.)

48. According to the protocol, how often should the patient's APTT be checked? q.________ h

    At 1730, the patient's APTT is 37 seconds. Rebolus with heparin ________ units (________ mL) (Record on the worksheet.)

    How much should you change the infusion rate? (Increase or decrease?) ________ heparin ________ units/h and ________ mL/h (Record on the worksheet.)

    The new infusion rate will be heparin ________ mL/h (Record on the worksheet.)

49. At 2330, the patient's APPT is 77 seconds. What should you do now?

    ____

    The infusion rate will be heparin ________ mL/h (Record on the worksheet.)

50. Describe the strategy you would implement to prevent this medication error.

    Possible Scenario

    Suppose the physician writes an order to induce labor, as follows: **Pitocin 20 U IV added to 1 liter of LR beginning at 1 mU/min, then increase by 1 mU/min q 15 min to a maximum of 20 mU/min until adequate labor is reached.** The labor and delivery unit stocks Pitocin ampules 10 units per mL in boxes of 50 ampules. The nurse preparing the IV solution misread the order as "20 mL of Pitocin added to 1 liter of lactated Ringer's . . ." and pulled 20 ampules of Pitocin from the supply shelf. Another nurse, seeing this nurse drawing up medication from several ampules, asked what the nurse was preparing. When the nurse described the IV solution being prepared, he suddenly realized he had misinterpreted the order.

    Potential Outcome

    The amount of Pitocin that was being drawn up (20 mL) to be added to the IV solution would have been 10 units/mL × 20 mL = 200 units of Pitocin, 10 times the ordered amount of 20 units. Starting this Pitocin solution, even at the usual slow rate, would have delivered an excessively high amount of Pitocin that could have led to fatal consequences for both the fetus and laboring mother. What should the nurse have done to avoid this type of error?

    Prevention

    ____

    ____

After completing these problems, see pages 538-543 to check your answers.

SECTION 4 SELF-EVALUATION

Chapter 14—Intravenous Solutions, Equipment, and Calculations

1. Which of the following IV solutions is normal saline? ________ 0.45% NaCl

   ________ 0.9% NaCl ________ D_5W

2. What is the solute and concentration of 0.9% NaCl? ________________________________

3. What is the solute and concentration of 0.45% NaCl? ________________________________

Use the following information to answer questions 4 and 5.

Order: **D_5 0.45% NaCl 1,000 mL IV q.8h**

4. The IV solution contains ________ g dextrose.

5. The IV solution contains ________ g sodium chloride.

6. An order specifies **0.45% NS 500 mL IV q.6h**. The IV solution contains ________ g sodium chloride.

Refer to this order for questions 7 and 8.

Order: **D_{10} 0.9% NaCl 750 mL IV q.8h**

7. The IV solution contains ________ g dextrose.

8. The IV solution contains ________ g sodium chloride.

9. Are most electronic infusion devices calibrated in gtt/min, mL/h, mL/min, or gtt/mL? ________

Use the following information to answer questions 10 and 11.

Mrs. Wilson has an order to receive **2,000 mL of D_5NS IV fluids over 24 h**. The IV tubing is calibrated for a drop factor of 15 gtt/mL.

10. Calculate the watch count flow rate for Mrs. Wilson's IV. ________ gtt/min

11. An infusion controller becomes available, and you decide to use it to regulate Mrs. Wilson's IV. Set the controller at ________ mL/h.

12. Mrs. Hawkins returns from the delivery room at 1530 with 400 mL D_5LR infusing at 24 gtt/min with your hospital's standard macrodrop infusion control set calibrated at 15 gtt/mL. You anticipate that Mrs. Hawkins's IV will be complete at ________ (hours).

13. You start your shift at 3:00 PM. On your nursing assessment rounds, you find that Mr. Johnson has an IV of $D_5 \frac{1}{2}$ NS infusing at 32 gtt/min. The tubing is calibrated for 10 gtt/mL. Mr. Johnson will receive ________ mL during your 8-hour shift.

Use the following information to answer questions 14 through 16.

As you continue on your rounds, you find Mr. Boyd with an infiltrated IV and decide to restart it and regulate it on an electronic infusion pump. The orders specify:
NS 1,000 mL IV $\bar{c}$ 20 mEq KCl q.8h
Kefzol 250 mg IV PB per 100 mL NS q.8h over 30 min
Limit IV total fluids to 3,000 mL daily

14. Interpret Mr. Boyd's IV and medication order. ________________________________

    ____

15. Regulate the electronic infusion pump for Mr. Boyd's standard IV at ________ mL/h.

16. Regulate the electronic infusion pump for Mr. Boyd's IV PB at ________ mL/h.

17. Order: **D_5LR 1,200 mL IV at 100 mL/h.** You start this IV at 1530 and regularly observe the IV and the patient. The IV has been infusing as scheduled, but during your nursing assessment at 2200, you find 650 mL remaining. The flow rate is 100 gtt/min using a microdrip infusion set. Describe your action now. ____

____

Chapter 15—Body Surface Area and Advanced Pediatric Calculations

18. Order: **20 mEq KCl/L D_5NS IV continuous infusion at 20 mL/h**

    Because this is a child, you choose a 250 mL IV bag of D_5W. The KCL is available in a solution strength of 2 mEq/mL. Add ________ mL KCL to the 250 mL bag of D_5W.

Calculate the hourly maintenance IV rate for the children described in questions 19 through 22. Use the following recommendations:

First, 10 kg of body weight: 100 mL/kg/day

Second, 10 kg of body weight: 50 mL/kg/day

Each additional kg over 20 kg of body weight: 20 mL/kg/day

19. A 40 lb child requires ________ mL/day for maintenance IV fluids.
20. The infusion rate for the same 40 lb child is ________ mL/h.
21. An 1,185 g infant requires ________ mL/day for maintenance IV fluids.
22. The infusion rate for the same 1,185 g infant is ________ mL/h.

Use the BSA formula method (378) to answer questions 23 and 24.

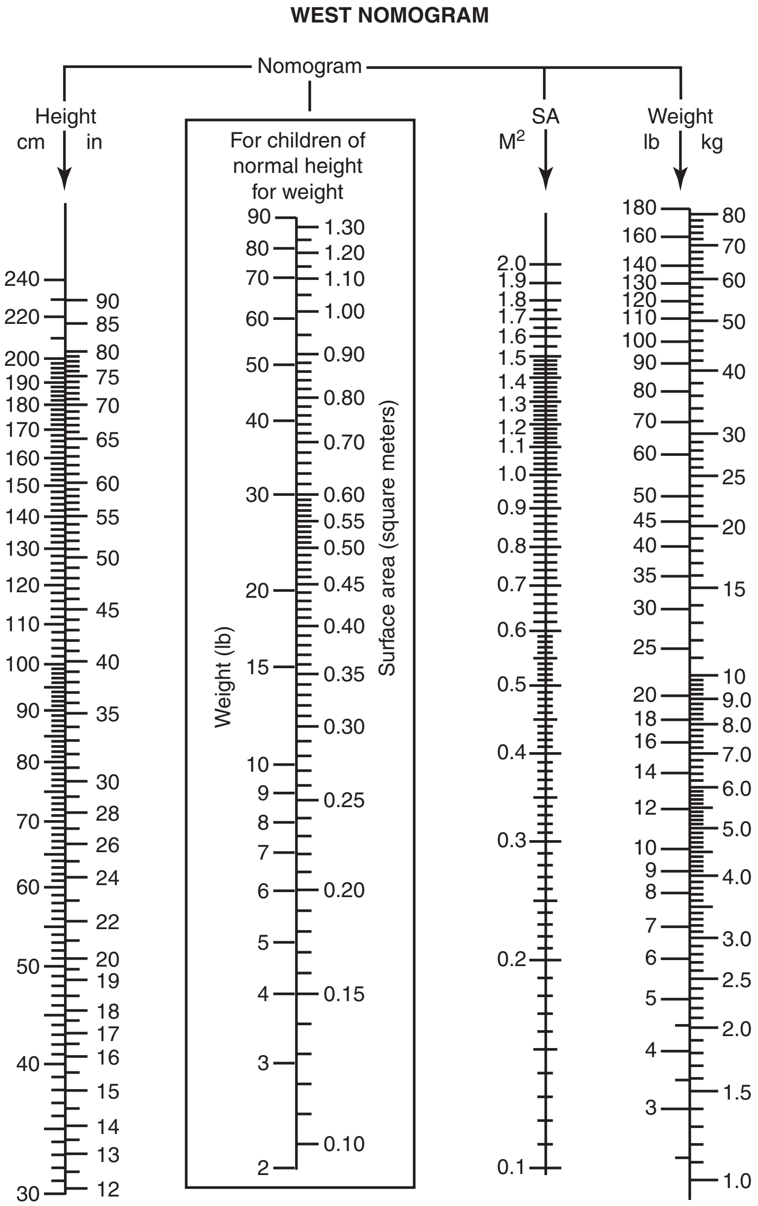
23. Height: 30 in Weight: 24 lb BSA: ________ m^2
24. Height: 155 cm Weight: 39 kg BSA: ________ m^2

Questions 25 through 31 refer to the following situation.

A child who is 28 in tall and weighs 25 lb will receive one dosage of cisplatin IV. The recommended dosage is 37 to 75 mg/m^2 once every 2 to 3 weeks. The order reads **cisplatin 18.5 mg IV at 1 mg/min today at 1500 hours.** You have available a 50 mg vial of cisplatin. Reconstitution directions state to add 50 mL of sterile water to yield 1 mg/mL. Minimal dilution instructions require 2 mL of IV solution for every 1 mg of cisplatin.

25. According to the nomogram (page 435), the child's BSA is ________ m^2.
26. The safe dosage range for this child is ________ to ________ mg.
27. Is this dosage safe? ________.
28. If safe, you will prepare ________ mL. If not, describe your action. ____________________

    ____
29. How many mL of IV fluid are required for safe dilution of the cisplatin? ________ mL
30. Given the ordered rate of 1 mg/min, set the infusion pump at ________ mL/h.
31. How long will this infusion take? ________ min



Metric:

$$\text{BSA (m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}}$$

Household:

$$\text{BSA (m}^2) = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}}$$

West Nomogram for estimation of body surface area. (From *Nelson Textbook of Pediatrics* (17th ed) by R. E. Behrman, R. M. Kliegman & H. B. Jenson, 2004, Philadelphia: Saunders. Reprinted with permission.)

Questions 32 through 35 refer to the following situation.

Order: **Oncovin 1.6 mg IV stat**. The child is 50 inches tall and weighs 40 lb. The following label represents the Oncovin solution you have available. The recommended dosage of Oncovin is 2 mg/m² daily.

32. According to the nomogram, the child's BSA is ________ m².

33. The recommended safe dosage for this child is ________ mg.

34. Is the dosage ordered safe? ________

35. If safe, you will prepare ________ mL Oncovin to add to the IV. If not safe, describe your action. ____________________________________

____

36. Order: **NS IV for continuous infusion at 40 mL/h $\bar{c}$ Ancef 250 mg IV q.8h over 30 min by volume control set**

    Available: Ancef 125 mg/mL

    Add ________ mL NS and ________ mL Ancef to the chamber to infuse at 40 mL/h.

37. Order: **ticarcillin 750 mg IV q.6h. Recommended minimal dilution (maximal concentration) is 100 mg/mL.** Calculate the number of mL to be used for minimal dilution of the ticarcillin as ordered. ________ mL

Chapter 16—Advanced Adult Intravenous Calculations

Use the following information to answer questions 38 through 41.

Mr. Smith is on restricted fluids. His IV order is: **NS 1,500 mL IV q.24 h $\bar{c}$ 300,000 units penicillin G potassium IV PB in 100 mL NS q.4h over 30 min**. The infusion set is calibrated at 60 gtt/mL.

38. Set Mr. Smith's regular IV at ________ gtt/min.

39. Set Mr. Smith's IV PB at ________ gtt/min.

40. Later during your shift, an electronic infusion pump becomes available. You decide to use it to regulate Mr. Smith's IVs. Regulate Mr. Smith's regular IV at ________ mL/h.

41. Regulate Mr. Smith's IV PB at ________ mL/h.

42. Order: **KCl 40 mEq/L D_5W IV at 2 mEq/h.**

    Regulate the infusion pump at ________ mL/h.

43. Order: **nitroglycerin 25 mg/L D_5W IV at 5 mcg/min**

    Regulate the infusion pump at ________ mL/h.

Refer to this order for questions 44 through 47.

Order: **Induce labor $\bar{c}$ Pitocin 15 units/L LR IV continuous infusion at 2 milliunits/min; increase by 1 milliunit/min q.30 min to a maximum of 20 milliunits/min**

44. The initial concentration of Pitocin is ________ milliunits/mL.

45. The initial Pitocin order will infuse at the rate of ________ mL/min.

46. Regulate the electronic infusion pump at ________ mL/h to initiate the order.

47. The infusion pump will be regulated at a maximum of ________ mL/h to infuse the maximum of 20 milliunits/min.

Use the following information to answer questions 48 and 49.

Order for Ms. Hill, who weighs 150 lb: **dopamine 400 mg per 0.5 L D_5W at 4 mcg/kg/min titrated to 12 mcg/kg/min to stabilize blood pressure**

48. Regulate the electronic infusion pump for Ms. Hill's IV at ________ mL/h to initiate the order.

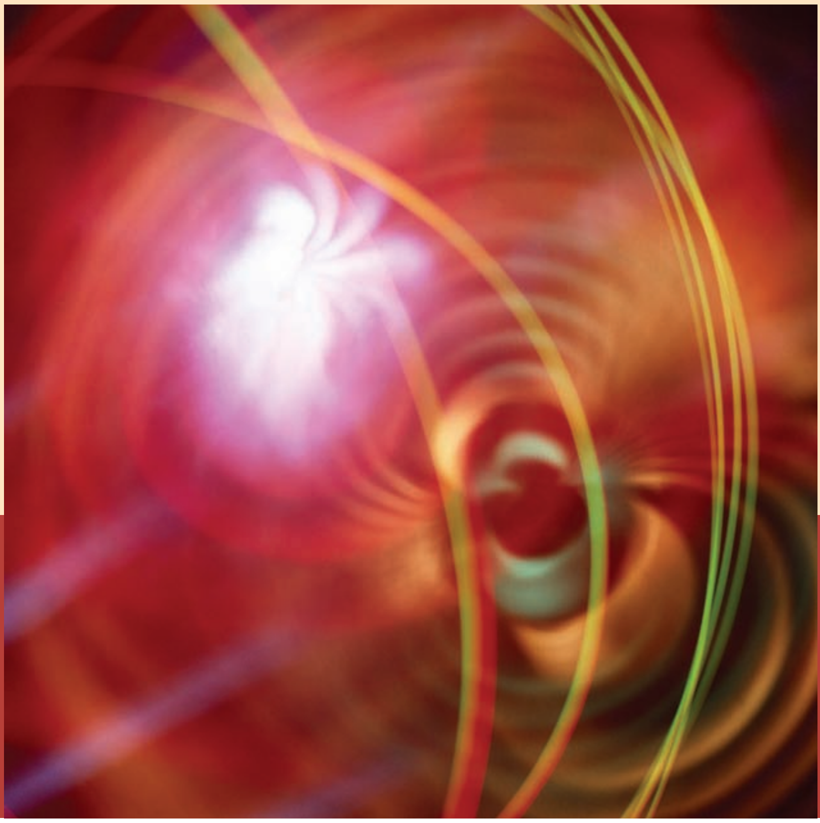
49. Anticipate that the maximum flow rate for Ms. Hill's IV to achieve the maximum safe titration would be ________ mL/h.

50. Mr. Black has a new order for **heparin 10,000 units in 500 mL NS IV at 750 units/h**. Regulate the infusion pump at ________ mL/h.

After completing these problems, refer to pages 543-546 to check your answers. Give yourself two points for each correct answer.

Perfect score = 100 My score = ________

Minimum mastery score = 86 (43 correct)



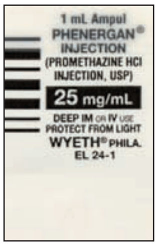
Essential Skills Evaluation

This evaluation is designed to assess your mastery of essential dosage calculation skills. It is similar to the type of entry-level test given by hospitals and health care agencies during orientation for new graduates and new employees. It excludes the advanced calculation skills presented in Chapters 15 and 16.

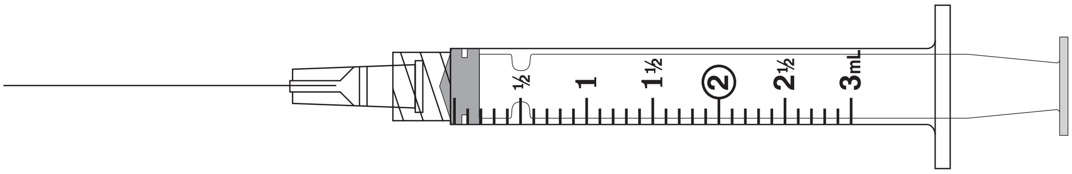
You are assigned to give Team Medications on a busy Adult Medical Unit. The following labels represent the medications available in your medication cart to fill the orders given in questions 1 through 17. Calculate the amount you will administer for one dose. Assume that all tablets are scored. Draw an arrow on the appropriate syringe to indicate how much you will prepare for parenteral medications.

1. Order: **Phenergan 12.5 mg IM q.4h p.r.n., nausea**

   Give: _________ mL



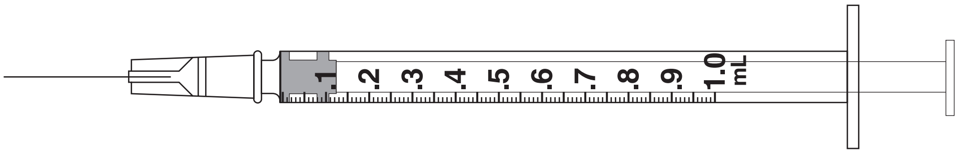
1 mL Ampul
PHENERGAN®
INJECTION
(PROMETHAZINE HCl
INJECTION, USP)
25 mg/mL
DEEP IM OR IV USE
PROTECT FROM LIGHT
WYETH® PHILA.
EL 24-1

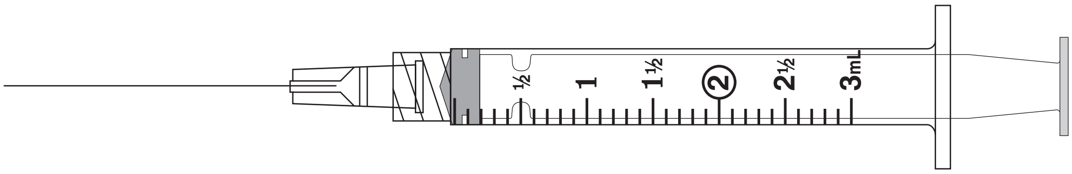


2. Order: Thorazine 35 mg IM stat

Give: __________ mL

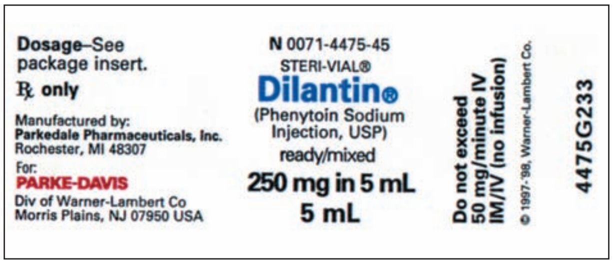
THORAZINE®
CHLORPRO-
MAZINE HCl
25mg/mL
Manufactured by
GlaxoSmithKline
Research Triangle Park,
NC 27709
LOT
EXP





3. Order: Dilantin 50 mg IV push q.8h (administer at the rate recommended on the label)

Give: __________ mL at __________ mL/min
or __________ mL per 15 sec



Dosage–See
package insert.
℞ only

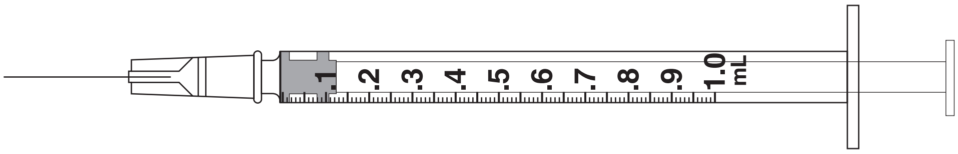
Manufactured by:
Parkedale Pharmaceuticals, Inc.
Rochester, MI 48307
For:
PARKE-DAVIS
Div of Warner-Lambert Co
Morris Plains, NJ 07950 USA

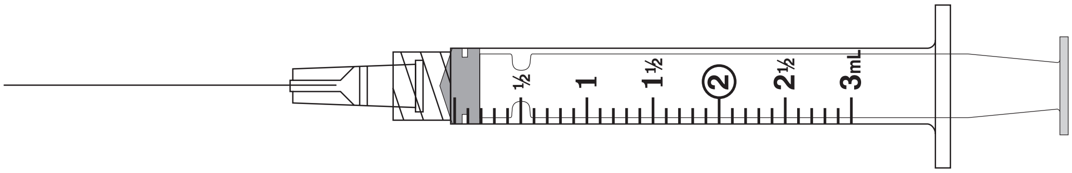
N 0071-4475-45
STERI-VIAL®
Dilantin®
(Phenytoin Sodium
Injection, USP)
ready/mixed
250 mg in 5 mL
5 mL

Do not exceed
50 mg/minute IV
IM/IV (no infusion)

© 1997-'98, Warner-Lambert Co.

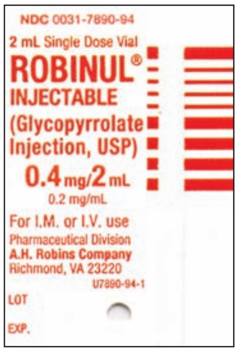
4475G233



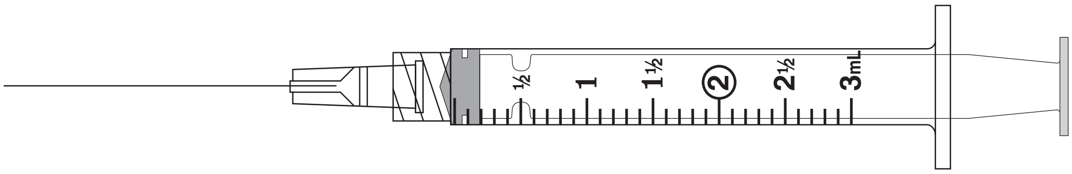


4. Order: Robinul 200 mcg IV stat

Give: __________ mL



NDC 0031-7890-94
2 mL Single Dose Vial
ROBINUL®
INJECTABLE
(Glycopyrrolate
Injection, USP)
0.4 mg/2 mL
0.2 mg/mL
For I.M. or I.V. use
Pharmaceutical Division
A.H. Robins Company
Richmond, VA 23220
U7890-94-1
LOT
EXP.



5. Order: Lortab 7.5 mg p.o. q.3h p.r.n., pain

Dosage is based on hydrocodone.

Give: __________ tablet(s)

ucb Pharma

PHARMACIST: Dispense in a tight, light-resistant container with a child-resistant closure.

Store at controlled room temperature, 15°-30°C (59°-86°F).

Lot No.:
Exp. Date:

Manufactured for
UCB Pharma, Inc.
Smyrna, GA 30080
by Mallinckrodt Inc.
Hobart, NY 13788

NDC 50474-902-01 **100 TABLETS**

LORTAB® 5/500

HYDROCODONE BITARTRATE
AND ACETAMINOPHEN
TABLETS, USP
5 mg/500 mg

Each scored, white with blue specks tablet contains:

Hydrocodone Bitartrate . . . . 5 mg
Acetaminophen . . . . 500 mg

℞ only

USUAL DOSAGE: See package insert for complete dosage recommendations.

N
3 50474-902-01 1

Rev. 6/01
P/N 1003723

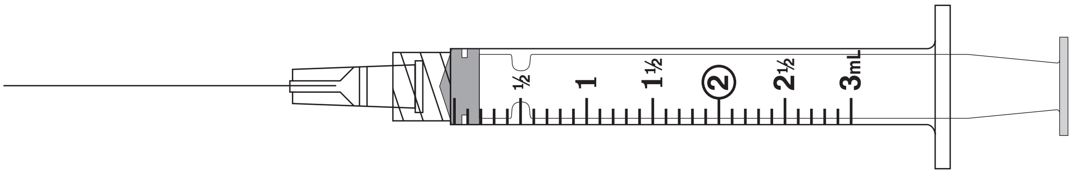
6. Order: Lanoxin 0.125 mg IV q. AM

Give: __________ mL

LANOXIN® **2 mL**
(digoxin) Injection **℞ only**
500 mcg (0.5 mg) in 2 mL
(250 mcg [0.25 mg] per mL)
Store at 25°C (77°F) [see insert].
PROTECT FROM LIGHT.
Dist.: GlaxoSmithKline
Research Triangle Park, NC 27709
Made in Canada
4144627
Rev. 3/02
220201

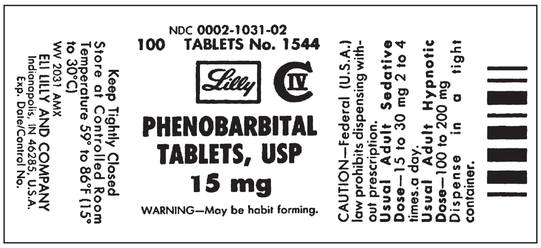
LOT
EXP

SAMPLE
For educational use only.



7. Order: phenobarbital gr $\frac{1}{8}$ p.o. q.i.d.

Give: __________ tablet(s)



Keep Tightly Closed
Store at Controlled Room
Temperature 59° to 86°F (15°
to 30°C)
WV 2031 AMX
ELI LILLY AND COMPANY
Indianapolis, IN 46285, U.S.A.
Exp. Date/Control No.

NDC **0002-1031-02**
100 TABLETS No. 1544

Lilly

CIV

PHENOBARBITAL
TABLETS, USP
15 mg

WARNING—May be habit forming.

CAUTION—Federal (U.S.A.) law prohibits dispensing with-out prescription.
Usual Adult Sedative Dose—15 to 30 mg 2 to 4 times.a day.
Usual Adult Hypnotic Dose—100 to 200 mg
Dispense in a tight container.

8. Order: Kantrex 350 mg IM b.i.d.

   Give: _________ mL

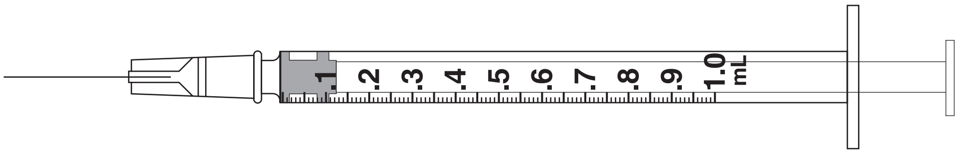
NDC 0015-3502-20
Kantrex®
(KANAMYCIN SULFATE
INJECTION, USP)
For I.M. or I.V. Use
EQUIVALENT TO
500 mg KANAMYCIN per 2 mL
CAUTION: Federal law prohibits dispensing without prescription

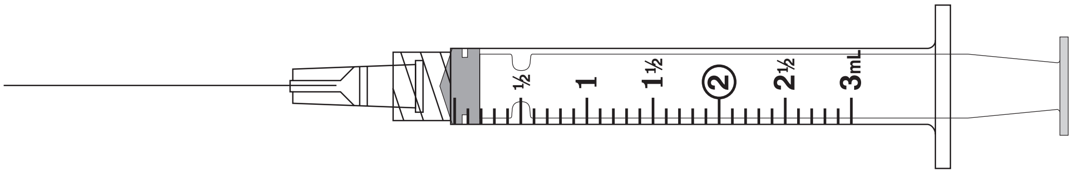
BRISTOL LABORATORIES

0.66% sodium bisulfite added as an antioxidant, buffered with 2.2% sodium citrate. • Adjusted to pH 4.5 with H_2SO_4. • Kantrex Injection should not be physically mixed with other antibacterial agents.
READ ACCOMPANYING CIRCULAR
350220DRL-14

MAXIMUM DAILY DOSE: 1.5 GRAM

Lot
Exp. Date





9. Order: Novolin L Lente U-100 insulin 46 units c̄ Novolin R Regular U-100 insulin 22 units subcut stat

   You will give _________ units total.

Novolin® L
Lente®,
Human Insulin
Zinc Suspension
(recombinant
DNA origin)
0213-31-101-1
10 ml 100 units/ml

NDC 0169-1835-11
Novo Nordisk™
Use with U-100 insulin syringes only
See insert
Shake carefully
Keep in a cold place
Avoid freezing
Change insulin only under medical supervision

For information contact:
Novo Nordisk
Pharmaceuticals Inc.
Princeton, NJ 08540

Manufactured by
Novo Nordisk A/S
DK-2880 Bagsvaerd,
Denmark

Exp. Date:
Control:

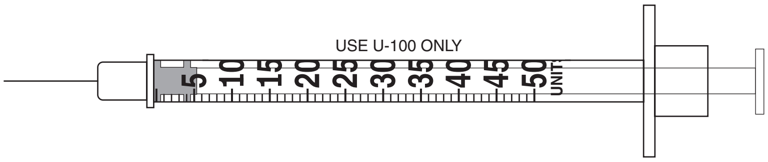
Novolin® R
Regular,
Human
Insulin Injection
(recombinant
DNA origin) USP
0203-31-101-1
10 ml 100 units/ml

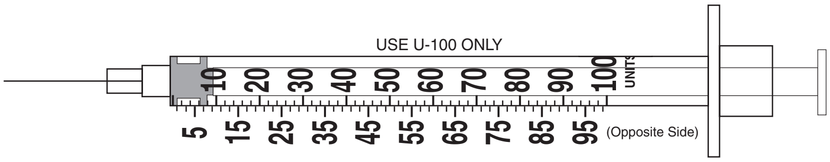
NDC 0169-1833-11
Novo Nordisk™
Use with U-100 insulin syringes only
See insert
Keep in a cold place
Avoid freezing
Change insulin only under medical supervision

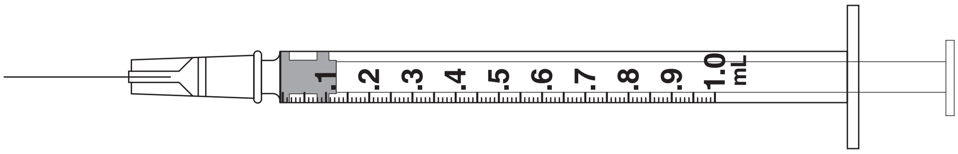
For information contact:
Novo Nordisk
Pharmaceuticals Inc.
Princeton, NJ 08540

Manufactured by
Novo Nordisk A/S
DK-2880 Bagsvaerd,
Denmark

Exp. Date:
Control:







10. Order: Synthroid 0.3 mg p.o. q. AM

Give: __________ tablet(s)

NDC 0048-1090-05
NSN 6505-01-153-3338
Code 3P1095

SYNTHROID®
(Levothyroxine Sodium Tablets, USP)

150 mcg (0.15 mg)

1000 TABLETS

Rx only

BASF Pharma
knoll

See full prescribing information for dosage and administration.

Dispense in a tight, light-resistant container as described in USP.

Store at 25°C (77°F); excursions permitted to 15°-30°C (59°-86°F). [See USP Controlled Room Temperature].

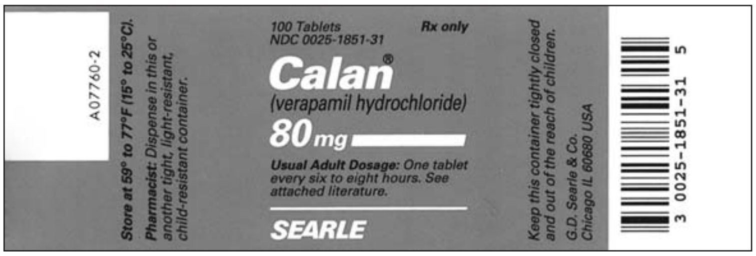
Knoll Pharmaceutical Company
Mount Olive, NJ 07828
USA

7890-03

3 0048-1090-05 8

11. Order: Calan 40 mg p.o. t.i.d.

Give: __________ tablet(s)



A07760-2

Store at 59° to 77°F (15° to 25°C).
Pharmacist: Dispense in this or another tight, light-resistant, child-resistant container.

100 Tablets
NDC 0025-1851-31
Rx only

Calan®
(verapamil hydrochloride)
80 mg

Usual Adult Dosage: One tablet every six to eight hours. See attached literature.

SEARLE

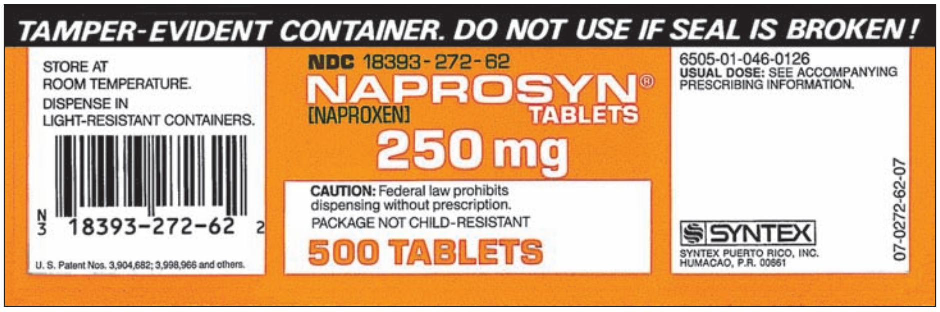
Keep this container tightly closed and out of the reach of children.

G.D. Searle & Co.
Chicago IL 60680 USA

3 0025-1851-31 5

12. Order: Naprosyn 375 mg p.o. b.i.d.

Give: __________ tablet(s)



TAMPER-EVIDENT CONTAINER. DO NOT USE IF SEAL IS BROKEN!

STORE AT ROOM TEMPERATURE.
DISPENSE IN LIGHT-RESISTANT CONTAINERS.

N 3 18393-272-62 2

U. S. Patent Nos. 3,904,682; 3,998,966 and others.

NDC 18393-272-62
NAPROSYN®
[NAPROXEN] **TABLETS**
250 mg

CAUTION: Federal law prohibits dispensing without prescription.
PACKAGE NOT CHILD-RESISTANT
500 TABLETS

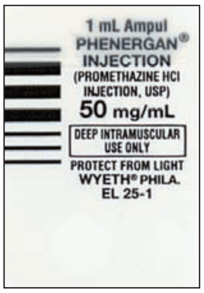
6505-01-046-0126
USUAL DOSE: SEE ACCOMPANYING PRESCRIBING INFORMATION.

SYNTEX
SYNTEX PUERTO RICO, INC.
HUMACAO, P.R. 00661

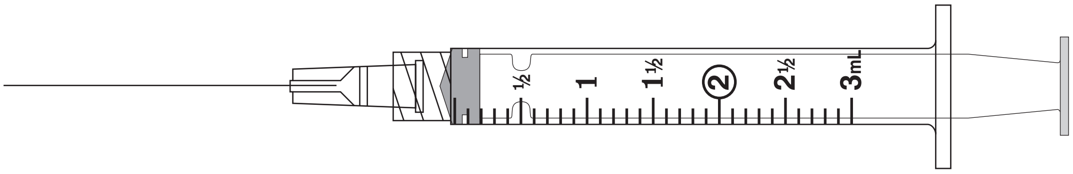
07-0272-62-07

13. Order: Phenergan 40 mg IM stat

Give: __________ mL



1 mL Ampul
PHENERGAN®
INJECTION
(PROMETHAZINE HCl INJECTION, USP)
50 mg/mL
DEEP INTRAMUSCULAR USE ONLY
PROTECT FROM LIGHT
WYETH® PHILA.
EL 25-1



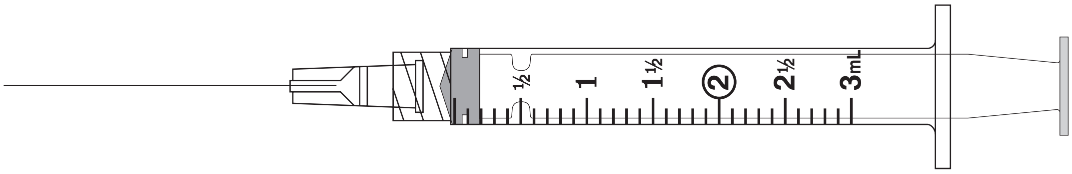
14. Order: Stadol 3 mg IM stat

Give: __________ mL

Lot
Exp. Date

BRISTOL LABORATORIES
Bristol-Myers U.S. Pharmaceutical and Nutritional Group, Evansville, Indiana 47721 Made in U.S.A.
READ ACCOMPANYING CIRCULAR for indications, dosage, and precautions.
U.S. Patent Nos. 3,819,635 / 4,139,534
564620DRL-04

NDC 0015-5646-20 1 mL
Stadol®
(BUTORPHANOL TARTRATE INJECTION, USP) For IM/IV Use
Store at Room Temp
2 mg (2 mg per mL)
SINGLE DOSE VIAL
CAUTION: Federal law prohibits dispensing without prescription.
©1977, Bristol-Myers Company



15. Order: Augmentin 100 mg p.o. q.8h

Give: __________ mL

AUGMENTIN®
125mg/5mL

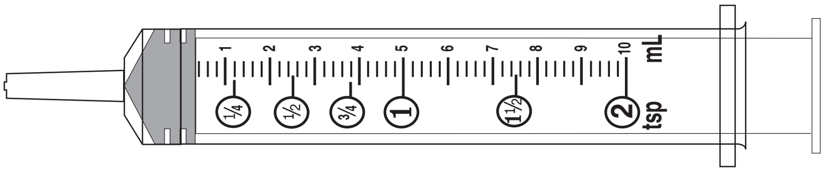
NSN 6505-01-340-0847
Directions for mixing:
Tap bottle until all powder flows freely. Add approximately 2/3 of total water for reconstitution (total = 67 mL); shake vigorously to wet powder. Add remaining water; again shake vigorously.
Dosage: See accompanying prescribing information.

Keep tightly closed.
Shake well before using.
Must be refrigerated.
Discard after 10 days.

125mg/5mL
NDC 0029-6085-39
AUGMENTIN®
AMOXICILLIN/
CLAVULANATE POTASSIUM
FOR ORAL SUSPENSION
When reconstituted, each 5 mL contains:
AMOXICILLIN, 125 MG,
as the trihydrate
CLAVULANIC ACID, 31.25 MG,
as clavulanate potassium
75mL (when reconstituted)
SB SmithKline Beecham

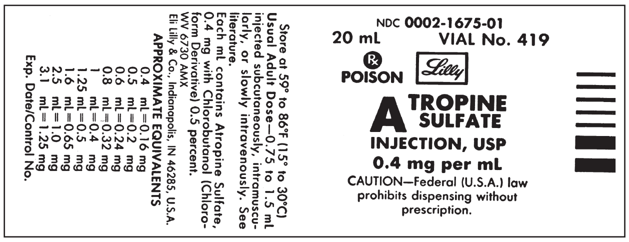
SAMPLE

Use only if inner seal is intact.
Net contents: Equivalent to 1.875 g amoxicillin and 0.469 g clavulanic acid.
Store dry powder at room temperature.
SmithKline Beecham Pharmaceuticals
Philadelphia, PA 19101
℞ only
3 0029-6085-39 3
LOT
EXP.
9405804-H



16. Order: atropine gr $\frac{1}{100}$ IM stat

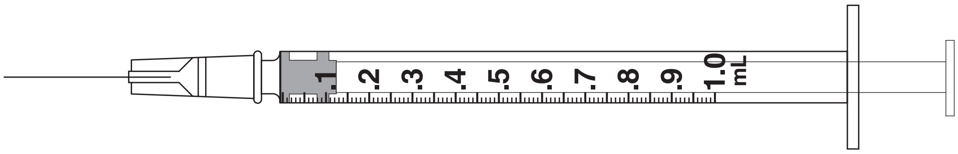
Give: __________ mL

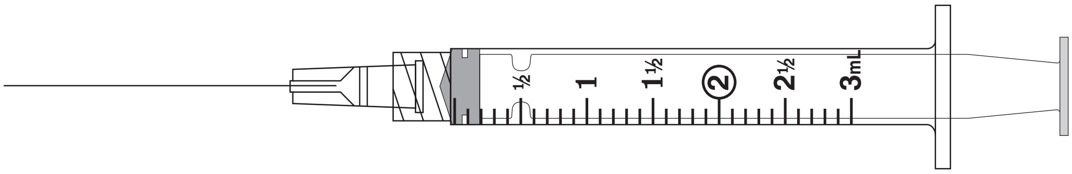


Store at 59° to 86°F (15° to 30°C)
Usual Adult Dose—0.75 to 1.5 ml injected subcutaneously, intramuscularly, or slowly intravenously. See literature.
Each ml contains Atropine Sulfate, 0.4 mg with Chlorobutanol (Chloroform Derivative) 0.5 percent.
WV 6730 AMX
Eli Lilly & Co., Indianapolis, IN 46285, U.S.A.

APPROXIMATE EQUIVALENTS
0.4 ml = 0.16 mg
0.5 ml = 0.2 mg
0.6 ml = 0.24 mg
0.8 ml = 0.32 mg
1 ml = 0.4 mg
1.25 ml = 0.5 mg
1.6 ml = 0.65 mg
2.5 ml = 1.0 mg
3.1 ml = 1.25 mg
Exp. Date/Control No.

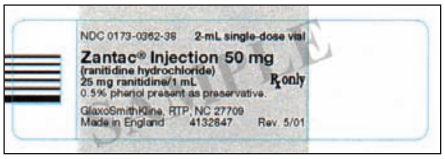
NDC 0002-1675-01
20 mL VIAL No. 419
℞ POISON Lilly
ATROPINE SULFATE
INJECTION, USP
0.4 mg per mL
CAUTION—Federal (U.S.A.) law prohibits dispensing without prescription.





17. Order: **Zantac 35 mg in 100 mL D_5W IV PB over 20 min**

Add _________ mL Zantac to the IV fluid, and set the flow rate to _________ gtt/min.



NDC 0173-0362-38 2-mL single-dose vial

Zantac® Injection 50 mg

(ranitidine hydrochloride)

25 mg ranitidine/1 mL

℞ only

0.5% phenol present as preservative.

GlaxoSmithKline, RTP, NC 27709

Made in England 4132847 Rev. 5/01

SAMPLE

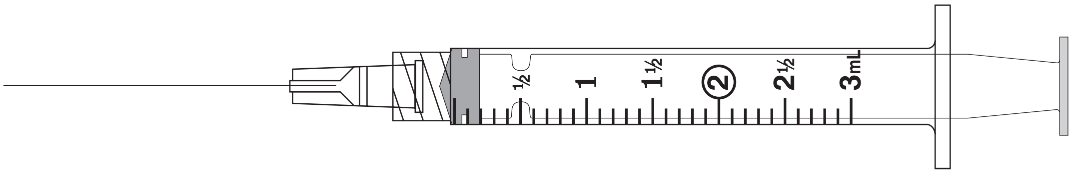
No. 4967

VENOSET® Piggyback

Primary I.V. Set, Vented, 80 Inch

15 DROPS/mL

ABBOTT LABORATORIES, NORTH CHICAGO, IL60064, USA



Refer to the Medical Administration Record (MAR) on page 444 to answer questions 18 through 22.

Mrs. Betty Smedley in Room 217A is assigned to your team. She is hospitalized with osteoarthritis. The medications available from the pharmacy are noted on the MAR.

18. Mrs. Smedley had her last dose of Tylenol at 2110 hours. It is now 0215 hours, and her temperature is 39°C. Is Tylenol indicated? _________

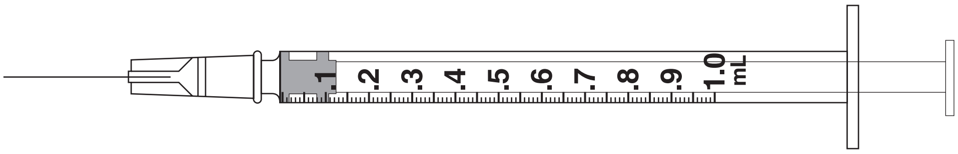
Explain: ____

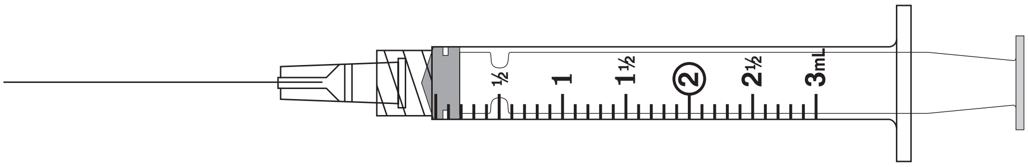
____

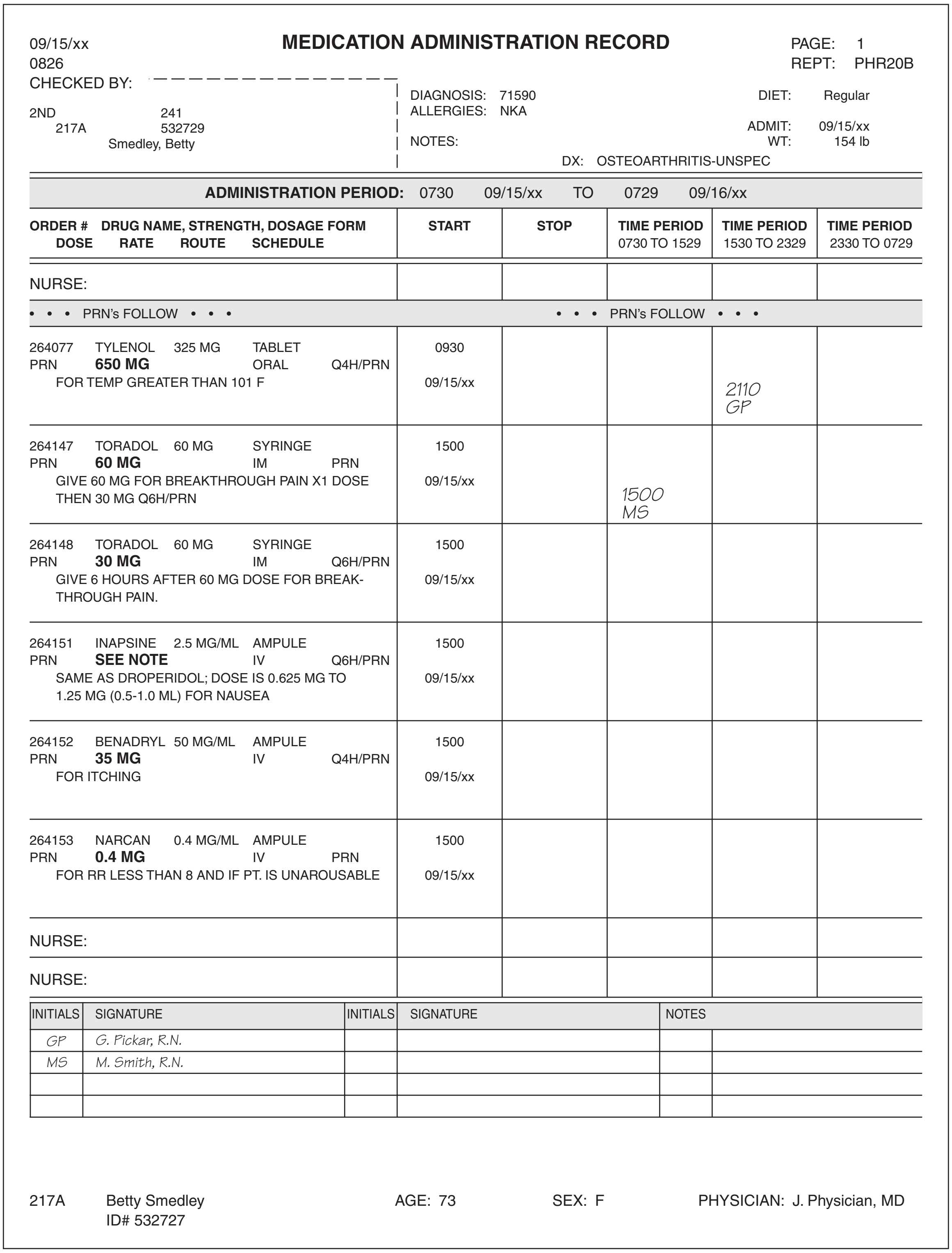
19. How many tablets of Tylenol should she receive for each dose? _________ tablet(s)

20. Mrs. Smedley had 60 mg of Toradol at 1500 hours. At 2130 hours she is complaining of severe pain again. How much Toradol in the prefilled syringe will you give her now? Give _________ of the syringe amount.

21. Mrs. Smedley is complaining of itching. What p.r.n. medication would you select, and how much will you administer? Select _________, and give _________ mL. Draw an arrow on the appropriate syringe to indicate how much you will give.







09/15/xx
0826
CHECKED BY:

MEDICATION ADMINISTRATION RECORD

PAGE: 1
REPT: PHR20B

2ND 241
217A 532729
Smedley, Betty

DIAGNOSIS: 71590
ALLERGIES: NKA
NOTES:

DIET: Regular
ADMIT: 09/15/xx
WT: 154 lb

DX: OSTEOARTHRITIS-UNSPEC

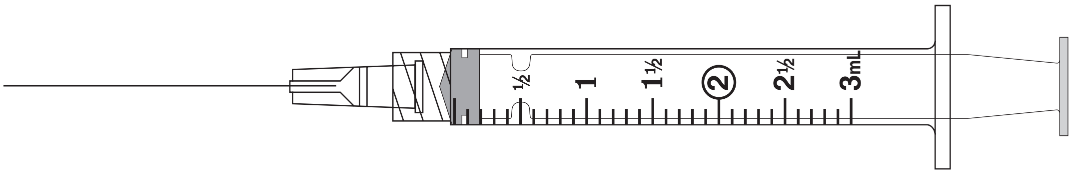
ADMINISTRATION PERIOD: 0730 09/15/xx TO 0729 09/16/xx

ORDER # DRUG NAME, STRENGTH, DOSAGE FORM **DOSE RATE ROUTE SCHEDULE**	**START**	**STOP**	**TIME PERIOD** 0730 TO 1529	**TIME PERIOD** 1530 TO 2329	**TIME PERIOD** 2330 TO 0729
NURSE:					
• • • PRN's FOLLOW • • •			• • • PRN's FOLLOW • • •		
264077 TYLENOL 325 MG TABLET PRN **650 MG** ORAL Q4H/PRN FOR TEMP GREATER THAN 101 F	0930 09/15/xx			2110 GP	
264147 TORADOL 60 MG SYRINGE PRN **60 MG** IM PRN GIVE 60 MG FOR BREAKTHROUGH PAIN X1 DOSE THEN 30 MG Q6H/PRN	1500 09/15/xx		1500 MS		
264148 TORADOL 60 MG SYRINGE PRN **30 MG** IM Q6H/PRN GIVE 6 HOURS AFTER 60 MG DOSE FOR BREAKTHROUGH PAIN.	1500 09/15/xx				
264151 INAPSINE 2.5 MG/ML AMPULE PRN **SEE NOTE** IV Q6H/PRN SAME AS DROPERIDOL; DOSE IS 0.625 MG TO 1.25 MG (0.5-1.0 ML) FOR NAUSEA	1500 09/15/xx				
264152 BENADRYL 50 MG/ML AMPULE PRN **35 MG** IV Q4H/PRN FOR ITCHING	1500 09/15/xx				
264153 NARCAN 0.4 MG/ML AMPULE PRN **0.4 MG** IV PRN FOR RR LESS THAN 8 AND IF PT. IS UNAROUSABLE	1500 09/15/xx				
NURSE:					
NURSE:					

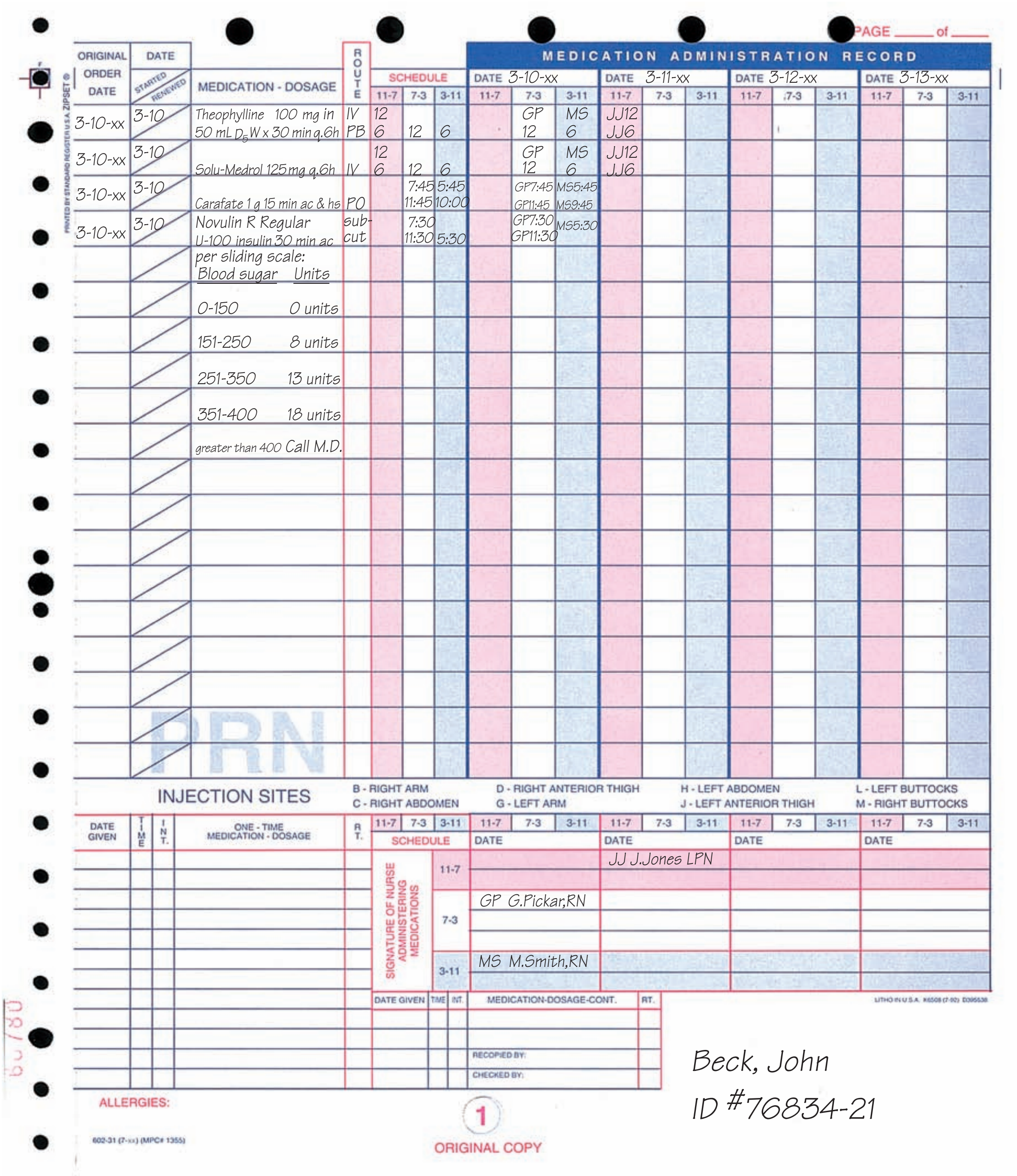
INITIALS	SIGNATURE	INITIALS	SIGNATURE	NOTES	
GP	G. Pickar, R.N.				
MS	M. Smith, R.N.				

217A Betty Smedley
ID# 532727
AGE: 73
SEX: F
PHYSICIAN: J. Physician, MD

22. Mrs. Smedley's respiratory rate (R.R.) is 7, and she is difficult to arouse. What medication is indicated? _________ Give _________ mL. Draw an arrow on the syringe to indicate how much of this medication you will give.



Refer to the following MAR to answer questions 23 through 27.



PAGE _____ of _____

MEDICATION ADMINISTRATION RECORD

ORIGINAL ORDER DATE	DATE STARTED / RENEWED	MEDICATION - DOSAGE	ROUTE	SCHEDULE			DATE 3-10-xx			DATE 3-11-xx			DATE 3-12-xx			DATE 3-13-xx		
				11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11	11-7	7-3	3-11
3-10-xx	3-10	Theophylline 100 mg in 50 mL D_5W x 30 min q.6h	IV PB	12 6	12	6		GP 12	MS 6	JJ12 JJ6								
3-10-xx	3-10	Solu-Medrol 125 mg q.6h	IV	12 6	12	6		GP 12	MS 6	JJ12 JJ6								
3-10-xx	3-10	Carafate 1 g 15 min ac & hs	PO		7:45 11:45	5:45 10:00		GP7:45 GP11:45	MS5:45 MS9:45									
3-10-xx	3-10	Novulin R Regular U-100 insulin 30 min ac	sub-cut		7:30 11:30	5:30		GP7:30 GP11:30	MS5:30									
		per sliding scale: Blood sugar Units																
		0-150 0 units																
		151-250 8 units																
		251-350 13 units																
		351-400 18 units																
		greater than 400 Call M.D.																

PRN

INJECTION SITES
B - RIGHT ARM
C - RIGHT ABDOMEN
D - RIGHT ANTERIOR THIGH
G - LEFT ARM
H - LEFT ABDOMEN
J - LEFT ANTERIOR THIGH
L - LEFT BUTTOCKS
M - RIGHT BUTTOCKS

DATE GIVEN	TIME	INT.	ONE - TIME MEDICATION - DOSAGE	RT.

SIGNATURE OF NURSE ADMINISTERING MEDICATIONS	DATE	DATE	DATE	DATE
11-7		JJ J.Jones LPN		
7-3	GP G.Pickar,RN			
3-11	MS M.Smith,RN			

DATE GIVEN	TIME	INT.	MEDICATION-DOSAGE-CONT.	RT.
			RECOPIED BY:	
			CHECKED BY:	

LITHO IN U.S.A. K6508 (7-92) D09553B

Beck, John
ID #76834-21

ALLERGIES:

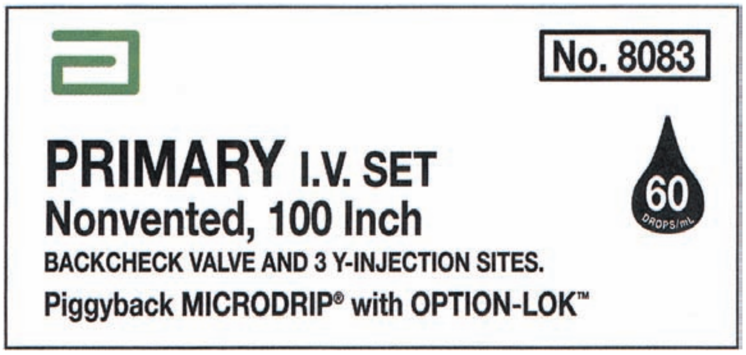
602-31 (7-xx) (MPC# 1355)

1
ORIGINAL COPY

PRINTED BY STANDARD REGISTER U.S.A. ZIPSET ®

John Beck, 19 years old, is diabetic. He is admitted to the medical unit with asthma. You are administering his medications. The MAR on page 445 is in the medication notebook on your medication cart. The labels represent the infusion set available and the medications in his medication cart drawer. Questions 23 through 27 refer to Mr. Beck.

23. Theophylline is available in a solution strength of 80 mg per 15 mL. There will be ________ mL theophylline in the IV PB. Set the flow rate at ________ gtt/min.



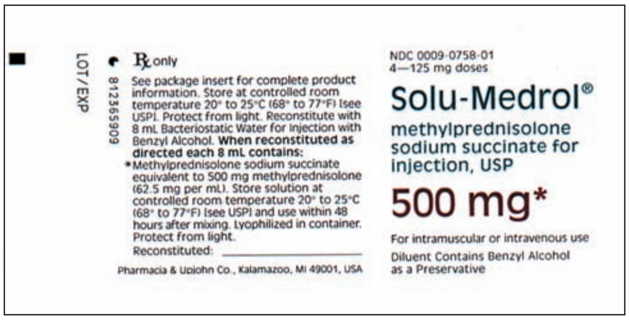
No. 8083

PRIMARY I.V. SET
Nonvented, 100 Inch
BACKCHECK VALVE AND 3 Y-INJECTION SITES.
Piggyback MICRODRIP® with OPTION-LOK™

60 DROPS/mL

24. An infusion pump becomes available, and you decide to use it for Mr. Beck's IV. It is calibrated in mL/h. To administer the theophylline by infusion pump, set the pump at ________ mL/h.

25. Reconstitute the Solu-Medrol with ________ mL diluent, and give ________ mL.



LOT/EXP

812365909

℞ only

See package insert for complete product information. Store at controlled room temperature 20° to 25°C (68° to 77°F) [see USP]. Protect from light. Reconstitute with 8 mL Bacteriostatic Water for Injection with Benzyl Alcohol. **When reconstituted as directed each 8 mL contains:**
*Methylprednisolone sodium succinate equivalent to 500 mg methylprednisolone (62.5 mg per mL). Store solution at controlled room temperature 20° to 25°C (68° to 77°F) [see USP] and use within 48 hours after mixing. Lyophilized in container. Protect from light.
Reconstituted: ________

Pharmacia & Upjohn Co., Kalamazoo, MI 49001, USA

NDC 0009-0758-01
4—125 mg doses

Solu-Medrol®
methylprednisolone sodium succinate for injection, USP

500 mg*

For intramuscular or intravenous use
Diluent Contains Benzyl Alcohol as a Preservative

26. Mealtimes and bedtime are 8 AM, 12 NOON, 6 PM, and 10 PM. Using international time, give ________ tablet(s) of Carafate per dose each day at ________, ________, ________, and ________ hours.

NDC 0088-1712-53

Carafate® Tablets
sucralfate
1 gram
120 Tablets
Aventis

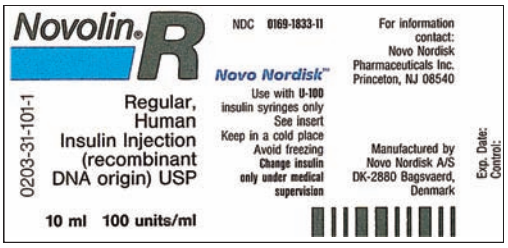
℞ ONLY
Each CARAFATE® Tablet contains 1g sucralfate.
Dosage and Administration: See package insert for dosage information.
WARNING: Keep out of reach of children.
Pharmacist: Dispense in light-resistant, tight container with child-resistant closure.
Important: This package is not child-resistant.
Store at controlled room temperature 59–86°F (15–30°C).
Aventis Pharmaceuticals Inc.
Kansas City, MO 64137
USA ©2000
www.aventispharma-us.com

Exp

3 0088-1712-53 6

50059224

27. At 0730 Mr. Beck's blood sugar is 360. You will give him __________ units of insulin by the __________ route. Draw an arrow on the appropriate syringe to indicate the correct dosage.



Novolin® R

0203-31-101-1

Regular, Human Insulin Injection (recombinant DNA origin) USP

10 ml 100 units/ml

NDC 0169-1833-11

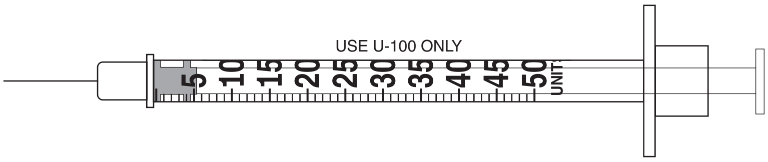
Novo Nordisk™

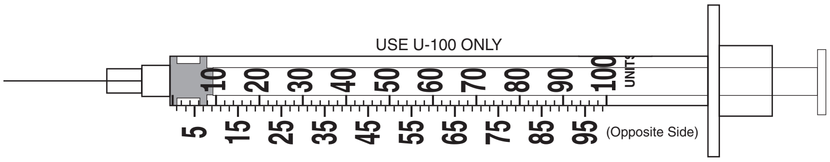
Use with U-100 insulin syringes only
See insert
Keep in a cold place
Avoid freezing
Change insulin only under medical supervision

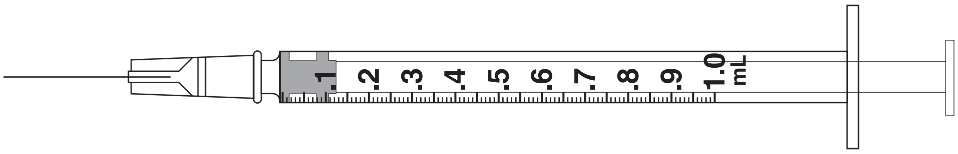
For information contact:
Novo Nordisk Pharmaceuticals Inc.
Princeton, NJ 08540

Manufactured by
Novo Nordisk A/S
DK-2880 Bagsvaerd, Denmark

Exp. Date:
Control:

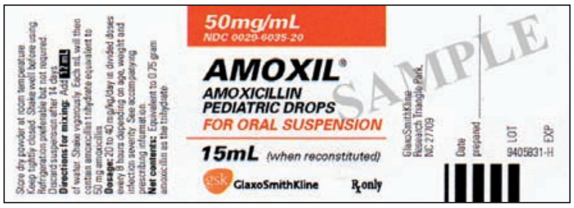






Jimmy Bryan is brought to the pediatric clinic by his mother. He is a 15 lb baby with an ear infection. Questions 28 through 31 refer to Jimmy.

28. The physician orders **amoxicillin 50 mg p.o. q.8h** for Jimmy. To reconstitute the amoxicillin, add __________ mL water.



Store dry powder at room temperature. Keep tightly closed. Shake well before using. Refrigeration preferable but not required. Discard suspension after 14 days. **Directions for mixing:** Add 12 mL of water. Shake vigorously. Each mL will then contain amoxicillin trihydrate equivalent to 50 mg amoxicillin. **Dosage:** 20 to 40 mg/kg/day in divided doses every 8 hours depending on age, weight and infection severity. See accompanying prescribing information. **Net contents:** Equivalent to 0.75 gram amoxicillin as the trihydrate.

50mg/mL
NDC 0029-6035-20

AMOXIL®
AMOXICILLIN
PEDIATRIC DROPS
FOR ORAL SUSPENSION

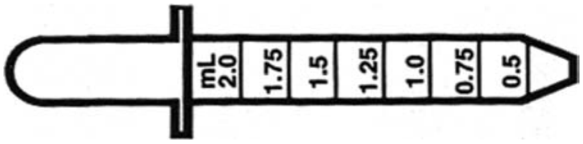
15mL (when reconstituted)

GlaxoSmithKline ℞only

SAMPLE

GlaxoSmithKline
Research Triangle Park, NC 27709

Date prepared
LOT 9405831-H
EXP



29. Is Jimmy's amoxicillin order safe and reasonable? __________ Explain: ____________________
____

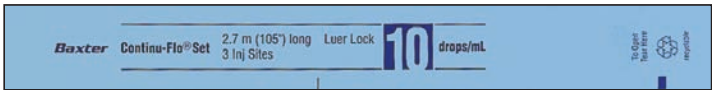
30. The physician asks you to give Jimmy one dose of the amoxicillin stat. You will give Jimmy __________ mL.

31. The physician also asks you to instruct Jimmy's mother about administering the medication at home. Tell Jimmy's mother to give the baby __________ droppersful to the __________ mL line for each dose. How often? __________

32. Jill Jones is a 16-year-old, 110 lb teenager with a duodenal ulcer and abdominal pain. Order: **cimetidine 250 mg q.6h in 50 mL D_5W IV PB to be infused in 20 min**

    The recommended cimetidine dosage is 20 to 40 mg/kg/day in 4 divided doses. Available is cimetidine for injection, 300 mg per 2 mL. The label represents the infusion set available. What is the safe single dosage range for this child? _________ mg/dose to _________ mg/dose. Is this ordered dosage safe? _________

    If safe, add _________ mL cimetidine, and set the flow rate at _________ gtt/min.



33. The doctor writes a new order for strict intake and output assessment for a child. During your 8-hour shift, in addition to his IV fluids of 200 mL D_5NS, he consumed the following oral fluids:

    gelatin—oz iv

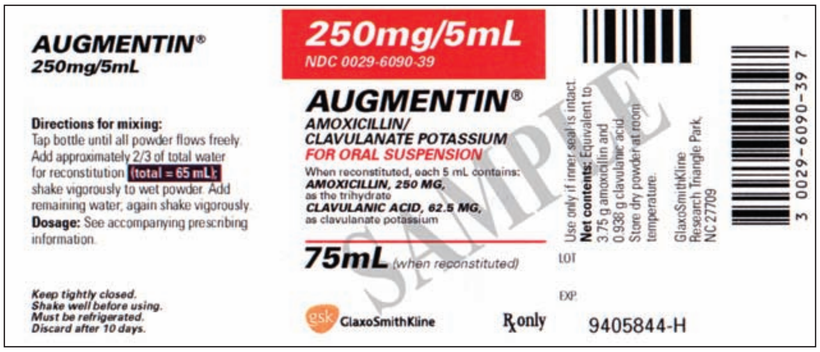
    water—oz iii × 2

    apple juice—pt i

    What is his total fluid intake during your shift? _________ mL

Use the following information to answer questions 34 through 36.

Order for a child with severe otitis media (inner ear infection) who weighs 40 lb: **Augmentin 240 mg p.o. q.8h.** The following Augmentin label represents the dosage you have available. Recommended Augmentin dosage is 40 mg/kg/day q.8h in divided doses.



34. Is the ordered dosage safe? _________

35. If it is safe, how much would you administer to the child? _________ mL per dose. If it is not safe, what would you do next? ____

36. The physician has ordered **washed, packed red blood cells 2 units (600 mL) IV to infuse in 4 h.** The IV tubing has a drop factor of 15 gtt/mL. You will regulate the IV flow rate at _________ gtt/min.

Use the following information to answer questions 37 and 38.

A child who weighs 61 lb 8 oz has an elevated temperature. For hyperthermia in children, the recommended dosage of acetaminophen is 10 to 15 mg/kg p.o. q.4h, not to exceed 5 doses per day.

37. What is the safe single dosage range of acetaminophen for this child? _________ mg/dose to _________ mg/dose

38. If the physician orders the maximum safe dosage and acetaminophen is available as a suspension of 80 mg per 2.5 mL, how many mL will you give per dose? _________ mL

Use the following information to answer questions 39 and 40 for a child who weighs 52 lb.

Order: **Benadryl 25 mg IV q.6h**

Supply: Benadryl 10 mg/mL

Recommended dosage: 5 mg/kg/day in 4 divided doses

39. A safe single dosage for this child is __________ mg/dose. Is the order safe? __________

40. If safe, administer __________ mL. If not safe, what should you do? ______________________________
____

Use the following information to answer questions 41 through 44.

At 1430, a patient is started on **Demerol PCA IV pump at 10 mg q.10 min.** The Demerol syringe in the pump contains 300 mg per 30 mL.

41. The patient can receive __________ mL every 10 minutes.

42. If the patient attempts 5 doses this hour, he would receive __________ mg and __________ mL of Demerol.

43. Based on the amount of Demerol in the syringe in the PCA pump, how many total doses can the patient receive? __________ dose(s)

44. If the patient receives 5 doses every hour, the Demerol will be empty at __________ hours. Convert this time to traditional AM/PM time. __________

45. Order: **Aldomet 250 mg stat in 100 mL D_5W IV PB, infuse over 30 min**

    Regulate the electronic infusion pump at __________ mL/h.

Use the following information to answer questions 46 through 49.

Order: **Fortaz 0.5 g IV q.8h**

The following label represents the drug you have available. You reconstitute the drug at 1400 on 1/30/xx.

Lot

Exp.

NDC 0173-0379-34

Fortaz®
(ceftazidime for injection)

2 g ℞ only

Equivalent to 2 g of ceftazidime. For IV use.

See package insert for Dosage and Administration. Before constitution, store between 15° and 30°C (59° and 86°F) and protect from light. **IMPORTANT:** The vial is under reduced pressure. Addition of diluent generates a positive pressure. Before constituting, see Instructions for Constitution. To prepare IV solution, add 10 mL of Sterile Water for Injection. After constitution, solutions maintain potency for 24 hours at room temperature (not exceeding 25°C [77°F]) or for 7 days under refrigeration. Constituted solutions in Sterile Water for Injection may be frozen. See package insert for details. Color changes do not affect potency. This vial contains 236 mg of sodium carbonate. The sodium content is approximately 108 mg (4.7 mEq).

GlaxoSmithKline, Research Triangle Park, NC 27709
Made in England Rev. 1/02

46. The total volume of Fortaz after reconstitution is __________ mL.

47. The resulting dosage strength of Fortaz is __________ mg per __________ mL.

48. Give __________ mL of Fortaz.

49. Prepare a reconstitution label for Fortaz.

50. Describe the strategy you would implement to prevent this medication error.

Possible Scenario
Order: Decadron 4 mg IV q.6h

Day 1 Supply: Decadron 4 mg/mL

Student nurse prepared and administered 1 mL.

Day 2 Supply: Decadron 10 mg/mL

Student nurse prepared 1 mL.

Potential Outcome
Day 2, the student's instructor asked the student to recheck the order, think about the action, check the calculation, and provide the rationale for the amount prepared. The student was alarmed at the possibility of administering two-and-a-half times the prescribed dosage. The student insisted that the pharmacy should consistently supply the same unit dosage. The instructor advised the student of the possibility that different pharmacy technicians could be involved, or possibly the original supply dosage was not available.

Prevention

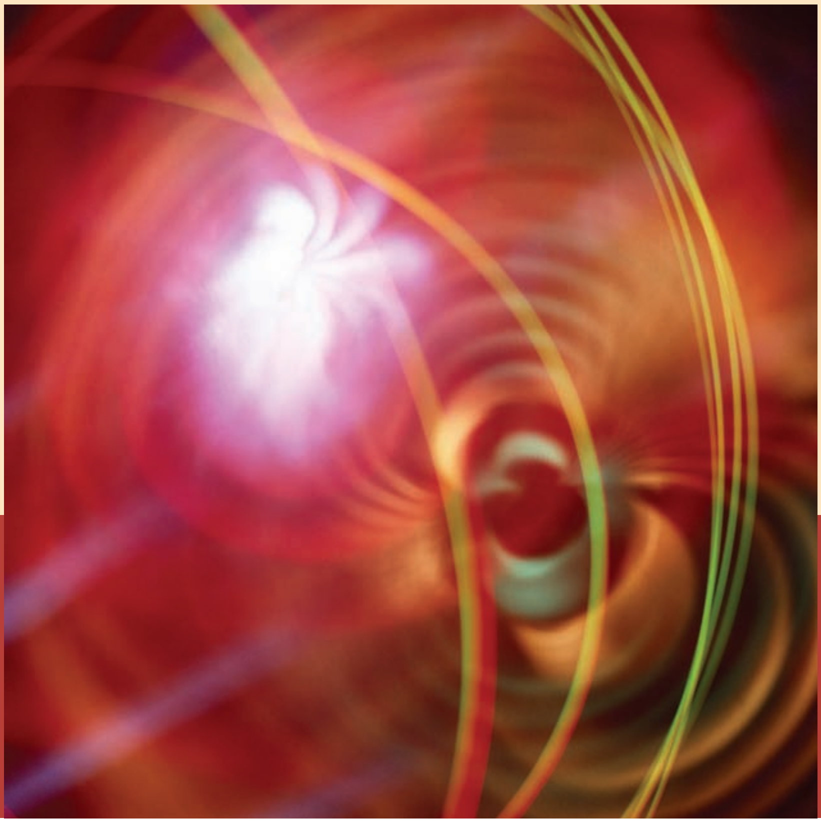
____

____

After completing these problems, see pages 546-552 to check your answers. Give yourself two points for each correct answer.

Perfect score = 100 My score = _________

Minimum mastery score = 90 (45 correct)



Comprehensive Skills Evaluation

This evaluation is a comprehensive assessment of your mastery of the concepts presented in all 16 chapters of *Dosage Calculations A Ratio-Proportion Approach.*

Donna Smith, a 46-year-old patient of Dr. J. Physician, has been admitted to the Progressive Care Unit (PCU) with complaints of an irregular heartbeat, shortness of breath, and chest pain relieved by nitroglycerin. Questions 1 through 14 refer to the admitting orders on page 452 for Mrs. Smith. The labels shown represent available medications and infusion set.

1. How many capsules of nitroglycerin will you give Mrs. Smith?

   Give: ________ capsules

N 3 58177-005-04 6

Each extended-release capsule contains:

Nitroglycerin .... 6.5 mg

KEEP THIS AND ALL DRUGS OUT OF THE REACH OF CHILDREN.

Manufactured by
Time-Cap Labs Inc. for
ETHEX Corporation
St. Louis, MO 63043-2413

NDC 58177-005-04

Nitroglycerin

Extended-release Capsules

6.5 mg

℞ Only

100 Capsules

Dispense in a tight container as defined in the USP/NF.

Store at controlled room temperature 15°-30°C (59°-86°F).

USUAL DOSAGE: See package insert for dosage, including nitrate-free intervals.

P3808 12/01

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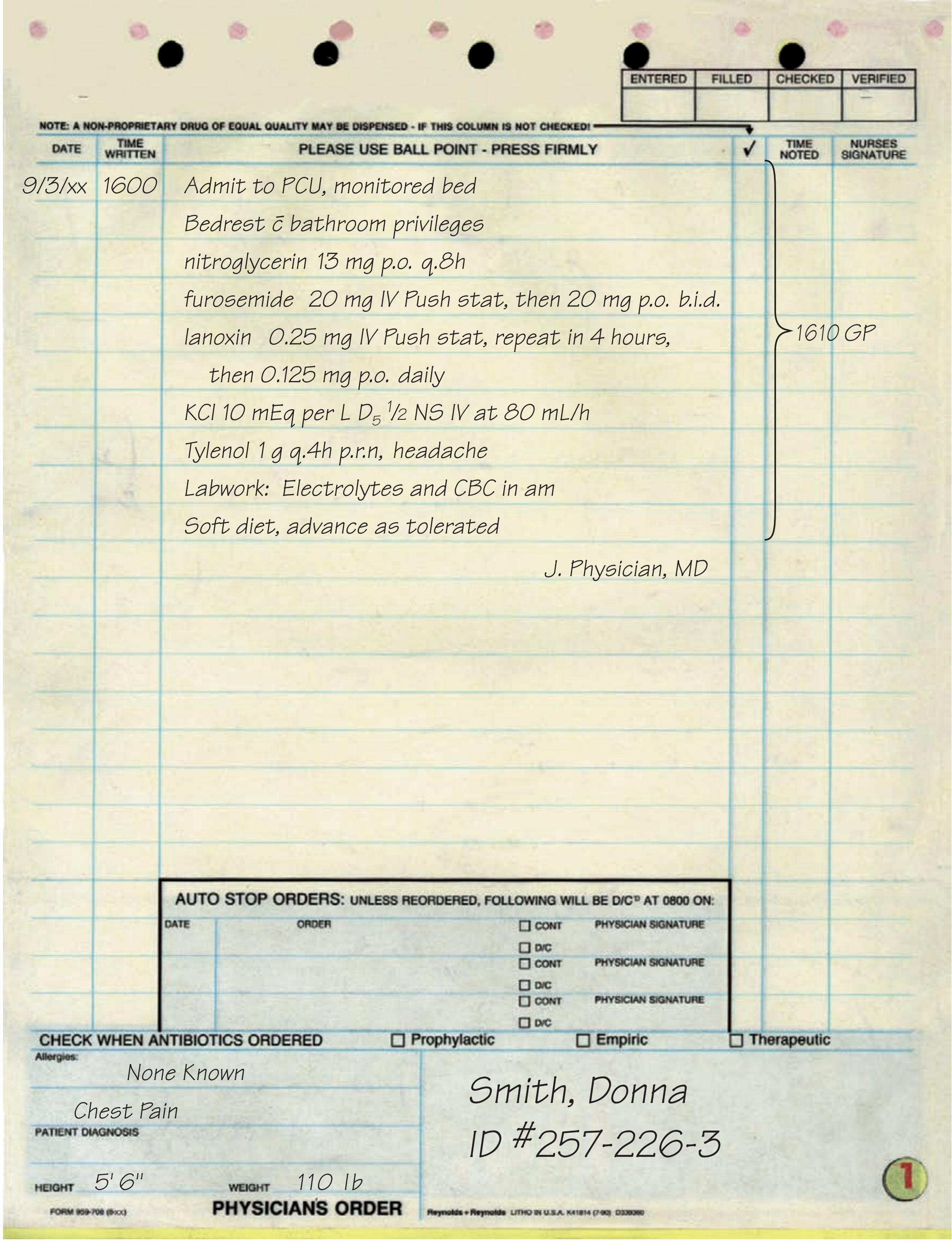

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NOTE: A NON-PROPRIETARY DRUG OF EQUAL QUALITY MAY BE DISPENSED - IF THIS COLUMN IS NOT CHECKED!

DATE	TIME WRITTEN	PLEASE USE BALL POINT - PRESS FIRMLY	✓	TIME NOTED	NURSES SIGNATURE
9/3/xx	1600	Admit to PCU, monitored bed			
		Bedrest c̄ bathroom privileges			
		nitroglycerin 13 mg p.o. q.8h			
		furosemide 20 mg IV Push stat, then 20 mg p.o. b.i.d.			
		lanoxin 0.25 mg IV Push stat, repeat in 4 hours,		1610 GP	
		then 0.125 mg p.o. daily			
		KCl 10 mEq per L D_5 $\frac{1}{2}$ NS IV at 80 mL/h			
		Tylenol 1 g q.4h p.r.n, headache			
		Labwork: Electrolytes and CBC in am			
		Soft diet, advance as tolerated			
		J. Physician, MD			

AUTO STOP ORDERS: UNLESS REORDERED, FOLLOWING WILL BE D/C'D AT 0800 ON:

DATE	ORDER		
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE

CHECK WHEN ANTIBIOTICS ORDERED ☐ Prophylactic ☐ Empiric ☐ Therapeutic

Allergies: None Known

Chest Pain

PATIENT DIAGNOSIS

HEIGHT 5' 6" WEIGHT 110 lb

Smith, Donna

ID #257-226-3

1

FORM 959-708 (8xx) **PHYSICIANS ORDER** Reynolds + Reynolds LITHO IN U.S.A. K41814 (7-90) D339380

2. Sometimes nitroglycerin is ordered by the SL route. SL is the medical abbreviation for ________

Explain: ____

3. How much and at what rate will you administer Mrs. Smith's first dose of furosemide? Draw an arrow on the appropriate syringe to indicate how much you will prepare. The recommended direct IV administration rate for furosemide is 40 mg per 2 min. Give: ________ mL at the rate of ________ mL/min or ________ mL per 15 sec


NDC 63323-280-02 28002

FUROSEMIDE

INJECTION, USP

20 mg/2 mL

(10 mg/mL)

For IM or IV Use Rx only

2 mL Single Dose Vial

Preservative Free

Discard unused portion.

PROTECT FROM LIGHT.

Do not use if discolored.

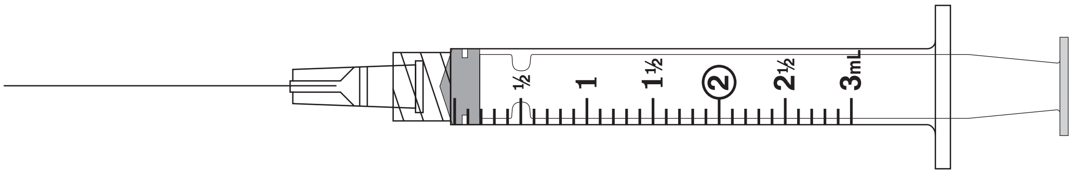
American Pharmaceutical Partners, Inc.

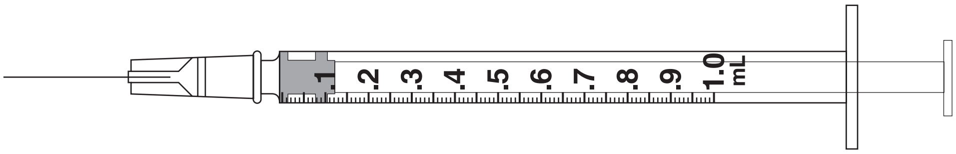
Los Angeles, CA 90024

401803A

LOT

EXP





4. After the initial dose of furosemide, how much will you administer for each subsequent dose?

Give: ________ tablet(s)


NDC 0039-0067-50

Lasix® 20mg

furosemide

500 Tablets

Aventis

3 0039-0067-50 9

℞ ONLY

Each LASIX® Tablet contains 20mg furosemide. **Dosage and Administration:** See package insert for dosage information. **WARNING:** Keep out of reach of children. Do not use if bottle closure seal is broken. **Pharmacist:** Dispense in well-closed, light-resistant container with child-resistant closure. **Store at room temperature.**

Hoechst-Roussel Pharmaceuticals

Division of **Aventis Pharmaceuticals Inc.**

Kansas City, MO 64137 USA ©2000

www.aventispharma-us.com

50058803 50058803 50058803

5. How much and at what rate will you administer the IV Lanoxin on admission? Draw an arrow on the syringe to indicate how much you will prepare. The recommended direct IV rate for digoxin (Lanoxin) is 0.25 mg in 4 mL NS administered IV at the rate of 0.25 mg per 5 min.

Give: ________ mL at the rate of ________ mL/min or ________ mL per 15 sec


LANOXIN® **2 mL**

(digoxin) Injection **℞only**

500 mcg (0.5 mg) in 2 mL

(250 mcg [0.25 mg] per mL)

Store at 25°C (77°F) [see insert].

PROTECT FROM LIGHT.

Dist.: GlaxoSmithKline

Research Triangle Park, NC 27709

Made in Canada

4144627

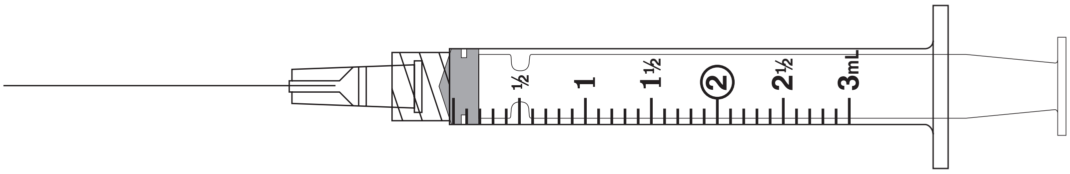
Rev. 3/02

220201

LOT

EXP

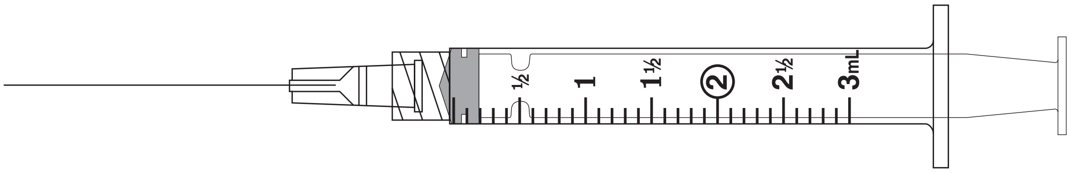
[redacted]

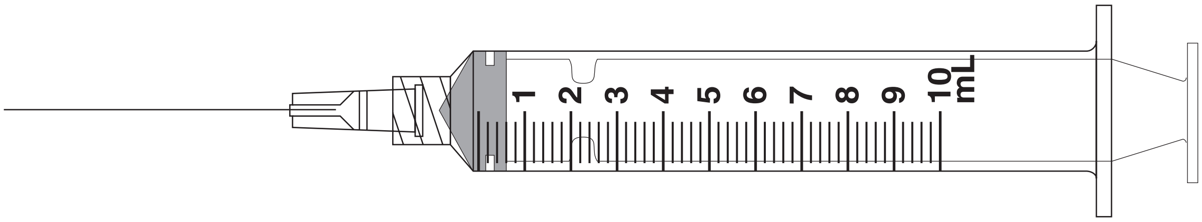


6. How many Lanoxin tablets will you need for a 24-hour supply of the p.o. order? __________ tablet(s)

7. Calculate the watch count flow rate for the IV fluid ordered. __________ gtt/min

8. How much KCl will you add to the IV? Draw an arrow on the appropriate syringe to indicate the amount. Add: __________ mL





9. How many mEq KCl will Mrs. Smith receive per hour? __________ mEq/h

10. At the present infusion rate, how much $D_5 \frac{1}{2}$ NS will Mrs. Smith receive in a 24-hour period? __________ mL/day

11. The IV is started at 1630. Estimate the time and date that you should plan to hang the next liter of $D_5 \frac{1}{2}$ NS. __________ hours __________ date

12. Mrs. Smith has a headache. How much Tylenol will you give her?

    Give: __________ tablet(s)

13. You have located an infusion controller for Mrs. Smith's IV. At what rate will you set the controller? __________ mL/h

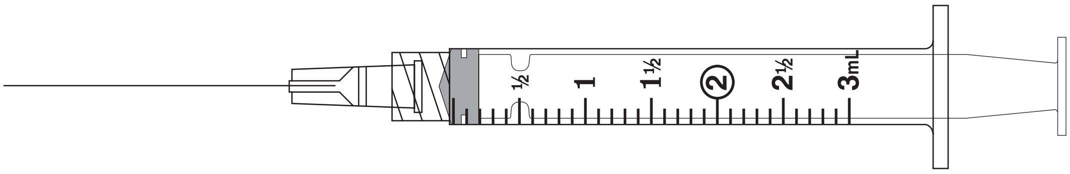
14. Compare the drug order and the labels to determine which of Mrs. Smith's medications are ordered by their generic or chemical names? ______________________________

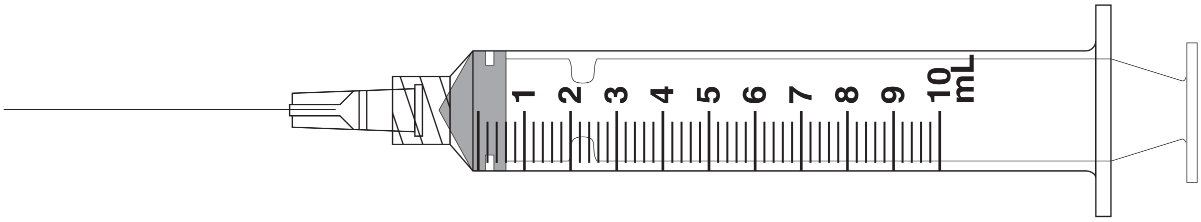
    ____

Despite your excellent care, Mrs. Smith's condition worsens. She is transferred into the coronary care unit (CCU) with the medical orders on page 456. Questions 15 through 20 refer to these orders. She weighs 110 lb.

15. You have lidocaine 10 mg/mL available. How much lidocaine will you give for the bolus? Draw an arrow on the appropriate syringe to indicate the amount you will give.

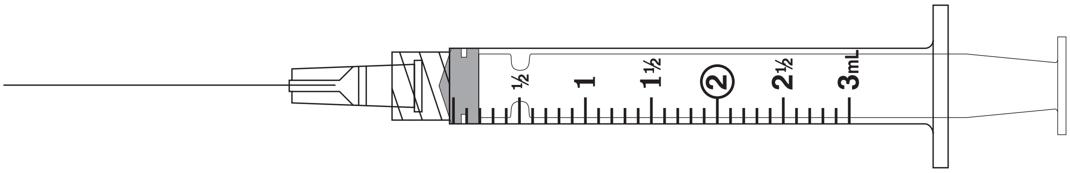
    Give: __________ mL

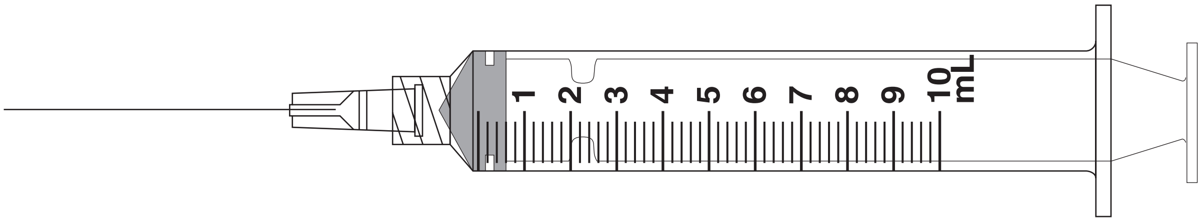


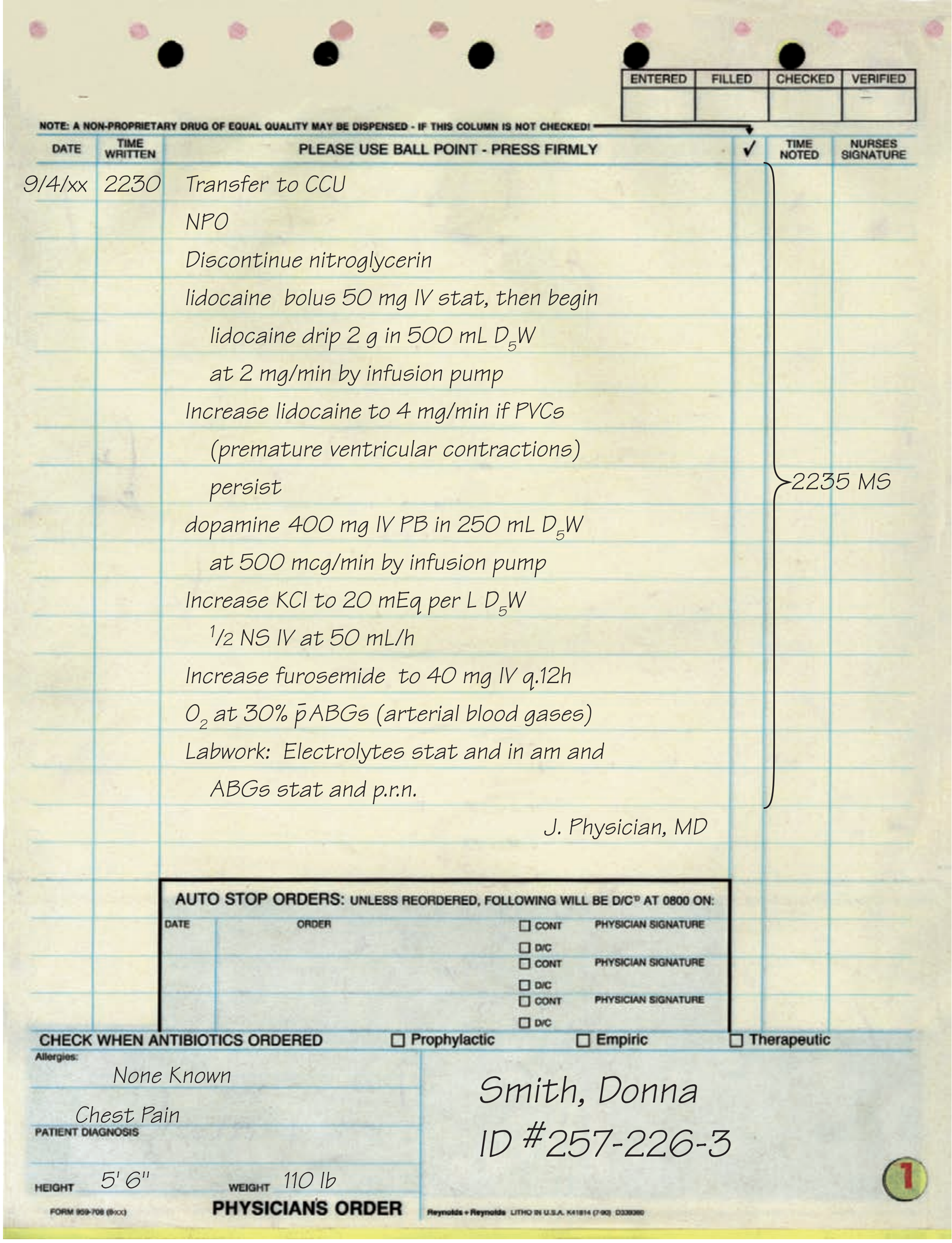


16. The infusion pump is calibrated to administer mL/h. At what rate will you initially set the infusion pump for the lidocaine drip? __________ mL/h

17. The recommended dosage of dopamine is 5–10 mcg/kg/min. Is the dosage ordered for Mrs. Smith safe? __________ If safe, how much dopamine will you add to mix the dopamine drip? You have dopamine 80 mg/mL available. Draw an arrow on the appropriate syringe to indicate the amount you will add. Add: __________ mL







ENTERED	FILLED	CHECKED	VERIFIED

NOTE: A NON-PROPRIETARY DRUG OF EQUAL QUALITY MAY BE DISPENSED - IF THIS COLUMN IS NOT CHECKED!

DATE	TIME WRITTEN	PLEASE USE BALL POINT - PRESS FIRMLY	✓	TIME NOTED	NURSES SIGNATURE
9/4/xx	2230	Transfer to CCU		2235	MS
		NPO			
		Discontinue nitroglycerin			
		lidocaine bolus 50 mg IV stat, then begin			
		lidocaine drip 2 g in 500 mL D_5W			
		at 2 mg/min by infusion pump			
		Increase lidocaine to 4 mg/min if PVCs			
		(premature ventricular contractions)			
		persist			
		dopamine 400 mg IV PB in 250 mL D_5W			
		at 500 mcg/min by infusion pump			
		Increase KCl to 20 mEq per L D_5W			
		$^1/_2$ NS IV at 50 mL/h			
		Increase furosemide to 40 mg IV q.12h			
		O_2 at 30% $\bar{p}$ ABGs (arterial blood gases)			
		Labwork: Electrolytes stat and in am and			
		ABGs stat and p.r.n.			
		J. Physician, MD			

AUTO STOP ORDERS: UNLESS REORDERED, FOLLOWING WILL BE D/C'D AT 0800 ON:

DATE	ORDER		
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE
		☐ CONT ☐ D/C	PHYSICIAN SIGNATURE

CHECK WHEN ANTIBIOTICS ORDERED ☐ Prophylactic ☐ Empiric ☐ Therapeutic

Allergies: None Known

Chest Pain
PATIENT DIAGNOSIS

HEIGHT 5' 6" WEIGHT 110 lb

PHYSICIANS ORDER

Smith, Donna
ID #257-226-3

1

18. Calculate the rate for the infusion pump for the dopamine drip. __________ mL/h

19. How much dopamine will Mrs. Smith receive per hour? __________ mcg/h or __________ mg/h

20. Mrs. Smith is having increasing amounts of PVCs. To increase her lidocaine drip to 4 mg/min, you will now change the IV infusion pump setting to __________ mL/h.

21. Julie Thomas is a 6-year-old pediatric patient who weighs 33 lb. She is in the hospital for fever of unknown origin. Julie complains of burning on urination and her urinalysis shows *E. coli* bacterial infection. The doctor prescribes Kantrex 75 mg IV q.8h to be administered by volume control set

on an infusion pump in 25 mL $D_5 \frac{1}{2}$ NS followed by 15 mL flush over one hour. The maximum recommended dosage of Kantrex is 15 mg/kg/day IV in three doses.

Is the order safe? ________

Explain: ________

If safe, add ________ mL Kantrex and ________ mL D_5W to the chamber, and set the flow rate for ________ mL/h.

22. Order: **Cardizem 125 mg in 100 mL D_5W IV at 15 mg/h**

    Set the IV pump at ________ mL/h.

23. Jamie Smith is hospitalized with a staphylococcal bone infection. He weighs 66 lb.

    Orders: **$D_5 \frac{1}{2}$ NS IV at 50 mL/h for continuous infusion**

    Vancocin 300 mg IV q.6h

    Supply: Vancocin 500 mg per 10 mL with instructions to "add to volume control set and infuse over 60 min."

    Recommended dosage: Vancomycin 40 mg/kg/day IV in 4 equally divided doses.

    Is this drug order safe? ________. Explain: ________

    If safe, how much Vancocin will you add to the chamber? ________ mL

    How much IV fluid will you add to the chamber with the Vancocin? ________ mL

    How much IV fluid will Jamie receive in 24 hours? ________ mL

24. You are preparing IV fluids for a young child according to the following order:

    $D_5 \frac{1}{2}$ NS $\bar{c}$ KCl 20 mEq/L IV at 30 mL/h

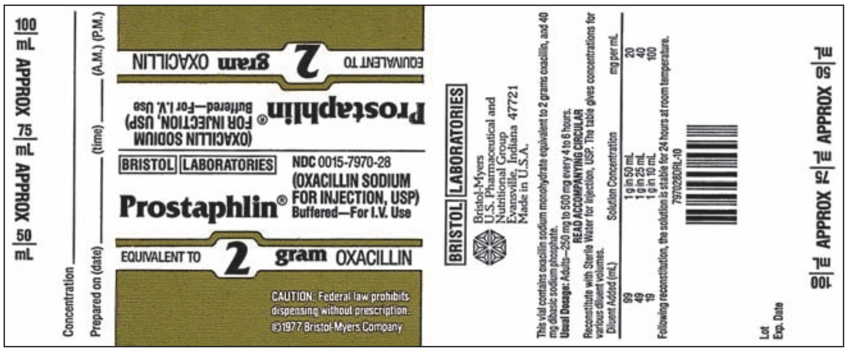
    You have chosen to use a 250 mL bag of $D_5 \frac{1}{2}$ NS. How many mEq KCl will you add? ________ mEq

    Your supply of KCl is 2 mEq/mL. How much KCl will you add to the 250 mL bag? ________ mL

Use the related orders and labels to answer questions 25 through 29. Select and mark the dose volume on the appropriate syringe, as indicated.

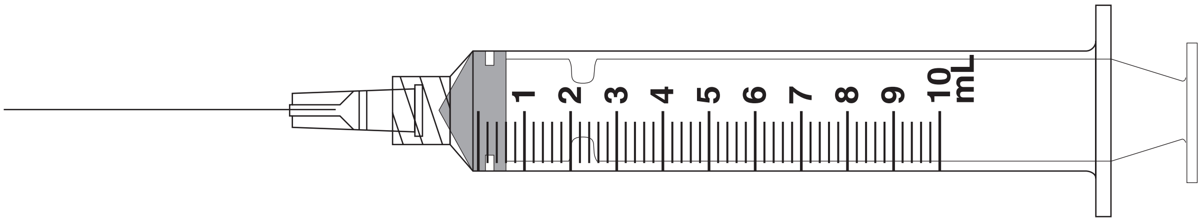
25. Order: **Prostaphlin 500 mg IV q.6h in 50 mL D_5W IV by volume control set over 60 min. Follow with 15 mL IV flush.**

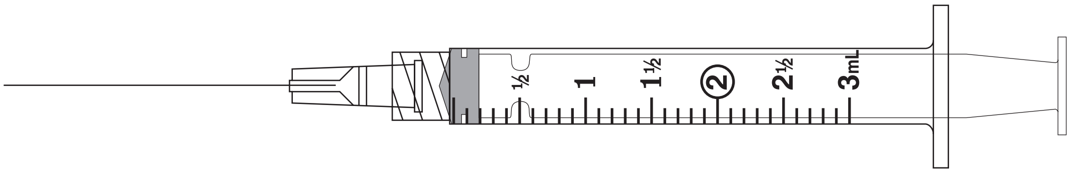
    Reconstitute with ________ mL diluent.



26. Prepare a reconstitution label for the Prostaphlin.

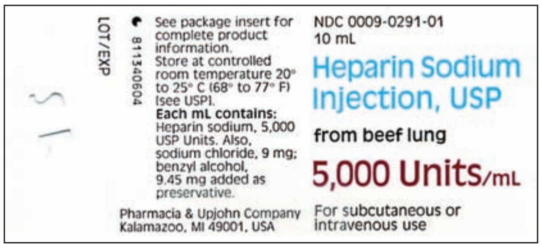
27. Add ________ mL Prostaphlin and ________ mL D_5W to the chamber.





28. The IV Prostaphlin is regulated on an infusion pump. Set the volume control set flow rate at ________ mL/h.

29. Order: **heparin 10,000 units IV in 500 mL D_5W to infuse at 1,200 units/h.**



LOT/EXP

8113540604

See package insert for complete product information.
Store at controlled room temperature 20° to 25° C (68° to 77° F) [see USP].
Each mL contains: Heparin sodium, 5,000 USP Units. Also, sodium chloride, 9 mg; benzyl alcohol, 9.45 mg added as preservative.

Pharmacia & Upjohn Company
Kalamazoo, MI 49001, USA

NDC 0009-0291-01
10 mL

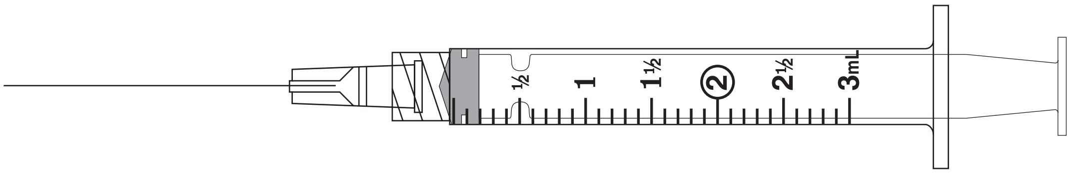
Heparin Sodium Injection, USP

from beef lung

5,000 Units/mL

For subcutaneous or intravenous use

Add ________ mL heparin to the IV solution. Set the flow rate to ________ mL/h on an IV infusion pump.



Questions 30 and 31 refer to a patient who weighs 125 lb and has IV heparin ordered per the following Weight Based Heparin Protocol.

Weight-Based Heparin Protocol:

Heparin IV infusion: **heparin 25,000 units IV in 250 mL of $\frac{1}{2}$ NS**

IV Boluses: Use heparin 1,000 units/mL

Bolus with heparin 80 units/kg. Then initiate heparin drip at 18 units/kg/h. Obtain APTT every 6 hours and adjust dosage and rate as follows:

If APTT is less than 35 seconds: Rebolus with 80 units/kg and increase rate by 4 units/kg/h.

If APTT is 36–44 seconds: Rebolus with 40 units/kg and increase rate by 2 units/kg/h.

If APTT is 45–75 seconds: Continue current rate.

If APTT is 76–90 seconds: Decrease rate by 2 units/kg/h.

If APTT is greater than 90 seconds: Hold heparin for one hour and then decrease rate by 3 units/kg/h.

30. Convert the patient's weight to kg (rounded to tenths): __________ kg

Calculate the initial heparin bolus dosage: __________ units

Calculate the bolus dose: __________ mL

Calculate the initial heparin infusion rate: __________ units/h or __________ mL/h

31. At 0930, the patient's APTT is 77 seconds. According to the protocol, what will your action be?

____

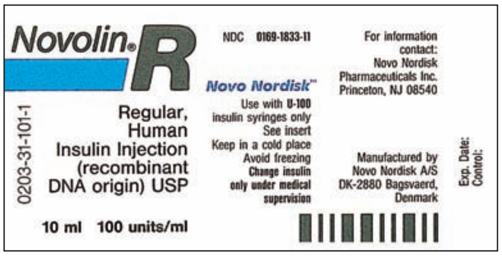
____

Reset infusion rate to __________ units/h or __________ mL/h.

32. Order: **Novolin R Regular U-100 insulin subcut ac per sliding scale and blood sugar (BS) level.** The patient's blood sugar at 1730 hours is 238.

Sliding Scale	Insulin Dosage
BS: 0–150	0 units
BS: 151–250	8 units
BS: 251–350	13 units
BS: 351–400	18 units
BS: greater than 400	Call M.D.

Give: __________ units, which equals __________ mL. (Mark dose on appropriate syringe.)



Novolin® R

0203-31-101-1

Regular, Human Insulin Injection (recombinant DNA origin) USP

10 ml 100 units/ml

NDC 0169-1833-11

Novo Nordisk™

Use with U-100 insulin syringes only

See insert

Keep in a cold place

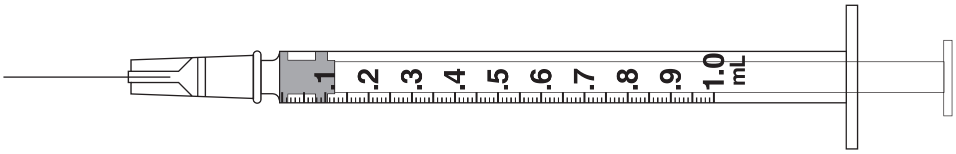
Avoid freezing

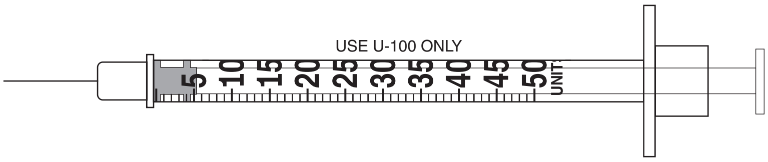
Change insulin only under medical supervision

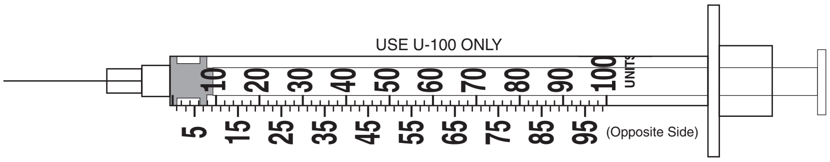
For information contact:
Novo Nordisk Pharmaceuticals Inc.
Princeton, NJ 08540

Manufactured by
Novo Nordisk A/S
DK-2880 Bagsvaerd,
Denmark

Exp. Date:
Control:

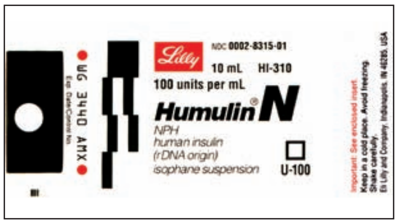


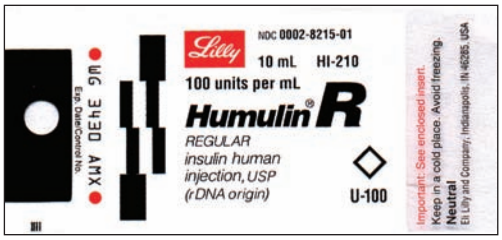


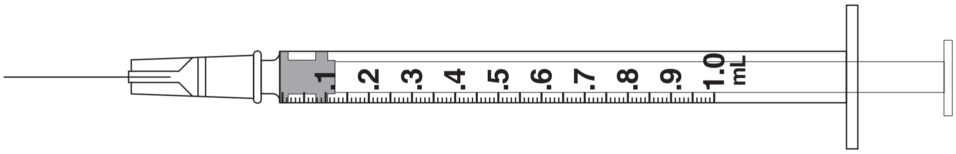


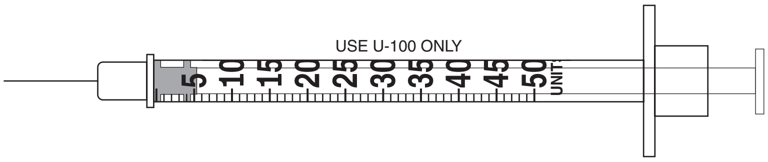
33. Order: **Humulin R Regular U-100 insulin 15 units $\bar{c}$ Humulin N NPH U-100 insulin 45 units subcut at 0730**

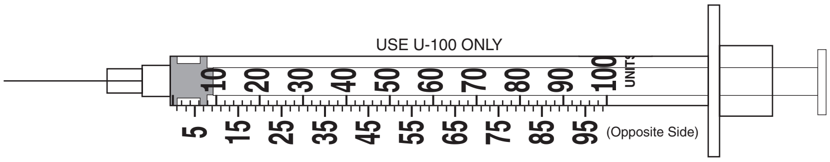
You will give a total of __________ units insulin. (Mark dose on appropriate syringe, designating Regular and NPH insulin.)











34. A patient with diabetes is receiving an insulin drip of **Humulin R Regular U-100 insulin 300 units in 150 mL NS IV infusing at 10 mL/h.** How many units/h of insulin is this patient receiving? __________ units/h

Questions 35 and 36 refer to an infant who weighs 16 lb and is admitted to the pediatric unit with vomiting and diarrhea for 3 days' duration.

Order: **$\frac{1}{4}$ strength Isomil 80 mL q.3h for 4 feedings; if tolerated, increase Isomil to $\frac{1}{2}$ strength 80 mL q.3h for 4 feedings**

Supply: Isomil Ready-to-Feed formula in 8 ounce cans

35. To reconstitute a full 8 ounce can of Isomil ready-to-feed to $\frac{1}{4}$ strength, you would add __________ mL water to mix a total of __________ mL $\frac{1}{4}$ strength reconstituted Isomil.

36. The child is not tolerating the oral feedings. Calculate this child's allowable daily and hourly IV maintenance fluids using the following recommendation. __________ mL/day or __________ mL/h.

Daily rate of pediatric maintenance IV fluids:

100 mL/kg for first 10 kg of body weight

50 mL/kg for next 10 kg of body weight

20 mL/kg for each kg above 20 kg of body weight

Use the following information and order to answer questions 37 and 38.

Metric: $\text{BSA (m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}}$ Household: $\text{BSA (m}^2) = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}}$

Order: **Mitomycin 28 mg IV Push stat**

Recommended dosage is 10–20 mg/m^2/single IV dose.

Patient is 5 ft 2 in tall and weighs 103 lb.

Mitomycin is available in a 40 mg vial with directions to reconstitute with 80 mL sterile water for injection and inject slowly over 10 minutes.

37. The patient's BSA is __________ m^2.

38. What is the recommended dosage of Mitomycin for this patient? __________ mg to __________ mg

Is the ordered dosage safe? __________

What is the concentration of Mitomycin after reconstitution? __________ mg/mL

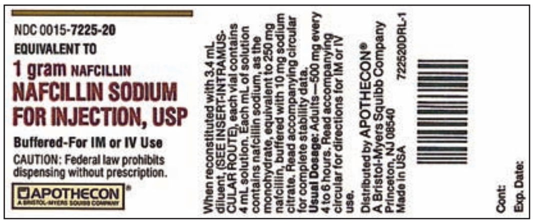
If the order is safe, administer __________ mL Mitomycin at the rate of __________ mL/min or __________ mL per 15 sec.

39. A child's IV is **1 L D_5 0.45% NaCl.** Calculate the amount of solute in this IV solution. __________ g dextrose and __________ g NaCl.

40. An IV order says to **add 20 mEq KCl/L after first urination.** KCl is available as 40 mEq per 20 mL. When it is time to add the KCl, there are 400 mL left in the IV bag. How many mEq of KCl will you add? __________ mEq How much KCl will you add? __________ mL

Use the following order and label for the available drug to answer questions 41 and 42.

Order: **nafcillin 540 mg IV q.6h in IV fluid for total volume of 50 mL to infuse over 1 h via volume control set**



41. Add __________ mL Nafcillin and __________ mL IV fluid to the chamber.

42. The minimal dilution (maximal concentration) of Nafcillin is 40 mg/mL. Is the ordered amount of IV fluid sufficient to safely dilute the Nafcillin? __________. Explain: ____________________

____

Use the following information to answer questions 43 and 44.

Order: **penicillin G potassium 400,000 units IV PB q.6h** for a child who weighs 10 kg. Recommended dosage for children: Give penicillin G potassium 150,000–250,000 units/kg/day in divided doses q.6h; dilute with 100 mL NS and infuse over 60 minutes.

43. How many units per day of penicillin G potassium is this child ordered to receive? __________ units/day

Is the ordered dosage safe? __________ Explain: ____________________

If safe, reconstitute with ______ mL diluent for a concentration of ______ units/mL, and prepare a reconstitution label.

Prepare to give ______ mL.

If not safe, what should you do? ______

44. The child's IV is infusing on an electronic infusion pump. If the dosage is safe, set the IV flow rate at ______ mL/h.

Use the following patient situation to answer questions 45 through 48.

A patient has been admitted to the hospital with fever and chills, productive cough with yellow-green sputum, shortness of breath, malaise, and anorexia. Laboratory tests and X-rays confirmed a diagnosis of pneumonia. The patient is complaining of nausea. The physician writes the following orders. The labels represent the drugs you have available.

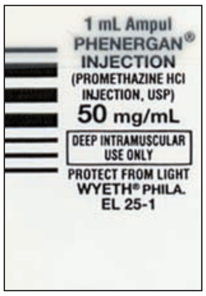
NS 1,000 mL IV at 125 mL/h

Fortaz 1,500 mg IV PB q.8h in 100 mL NS over 30 min

Phenergan 25 mg IV push q.4h p.r.n., nausea and vomiting

Lot
Exp.
NDC 0173-0379-34
Fortaz®
(ceftazidime for injection)
2 g ℞ only
Equivalent to 2 g of ceftazidime. For IV use.

See package insert for Dosage and Administration. Before constitution, store between 15° and 30°C (59° and 86°F) and protect from light. IMPORTANT: The vial is under reduced pressure. Addition of diluent generates a positive pressure. Before constituting, see Instructions for Constitution. To prepare IV solution, add 10 mL of Sterile Water for Injection. After constitution, solutions maintain potency for 24 hours at room temperature (not exceeding 25°C [77°F]) or for 7 days under refrigeration. Constituted solutions in Sterile Water for Injection may be frozen. See package insert for details. Color changes do not affect potency. This vial contains 236 mg of sodium carbonate. The sodium content is approximately 108 mg (4.7 mEq).
GlaxoSmithKline, Research Triangle Park, NC 27709
Made in England Rev. 1/02



1 mL Ampul
PHENERGAN®
INJECTION
(PROMETHAZINE HCl INJECTION, USP)
50 mg/mL
DEEP INTRAMUSCULAR USE ONLY
PROTECT FROM LIGHT
WYETH® PHILA.
EL 25-1

45. You can start the primary IV at 1:15 PM on an infusion pump. When do you estimate (using international time) the primary IV and one IVPB administration will be completely infused and the primary IV will have to be replaced? ______ hours

46. The recommendation for direct IV administration of Phenergan is at a rate not to exceed 25 mg/min. Give ______ mL Phenergan at the rate of ______ mL/min or ______ mL per 15 sec.

47. You will give ______ mL Fortaz per dose.

48. Set the IV PB flow rate for each dose of Fortaz at ______ mL/h.

49. Describe the strategy you would implement to prevent this medication error.

Possible Scenario

A student nurse was preparing for medication administration. One of the orders on the Medical Administration Record was written as **Lanoxin 0.125 mg od.** The student nurse crushed the Lanoxin tablet. Prior to giving the medication, the nursing instructor checked the medications that the student had prepared. The instructor asked the student to explain the rationale for crushing the

Lanoxin tablet. The student explained to the instructor that the Lanoxin order was for the right eye ("O.D." is an outdated abbreviation for right eye) and the student planned to add a small amount of sterile water to the crushed tablet and put it in the patient's eye.

Potential Outcome
What is wrong with the Lanoxin order? ______________________________

____

What could be the result? ______________________________

Prevention

____

____

50. Describe the strategy you would implement to prevent this medication error.

Possible Scenario
Order: **Quinine 300 mg p.o. bedtime**

Supply: Quinidine 300 mg tablets

A student nurse administering medications noted the difference between the order and the supply drug, and queried the staff nurse about the order and what had been administered. The staff nurse at first dismissed it as only the brand name versus the generic name of the drug. Later the nurse realized that the student was exactly right to question the order and the drug supplied, and admitted to the student that the patient had been receiving the wrong drug all week.

Potential Outcome
The student referred to a drug reference book and compared the therapeutic and side effects of both drugs. The quinine was correctly ordered for leg cramps. Quinidine is an anti-arrhythmic heart medication. The student reviewed the patient's record and noted that the patient had been experiencing serious hypotension (a side effect of quinidine) for the past several days.

Prevention

____

____

After completing these problems, see pages 553-559 to check your answers. Give yourself two points for each correct answer.

Perfect score = 100 My score = ________

Minimum mastery score = 90 (45 correct)

Mathematics Diagnostic Evaluation from pages 2-4

1) 1,517.63 **2)** 20.74 **3)** 100.66 **4)** $323.72 **5)** 46.11 **6)** 754.5 **7)** 16.91 **8)** 19,494.7 **9)** $173.04 **10)** 403.26 **11)** 36 **12)** 2,500 **13)** $\frac{2}{3}$ **14)** 6.25 **15)** $\frac{4}{5}$ **16)** 40% **17)** 0.4% **18)** 0.05 **19)** 1:3 **20)** 0.02 **21)** $1\frac{1}{4}$ **22)** $6\frac{13}{24}$ **23)** $1\frac{11}{18}$ **24)** $\frac{3}{5}$ **25)** $14\frac{7}{8}$ **26)** $\frac{1}{100}$ **27)** 0.009 **28)** 320 **29)** 3 **30)** 0.05 **31)** 4 **32)** 0.09 **33)** 0.22 **34)** 25 **35)** 4 **36)** 0.75 **37)** 3 **38)** 500 **39)** 18.24 **40)** 2.4 **41)** $\frac{1}{5}$ **42)** 1:50 **43)** 5 tablets **44)** 2 milligrams **45)** 30 kilograms **46)** 3.3 pounds **47)** $6\frac{2}{3} = 6.67$ centimeters **48)** 7.5 centimeters **49)** 90% **50)** 5:1

Solutions—Mathematics Diagnostic Evaluation

3)
$$\begin{array}{r} 9.50 \\ 17.06 \\ 32.00 \\ 41.11 \\ +\ 0.99 \\ \hline 100.66 \end{array}$$

6)
$$\begin{array}{r} 1{,}005.0 \\ -\ 250.5 \\ \hline 754.5 \end{array}$$

10)
$$\begin{array}{l} 17.16 \\ \underline{\times\ 23.5} \\ 8580 \\ 5148 \\ \underline{3432} \\ 403.260 = 403.26 \end{array}$$

12)
$$\begin{array}{r} 2500. \\ 0.001\overline{)2.500.} \end{array} = 2{,}500$$

19)
$$\frac{33\frac{1}{3}}{100} = \frac{\frac{100}{3}}{100} = \frac{100}{3} \div \frac{100}{1} = \frac{\cancel{100}}{3} \times \frac{1}{\cancel{100}} = \frac{1}{3} = 1:3$$

23)
$$\begin{array}{r} 1\frac{5}{6} = 1\frac{15}{18} \\ -\frac{2}{9} = -\frac{4}{18} \\ \hline 1\frac{11}{18} \end{array}$$

25)
$$4\frac{1}{4} \times 3\frac{1}{2} = \frac{17}{4} \times \frac{7}{2} = \frac{119}{8} = 14\frac{7}{8}$$

29)
$$\frac{0.02 + 0.16}{0.4 - 0.34}$$

$$\begin{array}{r} 0.02 \\ +\ 0.16 \\ \hline 0.18 \end{array} \qquad \begin{array}{r} 0.40 \\ -\ 0.34 \\ \hline 0.06 \end{array}$$

$$\frac{0.18}{0.06} = \begin{array}{r} 3. \\ 0.06.\overline{)0.18.} \end{array} = 3$$

32)
$$\frac{1}{2}\% = 0.5\% = 0.005 \qquad \begin{array}{r} 18 \\ \times 0.005 \\ \hline 0.090 \end{array} = 0.09$$

34)
$$\frac{\frac{1}{1{,}000}}{\frac{1}{100}} \times 250 = \frac{1}{\underset{10}{\cancel{1{,}000}}} \times \frac{\overset{1}{\cancel{100}}}{1} \times \frac{250}{1} = \frac{250}{10} = 25$$

45)
$$66 \text{ pounds} = \frac{66}{2.2} = 30 \text{ kilograms or}$$

$$\frac{2.2 \text{ pounds}}{1 \text{ kilogram}} \times \frac{66 \text{ pounds}}{X \text{ kilograms}}$$

$$2.2X = 66$$

$$\frac{2.2X}{2.2} = \frac{66}{2.2}$$

$$X = 30 \text{ kilograms}$$

49)
$$\begin{array}{r} 50 \\ -\ 5 \\ \hline 45 \end{array} \qquad \frac{45}{50} = \frac{9}{10} = 90\%$$

Review Set 1 from pages 10-12

1) $\frac{6}{6}, \frac{7}{5}$ **2)** $\frac{\frac{1}{100}}{\frac{1}{150}}$ **3)** $\frac{1}{4}, \frac{1}{14}$ **4)** $1\frac{2}{9}, 1\frac{1}{4}, 5\frac{7}{8}$ **5)** $\frac{3}{4} = \frac{6}{8}, \frac{1}{5} = \frac{2}{10}, \frac{3}{9} = \frac{1}{3}$ **6)** $\frac{13}{2}$ **7)** $\frac{6}{5}$ **8)** $\frac{32}{3}$ **9)** $\frac{47}{6}$ **10)** $\frac{411}{4}$ **11)** 2 **12)** 1 **13)** $3\frac{1}{3}$ **14)** $1\frac{1}{3}$ **15)** $2\frac{3}{4}$ **16)** $\frac{6}{8}$ **17)** $\frac{4}{16}$ **18)** $\frac{8}{12}$ **19)** $\frac{4}{10}$ **20)** $\frac{6}{9}$ **21)** $\frac{1}{100}$ **22)** $\frac{1}{10{,}000}$ **23)** $\frac{5}{9}$ **24)** $\frac{3}{10}$ **25)** $\frac{2}{5}$ bottle **26)** $1\frac{1}{2}$ bottles **27)** $\frac{1}{20}$ of the class are men **28)** $\frac{9}{10}$ of the questions were answered correctly **29)** $\frac{1}{2}$ dose **30)** $\frac{1}{2}$ teaspoon

Solutions—Review Set 1

8) $10\frac{2}{3} = \frac{(3 \times 10) + 2}{3} = \frac{32}{3}$

14) $\frac{100}{75} = 1\frac{25}{75} = 1\frac{1}{3}$

18) $\frac{2}{3} \times \frac{4}{4} = \frac{8}{12}$

25) 10 ounces – 6 ounces = 4 ounces remaining

$\frac{\overset{2}{\cancel{4}}}{\underset{5}{\cancel{10}}} = \frac{2}{5}$ bottle remaining

27)
$$\begin{array}{r} 57 \\ +\ 3 \\ \hline 60 \end{array}$$
people in class

The men represent $\frac{3}{60}$ or $\frac{1}{20}$ of the class.

29) $\frac{80}{160} = \frac{1}{2}$ of a dose

30) $\frac{1}{2}$ of 1 teaspoon $= \frac{1}{2}$ teaspoon

Review Set 2 from page 14

1) $8\frac{7}{15}$ **2)** $1\frac{5}{12}$ **3)** $17\frac{5}{24}$ **4)** $1\frac{1}{24}$ **5)** $32\frac{5}{6}$ **6)** $5\frac{7}{12}$ **7)** $1\frac{1}{3}$ **8)** $5\frac{53}{72}$ **9)** 43 **10)** $5\frac{118}{119}$ **11)** $2\frac{8}{15}$ **12)** $\frac{53}{132}$ **13)** $\frac{1}{2}$ **14)** $4\frac{5}{6}$ **15)** $\frac{1}{24}$ **16)** $63\frac{2}{3}$ **17)** $299\frac{4}{5}$ **18)** $\frac{1}{6}$ **19)** $1\frac{2}{5}$ **20)** $7\frac{1}{16}$ **21)** $7\frac{2}{9}$ **22)** $1\frac{1}{4}$ **23)** $24\frac{6}{11}$ **24)** $\frac{7}{12}$ **25)** $\frac{1}{25}$ **26)** $\frac{7}{12}$ ounce **27)** $1\frac{1}{8}$ inches **28)** 8 inches **29)** $21\frac{1}{2}$ pints **30)** $20\frac{1}{16}$ pounds

Solutions—Review Set 2

1)
$$7\frac{4}{5} + \frac{2}{3} : \begin{array}{r} 7\frac{12}{15} \\ +\ \frac{10}{15} \\ \hline 7\frac{22}{15} \end{array} = 8\frac{7}{15}$$

3)
$$4\frac{2}{3} + 5\frac{1}{24} + 7\frac{1}{2} : \begin{array}{r} 4\frac{16}{24} \\ 5\frac{1}{24} \\ +\ 7\frac{12}{24} \\ \hline 16\frac{29}{24} \end{array} = 17\frac{5}{24}$$

4) $\frac{3}{4} + \frac{1}{8} + \frac{1}{6} = \frac{18}{24} + \frac{3}{24} + \frac{4}{24} = \frac{18 + 3 + 4}{24} = \frac{25}{24} = 1\frac{1}{24}$

14)
$$8\frac{1}{12} - 3\frac{1}{4} = 8\frac{1}{12} - 3\frac{3}{12} : \begin{array}{r} 7\frac{13}{12} \\ -\ 3\frac{3}{12} \\ \hline 4\frac{10}{12} \end{array} = 4\frac{5}{6}$$

25) 50 pounds – 48 pounds = 2 pounds lost

$\frac{2}{50} = \frac{1}{25}$ of weight lost

26) $\frac{1}{4}$ ounce $+ \frac{1}{3}$ ounce $= \frac{3}{12} + \frac{4}{12} = \frac{7}{12}$ ounce

29)
$$56 - 34\frac{1}{2} : \begin{array}{r} 55\frac{2}{2} \\ -\ 34\frac{1}{2} \\ \hline 21\frac{1}{2} \end{array}$$
pints

30)
$$30\frac{1}{8} - 10\frac{1}{16} : \begin{array}{r} 30\frac{2}{16} \\ -\ 10\frac{1}{16} \\ \hline 20\frac{1}{16} \end{array}$$
pounds

Review Set 3 from pages 19-20

1) $\frac{1}{40}$ **2)** $\frac{36}{125}$ **3)** $\frac{35}{48}$ **4)** $\frac{3}{100}$ **5)** 3 **6)** $1\frac{2}{3}$ **7)** $\frac{4}{5}$ **8)** $6\frac{8}{15}$ **9)** $\frac{1}{2}$ **10)** $23\frac{19}{36}$ **11)** $\frac{3}{32}$ **12)** $254\frac{1}{6}$ **13)** 3 **14)** $1\frac{34}{39}$ **15)** $\frac{3}{14}$ **16)** $\frac{1}{11}$ **17)** $\frac{1}{2}$ **18)** $\frac{1}{30}$ **19)** $3\frac{1}{3}$ **20)** $\frac{3}{20}$ **21)** $\frac{1}{3}$ **22)** $\frac{7}{12}$ **23)** $1\frac{1}{9}$ **24)** 60 calories **25)** 560 seconds **26)** 40 doses **27)** $31\frac{1}{2}$ tablets **28)** 1,275 milliliters **29)** $52\frac{1}{2}$ ounces **30)** 6 full days

Solutions—Review Set 3

3) $\frac{5}{8} \times 1\frac{1}{6} = \frac{5}{8} \times \frac{7}{6} = \frac{35}{48}$

5)
$$\frac{\frac{1}{6}}{\frac{1}{4}} \times \frac{\frac{3}{2}}{\frac{2}{3}} = \left(\frac{1}{6} \times \frac{4}{1}\right) \times \left(\frac{3}{1} \times \frac{3}{2}\right) = \frac{\overset{2}{\cancel{4}}}{\underset{3}{\cancel{6}}} \times \frac{9}{2} = \frac{\overset{3}{\cancel{18}}}{\underset{1}{\cancel{6}}} = 3$$

16) $\frac{1}{33} \div \frac{1}{3} = \frac{1}{33} \times \frac{3}{1} = \frac{3}{33} = \frac{1}{11}$

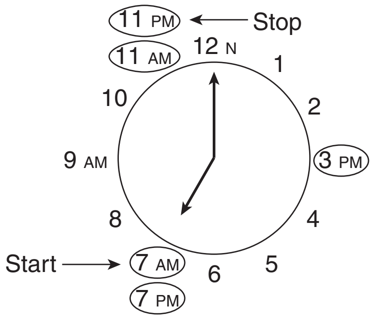
19) $2\frac{1}{2} \div \frac{3}{4} = \frac{5}{2} \div \frac{3}{4} = \frac{5}{\underset{1}{\cancel{2}}} \times \frac{\overset{2}{\cancel{4}}}{3} = \frac{10}{3} = 3\frac{1}{3}$

27) $3 \times 7 = 21$ doses

$21 \times 1\frac{1}{2} = 21 \times \frac{3}{2} = \frac{63}{2} = 31\frac{1}{2}$ tablets

28) $850 \div \frac{2}{3} = \frac{\overset{425}{\cancel{850}}}{1} \times \frac{3}{\underset{1}{\cancel{2}}} = 1{,}275$ milliliters

30)



Daily doses would be taken at: 7 AM, 11 AM, 3 PM, 7 PM, and 11 PM for 5 doses/day.

5 doses/day × $\frac{1}{2}$ ounce/dose = $\frac{5}{2} = 2\frac{1}{2}$ ounces/day

16 ounces ÷ $2\frac{1}{2}$ ounces/day = $\frac{16}{1} \div \frac{5}{2} = \frac{16}{1} \times \frac{2}{5} = \frac{32}{5} =$ $6\frac{2}{5}$ days or 6 full days

Review Set 4 from pages 26-27

1) 0.2, two-tenths **2)** $\frac{17}{20}$, 0.85 **3)** $1\frac{1}{20}$, one and five-hundredths **4)** $\frac{3}{500}$, six-thousandths **5)** 10.015, ten and fifteen-thousandths **6)** $1\frac{9}{10}$, one and nine-tenths **7)** $5\frac{1}{10}$, 5.1 **8)** 0.8, eight-tenths **9)** $250\frac{1}{2}$, two hundred fifty and five-tenths **10)** 33.03, thirty-three and three-hundredths **11)** $\frac{19}{20}$, ninety-five hundredths **12)** 2.75, two and seventy-five hundredths **13)** $7\frac{1}{200}$, 7.005 **14)** 0.084, eighty-four thousandths **15)** $12\frac{1}{8}$, twelve and one hundred twenty-five thousandths **16)** $20\frac{9}{100}$, twenty and nine hundredths **17)** $22\frac{11}{500}$, 22.022 **18)** $\frac{3}{20}$, fifteen hundredths **19)** 1,000.005, one thousand and five thousandths **20)** $4{,}085\frac{3}{40}$, 4,085.075 **21)** 0.0170 **22)** 0.25 **23)** 0.75 **24)** $\frac{9}{200}$ **25)** 0.12 **26)** 0.063 **27)** False **28)** False **29)** True **30)** 0.8 gram and 1.25 grams

Solutions—Review Set 4

4) $0.006 = \frac{6}{1{,}000} = \frac{3}{500}$

8) $\frac{4}{5} = 5\overset{\displaystyle 0.8}{\overline{\big)4.0}}$

14)

$$\frac{21}{250} = 250\begin{array}{r} 0.084 \\ \hline \big)21.000 \\ \underline{20\ 00} \\ 1\ 000 \\ \underline{1\ 000} \\ \hline \end{array}$$

15) $12.125 = 12\frac{125}{1{,}000} = 12\frac{1}{8}$

18) $0.15 = \frac{15}{100} = \frac{3}{20}$

30) 0.5 gram ≤ safe dose ≤ 2 grams

Safe doses: 0.8 grams and 1.25 grams

Note: ≤ means *less than or equal to*

Review Set 5 from pages 28-29

1) 22.585 **2)** 44.177 **3)** 12.309 **4)** 11.3 **5)** 175.199 **6)** 25.007 **7)** 0.518 **8)** \$9.48 **9)** \$18.91 **10)** \$22.71 **11)** 6.403 **12)** 0.27 **13)** 4.15 **14)** 1.51 **15)** 10.25 **16)** 2.517 **17)** 374.35 **18)** 604.42 **19)** 27.449 **20)** 23.619 **21)** 0.697 gram **22)** 18.55 ounces **23)** \$2,058.06 **24)** 12.3 grams **25)** 8.1 hours

Solutions—Review Set 5

2)

$$\begin{array}{r} 7.517 \\ 3.200 \\ 0.160 \\ \underline{33.300} \\ 44.177 \end{array}$$

9)

$$\begin{array}{r} \$1\overset{8}{\cancel{9}}.\overset{9}{\cancel{0}}\overset{10}{\cancel{0}} \\ -\ \ 0.09 \\ \hline \$18.91 \end{array}$$

25)

$$\begin{array}{rr} & 3\text{ h }20\text{ min} \\ & 40\text{ min} \\ & 3\text{ h }30\text{ min} \\ & 24\text{ min} \\ + & 12\text{ min} \\ \hline \end{array}$$

6 h 126 min = 8 h 6 min (60 minutes/hour)

$= 8\frac{6}{60} = 8\frac{1}{10} = 8.1$ hours

Review Set 6 from page 34

1) 5.83 **2)** 2.20 **3)** 42.75 **4)** 0.15 **5)** 403.14 **6)** 75,100.75 **7)** 32.86 **8)** 2.78 **9)** 348.58 **10)** 0.02 **11)** 400 **12)** 3.74 **13)** 5 **14)** 2.98 **15)** 4,120 **16)** 5.45 **17)** 272.67 **18)** 1.5 **19)** 50,020 **20)** 300 **21)** $562.\underset{\smile}{50}. = 56{,}250$ **22)** $16.\underset{\smile}{0}. = 160$ **23)** $.\underset{\smile}{025}. = 0.025$ **24)** $.\underset{\smile}{032}.005 = 0.032005$ **25)** $.\underset{\smile}{00}.125 = 0.00125$ **26)** $23.\underset{\smile}{2}.5 = 232.5$ **27)** $71.\underset{\smile}{7}.717 = 71.7717$ **28)** $83.\underset{\smile}{1}.6 = 831.6$ **29)** $0.\underset{\smile}{33}. = 33$ **30)** $14.\underset{\smile}{106}. = 14{,}106$

Solutions—Review Set 6

10) $1.14 \times 0.014 = 0.01596 = 0.02$

14) $45.5 \div 15.25 = 2.983 = 2.98$

Practice Problems—Chapter 1 from pages 34-36

1) $\frac{7}{20}$ **2)** 0.375 **3)** LCD = 21 **4)** LCD = 55 **5)** LCD = 18 **6)** LCD = 15 **7)** $3\frac{7}{15}$ **8)** $7\frac{29}{60}$ **9)** $\frac{1}{2}$ **10)** $2\frac{7}{24}$ **11)** $\frac{7}{27}$ **12)** $10\frac{1}{8}$ **13)** $4\frac{4}{17}$ **14)** $\frac{39}{80}$ **15)** $5\frac{1}{55}$ **16)** $5\frac{5}{18}$ **17)** $2\frac{86}{87}$ **18)** $\frac{3}{20}$ **19)** $\frac{1}{3{,}125}$ **20)** $\frac{1}{4}$ **21)** $1\frac{5}{7}$ **22)** $16\frac{1}{32}$ **23)** 60.27 **24)** 66.74 **25)** 42.98 **26)** 4,833.92 **27)** 190.8 **28)** 19.17 **29)** 9.48 **30)** 7.7 **31)** 42.75 **32)** 300 **33)** 12,930.43 **34)** 3,200.63 **35)** 2 **36)** 150.96 **37)** 9,716 **38)** 0.5025 **39)** 25 **40)** 5,750 **41)** 0.025 **42)** 115.25 **43)** 147 ounces **44)** 138 nurses; 46 maintenance/cleaners; 92 technicians; 92 others **45)** False **46)** \$915.08 **47)** \$1.46 **48)** 0.31 gram **49)** 800 milliliters **50)** 2.95 kilograms

Solutions—Practice Problems—Chapter 1

43) $3\frac{1}{2}$ ounces/feeding × 6 feedings/day =
21 ounces/day, and 21 ounces/day × 7 days/week =
147 ounces in one week

44) $\frac{3}{8} \times 368 = 138$ nurses
$\frac{1}{8} \times 368 = 46$ maintenance/cleaners
$\frac{1}{4} \times 368 = 92$ technicians and 92 others

45) $1\frac{2}{32} = 1.0625$; False, it's greater than normal.

46)

40 hours × \$17.43/hour =	\$697.20
6.25 hours overtime × \$34.86 =	+ 217.88
(Overtime rate = \$17.43 × 2 = \$34.86)	\$915.08

47) A case of 12 boxes with 12 catheters/box =
144 catheters
By case: \$975 ÷ 144 = \$6.77/catheter
By box: \$98.76 ÷ 12 = \$8.23/catheter
\$8.23
– 6.77
\$1.46 savings/catheter

48) 0.065 gram/ounce × 4.75 ounces = 0.31 gram

49) $1{,}200 \text{ milliliters} \times \frac{2}{3} = \frac{\overset{400}{\cancel{1{,}200}}}{1} \times \frac{2}{\underset{1}{\cancel{3}}} = 800 \text{ milliliters}$

50)
6.65 kilograms
– 3.70 kilograms
2.95 kilograms gained

Review Set 7 from pages 41-42

1) $\frac{1}{50}$ **2)** $\frac{3}{5}$ **3)** $\frac{1}{3}$ **4)** $\frac{4}{7}$ **5)** $\frac{3}{4}$ **6)** 0.5 **7)** 0.15 **8)** 0.14 **9)** 0.07 **10)** 0.24 **11)** 25% **12)** 40% **13)** 12.5% **14)** 70% **15)** 50% **16)** $\frac{9}{20}$ **17)** $\frac{3}{5}$ **18)** $\frac{1}{200}$ **19)** $\frac{1}{100}$ **20)** $\frac{2}{3}$ **21)** 0.03 **22)** 0.05 **23)** 0.06 **24)** 0.33 **25)** 0.01 **26)** 4:25 **27)** 1:4 **28)** 1:2 **29)** 9:20 **30)** 3:50 **31)** 0.9 **32)** $\frac{1}{5}$ **33)** 0.25% **34)** 0.5 **35)** $\frac{1}{100}$

Solutions—Review Set 7

1) $\frac{3}{150} = \frac{\overset{1}{\cancel{3}}}{\underset{50}{\cancel{150}}} = \frac{1}{50}$

3) $\frac{\overset{1}{\cancel{0.05}}}{\underset{3}{\cancel{0.15}}} = \frac{1}{3}$

7) $\dfrac{\frac{1}{1{,}000}}{\frac{1}{150}} = \dfrac{1}{\underset{100}{\cancel{1{,}000}}} \times \dfrac{\overset{15}{\cancel{150}}}{1} = \dfrac{15}{100} = 0.\underset{\curvearrowleft}{15}. = 0.15$

12) $2{:}5 = \frac{2}{5} = 0.4;\ 0.4 = \frac{4}{10} = \frac{40}{100} = 40\%$

13) $0.08 : 0.64 = \frac{0.08}{0.64} = \frac{1}{8} = 0.125;$

$0.125 = \frac{125}{1{,}000} = \frac{12.5}{100} = 12.5\%$

17) $60\% = \frac{60}{100} = \frac{3}{5}$

18) $0.5\% = \frac{0.5}{100} = 0.5 \div 100 = 0.\underset{\curvearrowleft}{00}.5 = 0.005 = \frac{5}{1{,}000} = \frac{1}{200}$

21) $2.94\% = \frac{2.94}{100} = 2.94 \div 100 = 0.\underset{\curvearrowleft}{02}.94 = 0.0294 = 0.03$

30) $6\% = \frac{6}{100} = \frac{3}{50} = 3{:}50$

31) Convert to decimals and compare:

0.9% = 0.009

0.9 = 0.900 (largest)

1:9 = 0.111

1:90 = 0.011

Review Set 8 from pages 45-46

1) 3 **2)** 3.3 **3)** 1.25 **4)** 5.33 **5)** 0.56 **6)** 1.8 **7)** 0.64 **8)** 12.6 **9)** 40 **10)** 0.48 **11)** 1 **12)** 0.96 **13)** 4.5 **14)** 0.94 **15)** 10 **16)** 0.4 **17)** 1.5 **18)** 10 **19)** 20 **20)** 1.8

Solutions—Review Set 8

2) $\dfrac{\frac{3}{4}}{\frac{1}{2}} \times 2.2 = X$

$\frac{3}{4} \div \frac{1}{2} \times \frac{2.2}{1} = X$

$\frac{3}{\underset{2}{\cancel{4}}} \times \frac{\overset{1}{\cancel{2}}}{1} \times \frac{2.2}{1} = X$

$\frac{6.6}{2} = X$

$X = 3.3$

4) $\frac{40\%}{60\%} \times 8 = X$

$\frac{\overset{2}{\cancel{0.4}}}{\underset{3}{\cancel{0.6}}} \times 8 = X$

$\frac{2}{3} \times \frac{8}{1} = X$

$\frac{16}{3} = X$

$X = 5.3\overline{33}$

$X = 5.33$

6) $\frac{0.15}{0.1} \times 1.2 = X$

$\frac{\overset{3}{\cancel{0.15}}}{\underset{2}{\cancel{0.10}}} \times \frac{1.2}{1} = X$

$\frac{3}{2} \times \frac{1.2}{1} = X$

$\frac{3.6}{2} = X$

$X = 1.8$

8) $\dfrac{\overset{3}{\cancel{1{,}200{,}000}}}{\underset{1}{\cancel{400{,}000}}} \times 4.2 = X$

$\frac{3}{1} \times \frac{4.2}{1} = X$

$\frac{12.6}{1} = X$

$X = 12.6$

10) $\dfrac{\overset{3}{\cancel{30}}}{\underset{5}{\cancel{50}}} \times 0.8 = X$

$\frac{3}{5} \times \frac{0.8}{1} = X$

$\frac{2.4}{5} = X$

$X = 0.48$

14) $\dfrac{\overset{1}{\cancel{250{,}000}}}{\underset{8}{\cancel{2{,}000{,}000}}} \times 7.5 = X$

$\frac{1}{8} \times \frac{7.5}{1} = X$

$\frac{7.5}{8} = X$

$X = 0.937$

$X = 0.94$

20) $\dfrac{\frac{1}{100}}{\frac{1}{150}} \times 1.2 = X$

$\frac{1}{100} \div \frac{1}{150} \times \frac{1.2}{1} = X$

$\frac{1}{\underset{2}{\cancel{100}}} \times \frac{\overset{3}{\cancel{150}}}{1} \times \frac{1.2}{1} = X$

$\frac{1}{2} \times \frac{3}{1} \times \frac{1.2}{1} = X$

$\frac{3.6}{2} = X$

$X = 1.8$

Review Set 9 from pages 49-50

1) 0.25 **2)** 1 **3)** 0.56 **4)** 1,000 **5)** 0.7 **6)** 8 **7)** 21.43 **8)** 500 **9)** 200 **10)** 10.5 **11)** 3 **12)** 0.63 **13)** 10 **14)** 0.67 **15)** 1.25 **16)** 31.25 **17)** 16.67 **18)** 240 **19)** 0.75 **20)** 2.27 **21)** 1 **22)** 6 **23)** 108 nurses **24)** 72 calories **25)** 81.82 milligrams/hour

Solutions—Review Set 9

4) $\frac{0.5}{2} \overset{\nwarrow\nearrow}{\underset{\swarrow\searrow}{=}} \frac{250}{X}$

$0.5X = 500$

$\frac{0.5X}{0.5} = \frac{500}{0.5}$

$X = 1{,}000$

6) $\frac{40}{X} \times 12 = 60$

$\frac{40}{X} \times \frac{12}{1} = 60$

$\frac{480}{X} \overset{\nwarrow\nearrow}{\underset{\swarrow\searrow}{=}} \frac{60}{1}$

$60X = 480$

$\frac{60X}{60} = \frac{480}{60}$

$X = 8$

9) $\frac{15}{500} \times X = 6$

$\frac{15X}{500} \overset{\nwarrow\nearrow}{\underset{\swarrow\searrow}{=}} \frac{6}{1}$

$15X = 3{,}000$

$\frac{15X}{15} = \frac{3{,}000}{15}$

$X = 200$

10) $\frac{5}{X} \overset{\nwarrow\nearrow}{\underset{\swarrow\searrow}{=}} \frac{10}{21}$

$10X = 105$

$\frac{10X}{10} = \frac{105}{10}$

$X = 10.5$

11) $\frac{250}{1} \overset{\nwarrow\nearrow}{\underset{\swarrow\searrow}{=}} \frac{750}{X}$

$250X = 750$

$\frac{250X}{250} = \frac{750}{250}$

$X = 3$

14) $\frac{\frac{1}{100}}{1} \overset{\nwarrow\nearrow}{\underset{\swarrow\searrow}{=}} \frac{\frac{1}{150}}{X}$

$\frac{1}{100}X = \frac{1}{150}$

$\frac{\frac{1}{100}X}{\frac{1}{100}} = \frac{\frac{1}{150}}{\frac{1}{100}}$

$X = \frac{1}{150} \div \frac{1}{100}$

$X = \frac{1}{\underset{3}{\cancel{150}}} \times \frac{\overset{2}{\cancel{100}}}{1}$

$X = \frac{2}{3} = 0.666 = 0.67$

22) $\frac{25\%}{30\%} = \frac{5}{X}$

$\frac{0.25}{0.3} \overset{\nwarrow\nearrow}{\underset{\swarrow\searrow}{=}} \frac{5}{X}$

$0.25X = 1.5$

$\frac{0.25X}{0.25} = \frac{1.5}{0.25}$

$X = 6$

23) $\frac{45}{100} \overset{\nwarrow\nearrow}{\underset{\swarrow\searrow}{=}} \frac{X}{240}$

$100X = 10{,}800$

$\frac{100X}{100} = \frac{10{,}800}{100}$

$X = 108$

Review Set 10 from page 51

1) 1.3 **2)** 4.75 **3)** 56 **4)** 0.43 **5)** 26.67 **6)** 15 **7)** 0.8 **8)** 2.38 **9)** 37.5 **10)** 112.5 **11)** 8 pills **12)** 720 milliliters **13)** $3,530.21 **14)** 7.2 ounces **15)** 700 calories

Solutions—Review Set 10

1) $0.0025 \times 520 = 1.3$

8) $0.07 \times 34 = 2.38$

11) 0.4×20 pills $= 8$ pills

13) 80% of \$17,651.07 = $0.8 \times$ \$17,651.07 = \$14,120.86

$$\begin{array}{rl} \$17{,}651.07 & \text{total bill} \\ -\ 14{,}120.86 & \text{paid by insurance co.} \\ \hline \$3{,}530.21 & \text{paid by patient} \end{array}$$

14) 0.4×18 ounces $= 7.2$ ounces

15) $0.2 \times 3{,}500$ calories $= 700$ calories

Practice Problems—Chapter 2 from pages 52-53

1) 0.4, 40%, 2:5 **2)** $\frac{1}{20}$, 5%, 1:20 **3)** 0.17, $\frac{17}{100}$, 17:100 **4)** 0.25, $\frac{1}{4}$, 25% **5)** 0.06, $\frac{3}{50}$, 3:50 **6)** 0.17, 17%, 1:6 **7)** 0.5, $\frac{1}{2}$, 1:2 **8)** 0.01, $\frac{1}{100}$, 1% **9)** $\frac{9}{100}$, 9%, 9:100 **10)** 0.38, 38%, 3:8 **11)** 0.67, $\frac{2}{3}$, 67% **12)** 0.33, 33%, 1:3 **13)** $\frac{13}{25}$, 52%, 13:25 **14)** 0.45, $\frac{9}{20}$, 45% **15)** 0.86, 86%, 6:7 **16)** 0.3, $\frac{3}{10}$, 30% **17)** 0.02, 2%, 1:50 **18)** $\frac{3}{5}$, 60%, 3:5 **19)** $\frac{1}{25}$, 4%, 1:25 **20)** 0.1, $\frac{1}{10}$, 1:10 **21)** 0.04 **22)** 1:40 **23)** 7.5% **24)** $\frac{1}{2}$ **25)** 3:4 **26)** 262.5 **27)** 3.64 **28)** 1.97 **29)** 1:4 **30)** 1:10 **31)** 84 **32)** 90,000 **33)** 1 **34)** 1.1 **35)** 100 **36)** 39 **37)** 0.75 **38)** 21 **39)** 120 **40)** 90 **41)** 25 grams protein; 6.25 grams fat **42)** 231 points **43)** 60 minutes **44)** 50 milliliters **45)** 27 milligrams **46)** 5.4 grams **47)** 283.5 milligrams **48)** 6.5 pounds **49)** \$10.42 **50)** 6 total doses

Solutions—Practice Problems—Chapter 2

36) $\frac{3}{9} = \frac{X}{117}$

$9X = 351$

$\frac{9X}{9} = \frac{351}{9}$

$X = 39$

41) $125 \times 0.2 = 25$ grams protein

$125 \times 0.05 = 6.25$ grams fat

$$\begin{array}{r} 125 \\ \times\ 0.2 \\ \hline 25.0 = 25 \end{array}$$

$$\begin{array}{r} 125 \\ \times\ 0.05 \\ \hline 6.25 = 6.25 \end{array}$$

43) $\frac{90}{27} = \frac{200}{X}$

$90X = 5{,}400$

$\frac{90X}{90} = \frac{5{,}400}{90}$

$X = 60$

45) $60 \times 0.45 = 27$ milligrams

$$\begin{array}{r} 60 \\ \times\ 0.45 \\ \hline 300 \\ 240 \\ \hline 27.00 = 27 \end{array}$$

46) $\frac{2.7}{0.75} \times \frac{X}{1.5}$

$0.75X = 4.05$

$\frac{0.75X}{0.75} = \frac{4.05}{0.75}$

$X = 5.4$

47) $\frac{6.75}{1} \times \frac{X}{42}$

$X = 283.5$

48) $130 \times 0.05 = 6.5$ pounds

$$\begin{array}{r} 130 \\ \times\ 0.05 \\ \hline 6.50 = 6.5 \end{array}$$

49) $0.17 \times \$12.56 = \$2.14$

$$\begin{array}{r} \$12.56 \\ -\,2.14 \\ \hline \$10.42 \end{array}$$

50) 10% of 150 = $0.10 \times 150 = 15$

$$\begin{array}{rl} 150 \text{ mg} & \text{first dose} \\ -\;\;15 & \\ \hline 135 \text{ mg} & \text{second dose} \\ -\;\;15 & \\ \hline 120 \text{ mg} & \text{third dose} \\ -\;\;15 & \\ \hline 105 \text{ mg} & \text{fourth dose} \\ -\;\;15 & \\ \hline 90 \text{ mg} & \text{fifth dose} \\ -\;\;15 & \\ \hline 75 \text{ mg} & \text{sixth dose} \end{array}$$

6 total doses

Section 1—Self-Evaluation from pages 54-55

1) 3.05 **2)** 4,002.5 **3)** 0.63 **4)** 723.27 **5)** LCD = 12 **6)** LCD = 110 **7)** $\frac{11}{12}$ **8)** $\frac{47}{63}$ **9)** 1 **10)** $\frac{1}{2}$ **11)** 45.78 **12)** 0.02 **13)** 59.24 **14)** 0.09 **15)** 12 **16)** $\frac{2}{3}$ **17)** $\frac{1}{2}$ **18)** 0.64 **19)** $\frac{1}{10}, \frac{1}{6}, \frac{1}{5}, \frac{1}{3}, \frac{1}{2}$ **20)** $\frac{2}{3}, \frac{3}{4}, \frac{5}{6}, \frac{7}{8}, \frac{9}{10}$ **21)** 0.009, 0.125, 0.1909, 0.25, 0.3 **22)** $\frac{1}{2}$%, 0.9%, 50%, 100%, 500% **23)** 1:3 **24)** 1:600 **25)** 0.01 **26)** 0.04 **27)** 0.9% **28)** $\frac{1}{3}$ **29)** 5:9 **30)** $\frac{1}{20}$ **31)** 1:200 **32)** $\frac{2}{3}$ **33)** 75% **34)** 40% **35)** 0.17 **36)** 1.21 **37)** 1.3 **38)** 2.5 **39)** 0.67 **40)** 100 **41)** 4 **42)** 20,000 **43)** 3.3 **44)** 300 **45)** 8.33 **46)** 24 participants **47)** 2 holidays **48)** $2.42 **49)** 12 cans of water **50)** 8 centimeters

Solutions—Section 1—Self-Evaluation

16) $$\frac{1}{150} \div \frac{1}{100} = \frac{1}{150} \times \frac{100}{1} = \frac{\overset{2}{\cancel{100}}}{\underset{3}{\cancel{150}}} = \frac{2}{3}$$

18) $$\frac{16\%}{\frac{1}{4}} = 16\% \times \frac{4}{1} = 0.16 \times 4 = 0.64$$

33) $$3:4 = \frac{3}{4} = 4\overset{0.75}{\overline{)3.0}} = 75\%$$

37) $$\frac{0.3}{2.6} \overset{\nwarrow\;\nearrow}{\underset{\swarrow\;\searrow}{\times}} \frac{0.15}{X}$$

$$0.3X = 2.6 \times 0.15$$

$$0.3X = 0.39$$

$$\frac{0.3X}{0.3} = \frac{0.39}{0.3}$$

$$X = 1.3$$

42) $$\frac{10\%}{\frac{1}{2}\%} \times 1,000 = X$$

$$\frac{0.1}{0.005} \times \frac{1,000}{1} = X$$

$$\frac{100}{0.005} = X$$

$$X = 20,000$$

46) $600 \times 0.04 = 24$ participants

$$\begin{array}{r} 600 \\ \times\,0.04 \\ \hline 24.00 \end{array} = 24$$

Review Set 11 from page 63

1) metric **2)** volume **3)** weight **4)** length **5)** $\frac{1}{1,000}$ or 0.001 **6)** 1,000 **7)** 10 **8)** kilogram **9)** milligram **10)** 1,000 **11)** 1 **12)** 1,000 **13)** 10 **14)** 0.3 g **15)** 1.33 mL **16)** 5 kg **17)** 1.5 mm **18)** 10 mg **19)** microgram **20)** milliliter **21)** cubic centimeter **22)** gram **23)** millimeter **24)** kilogram **25)** centimeter

Review Set 12 from page 66

1) dram **2)** ounce **3)** minim **4)** quart **5)** grain **6)** oz $\frac{1}{2}$ **7)** gr $\frac{1}{6}$ **8)** oz iv **9)** pt ii **10)** qt i $\frac{1}{4}$ **11)** gr x **12)** oz viii **13)** gr ii **14)** pt 16 **15)** gr iii **16)** oz 32 **17)** gr vii $\frac{1}{2}$ **18)** 32 **19)** i **20)** ii

Review Set 13 from page 69

1) twenty drops **2)** ten pounds **3)** ten milliequivalents **4)** four teaspoons **5)** ten tablespoons **6)** 4 gtt **7)** 30 mEq **8)** 5 T **9)** $1\frac{1}{2}$ t **10)** 10 t **11)** False **12)** False **13)** False **14)** units **15)** 3 **16)** 2 **17)** 1 **18)** 1 **19)** 1 **20)** milliequivalent, mEq

Practice Problems—Chapter 3 from pages 71-72

1) milli **2)** micro **3)** centi **4)** kilo **5)** 1 milligram **6)** 1 kilogram **7)** 1 microgram **8)** 1 centimeter **9)** meter **10)** gram **11)** liter **12)** drop **13)** ounce **14)** ounce **15)** grain **16)** milligram **17)** microgram **18)** dram **19)** milliequivalent **20)** teaspoon **21)** quart **22)** milliliter **23)** cubic centimeter **24)** pint **25)** tablespoon **26)** millimeter **27)** gram **28)** centimeter **29)** liter **30)** meter **31)** kilogram **32)** minim **33)** gr $\frac{1}{2}$ **34)** 2 t **35)** oz $\frac{1}{3}$ **36)** 5,000,000 units **37)** 0.5 L **38)** gr $\frac{1}{4}$ **39)** gr $\frac{1}{200}$ **40)** 0.05 mg **41)** eight and one-quarter ounces **42)** three hundred seventy-five grams **43)** one one-hundred twenty-fifths of a grain **44)** two and six tenths milliliters **45)** twenty milliequivalents **46)** four tenths of a liter **47)** four and one-half grains **48)** seventeen hundredths of a milligram

49) **Prevention:** This type of error can be prevented by avoiding the use of a decimal point or trailing zero when not necessary. In this instance the decimal point and zero serve no purpose and can easily be misinterpreted, especially if the decimal point is difficult to see. Question any order that is unclear or unreasonable.

50) **Prevention:** This is both an error in notation and transcription. One grain should have been written *gr i*. Health care facilities would be wise to require the use of metric notation, especially for narcotics. The nurse's knowledge of correct notation as well as common dosages for pain medication should signal a problem. Question any order that is unclear or unreasonable.

Review Set 14 from pages 77-78

1) true **2)** true **3)** 3 **4)** 3 **5)** $3\frac{1}{2}$ **6)** 16 **7)** 72 **8)** $1\frac{1}{2}$ **9)** $\frac{2}{3}$ **10)** 52 **11)** $\frac{1}{4}$ **12)** 30 **13)** $3\frac{1}{3}$ **14)** 14 **15)** $\frac{3}{4}$ **16)** $\frac{1}{12}$ **17)** $\frac{2}{3}$ **18)** $\frac{1}{4}$ **19)** 40 **20)** $3\frac{1}{2}$ **21)** 20 servings **22)** 8 quarts **23)** 64¢ **24)** 20¢ **25)** 24¢

Solutions—Review Set 14

6) Equivalent: 4 cups = 2 pints

$$\frac{4 \text{ cups}}{2 \text{ pints}} \times \frac{32 \text{ cups}}{X \text{ pints}}$$

$4X = 64$

$$\frac{4X}{4} = \frac{64}{4}$$

$X = 16$ pints

8) Equivalent: 1 yard = 3 feet

$$\frac{1 \text{ yard}}{3 \text{ feet}} \times \frac{\frac{1}{2} \text{ yard}}{X \text{ feet}}$$

$X = 3 \times \frac{1}{2}$

$X = 1\frac{1}{2}$ feet

19) Equivalents: 1 gallon = 4 quarts and 1 quart = 4 cups

$$\frac{1 \text{ quart}}{4 \text{ cups}} \times \frac{4 \text{ quarts}}{X \text{ cups}}$$

$X = 16$ cups

Therefore, if 1 gallon = 4 quarts and 4 quarts = 16 cups, then 1 gallon = 16 cups.

$$\frac{1 \text{ gallon}}{16 \text{ cups}} \times \frac{2\frac{1}{2} \text{ gallons}}{X \text{ cups}}$$

$X = 40$ cups

20) Equivalent: 1 yard = 36 inches

$$\frac{1 \text{ yard}}{36 \text{ inches}} \times \frac{X \text{ yard}}{126 \text{ inches}}$$

$36X = 126$

$$\frac{36X}{36} = \frac{126}{36}$$

$X = 3.5 = 3\frac{1}{2}$ yards

21) Equivalent: 1 quart = 4 cups

$$\frac{1 \text{ quart}}{4 \text{ cups}} \times \frac{2 \text{ quarts}}{X \text{ cups}}$$

$X = 8$ cups

$$\frac{1 \text{ gallon}}{16 \text{ cups}} \times \frac{\frac{1}{2} \text{ gallon}}{X \text{ cups}}$$

$X = 8$ cups

$$\begin{array}{r} 8 \text{ cups} \\ 8 \text{ cups} \\ + 4 \text{ cups} \\ \hline 20 \text{ cups or 20 1-cup servings} \end{array}$$

23) Store A price per gallon:

Equivalent: $\frac{1}{2}$ gallon = $1.56

$$\frac{\frac{1}{2}\text{ gallon}}{\$1.56} \times \frac{1\text{ gallon}}{X\ \$}$$

$$\frac{1}{2}X = \$1.56$$

$$\frac{\frac{1}{2}X}{\frac{1}{2}} = \frac{\$1.56}{\frac{1}{2}}$$

$$X = \$1.56 \times \frac{2}{1}$$

X = $3.12 (per gallon)

Store B price per gallon:

Equivalents: 1 quart = $0.94 and 1 gallon = 4 quarts

$$\frac{1\text{ quart}}{\$0.94} \times \frac{4\text{ quarts}}{X\ \$}$$

$$X = 4 \times \$0.94$$

X = $3.76 (per 4 quarts or per gallon)

$3.76 (Store B)
− $3.12 (Store A)
$0.64 (savings at Store A)

24) Equivalents: 1 gallon = $3.12 and 1 gallon = 16 cups

$$\frac{16\text{ cups}}{\$3.12} \times \frac{1\text{ cup}}{X\ \$}$$

$$16X = \$3.12$$

$$\frac{16X}{16} = \frac{\$3.12}{16}$$

X = $0.195 or 19.5¢/cup or 20¢/cup

25) Equivalents: 1 quart = $0.94 and 1 quart = 4 cups

$$\frac{4\text{ cups}}{\$0.94} \times \frac{1\text{ cup}}{X\ \$}$$

$$4X = \$0.94$$

$$\frac{4X}{4} = \frac{\$0.94}{4}$$

X = $0.235 or 23.5¢/cup or 24¢/cup

Review Set 15 from pages 82-83

1) 0.5 **2)** 15 **3)** 0.008 **4)** 0.01 **5)** 0.06 **6)** 0.3 **7)** 0.0002 **8)** 1,200 **9)** 2.5 **10)** 65 **11)** 5 **12)** 1,500 **13)** 0.002 **14)** 0.25 **15)** 2,000 **16)** 0.05608 **17)** 5 **18)** 1,000 **19)** 1,000 **20)** 0.001 **21)** 0.023 **22)** 0.00105 **23)** 0.018 **24)** 400 **25)** 0.025 **26)** 0.5 **27)** 10,000 **28)** 0.45 **29)** 0.005 **30)** 30,000

Solutions—Review Set 15

2) $\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{0.015\text{ g}}{X\text{ mg}}$

$$X = 1{,}000 \times 0.015$$

X = 15 mg

3) $\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{X\text{ g}}{8\text{ mg}}$

$$1{,}000X = 8$$

$$\frac{1{,}000X}{1{,}000} = \frac{8}{1{,}000}$$

X = 0.008 g

7) $\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{X\text{ g}}{0.2\text{ mg}}$

$$1{,}000X = 0.2$$

$$\frac{1{,}000X}{1{,}000} = \frac{0.2}{1{,}000}$$

X = 0.0002 g

9) $\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{0.0025\text{ kg}}{X\text{ g}}$

$$X = 1{,}000 \times 0.0025$$

X = 2.5 g

20) $\frac{1\text{ L}}{1{,}000\text{ mL}} \times \frac{X\text{ L}}{1\text{ mL}}$

$$1{,}000X = 1$$

$$\frac{1{,}000X}{1{,}000} = \frac{1}{1{,}000}$$

X = 0.001 L

23) $\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{X\text{ mg}}{18\text{ mcg}}$

$$1{,}000X = 18$$

$$\frac{1{,}000X}{1{,}000} = \frac{18}{1{,}000}$$

X = 0.018 mg

Review Set 16 from pages 86-88

1) 30, gr i = 60 mg **2)** 45, gr i = 60 mg **3)** 0.003, 1 kg = 1,000 g **4)** 0.4, gr i = 60 mg **5)** 0.5, 1 g = gr xv **6)** $\frac{1}{4}$, gr i = 60 mg **7)** 65, 1 t = 5 mL **8)** $\frac{1}{2}$, oz i = 30 mL **9)** 75, oz i = 30 mL **10)** $1\frac{1}{2}$, pt i = 500 mL **11)** 4, 1 t = 5 mL **12)** 60, 1 T = 15 mL **13)** 19.8, 1 kg = 2.2 lb **14)** viii, qt i = pt ii **15)** 96, 1 L = oz 32 **16)** 121, 1 kg = 2.2 lb **17)** 30, 1 in = 2.5 cm **18)** 2, qt i = 1 L **19)** 15, 1 t = 5 mL **20)** 45, 1 kg = 2.2 lb **21)** 300, gr i = 60 mg; or 325, gr i = 65 mg (in select cases) **22)** $\frac{1}{100}$, gr i = 60 mg **23)** 500, pt i = 500 mL **24)** 600, gr i = 60 mg; or 650, gr i = 65 mg (in select cases) **25)** v, gr i = 60 mg **26)** 12, 1 in = 2.5 cm **27)** $1\frac{1}{2}$, gr i = 60 mg **28)** ii, oz i = 30 mL **29)** 10, gr i = 60 mg **30)** i, gr i = 65 mg (only in select cases) **31)** 80, 1 in = 2.5 cm **32)** 14, 1 in = 2.5 cm, 1 cm = 10 mm **33)** 3, 1 in = 2.5 cm **34)** 50, 1 in = 2.5 cm, 1 cm = 10 mm **35)** 88, 1 kg = 2.2 lb **36)** 7,160, 1 kg = 1,000 g **37)** 50, 1 kg = 2.2 lb **38)** 7.7, 1 kg = 2.2 lb **39)** 28.64, 1 kg = 2.2 lb **40)** 53.75 **41)** 4, $\frac{1}{2}$ **42)** 15.75 **43)** 2,430 **44)** 1.25 **45)** 10 **46)** Dissolve 2 teaspoons of Betadine concentrate in 1 pint or 2 cups of warm water. **47)** 2 **48)** 3 **49)** 16 **50)** 93.64

Solutions—Review Set 16

2) $\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{3}{4}}{\text{X mg}}$

$X = 60 \times \frac{3}{4}$

$X = 45$ mg

4) $\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{150}}{\text{X mg}}$

$X = 60 \times \frac{1}{150}$

$X = 0.4$ mg

5) $\frac{1 \text{ g}}{\text{gr } 15} \times \frac{\text{X g}}{\text{gr } 7\frac{1}{2}}$

$15X = 7\frac{1}{2}$

$15X = 7.5$

$\frac{15X}{15} = \frac{7.5}{15}$

$X = 0.5$ g

6) $\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr X}}{15 \text{ mg}}$

$60X = 15$

$\frac{60X}{60} = \frac{15}{60}$

$X = \text{gr } \frac{1}{4}$

9) $\frac{\text{oz } 1}{30 \text{ mL}} \times \frac{\text{oz } 2\frac{1}{2}}{\text{X mL}}$

$X = 30 \times 2\frac{1}{2}$

$X = 75$ mL

11) $\frac{1 \text{ t}}{5 \text{ mL}} \times \frac{\text{X t}}{20 \text{ mL}}$

$5X = 20$

$\frac{5X}{5} = \frac{20}{5}$

$X = 4$ t

16) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{55 \text{ kg}}{\text{X lb}}$

$X = 2.2 \times 55$

$X = 121$ lb

20) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{\text{X kg}}{99 \text{ lb}}$

$2.2X = 99$

$\frac{2.2X}{2.2} = \frac{99}{2.2}$

$X = 45$ kg

24) $\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } 10}{\text{X mg}}$

$X = 600$ mg

28) $\frac{\text{oz } 1}{30 \text{ mL}} \times \frac{\text{oz X}}{60 \text{ mL}}$

$30X = 60$

$\frac{30X}{30} = \frac{60}{30}$

$X = \text{oz } 2 = \text{oz ii}$

34) $\frac{1 \text{ in}}{2.5 \text{ cm}} \times \frac{2 \text{ in}}{\text{X cm}}$

$X = 2.5 \times 2$

$X = 5$ cm

$\frac{1 \text{ cm}}{10 \text{ mm}} \times \frac{5 \text{ cm}}{\text{X mm}}$

$X = 50$ mm

41) $\frac{\text{oz } 1}{30 \text{ mL}} \times \frac{\text{oz X}}{120 \text{ mL}}$

$30X = 120$

$\frac{30X}{30} = \frac{120}{30}$

$X = \text{oz } 4 = \text{oz iv}$

$\frac{1 \text{ cup}}{\text{oz } 8} \times \frac{\text{X cups}}{\text{oz } 4}$

$8X = 4$

$\frac{8X}{8} = \frac{4}{8}$

$X = \frac{1}{2}$ cup

42) $\frac{1\text{ km}}{1,000\text{ m}} \times \frac{X\text{ km}}{500\text{ m}}$

$1,000X = 500$

$\frac{1,000X}{1,000} = \frac{500}{1,000}$

X = 0.5 km

0.75	Day 1
+ 0.50	
1.25	Day 2
+ 0.50	
1.75	Day 3
+ 0.50	
2.25	Day 4
+ 0.50	
2.75	Day 5
+ 0.50	
3.25	Day 6
+ 0.50	
3.75	Day 7

Total kilometers walked in 7 days =

0.75 + 1.25 + 1.75 + 2.25 + 2.75 + 3.25 + 3.75 =

15.75 km

43) Add up the ounces: 81 ounces

$\frac{\text{oz }1}{30\text{ ml}} \times \frac{\text{oz }81}{X\text{ ml}}$

X = 2,430 mL

44) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{55\text{ lb}}$

$2.2X = 55$

$\frac{2.2X}{2.2} = \frac{55}{2.2}$

X = 25 kg

$\frac{1\text{ kg}}{0.05\text{ mg}} \times \frac{25\text{ kg}}{X\text{ mg}}$

$X = 0.05 \times 25$

X = 1.25 mg

45) Find the total number of mL per day and the total number of mL per bottle.

mL per day for 4 doses

$\frac{12\text{ mL}}{1\text{ dose}} \times \frac{4\text{ mL}}{4\text{ doses}}$

X = 48 mL

mL per bottle:

$\frac{\text{oz }1}{30\text{ ml}} \times \frac{\text{oz }16}{X\text{ ml}}$

X = 480 mL (per bottle)

How many days will 480 mL (or 16 ounces) last?

$\frac{1\text{ day}}{48\text{ mL}} \times \frac{X\text{ days}}{480\text{ mL}}$

$48X = 480$

$\frac{48X}{48} = \frac{480}{48}$

X = 10 days

46) $\frac{1\text{ t}}{5\text{ mL}} \times \frac{X\text{ t}}{10\text{ mL}}$

$5X = 10$

$\frac{5X}{5} = \frac{10}{5}$

X = 2 t

500 mL = pt i or 2 cups water

Use 2 t Betadine concentrate in 1 pint or 2 cups of water

48) qt i = oz 32 (per container)

At 1 feeding every 3 hours, how many feedings does the infant require during 24 hours or per day?

$\frac{1\text{ feeding}}{3\text{ hours}} \times \frac{X\text{ feedings}}{24\text{ hours}}$

$3X = 24$

$\frac{3X}{3} = \frac{24}{3}$

X = 8 feedings

How many ounces will the infant consume for 8 feedings or per day?

$\frac{1\text{ feeding}}{\text{oz }4} \times \frac{8\text{ feedings}}{\text{oz }X}$

X = oz 32 (per day)

Each container holds 1 quart or 32 ounces (equivalent: 1 qt = oz 32), so you know she needs 3 containers of formula for 3 days.

Practice Problems—Chapter 4 from pages 89-90

1) 500 **2)** 10 **3)** 0.0075 **4)** 3 **5)** 0.004 **6)** 0.5 **7)** $\frac{1}{2}$ **8)** 0.3 **9)** 70 **10)** 149.6 **11)** 180 **12)** 105 **13)** 0.3 **14)** 15 **15)** 6 **16)** 90 **17)** 32.05 **18)** 7.99 **19)** 0.008 **20)** 2 **21)** 95 **22)** *v*ii$\frac{1}{2}$ **23)** $\frac{1}{100}$ **24)** 0.67 **25)** 68.18 **26)** i **27)** 1 **28)** 500 **29)** 2 **30)** iii **31)** 30 **32)** 30 **33)** 1 **34)** 1 **35)** 1 **36)** 1,500 **37)** 45 **38)** i$\frac{1}{2}$ **39)** $\frac{1}{6}$ **40)** 0.025 **41)** 4,300 **42)** 0.06 **43)** 15 **44)** 3 **45)** 0.8 **46)** 9 **47)** 8 **48)** 840 **49)** 100%; all of it

50) **Prevention:** The nurse didn't use the conversion rules correctly. The nurse divided instead of multiplied. This type of medication error is avoided by double-checking your dosage calculations and asking yourself, "Is this dosage reasonable?" Certainly you know if there are 1,000 mg in 1 g, and you want to give 2 g, then you need *more* than 1,000 milligrams, not less. The correct calculations are:

Convert:

$$\frac{1\text{ g}}{1{,}000\text{ mg}} = \frac{2\text{ g}}{\text{X mg}}$$

$X = 2 \times 1{,}000$

$X = 2{,}000$ mg

Calculate:

$$\frac{1{,}000\text{ mg}}{10\text{ mL}} = \frac{2{,}000\text{ mg}}{\text{X mL}}$$

$1{,}000X = 20{,}000$

$$\frac{1{,}000X}{1{,}000} = \frac{20{,}000}{1{,}000}$$

$X = 20$ mL

Solutions—Practice Problems—Chapter 4

46) Per bottle:

$$\frac{\text{oz } 1}{30\text{ mL}} \times \frac{\text{oz } 4}{\text{X mL}}$$

$X = 120$ mL

Each dose:

$$\frac{1\text{ t}}{5\text{ mL}} \times \frac{2\frac{1}{2}\text{ t}}{\text{X mL}}$$

$X = 12.5$ mL

Bottle holds 120 mL; each dose is 12.5 mL

$$\frac{1\text{ dose}}{12.5\text{ mL}} \times \frac{\text{X doses}}{120\text{ mL}}$$

$12.5X = 120$

$$\frac{12.5X}{12.5} = \frac{120}{12.5}$$

$X = 9.6$ doses or 9 full doses

47)

$$\frac{1\text{ dose}}{15\text{ mL}} \times \frac{\text{X doses}}{120\text{ mL}}$$

$15X = 120$

$$\frac{15X}{15} = \frac{120}{15}$$

$X = 8$ doses

48) $4 + 8 + 6 + 10 = 28$ ounces

$$\frac{\text{oz } 1}{30\text{ mL}} \times \frac{\text{oz } 28}{\text{X mL}}$$

$X = 840$ mL

49)

$$\frac{\text{gr } 1}{60\text{ mg}} \times \frac{\text{gr } \frac{1}{6}}{\text{X mg}}$$

$X = 60 \times \frac{1}{6}$

$X = 10$ mg

The ampule contains 10 mg, and the doctor orders gr $\frac{1}{6}$ or 10 mg; therefore, the patient should receive all of the solution in the ampule.

Review Set 17 from page 94

1) 12:32 AM **2)** 7:30 AM **3)** 4:40 PM **4)** 9:21 PM **5)** 11:59 PM **6)** 12:15 PM **7)** 2:20 AM **8)** 10:10 AM **9)** 1:15 PM
10) 6:25 PM **11)** 1330 **12)** 0004 **13)** 2145 **14)** 1200 **15)** 2315 **16)** 0345 **17)** 2400 **18)** 1530 **19)** 0620 **20)** 1745
21) *zero-six-twenty-three* **22)** *zero-zero-forty-one* **23)** *nineteen-zero-three* **24)** *twenty-three-eleven* **25)** *zero-three hundred*

Review Set 18 from page 96

1) –17.8 **2)** 185 **3)** 212 **4)** 89.6 **5)** 22.2 **6)** 37.2 **7)** 39.8 **8)** 104 **9)** 176 **10)** 97.5 **11)** 37.8 **12)** 66.2 **13)** 39.2 **14)** 34.6 **15)** 39.3 **16)** 35.3 **17)** 44.6 **18)** 31.1 **19)** 98.6 **20)** 39.7

Solutions—Review Set 18

1)

$$°C = \frac{°F - 32}{1.8}$$

$$°C = \frac{0 - 32}{1.8}$$

$$°C = \frac{-32}{1.8}$$

$°C = -17.8°$

2)

$°F = 1.8°C + 32$

$°F = (1.8 \times 85) + 32$

$°F = 153 + 32$

$°F = 185°$

Practice Problems—Chapter 5 from pages 97-98

1) 2:57 AM **2)** 0310 **3)** 1622 **4)** 8:01 PM **5)** 11:02 AM **6)** 0033 **7)** 0216 **8)** 4:42 PM **9)** 11:56 PM **10)** 0420 **11)** 1931 **12)** 2400 or 0000 **13)** 0645 **14)** 9:15 AM **15)** 9:07 PM **16)** 6:23 PM **17)** 5:40 AM **18)** 1155 **19)** 2212 **20)** 2106 **21)** 4 h **22)** 7 h **23)** 8 h 30 min **24)** 12 h 15 min **25)** 14 h 50 min **26)** 4 h 12 min **27)** 4 h 48 min **28)** 3 h 41 min **29)** 6 h 30 min **30)** 16 h 38 min **31)** False **32)** a. AM; b. PM; c. AM; d. PM **33)** 37.6 **34)** 97.7 **35)** 102.6 **36)** 37.9 **37)** 36.7 **38)** 99.3 **39)** 32 **40)** 40 **41)** 36.6 **42)** 95.7 **43)** 39.7 **44)** 77 **45)** 212 **46)** 5.6 **47)** –7.8 **48)** 37.2, 99 (98.96° rounds to 99.0°F) **49)** True

50) **Prevention:** Such situations can be easily prevented by accurately applying the complete formula for temperature conversion. Guessing is not acceptable in medical and health care calculations. Temperature conversion charts are readily available in most health care settings, but, when they are not, the conversion formulas should be used.

Solutions—Practice Problems—Chapter 5

24)
$$\begin{array}{r} 2150 \\ -\,0935 \\ \hline 1215 \end{array} = 12 \text{ h } 15 \text{ min}$$

26) 2316 = 11:16 PM, 0328 = 3:28 AM

11:16 PM ⟶ 3:16 AM = 4 h

3:16 AM ⟶ 3:28 AM = 12 min

4 h 12 min

28) 4:35 PM ⟶ 7:35 PM = 3 h

7:35 PM ⟶ 8:16 PM = 41 min

3 h 41 min

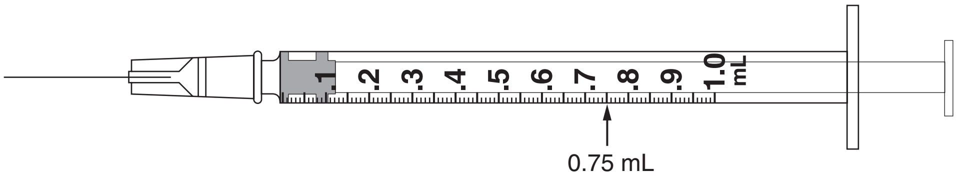
48) $\frac{37.6 + 35.5 + 38.1 + 37.6}{4} = \frac{148.8}{4} = 37.2°\text{C (average)}$

$°\text{F} = 1.8(37.2) + 32 = 99°$

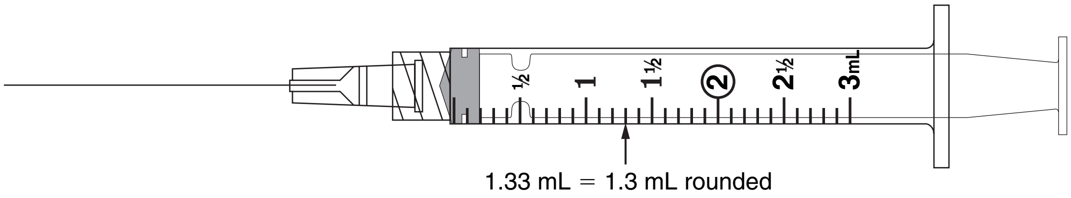
Review Set 19 from pages 108-110

1) 1 mL (tuberculin) **2)** Round 1.25 to 1.3 and measure on the mL scale as 1.3 mL. **3)** No **4)** 0.5 mL **5)** a. False; b. The size of the drop varies according to the diameter of the tip of the dropper. **6)** No **7)** Measure the oral liquid in a 3 mL syringe, which is not intended for injections. **8)** 5 **9)** Discard the excess prior to injecting the patient. **10)** To prevent needle-stick injury.

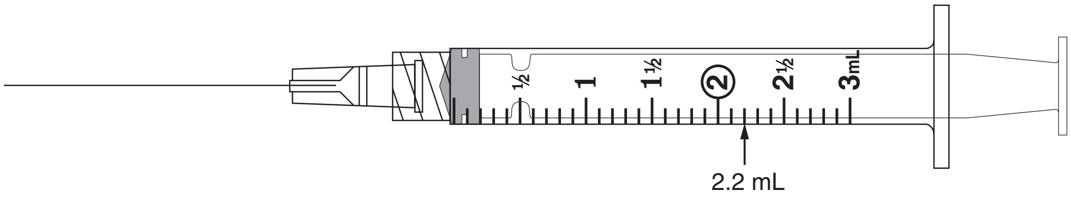
11)



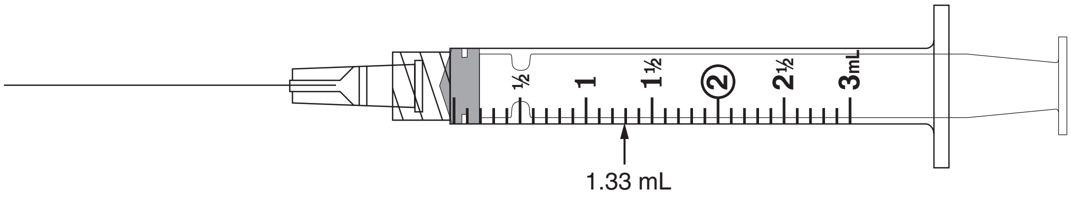
12)



13)



14)



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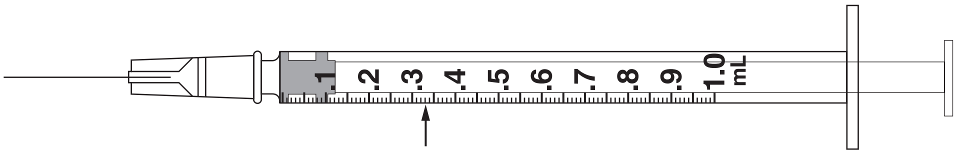
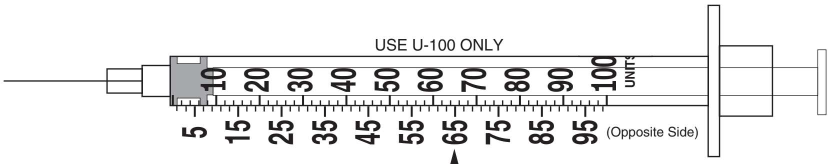
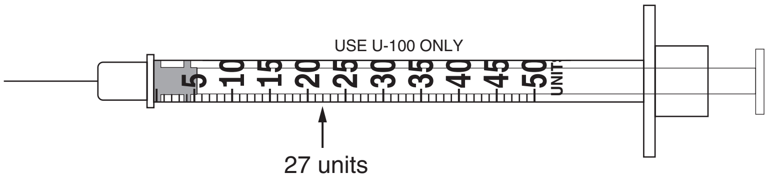


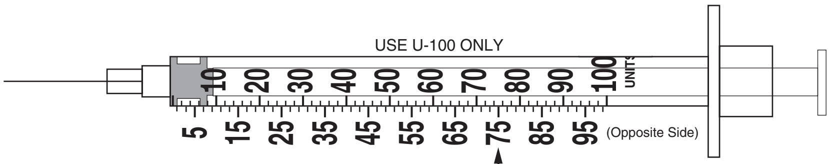
16)



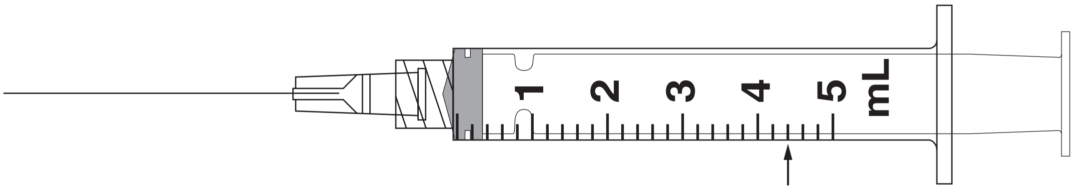
17)



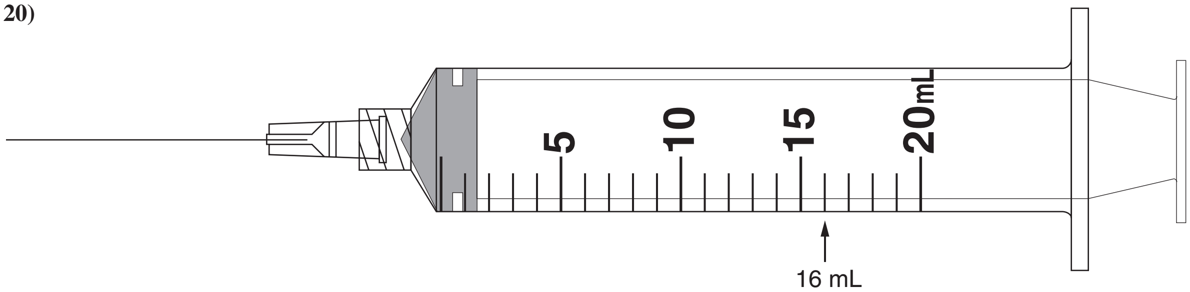
18)



19)



20)

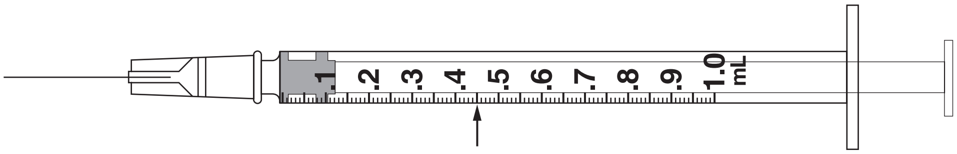


21) 0.2 mL **22)** 1 mL **23)** 0.2 mL

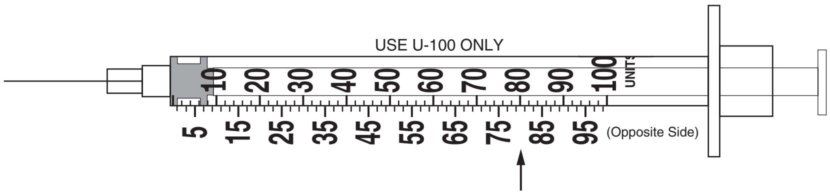
Practice Problems—Chapter 6 from pages 111-114

1) 1 **2)** hundredths or 0.01 **3)** No. The tuberculin syringe has a maximum capacity of 1 mL. **4)** Round to 1.3 mL and measure at 1.3 mL. **5)** 30 mL or 1 oz **6)** 1 mL **7)** 0.75 **8)** False **9)** False **10)** True **11)** To prevent accidental needle sticks during intravenous administration **12)** top ring **13)** 10 **14)** False **15)** 3 mL, 1 mL, and insulin

16)

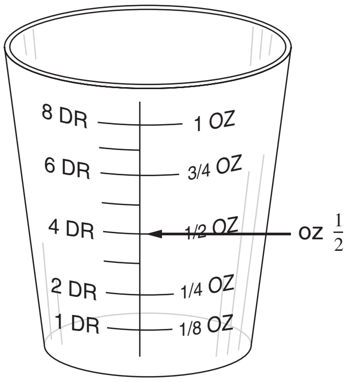


17)



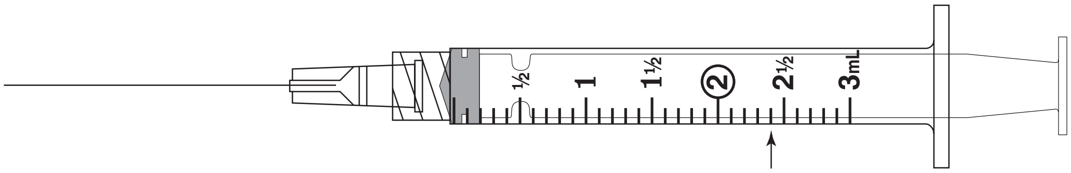
80 units

18)



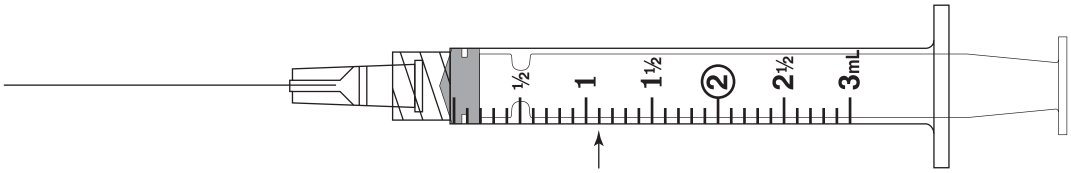
oz $\frac{1}{2}$

19)



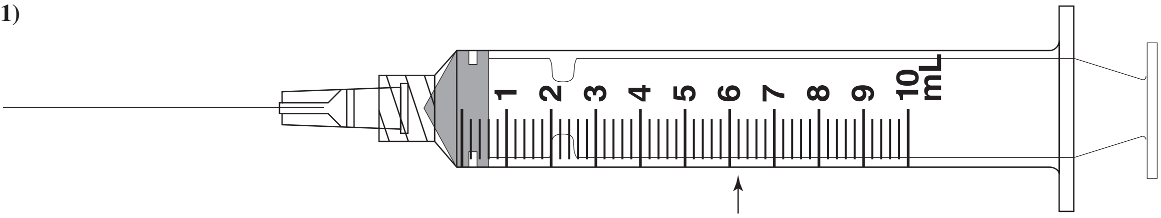
2.4 mL

20)



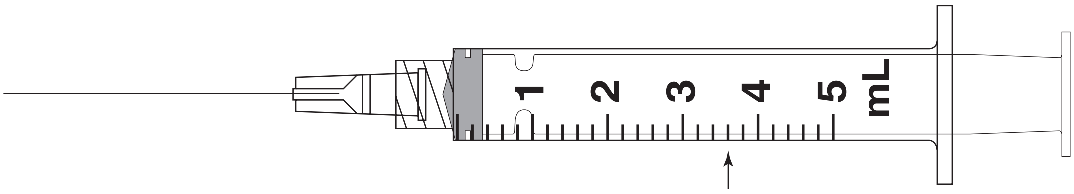
1.1 mL

21)



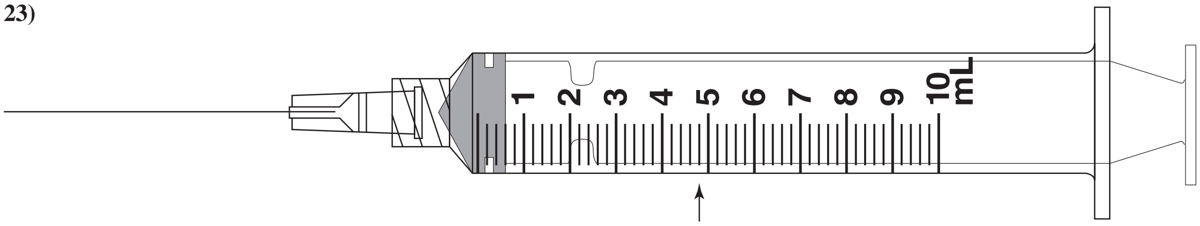
6.2 mL

22)



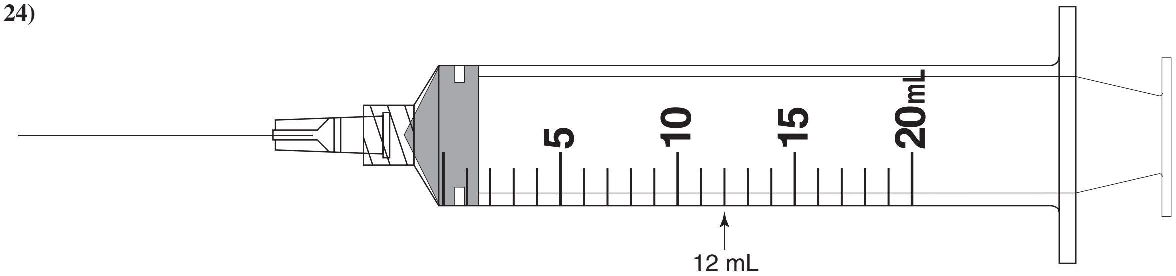
3.6 mL

23)



4.8 mL

24)



25) **Prevention:** This error could have been avoided by following a simple principle: Don't put oral drugs in syringes intended for injection. Instead, place the medication in an oral syringe to which a needle cannot be attached. In addition, the medication should have been labeled for oral use only. The medication was ordered orally, not by injection. An alert nurse would have noticed the discrepancy. Finally, but just as important, a medication should be administered only by the nurse who prepared it.

26) **Prevention:** The nurse should ask for assistance to learn how to use unfamiliar equipment. Do not put the patient at risk. The nurse must remove the cap on the oral syringe prior to administering the medication, so that the child cannot choke on the cap.

Review Set 20 from pages 118-119

1) Give 250 milligrams of naproxen orally 2 times a day. **2)** Give 30 units of Humulin N NPH U-100 insulin subcutaneously every day 30 minutes before breakfast. **3)** Give 500 milligrams of Ceclor orally immediately, and then give 250 milligrams every 8 hours. **4)** Give 25 micrograms of Synthroid orally once a day. **5)** Give 10 milligrams of Ativan intramuscularly every 4 hours as necessary for agitation. **6)** Give 20 milligrams of furosemide intravenously (slowly) immediately. **7)** Give 10 milliliters of Gelusil orally at bedtime. **8)** Give 2 drops of 1% atropine sulfate ophthalmic in the right eye every 15 minutes for 4 applications. **9)** Give $\frac{1}{4}$ grain of morphine sulfate intramuscularly every 3 hours as needed for pain. **10)** Give 0.25 milligram of Lanoxin orally once a day. **11)** Give 250 milligrams of tetracycline orally 4 times a day. **12)** Give $\frac{1}{400}$ grain of nitroglycerin sublingually immediately. **13)** Give 2 drops of Cortisporin otic suspension in both ears 3 times a day and at bedtime. **14)** The abbreviation t.i.d. means three times a day with no specific interval between times. An attempt is made to give the three doses during waking hours. The abbreviation q.8h means every 8 hours. These doses would be given around the clock at 8-hour intervals. For example, administration times for t.i.d. might be 0800, 1200, 1700; administration times for q.8h could be 0800, 1600, 2400. **15)** Contact the physician for clarification. **16)** No, q.i.d. orders are given 4 times in 24 hours with no specific interval between times indicated in order, typically during waking hours; whereas q.4h orders are given 6 times in 24 hours at 4-hour intervals. **17)** Determined by hospital or institutional policy. **18)** Patient, drug, dosage, route, frequency, date and time written, signature of physician/writer. **19)** Parts 1–5: patient's name, drug, dosage, route, frequency **20)** The right patient must receive the right drug in the right amount by the right route at the right time, followed by the right documentation.

Review Set 21 from page 124

1) 6 AM, 12 noon, 6 PM, 12 midnight **2)** 9 AM **3)** 7:30 AM, 11:30 AM, 4:30 PM, 9 PM **4)** 9 AM, 5 PM **5)** every 4 hours, as needed for severe pain **6)** 9/7/xx at 0900 or 9 AM **7)** sublingual, under the tongue **8)** once a day **9)** 125 mcg **10)** nitroglycerin, Darvocet-N 100, meperidine (Demerol), promethazine (Phenergan) **11)** subcutaneous injection **12)** once **13)** Keflex **14)** before breakfast (at 7:30 AM) **15)** milliequivalent **16)** Keflex and Slow-K **17)** Tylenol **18)** twice **19)** 0900 and 2100 **20)** 2400, 0600, 1200, and 1800 **21)** In the "One-Time Medication Dosage" section, lower left corner.

Practice Problems—Chapter 7 from pages 125-129

1) twice a day **2)** per rectum **3)** before meals **4)** after **5)** 3 times a day **6)** every 4 hours **7)** when necessary **8)** by mouth, orally **9)** intravenous **10)** four times a day **11)** immediately **12)** freely, as desired **13)** after meals **14)** intramuscular **15)** without **16)** noct **17)** gtt **18)** mL **19)** gr **20)** g **21)** q.i.d. **22)** $\bar{c}$ **23)** subcut **24)** t **25)** b.i.d. **26)** q.3h **27)** p.c. **28)** $\bar{a}$ **29)** kg **30)** Give 60 milligrams of Toradol intramuscularly immediately and every 6 hours. **31)** Give 300,000 units of procaine penicillin G intramuscularly 4 times a day. **32)** Give 5 milliliters of Mylanta orally 1 hour before and 1 hour after meals, at bedtime, and every 2 hours as needed at night for gastric upset. **33)** Give 25 milligrams of Librium orally every 6 hours when necessary for agitation. **34)** Give 5,000 units of heparin subcutaneously immediately. **35)** Give 50 milligrams of Demerol intramuscularly every 3 hours when necessary for pain. **36)** Give 0.25 milligram of digoxin orally every day. **37)** Give 2 drops of 10% Neosynephrine ophthalmic to the left eye every 30 minutes for 2 applications. **38)** Give 40 milligrams of Lasix intramuscularly immediately. **39)** Give 4 milligrams of Decadron intravenously twice a day. **40)** 12:00 midnight, 8:00 AM, 4:00 PM **41)** 20 units **42)** subcut: subcutaneous **43)** Give 500 milligrams of Cipro orally every 12 hours. **44)** 8:00 AM, 12:00 noon, 6:00 PM **45)** digoxin (Lanoxin) 0.125 mg p.o. daily **46)** with, $\bar{c}$ **47)** Give 150 milligrams of ranitidine tablets orally twice daily with breakfast and supper. **48)** Vancomycin **49)** 12 hours

50) **Prevention:** This error could have been avoided by paying careful attention to the ordered frequency and by writing the frequency on the MAR.

Review Set 22 from pages 140-142

1) B **2)** D **3)** C **4)** A **5)** E **6)** F **7)** G **8)** 5 mL **9)** IM or IV **10)** A, B, C, D, E, F, G—all of the labels **11)** Filmtab means *film sealed tablet.* **12)** 50 mg/mL **13)** 2 tablets **14)** A and D **15)** Both are Schedule 4 drugs. They have limited potential for abuse and are clinically useful. **16)** penicillin G potassium **17)** Pfizerpen **18)** 5,000,000 units per vial; reconstituted to 250,000 units/mL, 500,000 units/mL, or 1,000,000 units/mL **19)** IM or IV **20)** 0049-0520-83 **21)** Pfizer-Roerig **22)** 1 **23)** 1/100 **24)** 10

Practice Problems—Chapter 8 from pages 143-146

1) 50 mEq/50 mL or 1 mEq/mL **2)** 63323-006-50 **3)** 84 mg/mL **4)** cefpodoxime proxetil **5)** "Shake bottle to loosen granules. Add approximately $\frac{1}{2}$ the total amount of distilled water required for constitution (total water = 29 mL). Shake vigorously to wet the granules. Add remaining water and shake vigorously." **6)** Pharmacia and Upjohn **7)** 10 mL **8)** 25 mg/mL **9)** 1 mL **10)** Depo-Provera **11)** medroxyprogesterone acetate **12)** 0009-0626-01 **13)** injection solution **14)** 10 mL **15)** intramuscular **16)** Ayerst Laboratories, Inc. **17)** tablet **18)** Store at room temperature; approximately 25°C **19)** 12/2009 **20)** 2 mEq per mL **21)** I **22)** H **23)** H **24)** oral **25)** 0666060 **26)** 3 **27)** 2% **28)** 2/100; 20

29) **Prevention:** This error could have been prevented by carefully comparing the drug label and dosage to the MAR drug and dosage three times while preparing the medication. In this instance both the incorrect drug and the incorrect dosage strength sent by the pharmacy should have been noted by the nurse. Further, the nurse should have asked for clarification of the order.

30a) **Prevention:** The nurse should have recognized that the patient was still complaining of signs and symptoms that the medication was ordered to treat.

30b) If the order was difficult to read, the physician should have been called to clarify the order. Was the dosage of 100 mg a usual dosage for Celexa? The nurse should have consulted a drug guide to ensure that the dosage was appropriate. Also, if the patient wasn't complaining of or diagnosed with depression, the nurse should have questioned why Celexa was ordered.

Review Set 23 from page 158

1) Right patient, right drug, right amount (dosage or dose), right route, right time, right documentation **2)** *NPH insulin 20 units subcut daily* **3)** After obtaining the drug, just prior to administration **4)** To ensure patient safety and to prevent medication errors, patient injury, patient death, increased health care costs, unnecessary liability, stress, and costs to health care practitioners **5)** True **6)** Verify the drug order by consulting a reputable drug reference resource; e.g., the *Hospital Formulary.* **7)** Insulins **8)** To ensure dispensing and administration of the correct medication to the right patient **9)** $93 billion ($93,000,000,000) **10)** Write the order down on the patient's chart or enter it into the computer record, then read the order back, and finally get confirmation from the prescriber that it is correct. Before administering the medication, verify the safety of the order by consulting a reputable drug reference, if you are unfamiliar with the order.

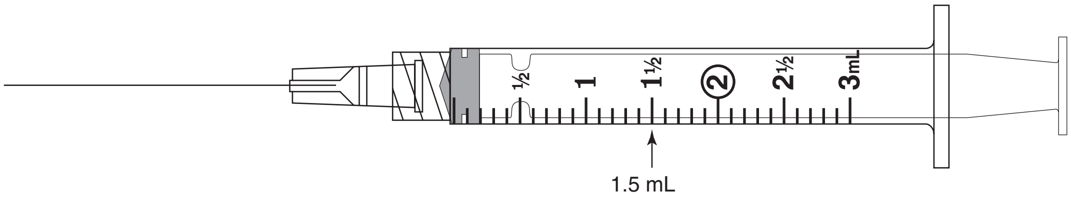
Practice Problems—Chapter 9 from pages 160-161

1) 44,000-98,000 **2)** False **3)** True **4)** True **5)** True **6)** Patient, drug (or medication), amount (or dosage or dose), route, time, documentation **7)** Prescription, transcription, administration **8)** Upon first contact with the drug, while measuring the dosage, and just prior to administration **9)** 0.75 mg **10)** Write out the order, read it back, and get confirmation from the prescriber. **11)** Any four of these: patient injury; loss of life; increased health care costs; additional technology expenses to prevent error; liability defense; increased length of stay; harm to the nurse involved in regard to his or her personal and professional status, confidence, and practice **12)** The health care professional originating the order should not have used qd to indicate the frequency of administration. The employee transcribing the order and the nurse signing off the order should have been alert to the risk of errors associated with the use of this notation and should have been especially cautious in transcribing the order correctly.

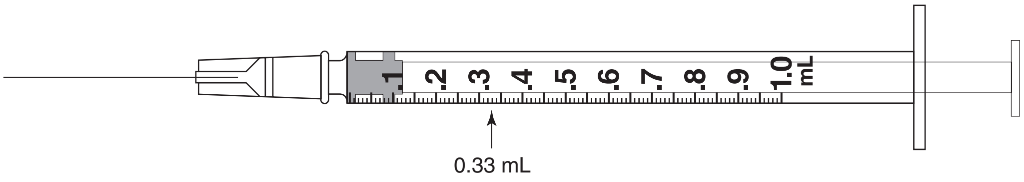
Section 2—Self-Evaluation from pages 163-166

1) gr $\frac{2}{3}$ **2)** 4 t **3)** gr $\frac{1}{300}$ **4)** 0.5 mL **5)** oz $\frac{1}{2}$ or $\frac{1}{2}$ oz **6)** four drops **7)** four hundred fifty milligrams **8)** one one-hundredth of a grain **9)** seven and one-half grains **10)** twenty-five hundredths of a liter **11)** 7,130 **12)** 0.925 **13)** 0.125 **14)** 16,400 **15)** 10; 0.01 **16)** 0.02; $\frac{1}{3}$ **17)** 12; 60 **18)** 9; 9,000 **19)** 37.5; 375 **20)** 5.62; 2.25 or $2\frac{1}{4}$ **21)** 90; 90,000 **22)** 11,590; 25.5 or $25\frac{1}{2}$ **23)** iii **24)** 360 **25)** 0.2 **26)** 6, vi **27)** 455 **28)** 2335 **29)** 6:44 PM **30)** 0417 **31)** 8:03 AM **32)** 100.4 **33)** 38.6 **34)** 99

35)



36)



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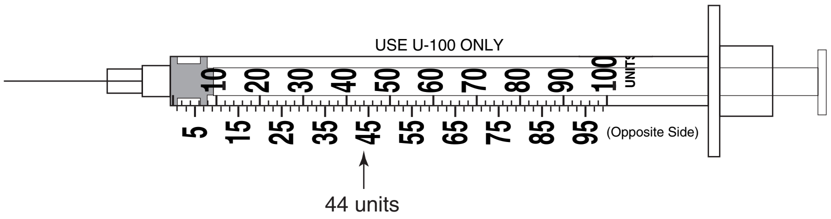

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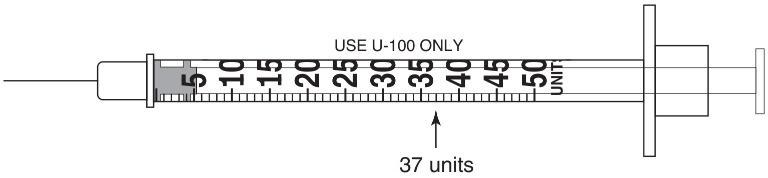

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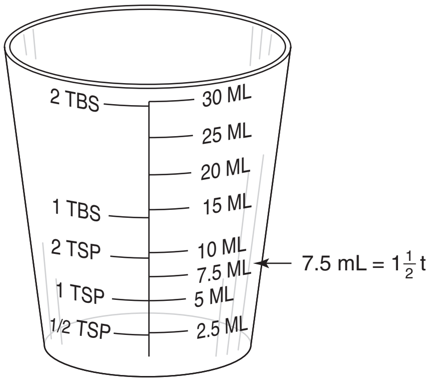


40) neomycin and polymixin B sulfates and hydrocortisone **41)** In the ear. **42)** 10 mL **43)** Give 2 drops of Cortisporin otic solution in both ears every 15 minutes for 3 doses. **44)** 5,000 units per mL **45)** 63323-262-01

46) Give 3,750 units of heparin subcutaneously every 8 hours. **47)** Ceclor **48)** 250 mg per 5 mL **49)** *heparin 5,000 units subcut daily* **50)** The right patient must receive the right drug, in the right amount, by the right route, at the right time, with the right documentation.

Solutions—Section 2—Self-Evaluation

15) $\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{6}}{\text{X mg}}$

$X = 60 \times \frac{1}{6}$

$X = 10 \text{ mg}$

$\frac{1 \text{ g}}{1{,}000 \text{ mg}} \times \frac{\text{X g}}{10 \text{ mg}}$

$1{,}000X = 10$

$\frac{1{,}000X}{1{,}000} = \frac{10}{1{,}000}$

$X = 0.01 \text{ g}$

21) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{\text{X kg}}{198 \text{ lb}}$

$2.2X = 198$

$\frac{2.2X}{2.2} = \frac{198}{2.2}$

$X = 90 \text{ kg}$

$\frac{1 \text{ kg}}{1{,}000 \text{ g}} \times \frac{90 \text{ kg}}{\text{X g}}$

$X = 90{,}000 \text{ g}$

24) $\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{3}{4}}{\text{X mg}}$

$X = 60 \times \frac{3}{4}$

$X = 45 \text{ mg}$

q.3h = 8 doses per 24 hours

$\frac{1 \text{ dose}}{45 \text{ mg}} \times \frac{8 \text{ doses}}{\text{X mg}}$

$X = 360 \text{ mg}$

27) $\frac{\text{oz } 1}{30 \text{ mL}} \times \frac{\text{oz } 15}{\text{X mL}}$

$X = 450 \text{ mL}$

1 t = 5 mL

450 mL + 5 mL = 455 mL

Review Set 24 from pages 180-182

1) 1 **2)** 1 **3)** $1\frac{1}{2}$ **4)** $\frac{1}{2}$ **5)** $\frac{1}{2}$ **6)** 2 **7)** 2 **8)** 2 **9)** $1\frac{1}{2}$ **10)** 2 **11)** 1 **12)** $\frac{1}{2}$ **13)** 2 **14)** 2 **15)** 2 **16)** $1\frac{1}{2}$ **17)** 10, 1 **18)** 10 and 5; 1 of each, 4 **19)** 15, 1 **20)** 60, 1 **21)** B, 1 caplet **22)** I, 2 tablets **23)** F, 1 tablet **24)** H, 2 tablets **25)** C, 1 tablet **26)** E, 2 tablets **27)** D, 2 tablets **28)** G, 2 tablets **29)** A, 1 tablet **30)** C, 1 tablet

Solutions—Review Set 24

1) Order: 0.1 g

Convert:

$$\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{0.1\text{ g}}{X\text{ mg}}$$

$X = 1{,}000 \times 0.1$

$X = 100$ mg

Supply: 100 mg/tab

Think: Now it is obvious that you want to give one tablet.

Calculate:

$$\frac{100\text{ mg}}{1\text{ tab}} \times \frac{100\text{ mg}}{X\text{ tab}}$$

$X = 1$ tab

5) Order: 0.125 mg

Supply 0.25 mg/tab

$$\frac{0.25\text{ mg}}{1\text{ tab}} \times \frac{0.125\text{ mg}}{X\text{ tab}}$$

$0.25X = 0.125$

$$\frac{0.25X}{0.25} = \frac{0.125}{0.25}$$

$X = \frac{1}{2}$ tab

10) Order: 5 mg

Supply: 2.5 mg/tab

$$\frac{2.5\text{ mg}}{1\text{ tab}} \times \frac{5\text{ mg}}{X\text{ tab}}$$

$2.5X = 5$

$$\frac{2.5X}{2.5} = \frac{5}{2.5}$$

$X = 2$ tab

14) Order: 0.1 mg

$$\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{0.1\text{ mg}}{X\text{ mcg}}$$

$X = 1{,}000 \times 0.1$

$X = 100$ mcg

Supply: 50 mcg/tab

$$\frac{50\text{ mcg}}{1\text{ tab}} \times \frac{100\text{ mcg}}{X\text{ tab}}$$

$50X = 100$

$$\frac{50X}{50} = \frac{100}{50}$$

$X = 2$ tab

17) Order gr $\frac{1}{6}$

$$\frac{\text{gr }1}{60\text{ mg}} \times \frac{\text{gr }\frac{1}{6}}{X\text{ mg}}$$

$X = 10$ mg

Supply: 10 mg and 2.5 mg/tab

Think: It is obvious that you should select the 10 mg tablet and give one.

$$\frac{10\text{ mg}}{1\text{ tablet}} \times \frac{10\text{ mg}}{X\text{ tablets}}$$

$10X = 10$

$$\frac{10X}{10} = \frac{10}{10}$$

$X = 1$ tab

Select 10 mg and give 1 tablet

28) Order: 0.5 mg

$$\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{0.5\text{ mg}}{X\text{ mcg}}$$

$X = 500$ mcg

Supply: 250 mcg/tab

$$\frac{250\text{ mcg}}{1\text{ tab}} \times \frac{500\text{ mcg}}{X\text{ tab}}$$

$250X = 500$

$$\frac{250X}{250} = \frac{500}{250}$$

$X = 2$ tab

Review Set 25 from pages 187-190

1) 7.5 **2)** 5 **3)** 20 **4)** 4 **5)** 1 **6)** 20 **7)** 2 **8)** 7.5 **9)** 3 **10)** 2.5 **11)** 22.5 **12)** 7.5 **13)** 2 **14)** 2.5 **15)** 5 **16)** v **17)** $1\frac{1}{2}$ **18)** i **19)** 15 **20)** 1 **21)** 2 **22)** B; 10 mL **23)** C; 10 mL **24)** A; 2 mL **25)** 5 **26)** 0.75 **27)** 10; 48 **28)** 3 **29)** 4 **30)** 0900, 1300, 1900

Solutions—Review Set 25

2) Order: gr $\frac{1}{6}$

$$\frac{\text{gr }1}{60\text{ mg}} \times \frac{\text{gr }\frac{1}{6}}{X\text{ mg}}$$

$X = 60 \times \frac{1}{6}$

$X = 10$ mg

Supply: 10 mg per 5 mL

$$\frac{10\text{ mg}}{5\text{ mL}} \times \frac{10\text{ mg}}{X\text{ mL}}$$

$10X = 50$

$$\frac{10X}{10} = \frac{50}{10}$$

$X = 5$ mL

4) Order: 100 mg

Supply: 125 mg per 5 mL

$\frac{125 \text{ mg}}{5 \text{ mL}} \times \frac{100 \text{ mg}}{X \text{ mL}}$

$125X = 500$

$\frac{125X}{125} = \frac{500}{125}$

$X = 4 \text{ mL}$

6) Order: 25 mg

Supply: 6.25 mg/t or 6.25 mg per 5 mL (1 t = 5 mL)

$\frac{6.25 \text{ mg}}{5 \text{ mL}} \times \frac{25 \text{ mg}}{X \text{ mL}}$

$6.25X = 125$

$\frac{6.25X}{6.25} = \frac{125}{6.25}$

$X = 20 \text{ mL}$

7) Order: 125 mg

Supply: 62.5 mg per 5 mL or 62.5 mg/1 t (1 t = 5 mL)

$\frac{62.5 \text{ mg}}{1 \text{ t}} \times \frac{125 \text{ mg}}{X \text{ t}}$

$62.5 X = 125$

$\frac{62.5X}{62.5} = \frac{125}{62.5}$

$X = 2 \text{ t}$

11) Order: 0.24 g

$\frac{1 \text{ g}}{1{,}000 \text{ mg}} \times \frac{0.24 \text{ g}}{X \text{ mg}}$

$X = 1{,}000 \times 0.24$

$X = 240 \text{ mg}$

Supply: 80 mg per 7.5 mL

$\frac{80 \text{ mg}}{7.5 \text{ mL}} \times \frac{240 \text{ mg}}{X \text{ mL}}$

$80X = 1{,}800$

$\frac{80X}{80} = \frac{1{,}800}{80}$

$X = 22.5 \text{ mL}$

15) Order: 0.25 mg

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{0.25 \text{ mg}}{X \text{ mcg}}$

$X = 1{,}000 \times 0.25$

$X = 250 \text{ mcg}$

Supply: 50 mcg/mL

$\frac{50 \text{ mcg}}{1 \text{ mL}} \times \frac{250 \text{ mcg}}{X \text{ mL}}$

$50X = 250$

$\frac{50X}{50} = \frac{250}{50}$

$X = 5 \text{ mL}$

17) Order: 375 mg

Supply: 250 mg per 5 mL

$\frac{250 \text{ mg}}{5 \text{ mL}} \times \frac{375 \text{ mg}}{X \text{ mL}}$

$250X = 1{,}875$

$\frac{250X}{250} = \frac{1{,}875}{250}$

$X = 7.5 \text{ mL}$

$5 \text{ mL} = 1 \text{ t}$

$\frac{1 \text{ t}}{5 \text{ mL}} \times \frac{X \text{ t}}{7.5 \text{ mL}}$

$5X = 7.5$

$\frac{5X}{5} = \frac{7.5}{5}$

$X = 1\frac{1}{2} \text{ t}$

19) Order: 1.2 g

$\frac{1 \text{ g}}{1{,}000 \text{ mg}} \times \frac{1.2 \text{ g}}{X \text{ mg}}$

$X = 1{,}000 \times 1.2$

$X = 1{,}200 \text{ mg}$

Supply: 400 mg per 5 mL

$\frac{400 \text{ mg}}{5 \text{ mL}} \times \frac{1{,}200 \text{ mg}}{X \text{ mL}}$

$400X = 6{,}000$

$\frac{400X}{400} = \frac{6{,}000}{400}$

$X = 15 \text{ mL}$

20) Order: 0.25 g

$\frac{1 \text{ g}}{1{,}000 \text{ mg}} \times \frac{0.25 \text{ g}}{X \text{ mg}}$

$X = 1{,}000 \times 0.25$

$X = 250 \text{ mg}$

Supply: 125 mg per 2.5 mL

$\frac{125 \text{ mg}}{2.5 \text{ mL}} \times \frac{250 \text{ mg}}{X \text{ mL}}$

$125X = 625$

$\frac{125X}{125} = \frac{625}{125}$

$X = 5 \text{ mL} = 1 \text{ t}$ (Equivalent: 1 t = 5 mL)

21) Order: 100 mg

Supply: 250 mg per 5 mL

$\frac{250 \text{ mg}}{5 \text{ mL}} \times \frac{100 \text{ mg}}{X \text{ mL}}$

$250X = 500$

$\frac{250X}{250} = \frac{500}{250}$

$X = 2 \text{ mL}$

Practice Problems—Chapter 10 from pages 192-200

1) $\frac{1}{2}$ **2)** 2 **3)** $\frac{1}{2}$ **4)** 2.5 **5)** 10 **6)** 2 **7)** 8 **8)** $1\frac{1}{2}$ **9)** 1 **10)** $\frac{1}{2}$ **11)** $1\frac{1}{2}$ **12)** 1 **13)** $1\frac{1}{2}$ **14)** 1 **15)** 1 **16)** 5; $1\frac{1}{2}$ **17)** 7.5 **18)** $1\frac{1}{2}$ **19)** 2 **20)** 3 **21)** 0.75; 1 **22)** $\frac{1}{2}$ **23)** 2 **24)** 2 **25)** 2 **26)** 2 **27)** 15 and 30; one of each **28)** 2.4 **29)** 5 **30)** 3 **31)** D; 2 tablets **32)** A; 1 capsule **33)** C; 1 tablet **34)** B; 1 capsule **35)** I; 2 tablets **36)** G; 2 tablets **37)** F; 2 tablets **38)** H; 1 tablet **39)** M; 2 tablets **40)** L; 2 tablets **41)** E; 30 mL **42)** K; 1 tablet **43)** J; 2 tablets **44)** N; 2 tablets **45)** O; 1 tablet **46)** Q; 2 tablets **47)** P; 4 tablets **48)** R; 1 tablet **49)** S; 1 tablet

50) **Prevention:** This medication error could have been prevented if the nurse had more carefully read the physician's order as well as the medication label. The doctor's order misled the nurse by noting the volume first and then the drug dosage. If confused by the order, the nurse should have clarified the intent with the physician. By focusing on the volume, the nurse failed to follow the steps in dosage calculation. Had the nurse noted 250 mg as the desired dosage and the supply (or on-hand) dosage as 125 mg per 5 mL, the correct amount to be administered would have been clear. Slow down and take time to compare the order with the labels. Calculate each dose carefully before preparing and administering both solid and liquid form medications.

Solutions—Practice Problems—Chapter 10

2) Order: gr $\frac{1}{2}$

$$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{2}}{\text{X mg}}$$

X = 60 × $\frac{1}{2}$

X = 30 mg

Supply: 15 mg/tab

$$\frac{15 \text{ mg}}{1 \text{ tab}} \times \frac{30 \text{ mg}}{\text{X tab}}$$

15X = 30

$$\frac{15X}{15} = \frac{30}{15}$$

X = 2 tab

3) Order: 0.075 mg

$$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{0.075 \text{ mg}}{\text{X mcg}}$$

X = 75 mcg

Supply: 150 mcg/tab

$$\frac{150 \text{ mcg}}{1 \text{ tab}} \times \frac{75 \text{ mcg}}{\text{X tab}}$$

150X = 75

$$\frac{150X}{150} = \frac{75}{150}$$

X = $\frac{1}{2}$ tab

8) Order: 150 mg

Supply: 0.1 g/tab

$$\frac{1 \text{ g}}{1{,}000 \text{ mg}} \times \frac{0.1 \text{ g}}{\text{X mg}}$$

X = 1,000 × 0.1

X = 100 mg

$$\frac{100 \text{ mg}}{1 \text{ tab}} \times \frac{150 \text{ mg}}{\text{X tab}}$$

100X = 150

$$\frac{100X}{100} = \frac{150}{100}$$

X = $1\frac{1}{2}$ tab

9) Order: gr v = gr 5

$$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } 5}{\text{X mg}}$$

X = 300 mg

Supply: 325 mg/tab

$$\frac{325 \text{ mg}}{1 \text{ tab}} \times \frac{300 \text{ mg}}{\text{X tab}}$$

325X = 300

$$\frac{325X}{325} = \frac{300}{325}$$

X = 0.92 tab

0.92 tablets is not a reasonable dosage. Remember, in some instances gr i = 65 mg is more appropriate for conversion from grains to milligrams.

$$\frac{\text{gr } 1}{65 \text{ mg}} \times \frac{\text{gr } 5}{\text{X mg}}$$

X = 325 mg

Supply: 325 mg/tab

$$\frac{325 \text{ mg}}{1 \text{ tab}} \times \frac{325 \text{ mg}}{\text{X tab}}$$

325X = 325

$$\frac{325X}{325} = \frac{325}{325}$$

X = 1 tab

14) Order: gr $\frac{1}{8}$

$$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{8}}{\text{X mg}}$$

$X = 60 \times \frac{1}{8}$

$X = 7.5$ mg

Supply: 7.5 mg/tab

Think: It is obvious that you want to give one tablet.

$$\frac{7.5 \text{ mg}}{1 \text{ tab}} \times \frac{7.5 \text{ mg}}{\text{X tab}}$$

$7.5X = 7.5$

$$\frac{7.5X}{7.5} = \frac{7.5}{7.5}$$

$X = 1$ tab

19) Order: 0.25 mg

Supply: 0.125 mg/tab

$$\frac{0.125 \text{ mg}}{1 \text{ tab}} \times \frac{0.25 \text{ mg}}{\text{X tab}}$$

$0.125X = 0.25$

$$\frac{0.125X}{0.125} = \frac{0.25 \text{ mg}}{0.125}$$

$X = 2$ tab

27) Order: gr $\frac{3}{4}$

$$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{3}{4}}{\text{X mg}}$$

$X = 60 \times \frac{3}{4}$

$X = 45$ mg

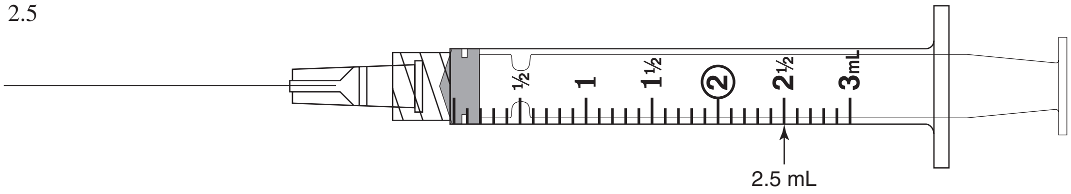
Supply: 15 mg, 30 mg, and 60 mg tablets

Select: One 15-mg tablet and one 30-mg tablet for 45 mg total dosage

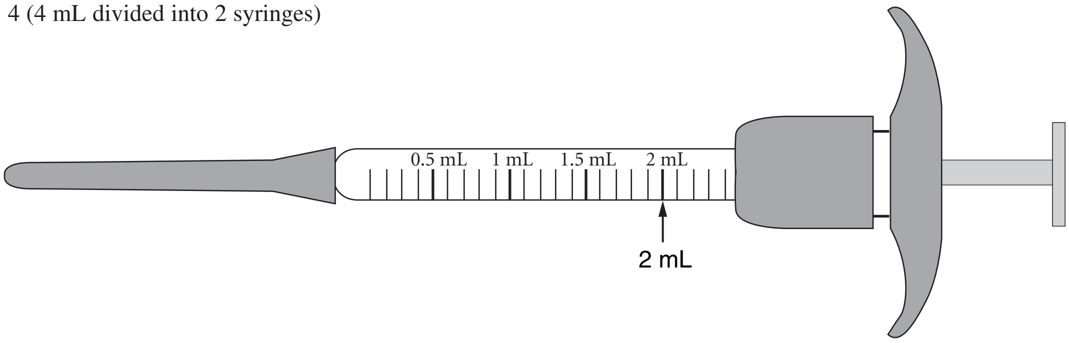
Remember: If you have a choice, give whole tablets and as few as possible

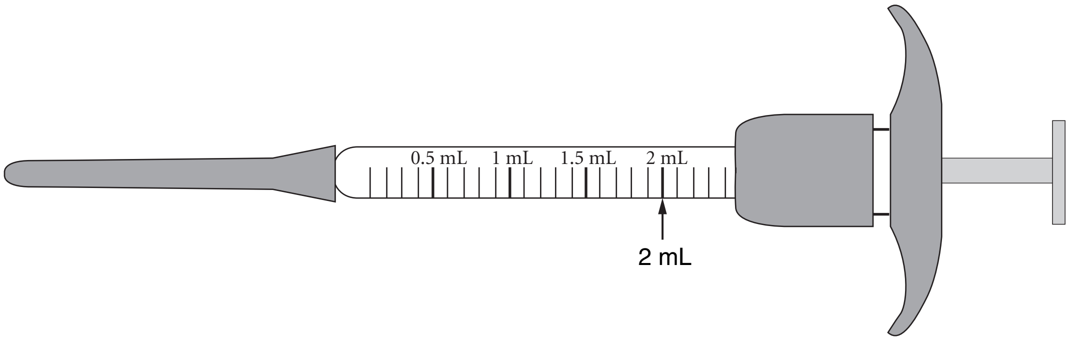
Review Set 26 from pages 208-213

1) 2.5

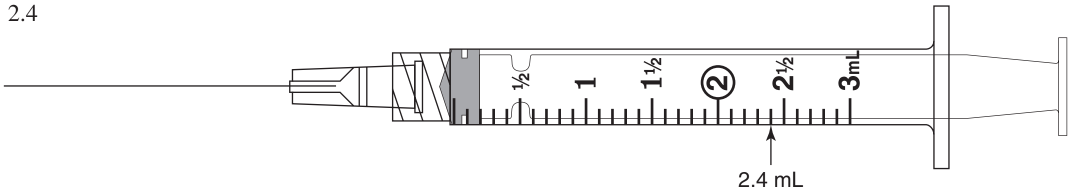


2) 4 (4 mL divided into 2 syringes)

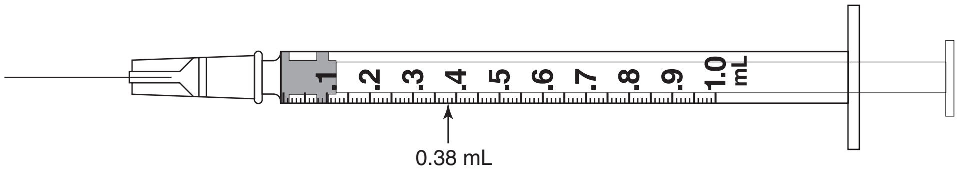




3) 2.4

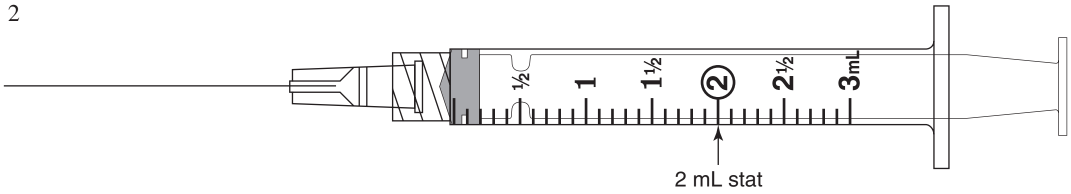


4) 0.38



The route is IM; the needle may need to be changed to an appropriate gauge and length.

5) 2



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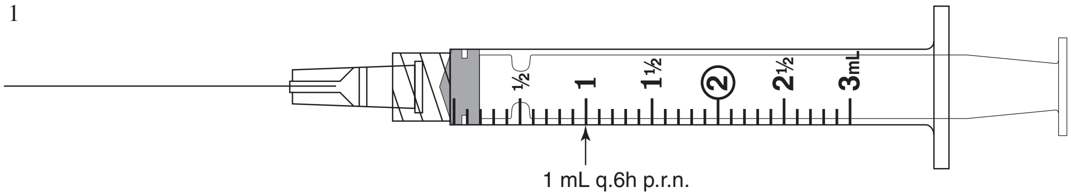
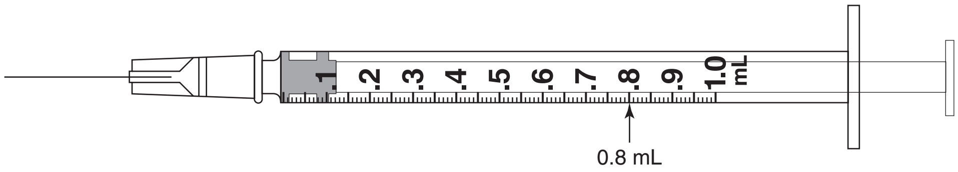
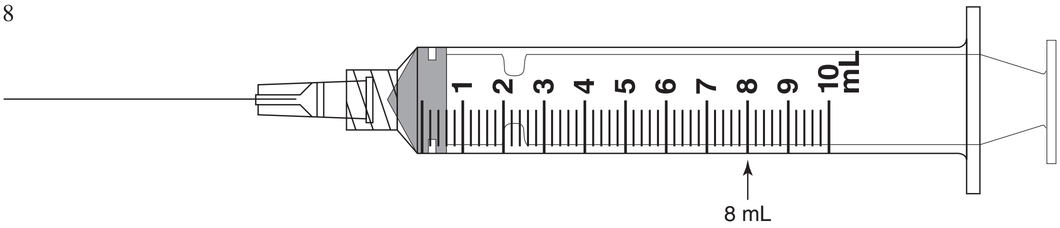


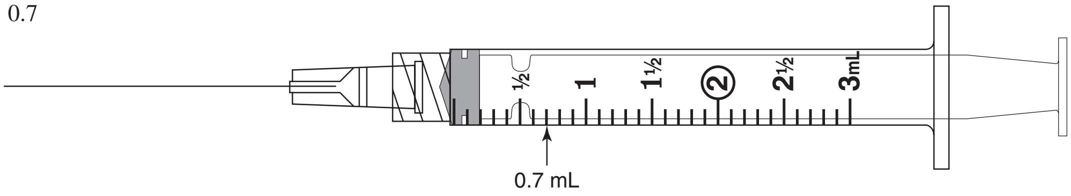
6) 0.8



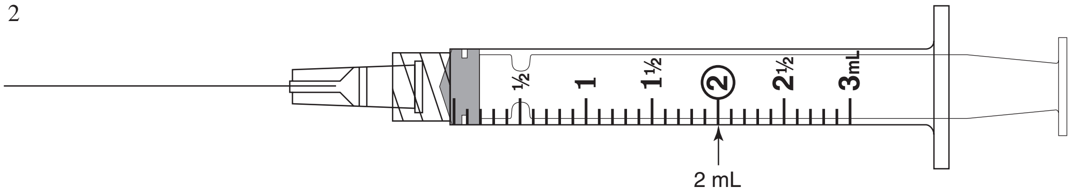
7) 8



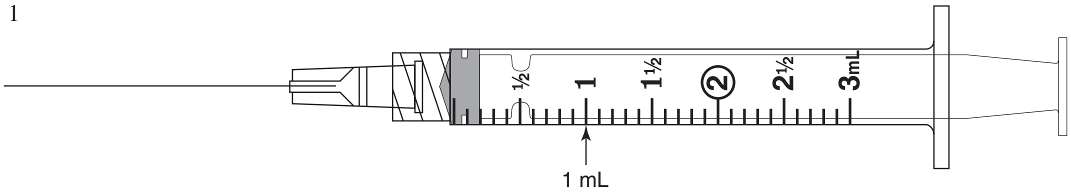
8) 0.7



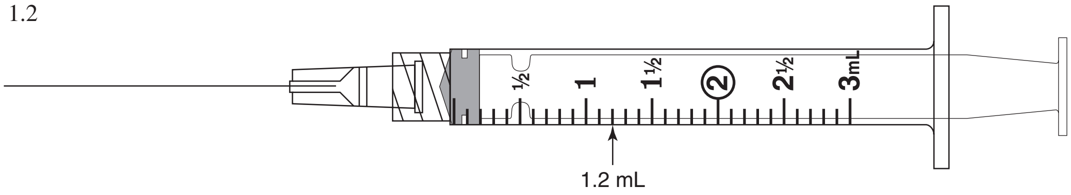
9) 2



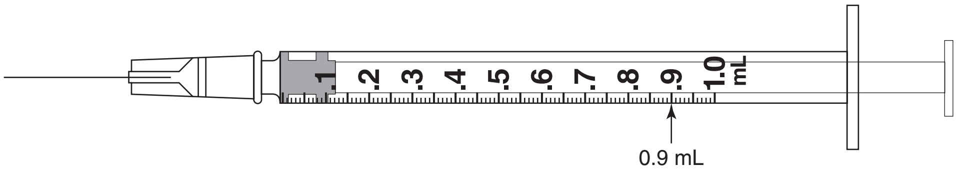
10) 1



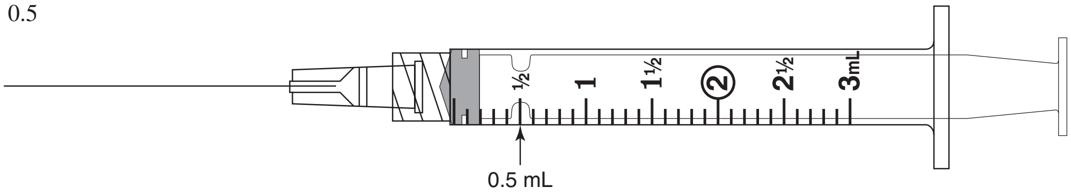
11) 1.2



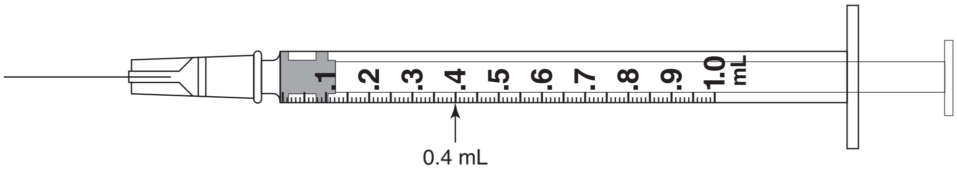
12) 0.9



13) 0.5

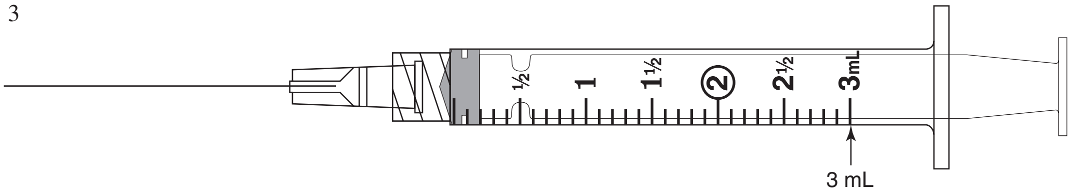


14) 0.4

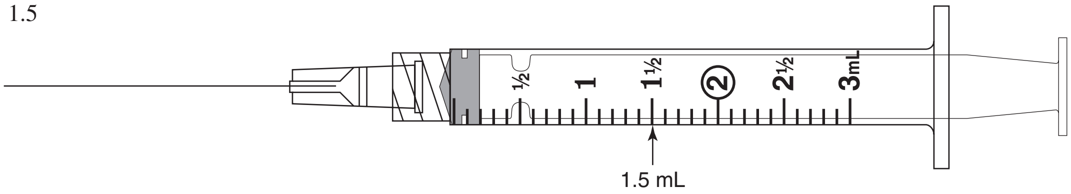


The route is IM; the needle may need to be changed to an appropriate gauge and length.

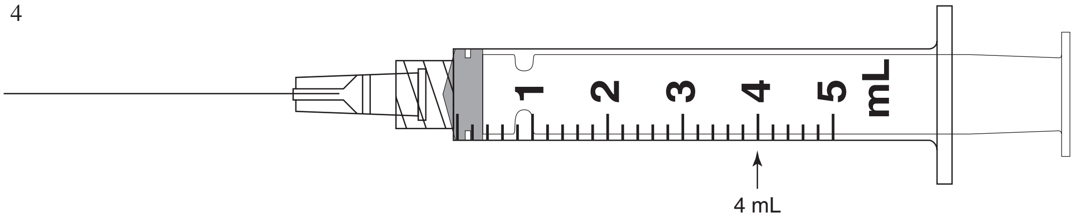
15) 3



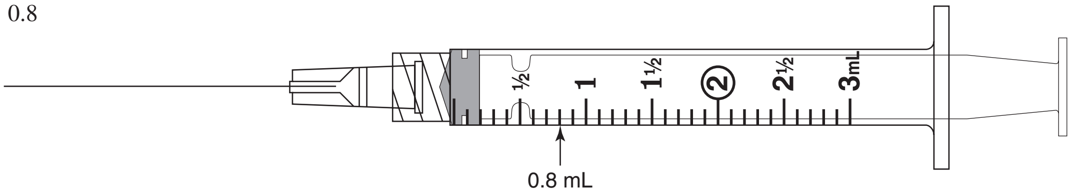
16) 1.5



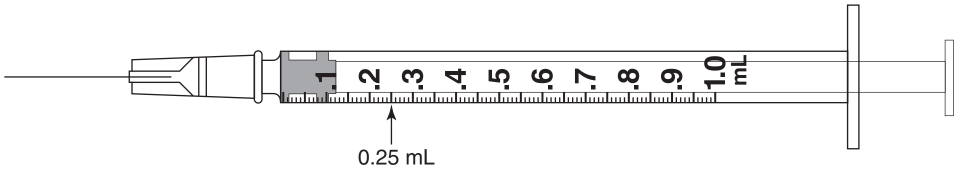
17) 4



18) 0.8

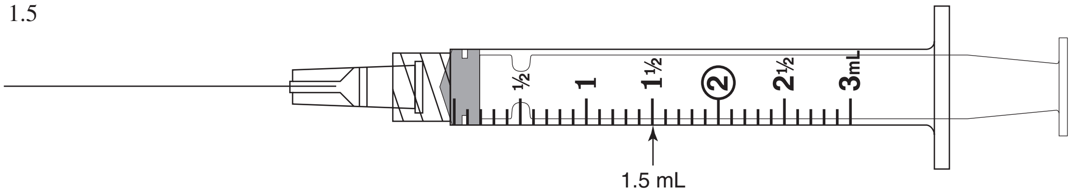


19) 0.25



The route is IM; the needle may need to be changed to an appropriate gauge and length.

20) 1.5



Solutions—Review Set 26

1) Order: 1 g = 1,000 mg

Supply: 400 mg/mL

$\frac{400 \text{ mg}}{1 \text{ mL}} \times \frac{1{,}000 \text{ mg}}{\text{X mg}}$

400X = 1,000

$\frac{400\text{X}}{400} = \frac{1{,}000}{400}$

X = 2.5 mL

2) Order: 2,400,000 units

Supply: 1,200,000 units per 2 mL

$\frac{1{,}200{,}000 \text{ units}}{2 \text{ mL}} \times \frac{2{,}400{,}000 \text{ units}}{\text{X mL}}$

1,200,000X = 4,800,000

$\frac{1{,}200{,}000\text{X}}{1{,}200{,}000} \times \frac{4{,}800{,}000}{1{,}200{,}000}$

X = 4 mL

3) Order: 600 mcg

Supply: 500 mcg per 2 mL

$\frac{500 \text{ mcg}}{2 \text{ mL}} \times \frac{600 \text{ mcg}}{\text{X mL}}$

500X = 1,200

$\frac{500\text{X}}{500} \times \frac{1{,}200}{500}$

X = 2.4 mL

6) Order: 4,000 units

Supply: 5,000 units/mL

$\frac{5{,}000 \text{ units}}{1 \text{ mL}} \times \frac{4{,}000 \text{ units}}{\text{X mL}}$

5,000X = 4,000

$\frac{5{,}000\text{X}}{5{,}000} \times \frac{4{,}000}{5{,}000}$

X = 0.8 mL

10) Order: gr $\frac{1}{4}$

$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{4}}{\text{X mg}}$

X = 60 × $\frac{1}{4}$

X = 15 mg

Supply: 15 mg/mL

Think: It is obvious that you want to give 1 mL.

$\frac{15 \text{ mg}}{1 \text{ mL}} \times \frac{15 \text{ mg}}{\text{X mL}}$

15X = 15

$\frac{15\text{X}}{15} = \frac{15}{15}$

X = 1 mL

11) Order: 30 mg

Supply: 25 mg/mL

$\frac{25 \text{ mg}}{1 \text{ mL}} \times \frac{30 \text{ mg}}{\text{X mL}}$

25X = 30

$\frac{25\text{X}}{25} = \frac{30}{25}$

X = 1.2 mL

19) Order: 12.5 mg

Supply: 50 mg/mL

$\frac{50 \text{ mg}}{1 \text{ mL}} \times \frac{12.5 \text{ mg}}{\text{X mL}}$

50X = 12.5

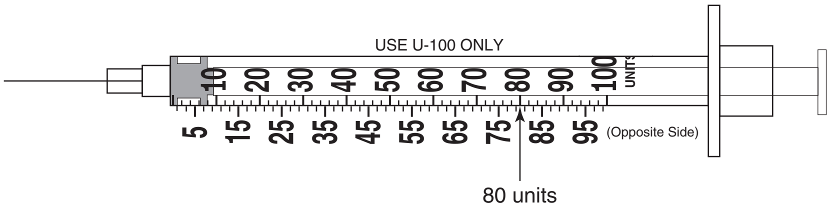
$\frac{50\text{X}}{50} = \frac{12.5}{50}$

X = 0.25 mL

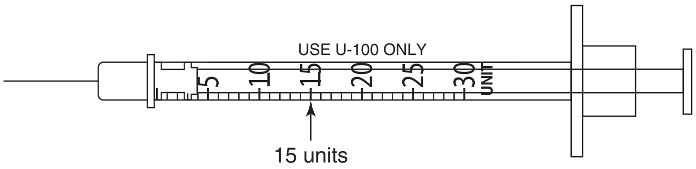
Review Set 27 from pages 221-225

1) Humulin R Regular, Rapid-acting **2)** Novolin N, Intermediate-acting **3)** Humulin U Ultralente, Long-acting **4)** Humalog, Rapid-acting **5)** Humulin L Lente, Intermediate-acting **6)** Lantus, Long-acting **7)** Standard, dual-scale 100 unit/mL U-100 syringe; Lo-dose, 50 unit/0.5 mL U-100 syringe; Lo-dose, 30 unit/0.3 mL U-100 syringe **8)** Lo-dose, 50 unit U-100 syringe **9)** 0.6 **10)** 0.25 **11)** Standard dual-scale 100 unit U-100 syringe **12)** False **13)** 68 **14)** 15 **15)** 23 **16)** 57

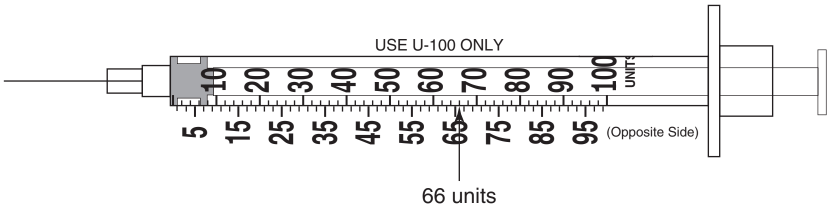
17)



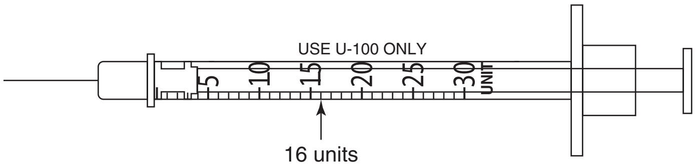
18)



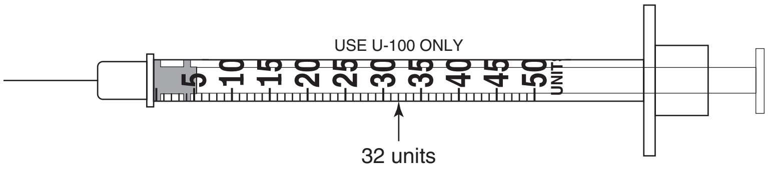
19)



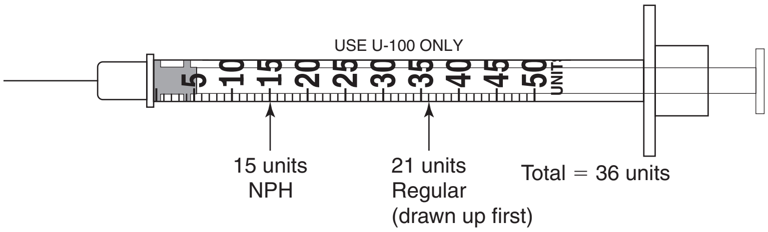
20)



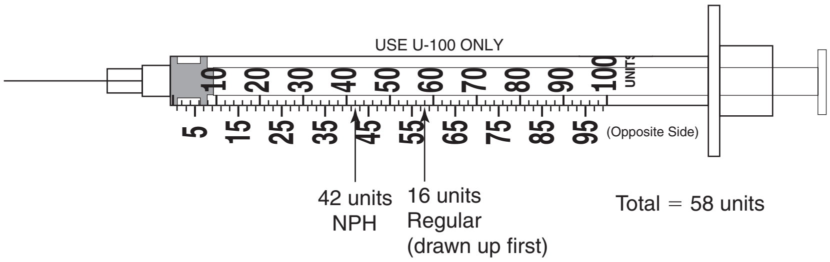
21)



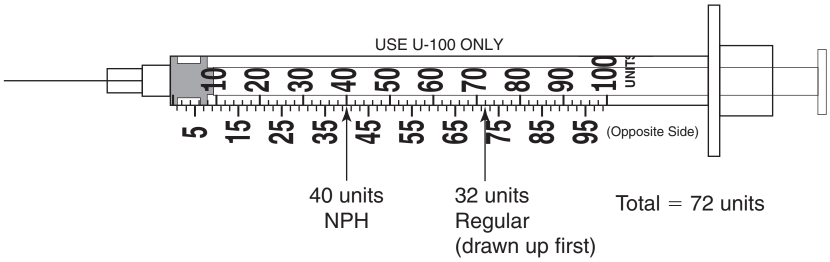
22)



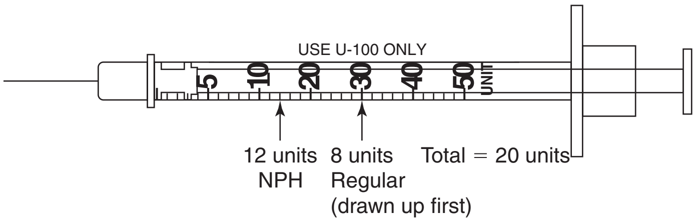
23)



24)



25)



26) Before meals and before insulin administration.

27) Blood glucose levels of 160–400.

28) Administer 4 units of Humulin R Regular U-100 insulin.

29) None, do not administer insulin.

30) Contact the physician for further instructions.

Solutions—Review Set 27

9) Recall U-100 = 100 units per mL

$$\frac{100 \text{ units}}{1 \text{ mL}} \times \frac{60 \text{ units}}{X \text{ mL}}$$

100X = 60

$$\frac{100X}{100} = \frac{60}{100}$$

X = 0.6 mL

Practice Problems—Chapter 11 from pages 226-234

1) 0.4; 1 mL tuberculin
The route is IM; the needle may need to be changed to an appropriate gauge and length.

2) 1.5; 3 mL

3) 2.4; 3 mL

4) 0.6; 1 mL or 3 mL

5) 2; 3 mL

6) 15; 20 mL

7) 0.8; 1 mL or 3 mL

8) 1; 3 mL

9) 1; 3 mL

10) 0.5; 1 mL or 3 mL

11) 1.5; 3 mL

12) 0.6; 1 mL or 3 mL

13) 0.6; 1 mL or 3 mL

14) 1.9; 3 mL

15) 0.6; 1 mL or 3 mL

16) 1; 3 mL

17) 0.67; 1 mL
The route is IM; the needle may need to be changed to an appropriate gauge and length.

18) 1; 3 mL

19) 1.2; 3 mL

20) 0.7; 1 mL or 3 mL

21) 0.75; 1 mL
The route is IM; the needle may need to be changed to an appropriate gauge and length.

22) 1.5; 3 mL

23) 0.7; 1 mL or 3 mL

24) 0.8; 1 mL or 3 mL

25) 1.3; 3 mL

26) 1.6; 3 mL

27) 6; 10 mL

28) 0.8; 1 mL or 3 mL

29) 1.5; 3 mL

30) 2.5; 3 mL

31) 1; 3 mL

32) 0.7; 1 mL or 3 mL

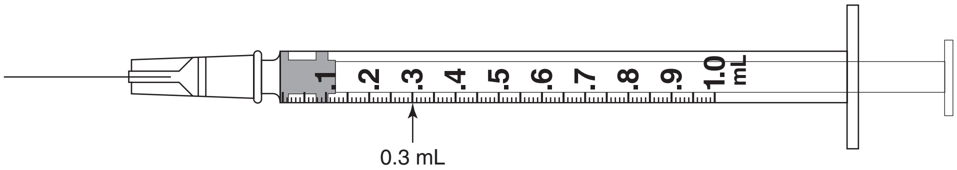
33) 1; 3 mL

34) 30; 20 mL (2 syringes)

35) 16; 30 units Lo-Dose U-100 insulin

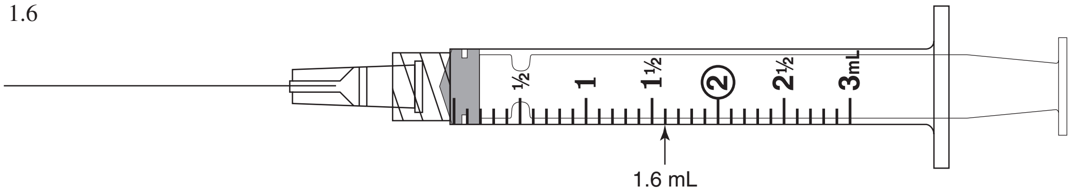
36) 25; 50 units Lo-Dose U-100 insulin

37) 0.3

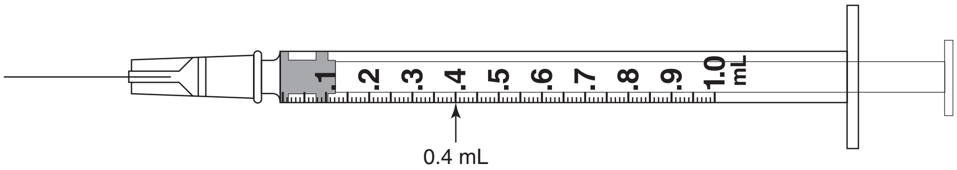


The route is IM; the needle may need to be changed to an appropriate gauge and length.

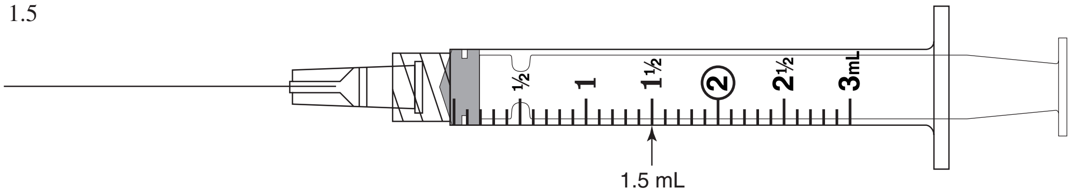
38) 1.6



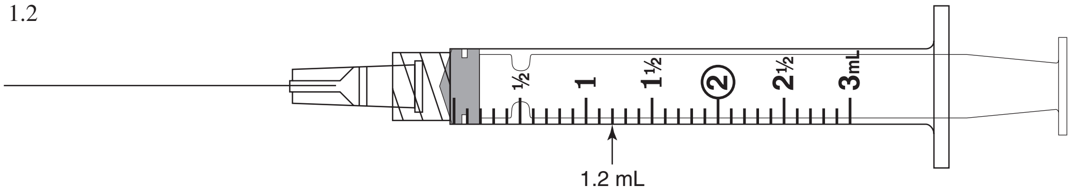
39) 0.4



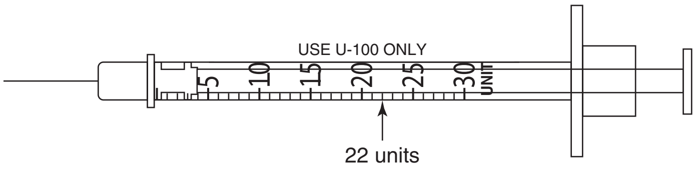
40) 1.5



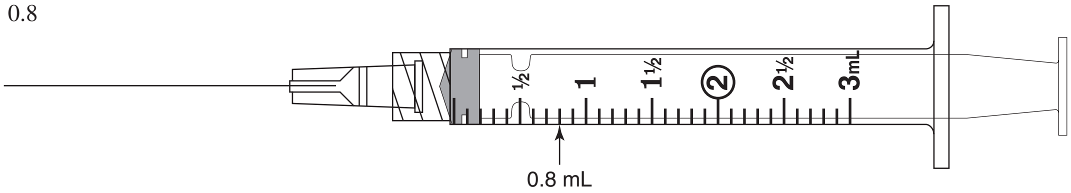
41) 1.2



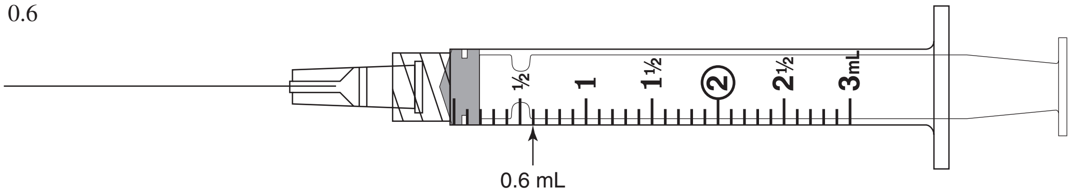
42) 22



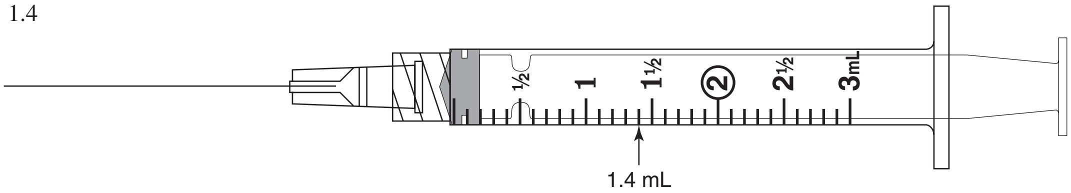
43) 0.8



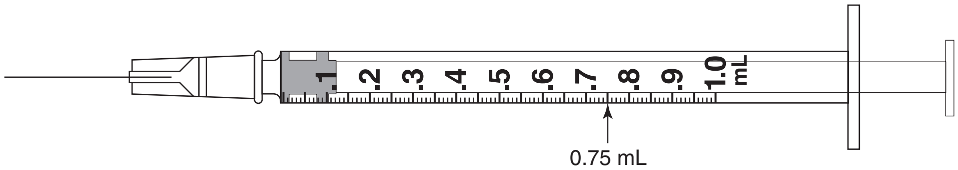
44) 0.6



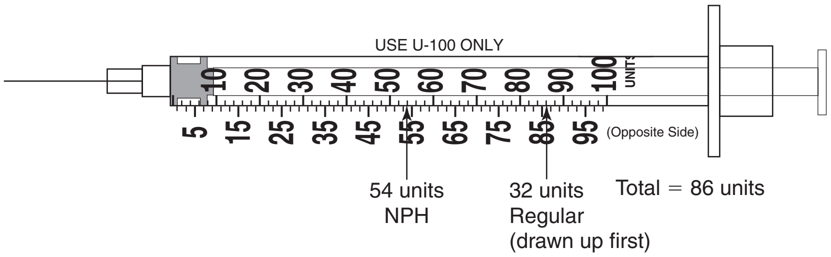
45) 1.4



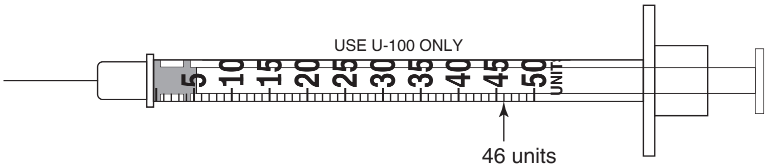
46) 0.75



47) 86



48) 46



49) **Prevention:** This error could have been avoided had the nurse been more careful checking the label of the insulin vial and comparing the label to the order. The nurse should have checked the label three times. In addition, the nurse should have asked another nurse to double-check her as she was drawing up the insulin, as required. Such hospital policies and procedures are written to protect the patient and the nurse.

50) **Prevention:** This insulin error should never occur. It is obvious that the nurse did not use Step 2 of the three-step method. The nurse did not stop to think of the reasonable dosage. If so, the nurse would have realized that the supply dosage of U-100 insulin is 100 units/mL, not 10 units/mL.

If you are unsure of what you are doing, you need to ask before you act. Insulin should only be given in an insulin syringe. The likelihood of the nurse needing to give insulin in a tuberculin syringe because an insulin syringe was unavailable is almost nonexistent today. The nurse chose the incorrect syringe. Whenever you are in doubt, you should ask for help. Further, if the nurse had asked another nurse to double-check the dosage, as required, the error could have been found before the patient received the wrong dosage of insulin. After giving the insulin, it is too late to rectify the error.

Solutions—Practice Problems—Chapter 11

3) Order: 0.6 mg

$$\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{0.6\text{ mg}}{X\text{ mcg}}$$

$X = 1{,}000 \times 0.6$

$X = 600\text{ mcg}$

Supply: 500 mcg per 2 mL

$$\frac{500\text{ mcg}}{2\text{ mL}} \times \frac{600\text{ mcg}}{X\text{ mL}}$$

$500X = 1{,}200$

$$\frac{500X}{500} = \frac{1{,}200}{500}$$

$X = 2.4\text{ mL}$

6) Order: 30 mEq

Supply: 2 mEq/mL

$$\frac{2\text{ mEq}}{1\text{ mL}} \times \frac{30\text{ mEq}}{X\text{ mL}}$$

$2X = 30$

$$\frac{2X}{2} = \frac{30}{2}$$

$X = 15\text{ mL}$

Note: route is IV so this large dose is acceptable

11) Order: gr $\frac{1}{100}$

$$\frac{\text{gr } 1}{60\text{ mg}} \times \frac{\text{gr } \frac{1}{100}}{X\text{ mg}}$$

$X = 60 \times \frac{1}{100}$

$X = 0.6\text{ mg}$

Supply: 0.4 mg/mL

$$\frac{0.4\text{ mg}}{1\text{ mL}} \times \frac{0.6\text{ mg}}{X\text{ mL}}$$

$0.4X = 0.6$

$$\frac{0.4X}{0.4} = \frac{0.6}{0.4}$$

$X = 1.5\text{ mL}$

14) Order: 75 mg

Supply: 80 mg per 2 mL

$\frac{80 \text{ mg}}{2 \text{ mL}} \times \frac{75 \text{ mg}}{\text{X mL}}$

$80X = 150$

$\frac{80X}{80} = \frac{150}{80}$

$X = 1.9$ mL

15) Order: gr $\frac{1}{10}$

$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{10}}{\text{X mg}}$

$X = 60 \times \frac{1}{10}$

$X = 6$ mg

Supply: 10 mg/mL

$\frac{10 \text{ mg}}{1 \text{ mL}} \times \frac{6 \text{ mg}}{\text{X mL}}$

$10X = 6$

$\frac{10X}{10} = \frac{6}{10}$

$X = 0.6$ mL

19) Order: 60 mg

Supply: 75 mg per 1.5 mL

$\frac{75 \text{ mg}}{1.5 \text{ mL}} \times \frac{60 \text{ mg}}{\text{X mL}}$

$75X = 90$

$\frac{75X}{75} = \frac{90}{75}$

$X = 1.2$ mL

26) Order: 0.4 mg

Supply: 500 mcg per 2 mL

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{0.4 \text{ mg}}{\text{X mcg}}$

$X = 400$ mcg

$\frac{500 \text{ mcg}}{2 \text{ mL}} \times \frac{400 \text{ mcg}}{\text{X mL}}$

$500X = 800$

$\frac{500X}{500} = \frac{800}{500}$

$X = 1.6$ mL

30) Order: 50 mg

Supply: 2% = 2 g per 100 mL

$\frac{1 \text{ g}}{1{,}000 \text{ mg}} \times \frac{2 \text{ g}}{\text{X mg}}$

$X = 2{,}000$ mg

$\frac{2{,}000 \text{ mg}}{100 \text{ mL}} \times \frac{50 \text{ mg}}{\text{X mL}}$

$2{,}000X = 5{,}000$

$\frac{2{,}000X}{2{,}000} = \frac{5{,}000}{2{,}000}$

$X = 2.5$ mL

33) Order: 0.5 mg

Supply: 1:2,000 = 1 g per 2,000 mL = 1,000 mg per 2,000 mL

$\frac{1{,}000 \text{ mg}}{2{,}000 \text{ mL}} \times \frac{0.5 \text{ mg}}{\text{X mL}}$

$1{,}000X = 1{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{1{,}000}{1{,}000}$

$X = 1$ mL

41) Order: 12,000 units

Supply: 10,000 units/mL

$\frac{10{,}000 \text{ units}}{1 \text{ mL}} \times \frac{12{,}000 \text{ units}}{\text{X mL}}$

$10{,}000X = 12{,}000$

$\frac{10{,}000X}{10{,}000} = \frac{12{,}000}{10{,}000}$

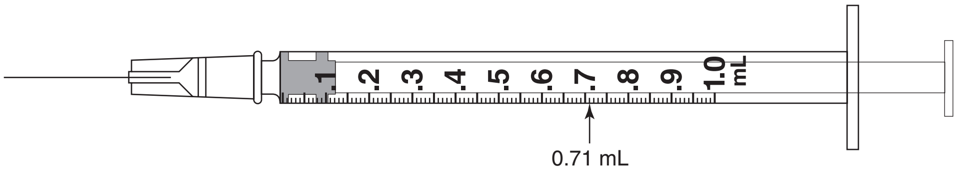
$X = 1.2$ mL

Review Set 28 from pages 253-264

1) 1.5; 280; 0.71; 2

Reconstitution label

2/6/XX, 0800, reconstituted as
280 mg/mL. Expires 2/13/XX, 0800. Keep
refrigerated. G.D.P.



The route is IM; the needle may need to be changed to an appropriate gauge and length.

2) 23; 200,000; 0.75

18; 250,000; 0.6

8; 500,000; 0.3

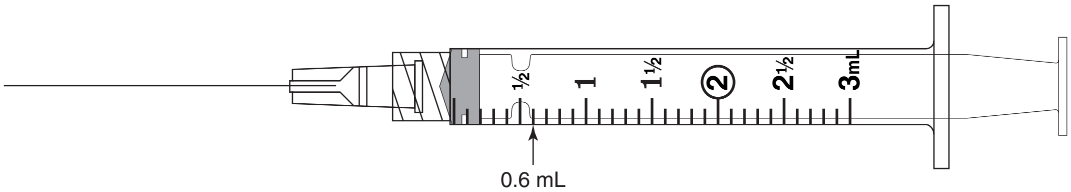
3; 1,000,000; 0.15

250,000; 0.6

The 250,000 units/mL concentration can be measured at 0.6 mL exactly in a 3 mL syringe, and 0.6 mL is a reasonable dose amount to measure in a 3 mL syringe. The 0.3 mL and 0.15 mL doses are more risky to measure in a 3 mL syringe. The nurse could measure them in a 1 mL syringe, but the nurse would then need to change needles for an IM injection, which is wasteful and not necessary with the solution strength choices available.

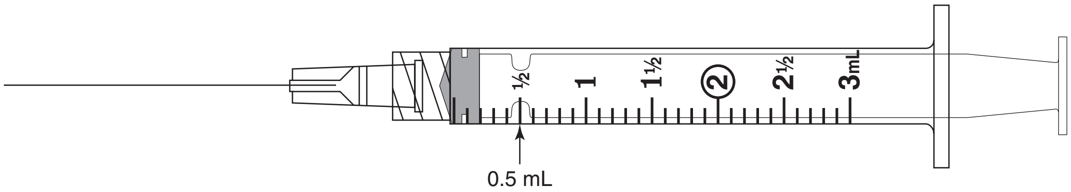
Reconstitution label

2/6/XX, 0800, reconstituted as
250,000 units/mL. Expires 2/13/XX, 0800.
Keep refrigerated. G.D.P.



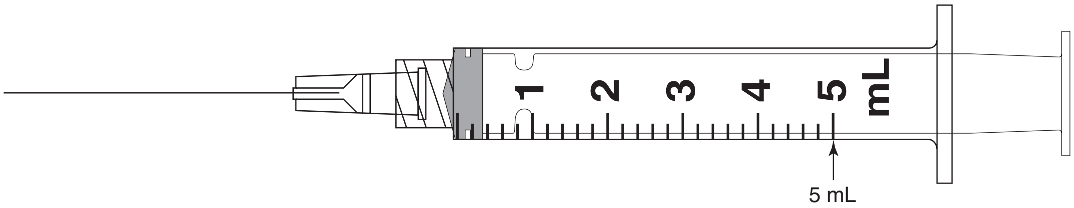
3) 2; 100/2; 0.5

Four doses are available; however, the unused solution is to be discarded. No reconstitution label would be needed.

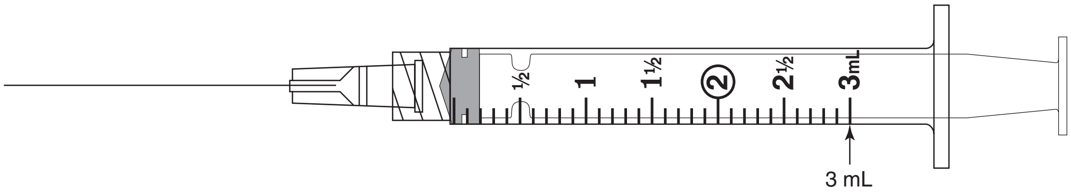


4) 4.8; 100; 5; 1

No reconstitution label is required; all of the medication will be used for 1 dose.



5) 3.6; 250; 3; 1



6) 18.2; 250,000; 4

8.2; 500,000; 2

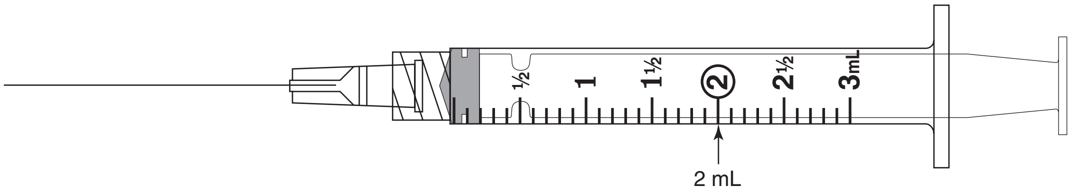
3.2; 1,000,000; 1

Select 500,000 units/mL and give 2 mL. Either 1 mL or 2 mL is an appropriate amount to give IM depending on reconstitution, but 500,000 units/mL is less concentrated than 1,000,000 units/mL and is therefore less irritating to the muscle.

5 doses available in vial

Reconstitution label

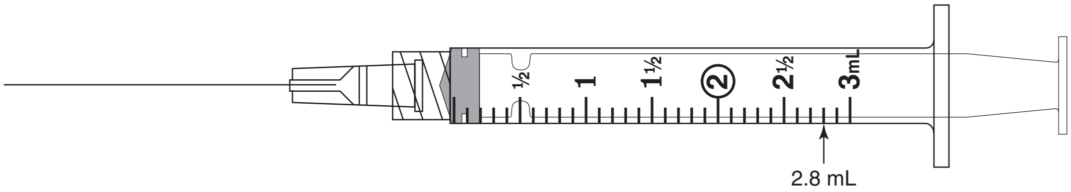
2/6/XX, 0800, reconstituted as 500,000 units/mL. Expires 2/13/XX, 0800. Keep refrigerated. G.D.P.



7) 8; 62.5; 2.8; 2

Reconstitution label

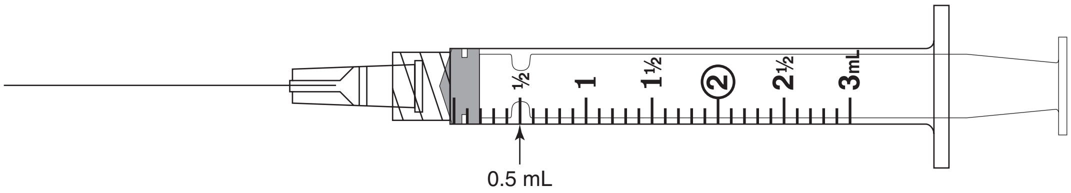
2/6/XX, 0800, reconstituted as 62.5 mg/mL. Expires 2/8/XX, 0800. Keep at room temperature and protect from light. G.D.P.



8) 4; 1/2.5 or 1,000/2.5; 0.5; 10

Reconstitution label

2/6/XX, 0800, reconstituted as 1 g/2.5 mL. Expires 2/8/XX, 0800. Keep refrigerated. G.D.P.



9) 20; 50,000; 10

10; 100,000; 5

4; 250,000; 2

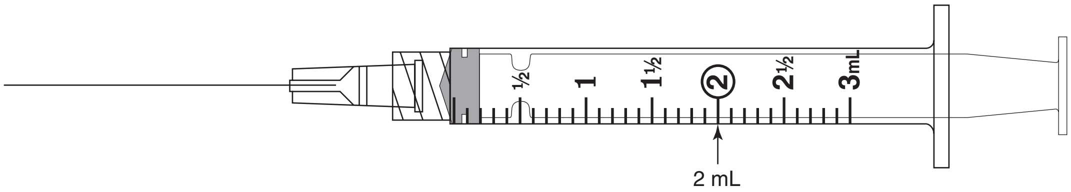
1.8; 500,000; 1

Select 250,000 units/mL and give 2 mL. This would be an appropriate IM dose and would be less concentrated than the 500,000 units/mL dosage strength. Therefore, it would be less irritating to the muscle.

2 doses available

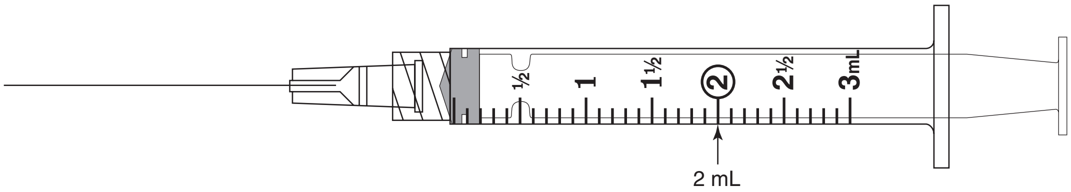
Reconstitution label

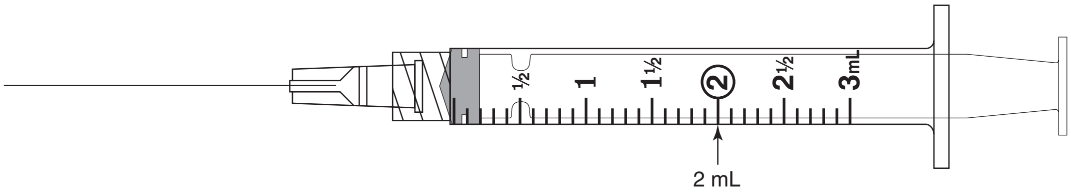
2/6/XX, 0800, reconstituted as
250,000 units/mL. Expires 2/13/XX,
0800. Keep refrigerated. G.D.P.



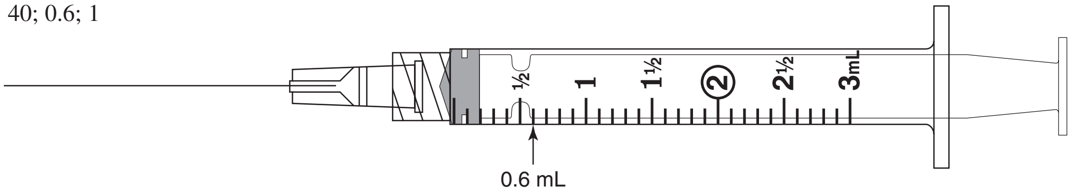
10) 3.2; 1.5/4; 375; 4; 1

(4 mL divided into 2 syringes)





11) 40; 0.6; 1



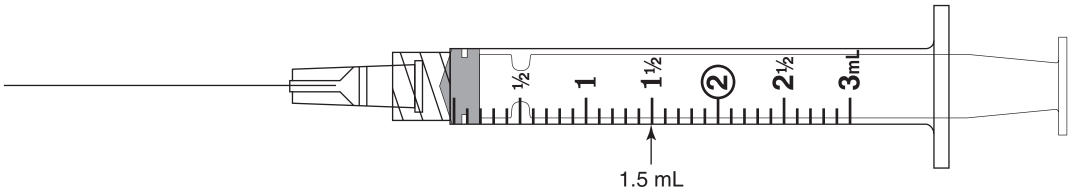
12) 10; 2/11.5; 170; 1.5; 7; yes

Seven full doses of 1.5 mL are available. Because of the need to round 1.47 mL to 1.5 mL, there will be only 7 full doses.

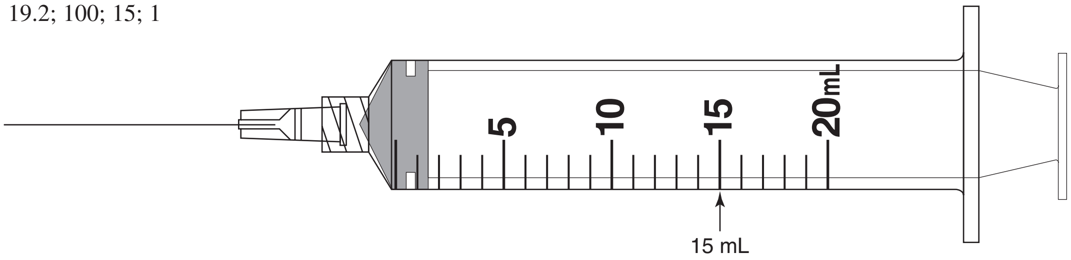
Yes; the drug is ordered for administration twice a day; the 7 full doses would be given over $3\frac{1}{2}$ days and the solution is good for 7 days under refrigeration.

Reconstitution label

2/6/XX, 0800, reconstituted as
170 mg/mL. Expires 2/13/XX, 0800. Keep
refrigerated. G.D.P.



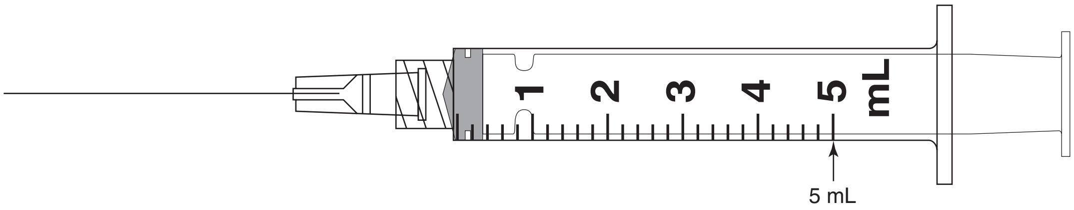
13) 19.2; 100; 15; 1



14) 5; 50; 5; 1

Reconstitution label

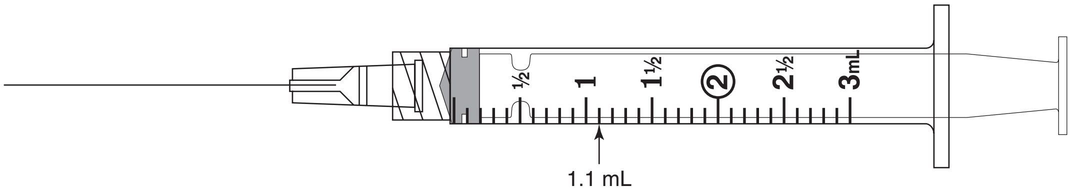
2/6/XX, 0800, reconstituted as 50 mg/mL. Expires 2/7/XX, 0800. Keep refrigerated. G.D.P.



15) 2; 225; 1.1; 2

Reconstitution label

2/6/XX, 0800, reconstituted as 225 mg/mL. Expires 2/7/XX, 0800 when kept at room temperature. G.D.P.



Solutions—Review Set 28

1) Order: 200 mg

Supply: 280 mg/mL

$$\frac{280 \text{ mg}}{1 \text{ mL}} \times \frac{200 \text{ mg}}{X \text{ mL}}$$

$280X = 200$

$$\frac{280X}{280} = \frac{200}{280}$$

$X = 0.71$ mL

$$\frac{200 \text{ mg}}{1 \text{ dose}} \times \frac{500 \text{ mg}}{X \text{ doses}}$$

$200X = 500$

$$\frac{200X}{200} = \frac{500}{200}$$

$X = 2.5$ doses (per vial; 2 full doses per vial available)

2) Order: 2,500 units

Supply: 5,000 units/mL

$$\frac{5{,}000 \text{ units}}{1 \text{ mL}} \times \frac{2{,}500 \text{ units}}{X \text{ mL}}$$

$5{,}000X = 2{,}500$

$$\frac{5{,}000X}{5{,}000} = \frac{2{,}500}{5{,}000}$$

$X = 0.5$ mL

$$\frac{2{,}5000 \text{ units}}{1 \text{ dose}} \times \frac{50{,}000 \text{ units}}{X \text{ doses}}$$

$2{,}500X = 50{,}000$

$$\frac{2{,}500X}{2{,}500} = \frac{50{,}000}{2{,}500}$$

$X = 20$ doses per vial

6) Order: 1,000,000 units

Supply: 250,000 units/mL

$$\frac{250{,}000 \text{ units}}{1 \text{ mL}} \times \frac{1{,}000{,}000 \text{ units}}{X \text{ mL}}$$

$250{,}000X = 1{,}000{,}000$

$$\frac{250{,}000X}{250{,}000} \times \frac{1{,}000{,}000}{250{,}000}$$

$X = 4$ mL

Order: 1,000,000 units

Supply: 500,000 units/mL

$$\frac{500{,}000 \text{ units}}{1 \text{ mL}} \times \frac{1{,}000{,}000 \text{ units}}{X \text{ mL}}$$

$500{,}000X = 1{,}000{,}000$

$$\frac{500{,}000X}{500{,}000} = \frac{1{,}000{,}000}{500{,}000}$$

$X = 2$ mL

Order: 1,000,000 units

Supply: 1,000,000 units/mL

$$\frac{1{,}000{,}000 \text{ units}}{1 \text{ mL}} \times \frac{1{,}000{,}000 \text{ units}}{X \text{ mL}}$$

$1{,}000{,}000X = 1{,}000{,}000$

$$\frac{1{,}000{,}000X}{1{,}000{,}000} = \frac{1{,}000{,}000}{1{,}000{,}000}$$

$X = 1$ mL

$$\frac{1{,}000{,}000 \text{ units}}{1 \text{ dose}} \times \frac{5{,}000{,}000 \text{ units}}{X \text{ doses}}$$

$1{,}000{,}000X = 5{,}000{,}000$

$$\frac{1{,}000{,}000X}{1{,}000{,}000} \times \frac{5{,}000{,}000}{1{,}000{,}000}$$

$X = 5$ doses (available per vial)

8) Order: 200 mg

Supply: 1,000 mg per 2.5 mL

$$\frac{1{,}000 \text{ mg}}{2.5 \text{ mL}} \times \frac{200 \text{ mg}}{X \text{ mL}}$$

$1{,}000X = 500$

$$\frac{1{,}000X}{1{,}000} = \frac{500}{1{,}000}$$

$X = 0.5$ mL

2 g per vial:

$$\frac{1{,}000 \text{ mg}}{1 \text{ g}} \times \frac{X \text{ mg}}{2 \text{ g}}$$

$X = 2$ g or 2,000 mg/vial

$$\frac{200 \text{ mg}}{1 \text{ dose}} \times \frac{2{,}000 \text{ mg}}{X \text{ doses}}$$

$200X = 2{,}000$

$$\frac{200\ X}{200} = \frac{2{,}000}{200}$$

$X = 10$ doses (available per vial)

12) Order: 250 mg

Supply: 170 mg/mL

$$\frac{170 \text{ mg}}{1 \text{ mL}} \times \frac{250 \text{ mg}}{X \text{ mL}}$$

$170X = 250$

$$\frac{170X}{170} = \frac{250}{170}$$

$X = 1.47$ mL $= 1.5$ mL (rounded to administer in 3 mL syringe)

You will compute the number of available doses based on the rounded amount to be administered. Therefore, because you will give 1.5 mL/dose, there are only 7 full doses available.

$$\frac{1.5 \text{ mL}}{1 \text{ dose}} \times \frac{11.5 \text{ mL}}{X \text{ doses}}$$

$1.5X = 11.5$

$$\frac{1.5X}{1.5} = \frac{11.5}{1.5}$$

$X = 7.7$ doses (per vial or 7 full doses)

Review Set 29 from pages 269-270

1) 160 mL hydrogen peroxide (solute) + 320 mL saline (solvent) = 480 mL $\frac{1}{3}$ strength solution.

2) 1 ounce hydrogen peroxide + 3 ounces saline = 4 ounces $\frac{1}{4}$ strength solution.

3) 180 mL hydrogen peroxide + 60 mL saline = 240 mL $\frac{3}{4}$ strength solution.

4) 8 ounces hydrogen peroxide + 8 ounces saline = 16 ounces $\frac{1}{2}$ strength solution.

5) 300 mL Ensure + 600 mL water = 900 mL $\frac{1}{3}$ strength Ensure; one 12-oz can. Discard 2 oz (60 mL).

6) 6 ounces (180 mL) Isomil + 18 ounces (540 mL) water = 24 ounces (720 mL) $\frac{1}{4}$ strength Isomil; one 6-oz can. None discarded.

7) 1,200 mL needed for daily supply. 800 mL Sustacal + 400 mL water = 1,200 mL $\frac{2}{3}$ strength Sustacal; three 10-oz cans. Discard 100 mL.

8) 13 ounces Ensure + 13 ounces water = 26 ounces $\frac{1}{2}$ strength Ensure; one 12-oz can + one 4-oz can. Discard 3 oz (180 mL).

9) 1,000 mL needed for daily supply. 500 mL Sustacal + 500 mL water = 1,000 mL $\frac{1}{2}$ strength Sustacal; two 10-oz cans. Discard 100 mL.

10) 36 ounces Isomil + 12 ounces water = 48 ounces $\frac{3}{4}$ strength Isomil; use three 12-oz cans. None discarded.

11) 4 ounces Ensure + 2 ounces water = 6 ounces $\frac{2}{3}$ strength Ensure; use one 4-oz can. None discarded.

12) 4 ounces Ensure + 12 ounces water = 16 ounces (pt i) $\frac{1}{4}$ strength Ensure; use one 4-oz can. None discarded.

Solutions—Review Set 29

1) $\frac{1}{3} \times \frac{X \text{ mL}}{480 \text{ mL}}$

$3X = 480$

$\frac{3X}{3} = \frac{480}{3}$

X = 160 mL (solute)

480 mL (quantity of solution desired) − 160 mL (solute) = 320 mL (solvent)

5) $\frac{1}{3} \times \frac{X \text{ mL}}{900 \text{ mL}}$

$3X = 900$

$\frac{3X}{3} = \frac{900}{3}$

X = 300 mL (Ensure)

900 mL (total solution) − 300 mL (Ensure) = 600 mL (water)

$\frac{1 \text{ oz}}{30 \text{ mL}} \times \frac{12 \text{ oz}}{X \text{ mL}}$

X = 360 mL (per can)

360 mL (full can) − 300 mL (Ensure needed) = 60 mL (discarded)

6) $\frac{1}{4} \times \frac{X \text{ oz}}{24 \text{ oz}}$

$4X = 24$

$\frac{4X}{4} = \frac{24}{4}$

X = 6 oz (Isomil)

24 oz (solution) − 6 oz (Isomil) = 18 oz (water); use one 6-oz can

12) $\frac{1}{4} \times \frac{X \text{ oz}}{16 \text{ oz}}$

$4X = 16$

$\frac{4X}{4} = \frac{16}{4}$

X = 4 oz (Ensure)

16 oz (solution) − 4 oz (Ensure) = 12 oz (water); use one 4-oz can of Ensure; none discarded

Practice Problems—Chapter 12 from pages 272-280

1) 3.375/5; 3.7; 5 mL **2)** 2; 3 mL **3)** 1.5; 3 mL **4)** 19.2; 100; 7.5; 2; 10 mL

5) 1.8; 3 mL; 2

> 2/6/XX, 0800, reconstituted as 280 mg/mL.
> Expires 2/13/XX, 0800. Keep refrigerated. G.D.P.

6) 3.8; 5 mL; 1 **7)** 2; 225; 1.3; 3 mL; 1; No **8)** 8; 125; 1.6; 3 mL; The vial states single-dose vial. If the vial was saved for additional doses, then a reconstitution label would be required. **9)** 1.5; 280; 1.3; 3 mL; 1; No **10)** 3; 1,000,000; 0.5; 3 mL; 10; Yes **11)** 10; 2/11.5; 170; 7.4; 10 mL; 1; No **12)** 29; 20; 10; 5; Yes **13)** 2; 225; 1.8; 3 mL; 1; No **14)** 3.2; 1,000,000; 2; 3 mL; 2; Yes **15)** 1.8; 500,000; 2; 3 mL; 1; No

16) 2 oz hydrogen peroxide + 14 oz normal saline = 16 oz of the $\frac{1}{8}$ strength solution.

17) 120 mL hydrogen peroxide + 200 mL normal saline = 320 mL of the $\frac{3}{8}$ strength solution.

18) 50 mL hydrogen peroxide + 30 mL normal saline = 80 mL of the $\frac{5}{8}$ strength solution.

19) 12 oz hydrogen peroxide + 6 oz normal saline = 18 oz of the $\frac{2}{3}$ strength solution.

20) 14 oz hydrogen peroxide + 2 oz normal saline = 16 oz (1 pt) of the $\frac{7}{8}$ strength solution.

21) 250 mL hydrogen peroxide + 750 mL normal saline = 1,000 mL (1 L) of the $\frac{1}{4}$ strength solution.

22) 30 mL Enfamil + 90 mL water = 120 mL of the $\frac{1}{4}$ strength Enfamil; one *3-oz* bottle. Discard 2 oz (60 mL).

23) 270 mL Sustacal + 90 mL water = 360 mL of the $\frac{3}{4}$ strength Sustacal; one *10-oz* can. Discard 1 oz (30 mL).

24) 300 mL Ensure + 150 mL water = 450 mL of the $\frac{2}{3}$ strength Ensure; two *8-oz* cans. Discard 6 oz (180 mL).

25) 36 oz Enfamil + 60 oz water = 96 oz of the $\frac{3}{8}$ strength Enfamil; six *6-oz* bottles. None discarded.

26) 20 mL Ensure + 140 mL water = 160 mL of the $\frac{1}{8}$ strength Ensure; one *4-oz* can. Discard 100 mL.

27) 275 mL Ensure + 275 mL water = 550 mL of the $\frac{1}{2}$ strength Ensure; one *12-oz* can. Discard 85 mL.

28) 2 cans are needed; $1\frac{1}{2}$ cans are used (*12 oz* Enfamil)

29) 36

30) **Prevention:** This type of error could have been prevented had the nurse read the label carefully for the correct amount of diluent for the dosage of medication to be prepared. Had the nurse read the label carefully before the medication was prepared, medication, valuable time, health care resources, and patient expense charges would have been saved. Additionally, if the nurse had used Step 2 (Think) of the three-step method, the nurse would have realized earlier (before preparing it) that 4 mL would be an unreasonable volume for an IM injection.

Solutions—Practice Problems—Chapter 12

1) Concentration is 3.375 g per 5 mL

Order: 2.5 g

Supply: 3.375 g per 5 mL

$$\frac{3.375 \text{ g}}{5 \text{ mL}} \times \frac{2.5 \text{ g}}{X \text{ mL}}$$

$3.375X = 12.5$

$$\frac{3.375X}{3.375} = \frac{12.5}{3.375}$$

$X = 3.7$ mL

4) Order: 750 mg

Supply: 100 mg/mL

$$\frac{100 \text{ mg}}{1 \text{ mL}} \times \frac{750 \text{ mg}}{X \text{ mL}}$$

$100X = 750$

$$\frac{100X}{100} = \frac{750}{100}$$

$X = 7.5$ mL

Vial has 2 g Rocephin. Order is for 750 mg/dose.

$$\frac{1{,}000 \text{ mg}}{1 \text{ g}} \times \frac{X \text{ mg}}{2 \text{ g}}$$

$X = 2{,}000$ mg/vial

$$\frac{750 \text{ mg}}{1 \text{ dose}} \times \frac{2{,}000 \text{ mg}}{X \text{ doses}}$$

$750X = 2{,}000$

$$\frac{750X}{750} = \frac{2{,}000}{750}$$

$X = 2.6$ doses (per vial or 2 full doses per vial)

6) Order: 375 mg

Supply: 100 mg/mL

$$\frac{100 \text{ mg}}{1 \text{ mL}} \times \frac{375 \text{ mg}}{X \text{ mL}}$$

$100X = 375$

$$\frac{100X}{100} = \frac{375}{100}$$

$X = 3.75$ mL $= 3.8$ mL

$$\frac{375 \text{ mg}}{1 \text{ dose}} \times \frac{500 \text{ mg}}{X \text{ dose}}$$

$375X = 500$

$$\frac{375X}{375} = \frac{500}{375}$$

$X = 1.3$ doses (per vial or 1 full dose per vial)

9) Order: 350 mg

Supply: 280 mg/mL

$$\frac{280 \text{ mg}}{1 \text{ mL}} \times \frac{350 \text{ mg}}{X \text{ mL}}$$

$280X = 350$

$$\frac{280X}{280} = \frac{350}{280}$$

$X = 1.25$ mL $= 1.3$ mL

$$\frac{350 \text{ mg}}{1 \text{ dose}} \times \frac{500 \text{ mg}}{X \text{ dose}}$$

$350X = 500$

$$\frac{350\ X}{350} = \frac{500}{375}$$

$X = 1.3$ doses (per vial or 1 full dose per vial)

14) Order: 1,000,000 units

Supply: 50,000 units/mL

$\frac{50{,}000 \text{ units}}{1 \text{ mL}} \times \frac{1{,}000{,}000 \text{ units}}{X \text{ mL}}$

$50{,}000X = 1{,}000{,}000$

$\frac{50{,}000X}{50{,}000} = \frac{1{,}000{,}000}{50{,}000}$

X = 20 mL (too much for an IM dose)

Order: 1,000,000 units

Supply: 100,000 units/mL

$\frac{100{,}000 \text{ units}}{1 \text{ mL}} \times \frac{1{,}000{,}000 \text{ units}}{X \text{ mL}}$

$100{,}000X = 1{,}000{,}000$

$\frac{100{,}000X}{100{,}000} = \frac{1{,}000{,}000}{100{,}000}$

X = 10 mL (too much for an IM dose)

Order: 1,000,000 units

Supply: 250,000 units/mL

$\frac{250{,}000 \text{ units}}{1 \text{ mL}} \times \frac{1{,}000{,}000 \text{ units}}{X \text{ mL}}$

$250{,}000X = 1{,}000{,}000$

$\frac{250{,}000X}{250{,}000} = \frac{1{,}000{,}000}{250{,}000}$

X = 4 mL (too much for an IM dose − 3 mL or less is preferred)

Order: 1,000,000 units

Supply: 500,000 units/mL

$\frac{500{,}000 \text{ units}}{1 \text{ mL}} \times \frac{1{,}000{,}000 \text{ units}}{X \text{ mL}}$

$500{,}000X = 1{,}000{,}000$

$\frac{500{,}000X}{500{,}000} = \frac{1{,}000{,}000}{500{,}000}$

X = 2 mL (acceptable IM dose)

22) 12 mL every hour for 10 hours = 12 × 10 = 120 mL total:

$\frac{1}{4} \times \frac{X \text{ mL}}{120 \text{ mL}}$

$4X = 120$

$\frac{4X}{4} = \frac{120}{4}$

X = 30 mL (Enfamil)

120 mL (solution) − 30 mL (Enfamil) = 90 mL (water); one 3-oz bottle = 90 mL

90 mL (full bottle) − 30 mL (Enfamil needed) = 60 mL (1 oz = 30 mL; 2 oz = 60 mL; therefore, 2 oz discarded)

28) $\frac{1}{4} \times \frac{X \text{ oz}}{48 \text{ oz}}$

$4X = 48$

$\frac{4X}{4} = \frac{48}{4}$

X = 12 oz (Enfamil)

$\frac{1 \text{ can}}{8 \text{ oz}} \times \frac{X \text{ cans}}{12 \text{ oz}}$

$8X = 12$

$\frac{8X}{8} = \frac{12}{8}$

$X = 1\frac{1}{2}$ cans

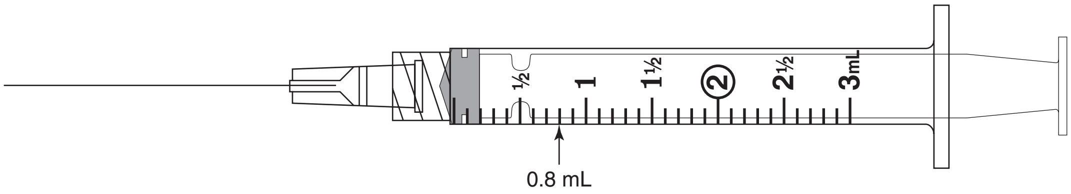
Need $1\frac{1}{2}$ cans (8 oz/can) of Enfamil for each infant.

29) 48 oz solution − 12 oz (Enfamil) = 36 oz (water)

Review Set 30 from pages 296-302

1) 25; 312.5; 78.1; 625; 156.3; Yes **2)** 10 **3)** 2.2; 110; 55; Yes **4)** 0.55 **5)** 15; 120; Yes **6)** 6; 8 **7)** 32; 320; 480; Yes **8)** 15 **9)** 20; 500; 125; 1,000; 250; Yes **10)** 5 **11)** 5; 7.5; 9.5; Yes

12) 0.8

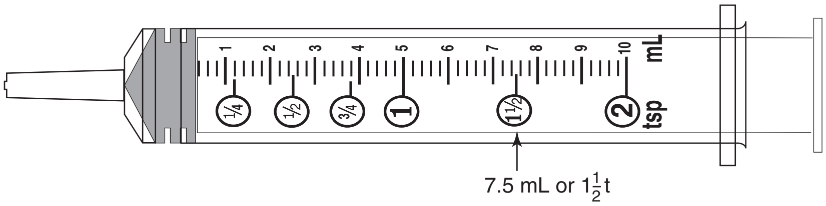


13) 3.4; 51; 17; No

14) The dosage of Kantrex 34 mg IV q.8h is higher than the recommended dosage. Therefore, the ordered dosage is not safe. The prescribing practitioner should be called and the order questioned.

15) 120; 60; 7.5; Yes

16) 7.5; $1\frac{1}{2}$

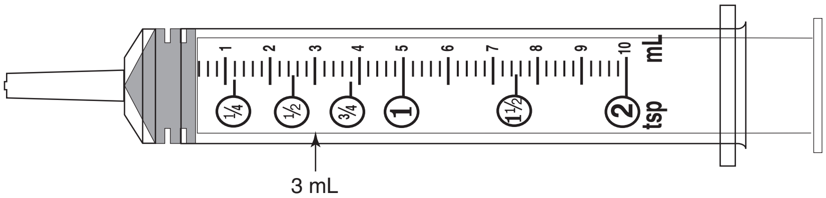


17) 1.8; 4.5; No

18) The ordered dosage is too high and ordered to be given too frequently. The recommended dosage is 4.5 mg q.8h. The ordered dosage is 40 mg q.8h. The prescribing practitioner should be notified and the order questioned.

19) 31.8; 0.22; 0.11; 0.32; 0.16; Yes

20) 3



21) 17.7; 354; 118; 708; 236; No

22) The dosage ordered of 100 mg q.8h does not fall within the recommended dosage range of 118–236 mg/dose. It is an underdosage and would not produce a therapeutic effect. The physician should be called for clarification.

23) 25; 375; 125; 625; 208.3; No

24) The ordered dosage of 100 mg q.8h does not fall within the recommended dosage range of 125–208.3 mg q.8h. It is an underdosage and the physician should be called for clarification.

25) No, the ordered dosage is not safe. The label states a maximum of 250 mg per single daily injection for children over 8 years of age. This child is only 7 and the order exceeds the maximum recommended dosage. The physician should be called to clarify the order.

26) 200–300 mg/kg/day by IV infusion in divided doses every 4 or 6 hours.

27) 150–200 mg/kg/day by IV infusion in divided doses every 4 or 6 hours.

28) 8.9; 11.8

29) 1.5; 2

30) 2.2; 3

Solutions—Review Set 30

1) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{55\text{ lb}}$

$2.2X = 55$

$\frac{2.2X}{2.2} = \frac{55}{2.2}$

$X = 25\text{ kg}$

Minimum daily dose: 12.5 mg/$\cancel{\text{kg}}$/day × 25 $\cancel{\text{kg}}$ = 312.5 mg/day, or:

$\frac{1\text{ kg}}{12.5\text{ mg}} \times \frac{25\text{ kg}}{X\text{ mg}}$

$X = 312.5\text{ mg/day}$

312.5 mg ÷ 4 doses = 78.1 mg/dose

Maximum daily dose:

25 mg/$\cancel{\text{kg}}$/day × 25 $\cancel{\text{kg}}$ = 625 mg/day or

$\frac{1\text{ kg}}{25\text{ mg}} \times \frac{25\text{ kg}}{X\text{ mg}}$

$X = 625\text{ mg/day}$

625 mg ÷ 4 doses = 156.3 mg/dose

Yes, dosage is safe.

2) $\frac{62.5\text{ mg}}{5\text{ mL}} \times \frac{125\text{ mg}}{X\text{ mL}}$

$62.5X = 625$

$\frac{62.5X}{62.5} = \frac{625}{62.5}$

$X = 10\text{ mL}$

3) $\frac{1\text{ kg}}{1{,}000\text{ g}} \times \frac{X\text{ kg}}{2{,}200\text{ g}}$

$1{,}000X = 2{,}200$

$\frac{1{,}000X}{1{,}000} = \frac{2{,}200}{1{,}000}$

$X = 2.2$ kg

Dose: 50 mg/$\cancel{\text{kg}}$/day × 2.2 $\cancel{\text{kg}}$ = 110 mg/day, or:

$\frac{1\text{ kg}}{50\text{ mg}} \times \frac{2.2\text{ kg}}{X\text{ mg}}$

$X = 110$ mg (per day)

110 mg ÷ 2 doses = 55 mg dose

Yes, dosage is safe.

4) $\frac{1{,}000\text{ mg}}{10\text{ mL}} \times \frac{55\text{ mg}}{X\text{ mL}}$

$1{,}000X = 550$

$\frac{1{,}000X}{1{,}000} = \frac{550}{1{,}000}$

$X = 0.55$ mL

6) $\frac{100\text{ mg}}{5\text{ mL}} \times \frac{120\text{ mg}}{X\text{ mL}}$

$100X = 600$

$\frac{100X}{100} = \frac{600}{100}$

$X = 6$ mL

50 $\cancel{\text{mL}}$ ÷ 6 $\cancel{\text{mL}}$ dose = 8.3 doses or 8 full doses

7) Minimum dose: 10 mg/$\cancel{\text{kg}}$/dose × 32 $\cancel{\text{kg}}$ =

320 mg/dose, or:

$\frac{1\text{ kg}}{10\text{ mg}} \times \frac{32\text{ kg}}{X\text{ mg}}$

$X = 320$ mg (per dose)

Maximum dose:

15 mg/$\cancel{\text{kg}}$/dose × 32 $\cancel{\text{kg}}$ = 480 mg/dose, or:

$\frac{1\text{ kg}}{15\text{ mg}} \times \frac{32\text{ kg}}{X\text{ mg}}$

$X = 480$ mg (per dose)

Dosage is the *maximum* dosage (480 mg) and is safe.

8) $\frac{160\text{ mg}}{5\text{ mL}} \times \frac{480\text{ mg}}{X\text{ mL}}$

$160X = 2{,}400$

$\frac{160X}{160} = \frac{2{,}400}{160}$

$X = 15$ mL

13) $\frac{1\text{ lb}}{16\text{ oz}} \times \frac{X\text{ lb}}{8\text{ oz}}$

$16X = 8$

$\frac{16X}{16} = \frac{8}{16}$

$X = \frac{1}{2}$ lb

7 lb 8 oz = $7\frac{1}{2}$ lb

$\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{7.5\text{ lb}}$

$2.2X = 7.5$

$\frac{2.2X}{2.2} = \frac{7.5}{2.2}$

$X = 3.4$ kg

15 mg/$\cancel{\text{kg}}$/day × 3.4 $\cancel{\text{kg}}$ = 51 mg/day, or:

$\frac{1\text{ kg}}{15\text{ mg}} \times \frac{3.4\text{ kg}}{X\text{ mg}}$

$X = 51$ mg (per day)

51 mg ÷ 3 doses = 17 mg/dose, if administered q.8h

Ordered dosage of 34 mg q.8h exceeds

recommended dosage and is not safe.

19) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{70\text{ lb}}$

$2.2X = 70$

$\frac{2.2X}{2.2} = \frac{70}{2.2}$

$X = 31.8$ kg

Minimum daily dosage:

7 mcg/$\cancel{\text{kg}}$/day × 31.8 $\cancel{\text{kg}}$ = 222.6 mcg/day, or:

$\frac{1\text{ kg}}{7\text{ mcg}} \times \frac{31.8\text{ kg}}{X\text{ mcg}}$

$X = 222.6$ mcg/day

$\frac{1\text{ mcg}}{1{,}000\text{ mcg}} \times \frac{X\text{ mg}}{222.6\text{ mcg}}$

$1{,}000X = 222.6$

$\frac{1{,}000X}{1{,}000} = \frac{222.6}{1{,}000}$

$X = 0.2226$ mg (per day or 0.22 mg/day)

Minimum single dosage: 0.22 mg ÷ 2 doses = 0.11 mg/dose

Maximum daily dosage:

10 mcg/$\cancel{\text{kg}}$/day × 31.8 $\cancel{\text{kg}}$ = 318 mcg/day, or:

$\frac{1\text{ kg}}{10\text{ mcg}} \times \frac{31.8\text{ kg}}{X\text{ mcg}}$

$X = 318$ mcg (per day)

$\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{X\text{ mg}}{318\text{ mcg}}$

$1{,}000X = 318$

$\frac{1{,}000X}{1{,}000} = \frac{318}{1{,}000}$

$X = 0.318$ mg (per day or 0.32 mg/day)

Maximum single dosage:

0.32 mg ÷ 2 doses = 0.16 mg/dose

Yes, ordered dosage is safe.

21) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{39\text{ lb}}$

$2.2X = 39$

$\frac{2.2X}{2.2} = \frac{39}{2.2}$

$X = 17.7\text{ kg}$

Minimum daily dosage:

$20\text{ mg}/\cancel{\text{kg}}/\text{day} \times 17.7\ \cancel{\text{kg}} = 354\text{ mg/day}$, or:

$\frac{1\text{ kg}}{20\text{ mg}} \times \frac{17.7\text{ kg}}{X\text{ mg}}$

$X = 354\text{ mg}$ (per day)

Minimum single dosage: 354 mg ÷ 3 doses = 118 mg/dose

Maximum daily dosage:

$40\text{ mg}/\cancel{\text{kg}}/\text{day} \times 17.7\ \cancel{\text{kg}} = 708\text{ mg/day}$, or:

$\frac{1\text{ kg}}{40\text{ mg}} \times \frac{17.7\text{ kg}}{X\text{ mg}}$

$X = 708\text{ mg}$ (per day)

Maximum single dosage:

708 mg ÷ 3 doses = 236 mg/dose

The dosage of 100 mg q.8h is not safe. It is an underdosage, and would not produce a therapeutic effect, as the recommended dosage range is 118–236 mg/dose.

28) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{130\text{ lb}}$

$2.2X = 130$

$\frac{2.2X}{2.2} = \frac{130}{2.2}$

$X = 59.1\text{ kg}$

$150\text{ mg}/\cancel{\text{kg}}/\text{day} \times 59.1\ \cancel{\text{kg}} = 8{,}865\text{ mg/day}$, or:

$\frac{1\text{ kg}}{150\text{ mg}} \times \frac{59.1\text{ kg}}{X\text{ mg}}$

$X = 8{,}865\text{ mg}$ (per day)

Convert mg to g:

$\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{X\text{ g}}{8{,}865\text{ mg}}$

$1{,}000X = 8{,}865$

$\frac{1{,}000X}{1{,}000} = \frac{8{,}865}{1{,}000}$

$X = 8.865\text{ g} = 8.9\text{ g}$ (per day)

$200\text{ mg}/\cancel{\text{kg}}/\text{day} \times 59.1\ \cancel{\text{kg}} = 11{,}820\text{ mg/day}$, or:

$\frac{1\text{ kg}}{200\text{ mg}} \times \frac{59.1\text{ kg}}{X\text{ mg}}$

$X = 11{,}820\text{ mg}$ (per day)

Convert mg to g: 11,820 mg/day =

$\frac{1\text{ g}}{1{,}000\text{ mg}} \times \frac{X\text{ g}}{11{,}820\text{ mg}}$

$1{,}000X = 11{,}820$

$\frac{1{,}000X}{1{,}000} = \frac{11{,}820}{1{,}000}$

$X = 11.8\text{ g/day}$

29) 8.9 g ÷ 6 doses = 1.5 g/dose

11.8 g ÷ 6 doses = 2 g/dose

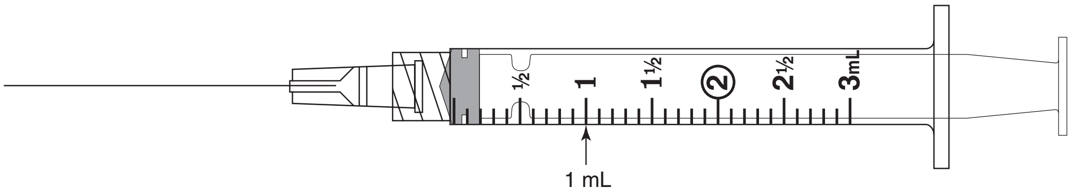
30) 8.9 g ÷ 4 doses = 2.2 g/dose

11.8 g ÷ 4 doses = 3 g/dose

Practice Problems—Chapter 13 from pages 303-313

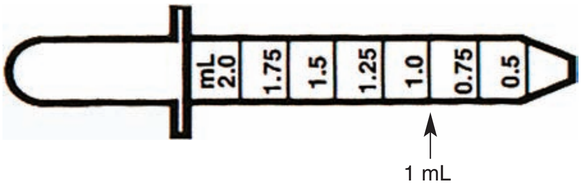
1) 5.5 **2)** 3.8 **3)** 1.6 **4)** 2.3 **5)** 15.5 **6)** 3 **7)** 23.6 **8)** 0.9 **9)** 240 **10)** 80 **11)** 19.5; 39; 48.8; Yes

12) 1



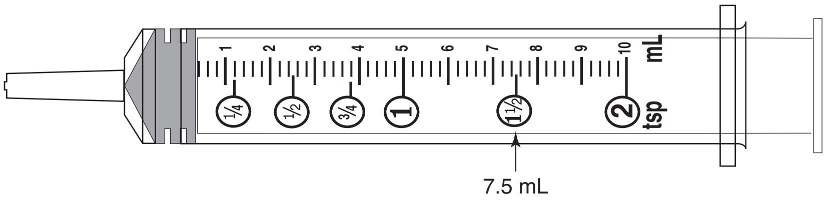
13) 7.3; 3.7; 14.6; Yes

14) 1



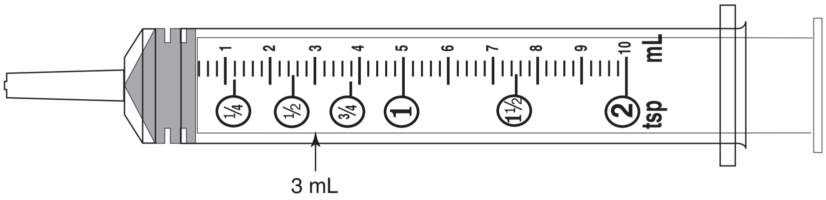
15) 18.2; 182; 91; 364; 182; Yes

16) 7.5



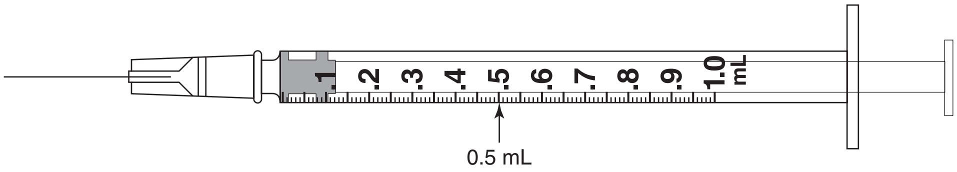
17) 29.1; 291; 145.5; 436.5; 218.3; Yes

18) 3



19) 2.5; 125,000; 125,000; Yes

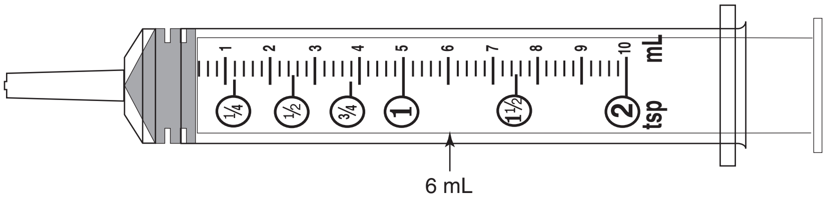
20) 18; 20; 250,000; 0.5



Route is IM; needle may need to be changed to appropriate gauge and length.

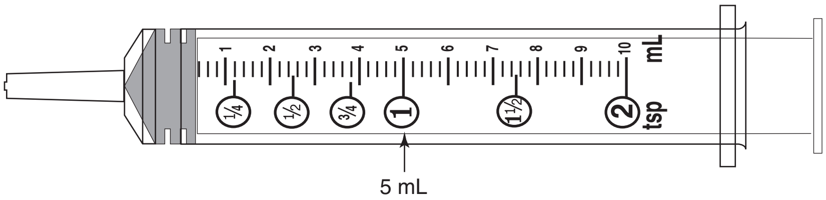
21) 18.6; 372; 124; 744; 248; Yes

22) 6



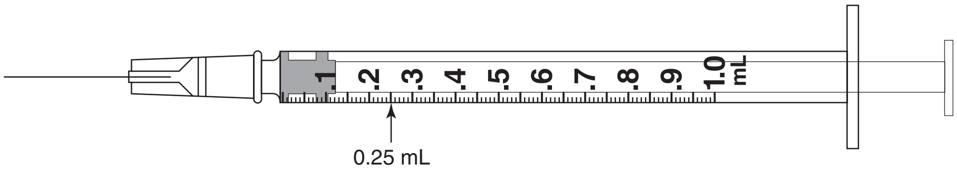
23) 9.3; 372; 186; Yes, the ordered dosage is reasonably safe.

24) 5



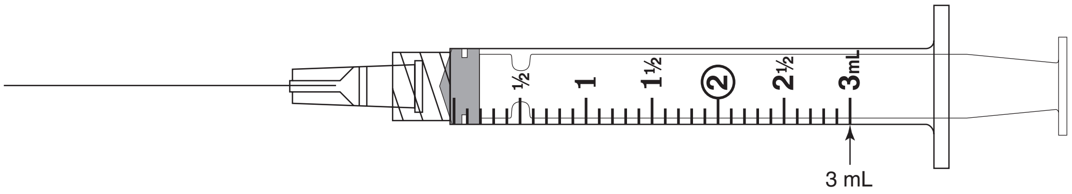
25) 10; 0.1; Yes

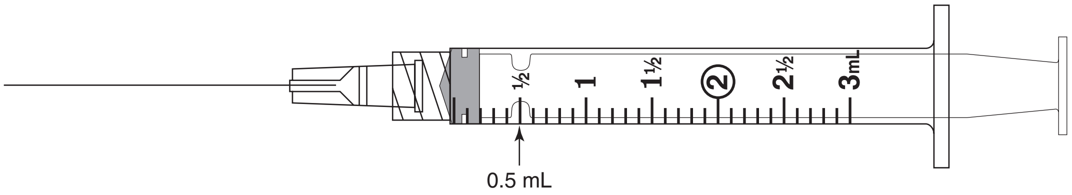
26) 0.25



27) 28; 35; Yes

28) 3.5



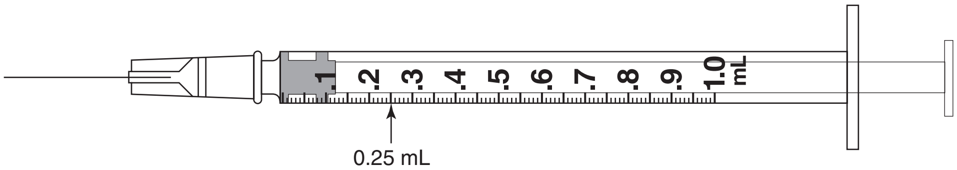


29) 9.1; 455; 227.5; 682.5; 341.3; No

30) The ordered dosage of 1 g is not safe. The recommended dosage range for a child of this weight is 227.5–341.3 mg/dose. Physician should be called for clarification.

31) 25.1; 0.05; Yes

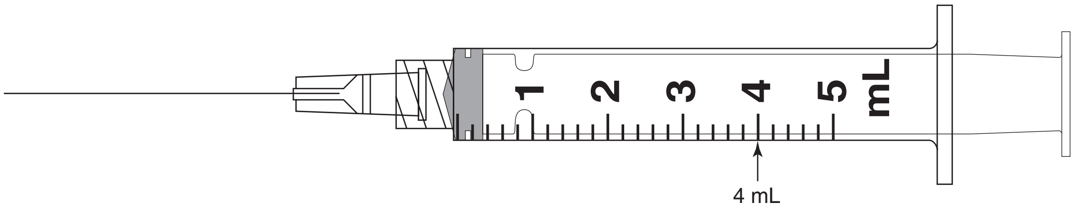
32) 0.25



Route is IM; may need to change needle to appropriate gauge and length.

33) 8.2; 1,200; 1.2; 246; 410; Yes

34) 5; 5; 100; 4



35) 20.5; 512.5; 256.3; No

36) The dosage ordered is not safe. It is too low compared to the recommended dosage. Call the prescriber and clarify the order.

37) 8.2; 164; 54.7; No

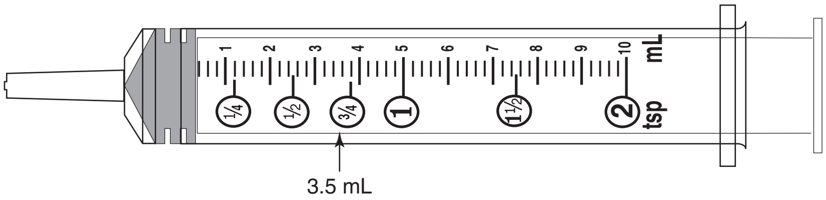
38) Dosage ordered is not safe. Call prescriber for clarification, as ordered dosage is higher than the recommended dosage.

39) 20.5; 200; 400; No

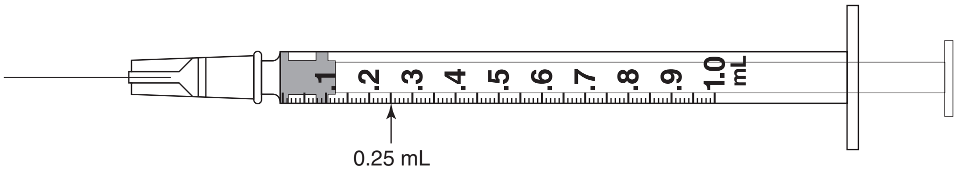
40) Dosage ordered is not safe based on recommended maximum daily dosage and on the frequency of the order. Call prescriber for clarification.

41) 23.2; 348; 174; Yes, dosage is reasonably safe.

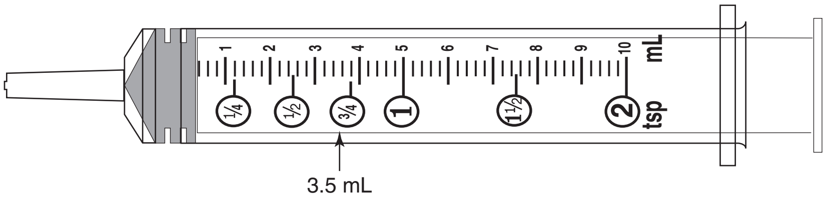
42) 3.5



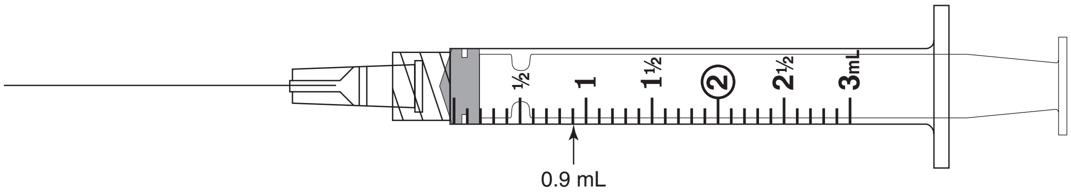
43) 0.25



44) 3.5



45) 500,000; 0.9

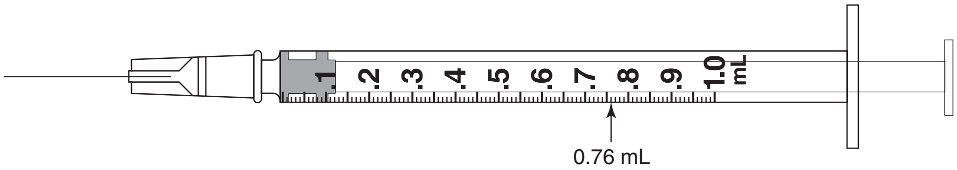


Needle may need to be changed to appropriate gauge and length for this small child.

46) Dosage is not safe; this child is ordered a total of 2 mg/day, which is too high. Prescriber should be called to clarify.

47) The ordered dosage of 20 mg q.4h p.r.n. is too high when compared to the recommended dosage range for a child of this weight. The order should be clarified with the prescriber.

48) 0.76



Route is IM; needle may need to be changed to appropriate gauge and length.

49) #45 (penicillin G potassium) and #48 (Kefzol). (Note: #43 Solu-Medrol is a single-dose vial. Check package insert to determine if storage after mixing is safe.)

50) **Prevention:** The child should have received 75 mg a day and no more than 25 mg per dose. The child received more than four times the safe dosage of tobramycin. Had the nurse calculated the safe dosage, the error would have been caught sooner, the resident consulted, and the dosage could have been adjusted before the child ever received the first dose. The pharmacist also should have caught the error but did not. In this scenario the resident, pharmacist, and nurse all committed medication errors. If the resident had not noticed the error, one can only wonder how many doses the child would have received. The nurse is the last safety net for the child when it comes to a dosage error, because the nurse administers the drug.

In addition, the nurse has to reconcile the fact that she actually gave the overdose. The nurse is responsible for whatever dosage is administered and must verify the safety of the order and the patient's Six Rights. We are all accountable for our actions. Taking shortcuts in administering medications to children can be disastrous. The time the nurse saved by not calculating the safe dosage was more than lost in the extra monitoring, not to mention the cost of follow-up to the medication error, and *most importantly*, the risk to the child.

Solutions—Practice Problems—Chapter 13

1) $$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{12 \text{ lb}}$$

$2.2X = 12$

$$\frac{2.2X}{2.2} = \frac{12}{2.2}$$

$X = 5.5$ kg

2) $8 \text{ lb } 4 \text{ oz} = 8\frac{4}{16} \text{ lb} = 8\frac{1}{4} \text{ lb} = 8.25 \text{ lb}$

$$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{8.25 \text{ lb}}$$

$2.2X = 8.25$

$$\frac{2.2X}{2.2} = \frac{8.25}{2.2}$$

$X = 3.8$ kg

3) $$\frac{1 \text{ kg}}{1{,}000 \text{ g}} \times \frac{X \text{ kg}}{1{,}570 \text{ g}}$$

$1{,}000X = 1{,}570$

$$\frac{1{,}000X}{1{,}000} = \frac{1{,}570}{1{,}000}$$

$X = 1.57$ kg $= 1.6$ kg

6) 1 lb = 16 oz

$$\frac{1 \text{ lb}}{16 \text{ oz}} \times \frac{X \text{ lb}}{10 \text{ oz}}$$

$16X = 10$

$$\frac{16X}{16} = \frac{10}{16}$$

$X = 0.625$ lb

6 lb 10 oz = 6.625 lb

$$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{6.625 \text{ lb}}$$

$2.2X = 6.625$

$$\frac{2.2X}{2.2} = \frac{6.625}{2.2}$$

$X = 3.01$ kg $= 3$ kg

17) $$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{64 \text{ lb}}$$

$2.2 X = 64$

$$\frac{2.2X}{2.2} = \frac{64}{2.2}$$

$X = 29.1$ kg

Minimum daily dosage:

$10 \text{ mg}/\cancel{\text{kg}}/\text{day} \times 29.1 \cancel{\text{kg}} = 291 \text{ mg/day}$, or:

$$\frac{1 \text{ kg}}{10 \text{ mg}} \times \frac{29.1 \text{ kg}}{X \text{ mg}}$$

$X = 291$ mg (per day)

Minimum single dose (based on b.i.d.)

291 mg per 2 doses = 145.5 mg/dose

Maximum daily dosage:

$15 \text{ mg}/\cancel{\text{kg}}/\text{day} \times 29.1 \cancel{\text{kg}} = 436.5 \text{ mg/day}$, or:

$$\frac{1 \text{ kg}}{15 \text{ mg}} \times \frac{29.1 \text{ kg}}{X \text{ mg}}$$

$X = 436.5$ mg (per day)

Maximum single dose (based on b.i.d.)

436.5 mg ÷ 2 doses = 218.25 = 218.3 mg/dose

Dosage ordered is safe. Child will receive 300 mg in a 24-hour period in divided doses of 150 mg b.i.d. This falls within the recommended dosage range of 145.5–218.3 mg/dose and does not exceed the maximum recommended single-dosage allowance of 250 mg/dose.

18) $$\frac{250 \text{ mg}}{5 \text{ mL}} \times \frac{150 \text{ mg}}{X \text{ mL}}$$

$250X = 750$

$$\frac{250X}{250} = \frac{750}{250}$$

$X = 3$ mL

19) $$\frac{1 \text{ kg}}{1{,}000 \text{ g}} \times \frac{X \text{ kg}}{2{,}500 \text{ g}}$$

$1{,}000X = 2{,}500$

$$\frac{1{,}000X}{1{,}000} = \frac{2{,}500}{1{,}000}$$

$X = 2.5$ kg

Recommended daily dosage:

$50{,}000 \text{ units}/\cancel{\text{kg}}/\text{day} \times 2.5 \cancel{\text{kg}} = 125{,}000 \text{ units/day}$, or:

$$\frac{1 \text{ kg}}{50{,}000 \text{ units}} \times \frac{2.5 \text{ kg}}{X \text{ units}}$$

$X = 50{,}000 \times 2.5$

$X = 125{,}000$ units (per day)

Recommended daily and single dosage:

125,000 units/dose

Ordered dose is safe

20) Select 250,000 units/mL concentration because the amount to give will be an exact measurement in the 1 mL syringe.

Solution volume:

$$\frac{1 \text{ mL}}{250{,}000 \text{ units}} \times \frac{X \text{ mL}}{5{,}000{,}000 \text{ units}}$$

$250{,}000X = 5{,}000{,}000$

$$\frac{250{,}000X}{250{,}000} = \frac{5{,}000{,}000}{250{,}000}$$

$X = 20$ mL

$$\frac{250{,}000 \text{ units}}{1 \text{ mL}} \times \frac{125{,}000 \text{ units}}{X \text{ mL}}$$

$250{,}000X = 125{,}000$

$$\frac{250{,}000X}{250{,}000} = \frac{125{,}000}{250{,}000}$$

$X = 0.5$ mL

23) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{20.5\text{ lb}}$

$2.2X = 20.5$

$\frac{2.2X}{2.2} = \frac{20.5}{2.2}$

$X = 9.3\text{ kg}$

Recommended daily dosage:

$40\text{ mg/}\cancel{\text{kg}}\text{/day} \times 9.3\ \cancel{\text{kg}} = 372\text{ mg/day}$, or:

$\frac{1\text{ kg}}{40\text{ mg}} \times \frac{9.3\text{ kg}}{X\text{ mg}}$

$X = 372\text{ mg}$ (per day)

Recommended single dosage:

$372\text{ mg} \div 2\text{ doses} = 186\text{ mg/dose}$

The ordered dosage of 187 mg p.o. is reasonably safe for this child.

24) Order: 187 mg

Supply: 187 mg per 5 mL

Think: It is obvious that you want to give 5 mL.

$\frac{187\text{ mg}}{5\text{ mL}} \times \frac{187\text{ mg}}{X\text{ mL}}$

$187X = 935$

$\frac{187X}{187} = \frac{935}{187}$

$X = 5\text{ mL}$

If we use the recommended single dosage of 186 mg/dose, the calculation would be:

$\frac{187\text{ mg}}{5\text{ mL}} \times \frac{186\text{ mg}}{X\text{ mL}}$

$187X = 190$

$\frac{187X}{187} = \frac{930}{187}$

$X = 4.97\text{ mL}$; which we would round up to 5 mL to measure in the pediatric oral syringe; therefore, as stated above, the ordered dosage is reasonably safe.

25) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{22\text{ lb}}$

$2.2X = 22$

$\frac{2.2X}{2.2} = \frac{22}{2.2}$

$X = 10\text{ kg}$

$0.01\text{ mg/}\cancel{\text{kg}}\text{/dose} \times 10\ \cancel{\text{kg}} = 0.1\text{ mg/dose}$, or:

$\frac{1\text{ kg}}{10\text{ mg}} \times \frac{0.01\text{ kg}}{X\text{ mg}}$

$X = 0.1\text{ mg/dose}$

$\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{0.1\text{ mg}}{X\text{ mcg}}$

$X = 100\text{ mcg}$

Ordered dose is safe

29) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{20\text{ lb}}$

$2.2\ X = 20$

$\frac{2.2X}{2.2} = \frac{20}{2.2}$

$X = 9.1\text{ kg}$

Recommended minimum daily dosage:

$50\text{ mg/}\cancel{\text{kg}}\text{/day} \times 9.1\ \cancel{\text{kg}} = 455\text{ mg/day}$, or:

$\frac{1\text{ kg}}{50\text{ mg}} \times \frac{9.1\text{ kg}}{X\text{ mg}}$

$X = 455\text{ mg}$ (per day)

Recommended minimum single dosage:

$455\text{ mg} \div 2\text{ doses} = 227.5\text{ mg/dose}$

Recommended maximum daily dosage:

$75\text{ mg/}\cancel{\text{kg}}\text{/day} \times 9.1\ \cancel{\text{kg}} = 682.5\text{ mg/day}$, or:

$\frac{1\text{ kg}}{75\text{ mg}} \times \frac{9.1\text{ kg}}{X\text{ mg}}$

$X = 682.5\text{ mg/day}$

Maximum single dosage:

$682.5\text{ mg} \div 2\text{ doses} = 341.3\text{ mg/dose}$

The dosage ordered (1 g q.12 h) is not safe. The recommended range for a child of this weight is 227.5–341.3 mg/dose. Physician should be called for clarification.

41) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{51\text{ lb}}$

$2.2X = 51$

$\frac{2.2X}{2.2} = \frac{51}{2.2}$

$X = 23.2\text{ kg}$

Recommended daily dosage:

$15\text{ mg/}\cancel{\text{kg}}\text{/day} \times 23.2\ \cancel{\text{kg}} = 348\text{ mg/day}$, or:

$\frac{1\text{ kg}}{15\text{ mg}} \times \frac{23.2\text{ kg}}{X\text{ mg}}$

$X = 348\text{ mg}$ (per day)

Recommended single dosage:

$348\text{ mg} \div 2\text{ doses} = 174\text{ mg/dose}$

Ordered dosage of 175 mg is reasonably safe as an oral medication and should be given.

43) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{95\text{ lb}}$

$2.2X = 95$

$\frac{2.2X}{2.2} = \frac{95}{2.2}$

$X = 43.2\text{ kg}$

$0.5\text{ mg/}\cancel{\text{kg}}\text{/day} \times 43.2\ \cancel{\text{kg}} = 21.6\text{ mg/day}$, or:

$\frac{1\text{ kg}}{0.5\text{ mg}} \times \frac{43.2\text{ kg}}{X\text{ mg}}$

$X = 21.6\text{ mg}$ (per day)

Because the recommended dosage is not less than 21.6 mg/day and the order is for 10 mg q.6h for a total of 40 mg/day, the order is safe.

$$\frac{40\text{ mg}}{1\text{ mL}} \times \frac{10\text{ mg}}{X\text{ mL}}$$

$$40X = 10$$

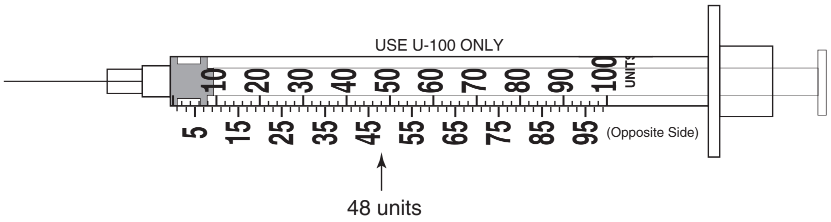
$$\frac{40X}{40} = \frac{10}{40}$$

$$X = 0.25\text{ mL}$$

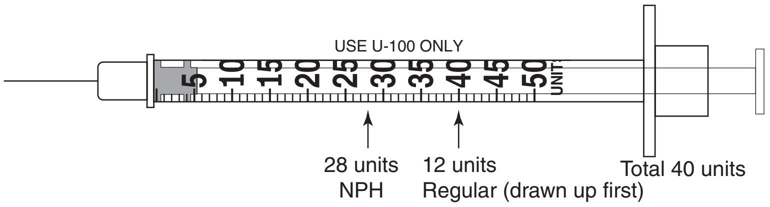
Section 3—Self-Evaluation from pages •••–•••

1) C; 2 **2)** F; 1 **3)** J; 1 **4)** B; 7.5 **5)** H; 12 **6)** I; 2 **7)** E; 2 **8)** K; $\frac{1}{2}$ **9)** M; 1.25 **10)** L; 7.5 **11)** E; 4; 2 **12)** C; 3.5 **13)** G; 0.2 **14)** A; 0.8 **15)** D; 1.5 **16)** F; 0.75 **17)** B; 0.6 **18)** H; 0.75

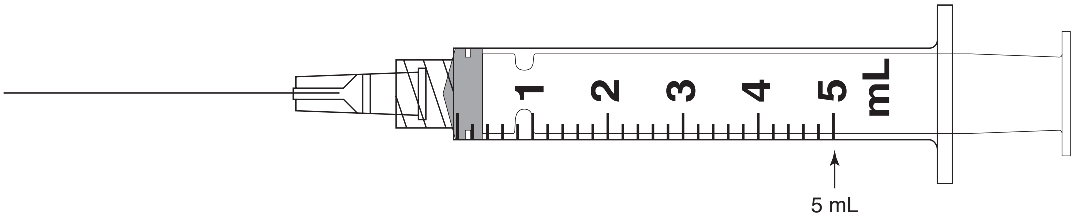
19)



20)

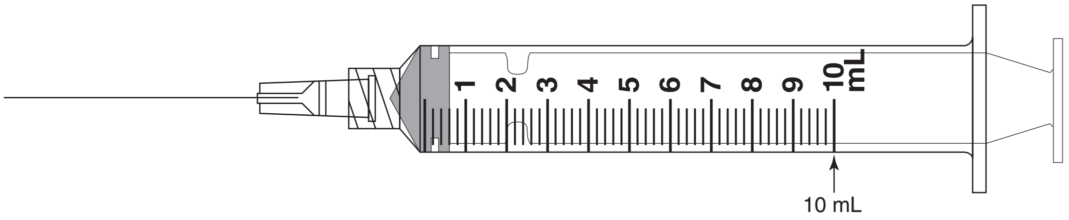


21) 4.8; 5; 100; 5



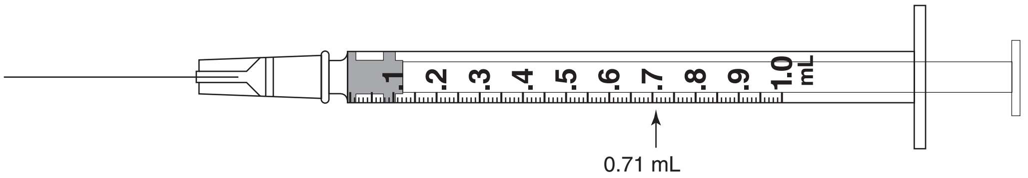
22) 20; 20; 1/20; 10

2/6/xx, 0800, reconstituted as
1 g per 20 mL. Expires 2/20/xx, 0800.
Keep refrigerated. G.D.P.

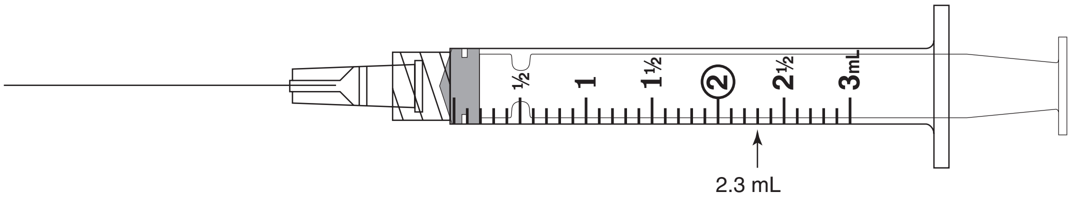


23) 1.5; 1.8; 280; 0.71 (May need to change needles as this is an IM dose.)

2/6/xx, 0800, reconstituted as
280 mg/mL. Expires 2/13/xx, 0800. Keep
refrigerated. G.D.P.

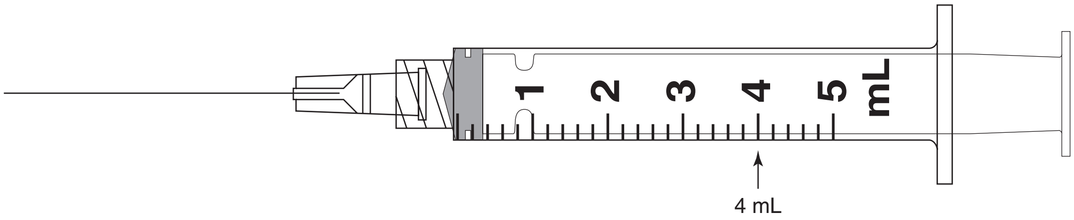


24) 2.5; 3; 330; 2.3



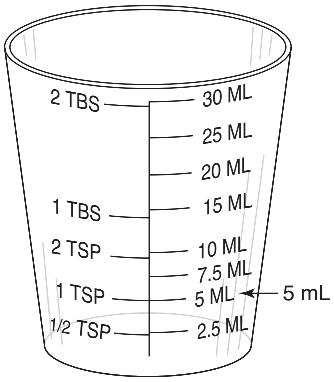
25) 8; 8; 62.5; 4

2/6/xx, 0800, reconstituted as
62.5 mg/mL. Expires 2/8/xx, 0800. Keep
at controlled room temperature 20–25°C
(66-77°F). G.D.P.



26) 29; 50; 100/5; 20; 25

2/6/xx, 0800, reconstituted as
100 mg per 5 mL. Expires 2/20/xx, 0800.
Keep refrigerated. G.D.P.

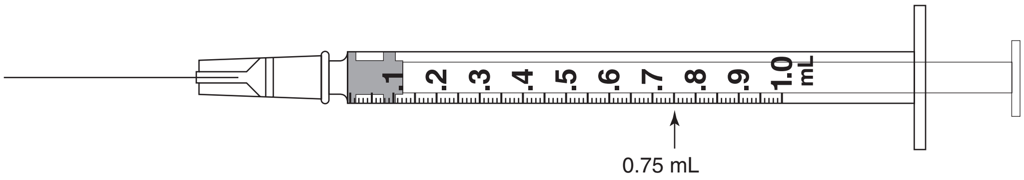


27) 10 doses are available.

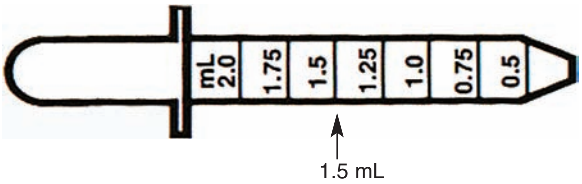
28) No; the medication supplied will be used up before it expires. It is good for 14 days under refrigeration. The medication is to be given every 12 hours; therefore 10 doses will be administered in 5 days.

29) 120; 240 **30)** 180; 60 **31)** 120 **32)** 1 **33)** 3 **34)** 540 **35)** 0.8 **36)** 7 **37)** 0.3 **38)** 1.5 **39)** 0.6 **40)** 7 **41)** 2 **42)** 1 **43)** 3 **44)** 3.8

45) 0.75



46) 12; 15; 50; 1.5



47) Order of 100 mg t.i.d. is too high and the maximum recommended dosage is 100 mg/day for this child. The order is not safe. Physician should be called for clarification.

48) Order is too high and the maximum recommended dosage for this child is 292 mg/day. This order would deliver 748 mg/day. Recommended dosage is also twice daily and this order is for 4 times/day. This order is not safe. Physician should be called for clarification.

49 **a)** Order is too high and is not safe. Recommended dosage is 36.5 mg/dose, or 109.5 mg/day. Physician should be called for clarification.

49 **b)** 500

50) **Prevention:** This type of calculation error occurred because the nurse set up the proportion incorrectly. In this instance the nurse mixed up the units with mg *and* mL in the numerators, and mg *and* mL in the denominators. The **mg** unit should be in both numerators of the proportion, and the **mL** unit in both denominators.

$$\frac{125 \text{ mg}}{5 \text{ mL}} \times \frac{50 \text{ mg}}{X \text{ mL}}$$

$$125X = 250$$

$$\frac{125X}{125} = \frac{250}{125}$$

$$X = 2 \text{ mL}$$

In addition, **think first**. Then use ratio and proportion to calculate the dosage.

Solutions—Section 3—Self-Evaluation

5) $\frac{20 \text{ mEq}}{15 \text{ mL}} \times \frac{16 \text{ mEq}}{X \text{ mL}}$

$20X = 240$

$\frac{20X}{20} = \frac{240}{20}$

$X = 12 \text{ mL}$

7) $\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{0.05 \text{ mg}}{X \text{ mcg}}$

$X = 1{,}000 \times 0.05$

$X = 50 \text{ mcg}$

$\frac{25 \text{ mcg}}{1 \text{ tab}} \times \frac{50 \text{ mcg}}{X \text{ tab}}$

$25X = 50$

$\frac{25X}{25} = \frac{50}{25}$

$X = 2$ tabs

Label N (Synthroid 100 mcg) not selected because it is best to give whole tablets when possible rather than trying to split a tablet in half.

8) Order: gr $\frac{1}{4}$

$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{4}}{X \text{ mg}}$

$X = 15$ mg

Supply: 30 mg/tab

$\frac{30 \text{ mg}}{1 \text{ tab}} \times \frac{15 \text{ mg}}{X \text{ tab}}$

$30X = 15$

$\frac{30X}{30} = \frac{15}{30}$

$X = \frac{1}{2}$ tab

9) Order: 12.5 mg

Supply: 10 mg/mL

$\frac{10 \text{ mg}}{1 \text{ mL}} \times \frac{12.5 \text{ mg}}{X \text{ mL}}$

$10X = 12.5$

$\frac{10X}{10} = \frac{12.5}{10}$

$X = 1.25$ mL

Answer should be left at 1.25 mL and not rounded as the dropper supplied with the medication will measure 1.25 mL. Notice the picture of the dropper on the label.

13) Order: 200 mcg

Supply: 1 mg/mL = 1,000 mcg/mL

$\frac{1{,}000 \text{ mcg}}{1 \text{ mL}} \times \frac{200 \text{ mcg}}{X \text{ mL}}$

$1{,}000X = 200$

$\frac{1{,}000X}{1{,}000} = \frac{200}{1{,}000}$

$X = 0.2$ mL

17) Order: gr $\frac{1}{10}$

$\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{10}}{X \text{ mg}}$

$X = 6$ mg

Supply: 10 mg/mL

$\frac{10 \text{ mg}}{1 \text{ mL}} \times \frac{6 \text{ mg}}{X \text{ mL}}$

$10X = 6$

$\frac{10X}{10} = \frac{6}{10}$

$X = 0.6$ mL

22) Order: 500 mg

Supply: 1 g per 20 mL = 1,000 mg per 20 mL

$\frac{1{,}000 \text{ mg}}{20 \text{ mL}} \times \frac{500 \text{ mg}}{X \text{ mL}}$

$1{,}000X = 10{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{10{,}000}{1{,}000}$

$X = 10$ mL

1 gram vial contains 1,000 mg

$\frac{500 \text{ mg}}{1 \text{ dose}} \times \frac{1{,}000 \text{ mg}}{X \text{ dose}}$

$500X = 1000$

$\frac{500X}{500} = \frac{1{,}000}{500}$

$X = 2$ doses (available)

25) $\frac{62.5 \text{ mg}}{1 \text{ mL}} \times \frac{250 \text{ mg}}{X \text{ mL}}$

$62.5X = 250$

$\frac{62.5X}{62.5} = \frac{250}{62.5}$

$X = 4$ mL

500 mg vial:

$\frac{250 \text{ mg}}{1 \text{ dose}} \times \frac{500 \text{ mg}}{X \text{ dose}}$

$250X = 500$

$\frac{250X}{250} = \frac{500}{250}$

$X = 2$ doses (available)

29) $\frac{1}{3} \times \frac{X \text{ mL}}{360 \text{ mL}}$

$3X = 360$

$\frac{3X}{3} = \frac{360}{3}$

$X = 120$ mL (hydrogen peroxide)

360 mL (total) − 120 mL (solute) = 240 mL (solvent)

31) $\frac{1 \text{ oz}}{30 \text{ mL}} \times \frac{8 \text{ oz}}{X \text{ mL}}$

$X = 240$ mL

$\frac{2}{3} \times \frac{240 \text{ mL}}{X \text{ mL}}$

$2X = 720$

$\frac{2X}{2} = \frac{720}{2}$

$X = 360$ mL (total quantity)

360 mL (total) − 240 mL (Ensure) = 120 mL (water)

33) 9 infants require 4 oz each; 4 oz × 9 = 36 oz total

$\frac{1}{2} \times \frac{X\text{ oz}}{36\text{ oz}}$

$2X = 36$

$\frac{2X}{2} = \frac{36}{2}$

X = 18 oz (Isomil)

$\frac{8\text{ oz}}{1\text{ can}} \times \frac{18\text{ oz}}{X\text{ can}}$

$8X = 18$

$\frac{8X}{8} = \frac{18}{8}$

$X = 2\frac{1}{4}$ cans (you would need to open 3 cans)

34) 36 oz total solution − 18 oz solute (Isomil) = 18 oz solvent (water)

$\frac{30\text{ mL}}{1\text{ oz}} \times \frac{X\text{ mL}}{18\text{ oz}}$

X = 540 mL (water)

36) Order: 175 mg

Supply: 25 mg/mL

$\frac{25\text{ mg}}{1\text{ mL}} \times \frac{175\text{ mg}}{X\text{ mL}}$

$25X = 175$

$\frac{25X}{25} = \frac{175}{25}$

X = 7 mL

40) Order: 350 mg

Supply: 500 mg per 10 mL

$\frac{500\text{ mg}}{10\text{ mL}} \times \frac{350\text{ mg}}{X\text{ mL}}$

$500X = 3{,}500$

$\frac{500X}{500} = \frac{3{,}500}{500}$

X = 7 mL

41) Order: gr $\frac{1}{100} = \frac{1}{100} \times 60 = 0.6$ mg

Supply: 0.3 mg/tab

$\frac{0.3\text{ mg}}{1\text{ tab}} \times \frac{0.6\text{ mg}}{X\text{ tab}}$

$0.3X = 0.6$

$\frac{0.3X}{0.3} = \frac{0.6}{0.3}$

X = 2 tab

45) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{67\text{ lb}}$

$2.2X = 67$

$\frac{2.2X}{2.2} = \frac{67}{2.2}$

X = 30.5 kg

Minimum recommended dosage:

100 mcg/$\cancel{\text{kg}}$/dose × 30.5 $\cancel{\text{kg}}$ = 3,050 mcg/dose, or:

$\frac{1\text{ kg}}{100\text{ mcg}} \times \frac{30.5\text{ kg}}{X\text{ mcg}}$

X = 100 × 30.5

X = 3,050 mcg/dose

Maximum recommended dosage:

200 mcg/$\cancel{\text{kg}}$/dose × 30.5 $\cancel{\text{kg}}$ = 6,100 mcg/dose, or:

$\frac{1\text{ kg}}{200\text{ mcg}} \times \frac{30.5\text{ kg}}{X\text{ mg}}$

X = 6,100 mcg/dose

Order: gr $\frac{1}{10}$

$\frac{\text{gr }1}{60\text{ mg}} \times \frac{\text{gr }\frac{1}{10}}{X\text{ mg}}$

X = 6 mg

$\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{X\text{ mcg}}{6\text{ mg}}$

X = 6,000 mcg

This dose is safe.

$\frac{8\text{ mg}}{1\text{ mL}} \times \frac{6\text{ mg}}{X\text{ mcg}}$

$8X = 6$

$\frac{8X}{8} = \frac{6}{8}$

X = 0.75 mL

46) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{15\text{ lb}}$

$2.2X = 15$

$\frac{2.2X}{2.2} = \frac{15}{2.2}$

X = 6.8 kg

Minimum daily dosage:

20 mg/$\cancel{\text{kg}}$/day × 6.8 $\cancel{\text{kg}}$ = 136 mg/day, or:

$\frac{1\text{ kg}}{20\text{ mg}} \times \frac{6.8\text{ kg}}{X\text{ mg}}$

X = 136 mg (per day)

Minimum single dosage: 136 mg ÷ 3 doses = 45.3 mg/dose

Maximum daily dosage:

40 mg/$\cancel{\text{kg}}$/day × 6.8 $\cancel{\text{kg}}$ = 272 mg/day, or:

$\frac{1\text{ kg}}{40\text{ mg}} \times \frac{6.8\text{ kg}}{X\text{ mg}}$

X = 272 mg (per day)

Maximum single dosage: 272 mg ÷ 3 doses = 90.7 mg/dose

Dosage ordered is safe.

$\frac{50\text{ mg}}{1\text{ mL}} \times \frac{75\text{ mg}}{X\text{ mL}}$

$50X = 75$

$\frac{50X}{50} = \frac{75}{50}$

$X = 1.5$ mL

47) Recommended dosage:

$5\text{ mg}/\cancel{\text{kg}}/\text{day} \times 20\ \cancel{\text{kg}} = 100\text{ mg/day}$, or:

$\frac{1\text{ kg}}{5\text{ mg}} \times \frac{20\text{ kg}}{X\text{ mg}}$

$X = 100$ mg (per day)

$100\text{ mg} \div 3\text{ doses} = 33.3\text{ mg/dose}$

Order of 100 mg t.i.d. is not safe. It is higher than the recommended dosage of 33.3 mg/dose.

48) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{16\text{ lb}}$

$2.2X = 16$

$\frac{2.2X}{2.2} = \frac{16}{2.2}$

$X = 7.3$ kg

Recommended dosage:

$40\text{ mg}/\cancel{\text{kg}}/\text{day} \times 7.3\ \cancel{\text{kg}} = 292\text{ mg/day}$, or:

$\frac{1\text{ kg}}{40\text{ mg}} \times \frac{7.3\text{ kg}}{X\text{ mg}}$

$X = 292$ mg/day

Ordered dose is not safe. The child would receive 187 mg/dose × 4 doses/day or a total of 748 mg per day, which is over the recommended dosage of 292 mg/day.

49a) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{16\text{ lb}}$

$2.2X = 16$

$\frac{2.2X}{2.2} = \frac{16}{2.2}$

$X = 7.3$ kg

Recommended dosage:

$15\text{ mg}/\cancel{\text{kg}}/\text{day} \times 7.3\ \cancel{\text{kg}} = 109.5\text{ mg/day}$, or:

$\frac{1\text{ kg}}{15\text{ mg}} \times \frac{7.3\text{ kg}}{X\text{ mg}}$

$X = 109.5$ mg/day

$109.5\text{ mg} \div 3\text{ doses} = 36.5\text{ mg/dose}$

Dosage ordered as 60 mg q.8h, which is over the recommended dosage of 35.6 mg/dose. Although the total daily dosage is within limits, the q.8h dosage is too high and is not safe.

49b) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{275\text{ lb}}$

$2.2X = 275$

$\frac{2.2X}{2.2} = \frac{275}{2.2}$

$X = 125$ kg

$15\text{ mg}/\cancel{\text{kg}}/\text{day} \times 125\ \cancel{\text{kg}} = 1{,}875\text{ mg/day}$, or:

$\frac{1\text{ kg}}{15\text{ mg}} \times \frac{125\text{ kg}}{X\text{ mg}}$

$X = 1{,}875$ mg (per day)

Because 1,875 mg/day or 1.9 g/day exceeds the recommended maximum dose of 1.5 g/day, you would expect the order for this adult to be the maximum recommended dosage of 1.5 g/day or 1,500 mg/day. This could be divided into 3 doses of 0.5 mg q.8h or 500 mg q.8h.

Review Set 31 from page 333

1) C; sodium chloride 0.9%, 0.9 g per 100 mL; 308 mOsm/L; isotonic

2) E; dextrose 5%, 5 g per 100 mL; 252 mOsm/L; isotonic

3) G; dextrose 5%, 5 g per 100 mL; sodium chloride 0.9%, 0.9 g per 100 mL; 560 mOsm/L; hypertonic

4) D; dextrose 5%, 5 g per 100 mL, sodium chloride 0.45%, 0.45 g per 100 mL; 406 mOsm/L; hypertonic

5) A; dextrose 5%, 5 g per 100 mL, sodium chloride 0.225%, 0.225 g per 100 mL; 329 mOsm/L; isotonic

6) H; dextrose 5%, 5 g per 100 mL; sodium lactate 0.31 g per 100 mL, NaCl 0.6 g per 100 mL; KCl 0.03 g per 100 mL; CaCl 0.02 g per 100 mL; 525 mOsm/L; hypertonic

7) B; dextrose 5%, 5 g per 100 mL; sodium chloride 0.45%; 0.45 g per 100 mL; potassium chloride 20 mEq per liter (0.149 g per 100 mL); 447 mOsm/L; hypertonic

8) F; sodium chloride 0.45%, 0.45 g per 100 mL; 154 mOsm/L; hypotonic

Review Set 32 from page 337

1) 50; 9 **2)** 25; 2.25 **3)** 25 **4)** 6.75 **5)** 25; 1.125 **6)** 150; 27 **7)** 50; 1.125 **8)** 36; 2.7 **9)** 100; 4.5 **10)** 3.375

Solutions—Review Set 32

1) D_5 NS = 5 g dextrose per 100 mL and 0.9 g NaCl per 100 mL

Dextrose:

$$\frac{5\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{1{,}000\text{ mL}}$$

$$100X = 5{,}000$$

$$\frac{100X}{100} = \frac{5{,}000}{100}$$

$$X = 50\text{ g}$$

NaCl:

$$\frac{0.9\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{1{,}000\text{ mL}}$$

$$100X = 900$$

$$\frac{100X}{100} = \frac{900}{100}$$

$$X = 9\text{ g}$$

7) $D_{10}\frac{1}{4}$NS = 10 g dextrose per 100 mL and 0.225 g NaCl per 100 mL

Dextrose:

$$\frac{10\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{500\text{ mL}}$$

$$100X = 5{,}000$$

$$\frac{100X}{100} = \frac{5{,}000}{100}$$

$$X = 50\text{ g}$$

NaCl:

$$\frac{0.225\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{500\text{ mL}}$$

$$100X = 112.5$$

$$\frac{100X}{100} = \frac{112.5}{100}$$

$$X = 1.125\text{ g}$$

Review Set 33 from pages 345-346

1) 100 **2)** 120 **3)** 83 **4)** 200 **5)** 120 **6)** 125 **7)** 125 **8)** 200 **9)** 75 **10)** 125 **11)** 63 **12)** 24 **13)** 150 **14)** 125 **15)** 42

Solutions—Review Set 33

1) 1 L = 1,000 mL

$$\frac{\text{Total mL}}{\text{Total h}} = \frac{1{,}000\text{ mL}}{10\text{ h}} = 100\text{ mL/h}$$

3) $\frac{\text{Total mL}}{\text{Total h}} = \frac{2{,}000\text{ mL}}{24\text{ h}} = 83.3\text{ mL/h} = 83\text{ mL/h}$

4) $\frac{100\text{ mL}}{30\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$

$$30X = 6{,}000$$

$$\frac{30X}{30} = \frac{6{,}000}{30}$$

$$X = 200\text{ mL/h}$$

5) $\frac{30\text{ mL}}{15\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$

$$15X = 900$$

$$\frac{15X}{15} = \frac{900}{15}$$

$$X = 120\text{ mL/h}$$

6) $\frac{1\text{ L}}{1{,}000\text{ mL}} = \frac{2.5\text{ L}}{X\text{ mL}}$

$$X = 2{,}500\text{ mL}$$

$$\frac{\text{Total mL}}{\text{Total h}} = \frac{2{,}500\text{ mL}}{20\text{ h}} = 125\text{ mL/h}$$

Review Set 34 from pages 347-348

1) 15 **2)** 10 **3)** 60 **4)** 60 **5)** 10

Review Set 35 from page 351

1) $\frac{V}{T} \times C = R$ **2)** 21 **3)** 50 **4)** 33 **5)** 25 **6)** 83 **7)** 26 **8)** 50 **9)** 50 **10)** 80 **11)** 20 **12)** 30 **13)** 17 **14)** 55 **15)** 40

Solutions—Review Set 35

1) $\frac{V}{T} \times C = R$ or $\frac{\text{Volume}}{\text{Time in min}} \times \text{Drop Factor} = \text{Rate}$

Volume in mL divided by *time* in minutes, multiplied by the *drop factor calibration* in drops per milliliter, equals the flow *rate* in drops per minute.

2) $\frac{V}{T} \times C = \frac{125\ \cancel{\text{mL}}}{\underset{6}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{10}}\text{ gtt}/\cancel{\text{mL}} = \frac{125\text{ gtt}}{6\text{ min}}$

$= 21$ gtt/min

3) $\frac{V}{T}\times C=\frac{50\ \cancel{mL}}{\underset{1}{\cancel{60}}\ \text{min}}\times\overset{1}{\cancel{60}}\ \text{gtt/}\cancel{mL}=50\ \text{gtt/min}$

Recall that when drop factor is 60 mL/h, then mL/h = gtt/min.

4) $\frac{V}{T}\times C=\frac{100\ \cancel{mL}}{\underset{3}{\cancel{60}}\ \text{min}}\times\overset{1}{\cancel{20}}\ \text{gtt/}\cancel{mL}=\frac{100\ \text{gtt}}{3\ \text{min}}$

$= 33$ gtt/min

6) Two 500 mL units of blood = 1,000 mL total volume

mL/h $=\frac{1{,}000\ \text{mL}}{4\ \text{h}}=250$ mL/h

$\frac{V}{T}\times C=\frac{250\ \cancel{mL}}{\underset{3}{\cancel{60}}\ \text{min}}\times\overset{1}{\cancel{20}}\ \text{gtt/}\cancel{mL}=\frac{250\ \text{gtt}}{3\ \text{min}}$

$= 83$ gtt/min

7) $\frac{\text{Total mL}}{\text{total h}}=\frac{1{,}240\ \text{mL}}{12\ \text{h}}=103.3\ \text{mL/h}=103\ \text{mL/h}$

$\frac{V}{T}\times C=\frac{103\ \cancel{mL}}{\underset{4}{\cancel{60}}\ \text{min}}\times\overset{1}{\cancel{15}}\ \text{gtt/}\cancel{mL}=\frac{103\ \text{gtt}}{4\ \text{min}}$

$= 26$ gtt/min

9) $\frac{150\ \text{mL}}{\underset{3}{\cancel{45}}\ \text{min}}\times\overset{1}{\cancel{15}}\ \text{gtt/}\cancel{mL}=\frac{\overset{50}{\cancel{150}}\ \text{gtt}}{\underset{1}{\cancel{3}}\ \text{min}}=50\ \text{gtt/min}$

Review Set 36 from pages 353-354

1) 60 **2)** 1 **3)** 3 **4)** 4 **5)** 6 **6)** $\frac{\text{mL/h}}{\text{drop factor constant}}$ = gtt/min **7)** 50 **8)** 42 **9)** 28 **10)** 60 **11)** 8 **12)** 31 **13)** 28 **14)** 25 **15)** 11

Solutions—Review Set 36

4) $\frac{60}{15}=4$

7) $\frac{\text{mL/h}}{\text{drop factor constant}}=\text{gtt/min: }\frac{200\ \text{mL/h}}{4}=50\ \text{gtt/min}$

8) $\frac{\text{mL/h}}{\text{drop factor constant}}=\text{gtt/min: }\frac{125\ \text{mL/h}}{3}=41.7\ \text{gtt/min}$

$= 42$ gtt/min

9) $\frac{\text{mL/h}}{\text{drop factor constant}}=\text{gtt/min: }\frac{165\ \text{mL/h}}{6}=27.5\ \text{gtt/min}$

$= 28$ gtt/min

10) $\frac{\text{mL/h}}{\text{drop factor constant}}=\text{gtt/min: }\frac{60\ \text{mL/h}}{1}=60\ \text{gtt/min}$

(Set the flow rate at the same number of gtt/min as the number of mL/h when the drop factor is 60 gtt/mL because the drop factor constant is 1.)

14) 0.5 L = 500 mL; $\frac{500\ \text{mL}}{20\ \text{h}}=25$ mL/h; because drop factor is 60 gtt/mL, then mL/h = gtt/min; so rate is 25 gtt/min.

15) $\frac{650\ \text{mL}}{10\ \text{h}}=65\ \text{mL/h}$

$\frac{\text{mL/h}}{\text{drop factor constant}}=\text{gtt/min: }\frac{65\ \text{mL/h}}{6}$

$= 11$ gtt/min

Review Set 37 from pages 355-356

1) 125; 31 **2)** 100 **3)** 100; 33 **4)** 50 **5)** 125; 31 **6)** 125; 125 **7)** 35 **8)** 17 **9)** 25 **10)** 125 **11)** 83 **12)** 125 **13)** 200 **14)** 150 **15)** 200 **16)** 13.5 **17)** 20; 1.8 **18)** 22.5 **19)** 32.5; 2.925 **20)** 50; 2.25

Solutions—Review Set 37

1) $\frac{\text{Total mL}}{\text{Total h}}=\frac{3{,}000\ \text{mL}}{24\ \text{h}}=125\ \text{mL/h}$

$\frac{V}{T}\times C=\frac{125\ \cancel{mL}}{\underset{4}{\cancel{60}}\ \text{min}}\times\overset{1}{\cancel{15}}\ \text{gtt/}\cancel{mL}=\frac{125\ \text{gtt}}{4\ \text{min}}$

$=31$ gtt/min

7) $\frac{\text{mL/h}}{\text{drop factor constant}}=\text{gtt/min: }\frac{105\ \text{mL/h}}{3}=35\ \text{gtt/min}$

8) $\frac{\text{mL/h}}{\text{drop factor constant}}=\text{gtt/min: }\frac{100\ \text{mL/h}}{6}=17\ \text{gtt/min}$

10) $\frac{\text{Total mL}}{\text{Total h}}=\frac{1{,}000\ \text{mL}}{8\ \text{h}}=125\ \text{mL/h}$

13) $\frac{100\text{ mL}}{30\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$

$30X = 6{,}000$

$\frac{30X}{30} = \frac{6{,}000}{30}$

$X = 200\text{ mL/h}$

15) $\frac{150\text{ mL}}{45\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$

$45X = 9{,}000$

$\frac{45X}{45} = \frac{9{,}000}{45}$

$X = 200\text{ mL/h}$

16) $\frac{1}{2}$ NS $= 0.45\%$ NaCl $= 0.45$ g NaCl per 100 mL

$\frac{0.45\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{3{,}000\text{ mL}}$

$100X = 1{,}350$

$\frac{100X}{100} = \frac{1{,}350}{100}$

$X = 13.5\text{ g (NaCl)}$

17) $D_{10}N5 = 10\%$ dextrose $= 10$ g dextrose per 100 mL and 0.9% NaCl $= 0.9$ g NaCl per 100 mL

Dextrose:

$\frac{10\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{200\text{ mL}}$

$100X = 2{,}000$

$\frac{100X}{100} = \frac{2{,}000}{100}$

$X = 20\text{ g}$

$NS = 0.9\%\text{ NaCl} = 0.9\text{ g NaCl per 100 mL}$

NaCl:

$\frac{0.9\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{200\text{ mL}}$

$100X = 180$

$\frac{100X}{100} = \frac{180}{100}$

$X = 1.8\text{ g}$

Review Set 38 from pages 359-361

1) 42; 6; 142; 47; 12%; reset to 47 gtt/min (12% increase is acceptable).

2) 42; 2; 180; 45; 7%; reset to 45 gtt/min (7% increase is acceptable).

3) 42; 4; 200; 67; 60%; recalculated rate 67 gtt/min (60% increase is unacceptable). Consult physician.

4) 28; 4; 188; 31; 11%; reset to 31 gtt/min (11% increase is acceptable).

5) 21; 4; 188; 31; 48%; (48% increase is unacceptable). Consult physician.

6) 31; 1,350; 10; 135; 34; 10%; reset to 34 gtt/min (10% increase is acceptable).

7) 50; 3; 233; 78; 56%; (56% increase is unacceptable). Consult physician.

8) 33; 3; 83; 28; –15%; (–15% slower is acceptable). IV is ahead of schedule. Slow rate to 28 gtt/min, and observe patient's condition.

9) 13; 10; 60; 15; 15%; reset to 15 gtt/min (15% increase is acceptable).

10) 100; 5; 100; 100; 0%; IV is on time, so no adjustment is needed.

Solutions—Review Set 38

1) $\frac{V}{T} \times C = \frac{125\,\cancel{\text{mL}}}{\underset{3}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{20}}\text{ gtt/}\cancel{\text{mL}} = \frac{125\text{ gtt}}{3\text{ min}} = 42\text{ gtt/min (ordered rate)}$

$12\text{ h} - 6\text{ h} = 6\text{ h}$

$\frac{\text{Remaining volume}}{\text{Remaining hours}} = \text{Recalculated mL/h; } \frac{850\text{ mL}}{6\text{ h}} = 142\text{ mL/h}$

$\frac{V}{T} \times C = \frac{142\,\cancel{\text{mL}}}{\underset{3}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{20}}\text{ gtt/}\cancel{\text{mL}} = \frac{142\text{ gtt}}{3\text{ min}} = 47\text{ gtt/min (adjusted rate)}$

$\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%\text{ of variation; } \frac{47 - 42}{42} = \frac{5}{42} = 0.12 = 12\%$ (within the acceptable % of variation); reset rate to 47 gtt/min

3) $\frac{V}{T} \times C = \frac{125\,\cancel{\text{mL}}}{\underset{3}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{20}}\text{ gtt}/\cancel{\text{mL}} = \frac{125\text{ gtt}}{3\text{ min}} = 42$ gtt/min (ordered rate)

$8\text{ h} - 4\text{ h} = 4\text{ h}$

$\frac{800\text{ mL}}{4\text{ h}} = 200\text{ mL/h}$; $\frac{V}{T} \times C = \frac{200\,\cancel{\text{mL}}}{\underset{3}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{20}}\text{ gtt}/\cancel{\text{mL}} = \frac{200\text{ gtt}}{3\text{ min}} = 67$ gtt/min (adjusted rate)

$\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%$ of variation; $\frac{67 - 42}{42} = \frac{25}{42} = 0.595 = 0.6 = 60\%$ faster; unacceptable % of variation—call physician for a revised order

6) $\frac{V}{T} \times C = \frac{125\,\cancel{\text{mL}}}{\underset{4}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{15}}\text{ gtt}/\cancel{\text{mL}} = \frac{125\text{ gtt}}{4\text{ min}} = 31.3$ gtt/min $= 31$ gtt/min (ordered rate)

$2{,}000\text{ mL} - 650\text{ mL} = 1{,}350$ mL remaining; $16\text{ h} - 6\text{ h} = 10\text{ h}$

$\frac{1{,}350\text{ mL}}{10\text{ h}} = 135\text{ mL/h}$; $\frac{V}{T} \times C = \frac{135\,\cancel{\text{mL}}}{\underset{4}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{15}}\text{ gtt}/\cancel{\text{mL}} = \frac{135\text{ gtt}}{4\text{ min}} = 34$ gtt/min

$\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%$ of variation; $\frac{34 - 31}{31} = \frac{3}{31} = 0.096 = 0.10 = 10\%$ (within acceptable % of variation); reset rate to 34 gtt/min

8) $\frac{V}{T} \times C = \frac{100\,\cancel{\text{mL}}}{\underset{3}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{20}}\text{ gtt}/\cancel{\text{mL}} = \frac{100\text{ gtt}}{3\text{ min}} = 33$ gtt/min (ordered rate)

$5\text{ h} - 2\text{ h} = 3\text{ h}$

$\frac{250\text{ mL}}{3\text{ h}} = 83.3\text{ mL/h} = 83\text{ mL/h}$; $\frac{V}{T} \times C = \frac{83\,\cancel{\text{mL}}}{\underset{3}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{20}}\text{ gtt}/\cancel{\text{mL}} = \frac{83\text{ gtt}}{3\text{ min}} = 28$ gtt/min (adjusted rate)

$\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%$ of variation; $\frac{28 - 33}{33} = \frac{-5}{33} = -0.15 = -15\%$ (Remember the [–] sign indicates the IV is ahead of schedule and rate must be decreased.) Within the acceptable % of variation. Slow IV to 28 gtt/min, and closely monitor patient.

Review Set 39 from pages 365-367

1) 133 **2)** 133 **3)** 50 **4)** 200 **5)** 100 **6)** 25 **7)** 50 **8)** 200 **9)** 150 **10)** 167 **11)** 133 **12)** 25 **13)** 120 **14)** 56 **15)** 200 **16)** 12; 3; 1 **17)** 3; 3; 0.25 **18)** 0.6; 2; 24; 0.06 **19)** 2; 18; 10; 2.5 **20)** 1.5; 0.75; 0.19

Solutions—Review Set 39

1) $\frac{V}{T} \times C = \frac{100\,\cancel{\text{mL}}}{\underset{3}{\cancel{45}}\text{ min}} \times \overset{4}{\cancel{60}}\text{ gtt}/\cancel{\text{mL}} = \frac{400\text{ gtt}}{3\text{ min}}$

$= 133$ gtt/min

2) $\frac{100\text{ mL}}{45\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$

$45X = 6{,}000$

$\frac{45X}{45} = \frac{6{,}000}{45}$

$X = 133\text{ mL/h}$

3) $\frac{V}{T} \times C = \frac{50\,\cancel{\text{mL}}}{\underset{1}{\cancel{15}}\text{ min}} \times \overset{1}{\cancel{15}}\text{ gtt}/\cancel{\text{mL}} = 50$ gtt/min

4) $\frac{50\text{ mL}}{15\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$

$15X = 3{,}000$

$\frac{15X}{15} = \frac{3{,}000}{15}$

$X = 200\text{ mL/h}$

11) $\frac{V}{T}\times C=\frac{100\text{ }\cancel{\text{mL}}}{\underset{3}{\cancel{15}}\text{ min}}\times\overset{4}{\cancel{20}}\text{ gtt}/\cancel{\text{mL}}=\frac{400\text{ gtt}}{3\text{ min}}$

$= 133$ gtt/min

16) $\frac{10\text{ mg}}{1\text{ mL}} \times \frac{120\text{ mg}}{X\text{ mL}}$

$10X = 120$

$\frac{10X}{10} = \frac{120}{10}$

$X = 12$ mL

$\frac{40\text{ mg}}{1\text{ min}} \times \frac{120\text{ mg}}{X\text{ min}}$

$40X = 120$

$\frac{40X}{40} = \frac{120}{40}$

$X = 3$ min

Administer 12 mL over at least 3 min.

1 min = 60 sec

3 min = 3 × 60 = 180 sec

$\frac{12\text{ mL}}{180\text{ sec}} \times \frac{X\text{ mL}}{15\text{ sec}}$

$180X = 180$

$\frac{180X}{180} = \frac{180}{180}$

$X = 1$ mL (per 15 sec)

17) $\frac{250\text{ mg}}{5\text{ mL}} \times \frac{150\text{ mg}}{X\text{ mL}}$

$250X = 750$

$\frac{250X}{250} = \frac{750}{250}$

$X = 3$ mL

$\frac{50\text{ mg}}{1\text{ min}} \times \frac{150\text{ mg}}{X\text{ min}}$

$50X = 150$

$\frac{50X}{50} = \frac{150}{50}$

$X = 3$ min

Administer 3 mL over 3 min.

1 min = 60 sec

3 min = 3 × 60 = 180 sec

$\frac{3\text{ mL}}{180\text{ sec}} \times \frac{X\text{ mL}}{15\text{ sec}}$

$180X = 45$

$\frac{180X}{180} = \frac{45}{180}$

$X = 0.25$ mL (per 15 sec)

18) $\frac{10\text{ mg}}{1\text{ mL}} \times \frac{6\text{ mg}}{X\text{ mL}}$

$10X = 6$

$\frac{10X}{10} = \frac{6}{10}$

$X = 0.6$ mL

$\frac{2.5\text{ mg}}{1\text{ min}} \times \frac{6\text{ mg}}{X\text{ min}}$

$2.5X = 6$

$\frac{2.5X}{2.5} = \frac{6}{2.5}$

$X = 2.4$ min

1 min = 60 sec

2 min = 2 × 60 = 120 sec; 0.4 min = 0.4 × 60 = 24 sec

120 sec + 24 sec = 144 sec

$\frac{0.6\text{ mL}}{144\text{ sec}} = \frac{X\text{ mL}}{15\text{ sec}}$

$144X = 9$

$\frac{144X}{144} = \frac{9}{144}$

$X = 0.06$ mL (per 15 sec)

Review Set 40 from pages 371-372

1) 5 h and 33 min **2)** 6 h and 40 min **3)** 8 **4)** 6; 20 **5)** 4; 20 **6)** Approximately 11; 0300 the next morning **7)** 16; 0730 the next morning **8)** 3,000 **9)** 1,152 **10)** 3,024 **11)** 260 **12)** 300 **13)** 600 **14)** 480, 320 **15)** 240, 540

Solutions—Review Set 40

1) $\frac{V}{T} \times C = R$; notice T is the missing quantity

$\frac{500\text{ mL}}{T\text{ min}} \times 20\text{ gtt/mL} = 30\text{ gtt/min}$

$\frac{10{,}000}{T} \times \frac{30}{1}$

$30T = 10{,}000$

$\frac{30T}{30} = \frac{10{,}000}{30}$

$T = 333$ min

$333\text{ min} = \frac{333}{60} = 5$ h and 33 min

2) $\frac{V}{T} \times C = R$; notice T is the missing quantity

$\frac{1{,}000\text{ mL}}{T\text{ min}} \times 10\text{ gtt/mL} = 25\text{ gtt/min}$

$\frac{10{,}000}{T} \times \frac{25}{1}$

$25T = 10{,}000$

$\frac{25T}{25} = \frac{10{,}000}{25}$

$T = 400$ min

$400\text{ min} = \frac{400}{60} = 6$ h and 40 min

4) Time: $\frac{\text{Total vol}}{\text{mL/h}} = \text{Total h}$

$\frac{120\,\cancel{\text{mL}}}{20\,\cancel{\text{mL}}\text{/h}} = 6\text{ h}$

$\frac{V}{T} \times C = \frac{20\,\cancel{\text{mL}}}{\underset{1}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{60}}\text{ gtt/}\cancel{\text{mL}} = 20\text{ gtt/min}$

6) $\frac{V}{T} \times C = R$; notice T is the missing quantity

$\frac{1{,}200\text{ mL}}{T\text{ min}} \times 15\text{ gtt/mL} = 27\text{ gtt/min}$

$\frac{18{,}000}{T} \times \frac{27}{1}$

$27T = 18{,}000$

$\frac{27T}{27} = \frac{18{,}000}{27}$

$T = 667\text{ min}; 667\text{ min} = \frac{667}{60} = 11\text{ h and }7\text{ min}$
or 11 h (rounded)

$2400 - 1600 = 8\text{h}$ (until midnight)

$11\text{h} - 8\text{h} = 3\text{h}$ (into next day)

Completion time: 0300 (the next morning)

7) Time: $\frac{\text{Total vol}}{\text{mL/h}} = \text{Total h}$

$\frac{2{,}000\,\cancel{\text{mL}}}{125\,\cancel{\text{mL}}\text{/h}} = 16\text{ h}$

$2400 - 1530 = 8\text{h }30\text{ min}$ (until midnight)

$16\text{h} - 8\text{h }30\text{ min} = 7\text{h }30\text{ min}$ (into the next day)

Completion time: 0730 (the next morning)

8) Total hours × mL/h = Total volume

$24\,\cancel{\text{h}} \times 125\text{ mL/}\cancel{\text{h}} = 3{,}000\text{ mL}$

9) $\frac{V}{T} \times C = R$; notice V is the missing quantity

$\frac{V\text{ mL}}{1{,}440\text{ min}} \times 15\text{ gtt/mL} = 12\text{ gtt/min}$

$\frac{15V}{1{,}440} \times \frac{12}{1}$

$15V = 17{,}280$

$\frac{15V}{15} = \frac{17{,}280}{15}$

$V = 1{,}152\text{ mL}$

11) $65\text{ mL/}\cancel{\text{h}} \times 4\,\cancel{\text{h}} = 260\text{ mL}$

14) $8\text{ h} = 8 \times 60 = 480\text{ min}$

$\frac{V}{T} \times C = R$; notice V is the missing quantity

$\frac{60V}{480} \times \frac{40}{1}$

$60V = 19{,}200$

$\frac{60V}{60} = \frac{19{,}200}{60}$

$V = 320\text{ mL}$

15) $4\text{ h} = 4 \times 60 = 240\text{ min}$

$\frac{V}{T} \times C = R$; notice V is the missing quantity

$\frac{V\text{ mL}}{240\text{ min}} \times 20\text{ gtt/mL} = 45\text{ gtt/min}$

$\frac{20V}{240} \times \frac{45}{1}$

$20V = 10{,}800$

$\frac{20V}{20} = \frac{10{,}800}{20}$

$V = 540\text{ mL}$

Practice Problems—Chapter 14 from pages 373-376

1) 17 **2)** 42 **3)** 42 **4)** 8 **5)** 125 **6)** Assess patient. If stable, recalculate and reset to 114 mL/h; observe patient closely. **7)** 31 **8)** 42 **9)** Assess patient. If stable, recalculate and reset to 50 gtt/min; observe patient closely. **10)** 3,000 **11)** Abbott Laboratories **12)** 15 gtt/mL **13)** 4

14) $\text{mL/h} = \frac{500\text{ mL}}{4\text{ h}} = 125\text{ mL/h}$

$\frac{\text{mL/h}}{\text{drop factor constant}} = \text{gtt/min}: \frac{125\text{ mL/h}}{4} = 31\text{ gtt/min}$

15) $\frac{V}{T} \times C = \frac{125\,\cancel{\text{mL}}}{\underset{4}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{15}}\text{ gtt/}\cancel{\text{mL}} = \frac{125\text{ gtt}}{4\text{ min}} = 31\text{ gtt/min}$

16) 1930 (or 7:30 PM) **17)** 250 **18)** Recalculate 210 mL to infuse over remaining 2 hours. Reset IV to 26 gtt/min and observe patient closely. **19)** 125 **20)** 100 **21)** Dextrose 2.5% (2.5 g per 100 mL) and NaCl 0.45% (0.45 g per 100 mL) **22)** 25; 4.5 **23)** A central line is a special catheter inserted to access a large vein in the chest. **24)** A primary line is the IV tubing used to set up a primary IV infusion. **25)** The purpose of a saline/heparin lock is to administer IV medications when the patient does not require continuous IV fluids. **26)** 10; 5; 0.5; 0.13 **27)** The purpose of the PCA pump is to allow the patient to safely self-administer IV pain medication without having to call the nurse for a p.r.n. medication. **28)** Advantages of the syringe pump are that a small amount of medication can be delivered directly from the syringe, and a specified time can be programmed in the pump. **29)** Phlebitis and infiltration **30)** q $\frac{1}{2} - 1$ h, according to hospital policy **31)** This IV tubing has two spikes—one for blood, the other for saline—that join at a common drip chamber or Y connection. **32)** 14 **33)** 21 **34)** 28 **35)** 83 **36)** 17 **37)** 25 **38)** 33 **39)** 100 **40)** 33 **41)** 50 **42)** 67 **43)** 200 **44)** 8 **45)** 11 **46)** 15 **47)** 45 **48)** 150. The IV will finish in one hour. Leave a new IV bag in case you are delayed so the relief nurse can spike the new bag and continue the infusion. **49)** 1250 (or 12:50 PM)

50) **Prevention:** This error could have been prevented had the nurse carefully inspected the IV tubing package to determine the drop factor. Every IV tubing set has the drop factor printed on the package, so it is not necessary to memorize or guess the drop factor. The IV calculation should have looked like this:

$$\frac{125\ \cancel{mL}}{\underset{3}{\cancel{60}}\ min} \times \overset{1}{\cancel{20}}\ gtt/\cancel{mL} = \frac{125\ gtt}{3\ min} = 42\ gtt/min$$

With the infusion set of 20 gtt/mL, a flow rate of 42 gtt/min would infuse 125 mL/h. At the 125 gtt/min rate the nurse calculated, the patient received three times the IV fluid ordered hourly. Thus, the patient actually received 375 mL/h of IV fluids.

Solutions—Practice Problems—Chapter 14

1) $\frac{\text{Total mL}}{\text{Total h}} = \frac{200\ mL}{2\ h} = 100\ mL/h$

$\frac{V}{T} \times C = \frac{100\ \cancel{mL}}{\underset{6}{\cancel{60}}\ min} \times \overset{1}{\cancel{10}}\ gtt/\cancel{mL} = \frac{100\ gtt}{6\ min}$

$= 17\ gtt/min$

2) $\frac{\text{Total mL}}{\text{Total h}} = \frac{1{,}000\ mL}{24\ h} = 42\ mL/h$

drop factor is 60 gtt/mL: 42 mL/h = 42 gtt/min

5) $\frac{\text{Total mL}}{\text{Total h}} = \frac{1{,}000\ mL}{8\ h} = 125\ mL/h$

6) $\frac{\text{Total mL}}{\text{Total h}} = \frac{800\ mL}{7\ h} = 114.2\ mL/h = 114\ mL/h$

$\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%$ variation:

$\frac{144 - 25}{125} = \frac{-11}{125} = -0.088 = -9\%$ (decrease);

within safe limits of 25% variance.

Reset infusion rate to 114 mL/h.

7) 1,000 mL + 2,000 mL = 3,000 mL;

$\frac{\text{Total mL}}{\text{Total h}} = \frac{3{,}000\ mL}{24\ h} = 125\ mL/h$

$\frac{V}{T} \times C = \frac{125\ \cancel{mL}}{\underset{4}{\cancel{60}}\ min} \times \overset{1}{\cancel{15}}\ gtt/\cancel{mL} = \frac{125\ gtt}{4\ min}$

$= 31\ gtt/min$

8) $\frac{V}{T} \times C = \frac{125\ \cancel{mL}}{\underset{3}{\cancel{60}}\ min} \times \overset{1}{\cancel{20}}\ gtt/\cancel{mL} = \frac{125\ gtt}{3\ min}\ gtt/min$

$= 42\ gtt/min$

9) $\frac{\text{Total mL}}{\text{Total h}} = \frac{1{,}000\ mL}{6\ h} = 167\ mL/h$

$\frac{V}{T} \times C = \frac{167\ \cancel{mL}}{\underset{4}{\cancel{60}}\ min} \times \overset{1}{\cancel{15}}\ gtt/\cancel{mL} = \frac{167\ gtt}{4\ min}$

$= 42\ gtt/min$

6 h − 2 h = 4 h remaining; $\frac{\text{Total mL}}{\text{Total h}} = \frac{\overset{200}{\cancel{800}}\ mL}{\underset{1}{\cancel{4}}\ h} =$

200 mL/h

$\frac{V}{T} \times C = \frac{200\ \cancel{mL}}{\underset{4}{\cancel{60}}\ min} \times \overset{1}{\cancel{15}}\ gtt/\cancel{mL} = \frac{\overset{50}{\cancel{200}}\ gtt}{\underset{1}{\cancel{4}}\ min} =$

50 gtt/min

$\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%$ variation:

$\frac{50 - 42}{42} = \frac{8}{42} = 0.19 = 19\%$ increase;

within safe limits of 25% variance

Reset infusion rate to 50 gtt/min.

10) q.4h = 6 times per 24 h; 6 × 500 mL = 3,000 mL

13) $\frac{60}{15} = 4$

16) 1530 + 4 h = 1530 + 0400 = 1930; 1930 − 1200 = 7:30 PM

17) $\frac{\text{Total mL}}{\text{Total h}} = \frac{500\ mL}{4\ h} = 125\ mL/h$

$125\ mL/\cancel{h} \times 2\ \cancel{h} = 250\ mL$

18) $\frac{\text{Total mL}}{\text{Total h}} = \frac{210\ mL}{2\ h} = 105\ mL/h$

$\frac{V}{T} \times C = \frac{105\ \cancel{mL}}{\underset{4}{\cancel{60}}\ min} \times \overset{1}{\cancel{15}}\ gtt/\cancel{mL} = \frac{105\ gtt}{4\ min}$

$= 26\ gtt/min$

$$\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%\text{ variation:}$$

$\frac{26-31}{31} = \frac{-5}{31} = -0.16 = -16\%$ decrease; within safe limits

Reset infusion rate to 26 gtt/min.

19) $\frac{\text{Total mL}}{\text{Total h}} = \frac{500\text{ mL}}{4\text{ h}} = 125\text{ mL/h}$

20) $\frac{50\text{ mL}}{30\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$

$30X = 3{,}000$

$\frac{30X}{30} = \frac{3{,}000}{30}$

$X = 100\text{ mL/h}$

22) Dextrose 5% = 5 g per 100 mL NaCl 0.9% = 0.9 g per 100 mL

Dextrose:

$\frac{5\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{500\text{ mL}}$

$100X = 2{,}500$

$\frac{100X}{100} = \frac{2{,}500}{100}$

$X = 25\text{ g}$

NaCl:

$\frac{0.9\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{500\text{ mL}}$

$100X = 450$

$\frac{100X}{100} = \frac{450}{100}$

$X = 4.5\text{ g}$

26) $\frac{5\text{ mg}}{1\text{ min}} \times \frac{50\text{ mg}}{X\text{ min}}$

$5X = 50$

$\frac{5X}{5} = \frac{50}{5}$

$X = 10\text{ min}$

$\frac{10\text{ mg}}{1\text{ mL}} \times \frac{50\text{ mg}}{X\text{ mL}}$

$10X = 50$

$\frac{10X}{10} = \frac{50}{10}$

$X = 5\text{ mL}$

Give 50 mg per 10 min or 5 mL per 10 min;

0.5 mL/min

1 min = 60 sec

$\frac{0.5\text{ mL}}{60\text{ sec}} = \frac{X\text{ mL}}{15\text{ sec}}$

$60X = 7.5$

$\frac{60X}{60} = \frac{7.5}{60}$

$X = 0.13$ mL (per 15 sec)

32) $\frac{\text{Total mL}}{\text{Total h}} = \frac{1{,}000\text{ mL}}{12\text{ h}} = 83\text{ mL/h}; \frac{V}{T} \times C =$

$\frac{83\,\cancel{\text{mL}}}{\underset{6}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{10}}\text{ gtt/}\cancel{\text{mL}} = \frac{83\text{ gtt}}{6\text{ min}} = 14\text{ gtt/min}$

33) $\frac{V}{T} \times C = \frac{83\,\cancel{\text{mL}}}{\underset{4}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{15}}\text{ gtt/}\cancel{\text{mL}} = \frac{83\text{ gtt}}{4\text{ min}}$

$= 21\text{ gtt/min}$

34) $\frac{V}{T} \times C = \frac{83\,\cancel{\text{mL}}}{\underset{3}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{20}}\text{ gtt/}\cancel{\text{mL}} = \frac{83\text{ gtt}}{3\text{ min}}$

$= 28\text{ gtt/min}$

35) $\frac{V}{T} \times C = \frac{83\,\cancel{\text{mL}}}{\underset{1}{\cancel{60}}\text{ min}} \times \overset{1}{\cancel{60}}\text{ gtt/}\cancel{\text{mL}} = 83\text{ gtt/min}$

Remember, if drop factor is 60 gtt/mL, then mL/h = gtt/min; so 83 mL/h = 83 gtt/min

48) $\frac{V}{T} \times C = R$; V is the unknown quantity

$\frac{V\text{ mL}}{60\text{ min}} \times 10\text{ gtt/mL} = 25\text{ gtt/min}$

$\frac{10V}{60} \times \frac{25}{1}$

$10V = 1{,}500$

$\frac{10V}{10} = \frac{1{,}500}{10}$

$V = 150\text{ mL}$

49) $\frac{400\,\cancel{\text{mL}}}{75\,\cancel{\text{mL}}/\text{h}} = 5\frac{1}{3}$ h or 5 h and 20 min

0730 + 0520 = 1250 (or 12:50 PM)

Review Set 41 from page 381

1) 0.68 **2)** 2.35 **3)** 0.69 **4)** 1.4 **5)** 2.03 **6)** 1 **7)** 1.67 **8)** 0.4 **9)** 1.69 **10)** 0.52 **11)** 1.11 **12)** 0.78 **13)** 0.15 **14)** 0.78 **15)** 0.39 **16)** 0.64 **17)** 0.25 **18)** 1.08 **19)** 0.5 **20)** 0.88

Solutions—Review Set 41

1) Household: $\text{BSA (m}^2) = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} = \sqrt{\frac{36 \times 40}{3{,}131}} = \sqrt{\frac{1{,}440}{3{,}131}} = \sqrt{0.459...} = 0.68\text{ m}^2$

2) Metric: $\text{BSA (m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} = \sqrt{\frac{190 \times 105}{3{,}600}} = \sqrt{\frac{19{,}950}{3{,}600}} = \sqrt{5.541...} = 2.35\text{ m}^2$

Review Set 42 from pages 383-385

1) 1,640,000 **2)** 5.9; 11.8 **3)** 735 **4)** 15.84; 63.36 **5)** 250 **6)** 0.49; 122.5; Yes; 2.5 **7)** 0.89; 2.9; Yes; 1.2 **8)** 66; 22; Yes **9)** 198; Yes; 990 **10)** 612; 612; 1,224; 2,448 **11)** 8.1; 24.7 **12)** 67–167.5; 33.5–83.8; Yes **13)** 8–14.4; Yes **14)** 0.82; 2,050; Yes; 2.7; 102.7; 51 **15)** 1.62; 4,050; Yes; 5.4; 105.4; 53

Solutions—Review Set 42

1) $2{,}000{,}000 \text{ units}/\cancel{m^2} \times 0.82\ \cancel{m^2} = 1{,}640{,}000 \text{ units}$

2) $10 \text{ mg}/\cancel{m^2}/\text{day} \times 0.59\ \cancel{m^2} = 5.9 \text{ mg/day}$ (minimum safe dosage)

$20 \text{ mg}/\cancel{m^2}/\text{day} \times 0.59\ \cancel{m^2} = 11.8 \text{ mg/day}$ (maximum safe dosage)

3) $500 \text{ mg}/\cancel{m^2} \times 1.47\ \cancel{m^2} = 735 \text{ mg}$

4) $6 \text{ mg}/\cancel{m^2}/\text{day} \times 2.64\ \cancel{m^2} = 15.84 \text{ mg/day}$

$15.84 \text{ mg}/\cancel{\text{day}} \times 4\ \cancel{\text{days}} = 63.36 \text{ mg}$

6) $\text{BSA (m}^2) = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} = \sqrt{\frac{30 \times 25}{3{,}131}} = \sqrt{\frac{750}{3{,}131}}$

$= \sqrt{0.239...} = 0.49 \text{ m}^2$

$250 \text{ mg}/\cancel{m^2} \times 0.49\ \cancel{m^2} = 122.5 \text{ mg}$; dosage is safe

$\frac{50 \text{ mg}}{1 \text{ mL}} \times \frac{122.5 \text{ mg}}{X \text{ mL}}$

$50X = 122.5$

$\frac{50X}{50} = \frac{122.5}{50}$

$X = 2.5 \text{ mL}$

8) $150 \text{ mg}/\cancel{m^2}/\text{day} \times 0.44\ \cancel{m^2} = 66 \text{ mg/day}$

$\frac{66 \text{ mg}}{3 \text{ doses}} = 22 \text{ mg/dose}$; dosage is safe

9) $900 \text{ mg}/\cancel{m^2}/\text{day} \times 0.22\ \cancel{m^2} = 198 \text{ mg/day}$; dosage is safe

$198 \text{ mg/day} \times 5 \text{ days} = 990 \text{ mg}$

10) $600 \text{ mg}/\cancel{m^2} \times 1.02\ \cancel{m^2} = 612 \text{ mg}$, initially

$300 \text{ mg}/\cancel{m^2} \times 1.02\ \cancel{m^2} = 306 \text{ mg}$; for 2 doses:

$306 \text{ mg} \times 2 = 612 \text{ mg}$

q.12h is 2 doses/day; and $2 \text{ doses}/\cancel{\text{day}} \times 2\ \cancel{\text{days}} =$ 4 doses

$306 \text{ mg} \times 4 = 1{,}224 \text{ mg}$

$612 \text{ mg} + 612 \text{ mg} + 1{,}224 \text{ mg} = 2{,}448 \text{ mg (total)}$

11) $10 \text{ mg}/\cancel{m^2} \times 0.81\ \cancel{m^2} = 8.1 \text{ mg (bolus)}$

$30.5 \text{ mg}/\cancel{m^2}/\text{day} \times 0.81\ \cancel{m^2} = 24.7 \text{ mg/day}$

14) $\text{Metric: BSA (m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} = \sqrt{\frac{100 \times 24}{3{,}600}} =$

$\sqrt{\frac{2{,}400}{3{,}600}} = \sqrt{0.666...} = 0.82 \text{ m}^2$

$2{,}500 \text{ units}/\cancel{m^2} \times 0.82\ \cancel{m^2} = 2{,}050 \text{ units}$; dosage is safe

$\frac{750 \text{ units}}{1 \text{ mL}} \times \frac{2{,}050 \text{ units}}{X \text{ mL}}$

$750X = 2{,}050$

$\frac{750X}{750} = \frac{2{,}050}{750}$

$X = 2.7 \text{ mL}$

$2.7 \text{ mL (Oncaspar)} + 100 \text{ mL } (D_5W)$

$= 102.7 \text{ mL (Total volume)}$

$\frac{102.7 \text{ mL}}{2 \text{ h}} = 51 \text{ mL/h}$

15) $\text{Metric: BSA (m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} =$

$\sqrt{\frac{58.2 \times 162}{3{,}600}} = \sqrt{\frac{9{,}428.4}{3{,}600}} = \sqrt{2.619} = 1.62 \text{ m}^2$

$2{,}500 \text{ units}/\cancel{m^2} \times 1.62\ \cancel{m2} = 4{,}050 \text{ units}$; dosage is safe

$\frac{750 \text{ units}}{1 \text{ mL}} \times \frac{4{,}050 \text{ units}}{X \text{ mL}}$

$750X = 4{,}050$

$\frac{750X}{750} = \frac{4{,}050}{750}$

$X = 5.4 \text{ mL}$

$5.4 \text{ mL (Oncaspar)} + 100 \text{ mL } (D_5W)$

$= 105.4 \text{ (Total volume)}$

$\frac{105.4 \text{ mL}}{2 \text{ h}} = 53 \text{ mL/h}$

Review Set 43 from pages 388-389

1) 87; 2; 48 **2)** 75; 3; 57 **3)** 120; 3; 22 **4)** 80; 6; 44 **5)** 60; 1; 31; 180 **6)** 2; 23 **7)** 2; 8 **8)** 12; 45 **9)** 7.2; 36.8 **10)** 7.5; 88.5

Solutions—Review Set 43

1) Total volume: 50 mL + 15 mL = 65 mL

$\frac{V}{T} \times C = \frac{65\ \cancel{\text{mL}}}{\underset{3}{\cancel{45}} \text{ min}} \times \overset{4}{\cancel{60}} \text{ gtt}/\cancel{\text{mL}} =$

$\frac{260 \text{ gtt}}{3 \text{ min}} = 87 \text{ gtt/min}$

$\frac{60 \text{ mg}}{2 \text{ mL}} \times \frac{60 \text{ mg}}{X \text{ mL}}$

$60X = 120$

$\frac{60X}{60} = \frac{120}{60}$

X = 2 mL (medication)

Volume IV fluid to add to chamber: 50 mL − 2 mL = 48 mL

4) Total volume: 50 mL + 30 mL = 80 mL

80 mL per 60 min = 80 mL/h

$\frac{1\text{ g}}{10\text{ mL}} \times \frac{0.6\text{ g}}{X\text{ mL}}$

X = 6 mL (medication)

Volume IV fluid to add to chamber: 50 mL − 6 mL = 44 mL

6) $\frac{50\text{ mL}}{60\text{ min}} \times \frac{X\text{ mL}}{30\text{ min}}$

$60X = 1{,}500$

$\frac{60X}{60} = \frac{1{,}500}{60}$

X = 25 mL (total volume)

$\frac{125\text{ mg}}{1\text{ mL}} \times \frac{250\text{ mg}}{X\text{ mL}}$

$125X = 250$

$\frac{125X}{125} = \frac{250}{125}$

X = 2 mL (medication)

Volume IV fluid to add to chamber: 25 mL − 2 mL = 23 mL

8) $\frac{85\text{ mL}}{60\text{ min}} \times \frac{X\text{ mL}}{40\text{ min}}$

$60X = 3{,}400$

$\frac{60X}{60} = \frac{3{,}400}{60}$

X = 57 mL (total volume)

$\frac{50\text{ mg}}{1\text{ mL}} \times \frac{600\text{ mg}}{X\text{ mL}}$

$50X = 600$

$\frac{50X}{50} = \frac{600}{50}$

X = 12 mL (medication)

Volume IV fluid to add to chamber: 57 mL − 12 mL = 45 mL

9) $\frac{66\text{ mL}}{60\text{ min}} \times \frac{X\text{ mL}}{40\text{ min}}$

$60X = 2{,}640$

$\frac{60X}{60} = \frac{2{,}640}{60}$

X = 44 mL (total volume)

$\frac{1{,}000\text{ mg}}{10\text{ mL}} \times \frac{720\text{ mg}}{X\text{ mL}}$

$1{,}000X = 7{,}200$

$\frac{1{,}000X}{1{,}000} = \frac{7{,}200}{1{,}000}$

X = 7.2 mL (medication)

Volume IV fluid to add to chamber: 44 mL − 7.2 mL = 36.8 mL

Hint: Add the medication to the volume control chamber, and fill with IV fluid to the 44 mL mark. The chamber measures whole (not fractional) mL.

10) $48\text{ mL}/\cancel{\text{h}} \times 2\ \cancel{\text{h}} = 96\text{ mL}$ (total volume)

$\frac{100\text{ mg}}{10\text{ mL}} \times \frac{75\text{ mg}}{X\text{ mL}}$

$100X = 750$

$\frac{100X}{100} = \frac{750}{100}$

X = 7.5 mL

Volume IV fluid to add to chamber: 96 mL − 7.5 mL = 88.5 mL

Review Set 44 from page 391

1) 360 **2)** 250; Child will only receive 360 mL in a 24-hour period. The 500-mL bag would be hanging longer than 24 hours, which is not safe. **3)** 5 **4)** 2.5 **5)** 0.3 **6)** 7.2 **7)** 0.17; 6.8; No, not safe. Dosage as ordered would be too high. The physician should be called for clarification. **8)** 4.8; 2.4 **9)** 18; 9 **10)** 12.8; 6.4

Solutions—Review Set 44

1) $15\text{ mL}/\cancel{\text{h}} \times 24\ \cancel{\text{h}}/\text{day} = 360\text{ mL/day}$

3) $\frac{20\text{ mEq}}{1{,}000\text{ mL}} \times \frac{X\text{ mEq}}{250\text{ mL}}$

$1{,}000X = 5{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{5{,}000}{1{,}000}$

X = 5 mEq

4) $\frac{2\text{ mEq}}{1\text{ mL}} \times \frac{5\text{ mEq}}{X\text{ mL}}$

$2X = 5$

$\frac{2X}{2} = \frac{5}{2}$

X = 2.5 mL

5) Total volume: 250 mL ($D_5W\,\frac{1}{2}$ NS) + 2.5 mL (KCl) = 252.5 mL

Per hour:

$$\frac{5 \text{ mEq}}{252.5 \text{ mL}} \times \frac{X \text{ mEq}}{15 \text{ mL}}$$

$$252.5X = 75$$

$$\frac{252.5X}{252.5} = \frac{75}{252.5}$$

$$X = 0.3 \text{ mEq (per hour)}$$

6) $0.3 \text{ mEq}/\cancel{\text{h}} \times 24 \ \cancel{\text{h}}/\text{day} = 7.2 \text{ mEq/day}$

7) $\text{BSA (m}^2) = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} = \sqrt{\frac{18 \times 5}{3{,}131}} = \sqrt{\frac{90}{3{,}131}}$

$= \sqrt{0.028...} = 0.17 \text{ m}^2$

Recommended maximum daily dosage:

$40 \text{ mEq}/\cancel{\text{m}^2}/\text{day} \times 0.17 \ \cancel{\text{m}^2} = 6.8 \text{ mEq/day}$

Ordered dosage is not safe. Dosage as ordered would be too high. The physician should be called for clarification.

8) $$\frac{10 \text{ mEq}}{1{,}000 \text{ mL}} \times \frac{X \text{ mEq}}{480 \text{ mL}}$$

$$1{,}000X = 4{,}800$$

$$\frac{1{,}000X}{1{,}000} = \frac{4{,}800}{1{,}000}$$

$$X = 4.8 \text{ mEq}$$

$$\frac{2 \text{ mEq}}{1 \text{ mL}} \times \frac{4.8 \text{ mEq}}{X \text{ mL}}$$

$$2X = 4.8$$

$$\frac{2X}{2} = \frac{4.8}{2}$$

$$X = 2.4 \text{ mL}$$

Review Set 45 from page 395

1) 4 **2)** 25 **3)** 1,600; 67 **4)** 1,150; 48 **5)** 1,800; 75 **6)** 350; 15 **7)** 3.5 or 4; 11.6 or 12 **8)** 2.6 or 3; 65 **9)** 2.3 or 3; 35 **10)** This order should be questioned because normal saline is an isotonic solution and appears to be a continuous infusion for this child. This solution does not contribute enough electrolytes for the child and water intoxication may result. Hint: The equipment measures whole mL; therefore, round to the next whole mL.

Solutions—Review Set 45

1) $$\frac{100 \text{ mg}}{1 \text{ mL}} \times \frac{400 \text{ mg}}{X \text{ mL}}$$

$$100X = 400$$

$$\frac{100X}{100} = \frac{400}{100}$$

$$X = 4 \text{ mL}$$

3) $100 \text{ mL}/\cancel{\text{kg}}/\text{day} \times 10 \ \cancel{\text{kg}} = 1{,}000 \text{ mL/day for first 10 kg}$

$50 \text{ mL}/\cancel{\text{kg}}/\text{day} \times 10 \ \cancel{\text{kg}} = 500 \text{ mL/day for next 10.5 kg}$

$20 \text{ mL}/\cancel{\text{kg}}/\text{day} \times 5 \ \cancel{\text{kg}} = \underline{100 \text{ mL/day for remaining}}$

$\text{Total} = 1{,}600 \text{ mL/day or per 24 h}$

$\frac{1{,}600 \text{ mL}}{24 \text{ h}} = 67 \text{ mL/h}$

4) $100 \text{ mL}/\cancel{\text{kg}}/\text{day} \times 10 \ \cancel{\text{kg}} = 1{,}000 \text{ mL/day for first 10 kg}$

$50 \text{ mL}/\cancel{\text{kg}}/\text{day} \times 3 \ \cancel{\text{kg}} = \underline{150 \text{ mL/day for up to next 10 kg}}$

$\text{Total} = 1{,}150 \text{ mL/day or per 24 h}$

$\frac{1{,}150 \text{ mL}}{24 \text{ h}} = 48 \text{ mL/h}$

5) $$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{77 \text{ lb}}$$

$$2.2X = 77$$

$$\frac{2.2X}{2.2} = \frac{77}{2.2}$$

$$X = 35 \text{ kg}$$

$$
\begin{aligned}
100\text{ mL}/\cancel{\text{kg}}/\text{day} \times 10\ \cancel{\text{kg}} &= 1{,}000\text{ mL/day for first 10}\\
50\text{ mL}/\cancel{\text{kg}}/\text{day} \times 10\ \cancel{\text{kg}} &= \phantom{1{,}}500\text{ mL/day for next 10}\\
20\text{ mL}/\cancel{\text{kg}}/\text{day} \times 5\ \cancel{\text{kg}} &= \underline{\phantom{1{,}}300\text{ mL/day for remaining}}\\
\text{Total} &= 1{,}800\text{ mL/day or per 24 h}\\
\frac{1{,}800\text{ mL}}{24\text{ h}} &= 75\text{ mL/h}
\end{aligned}
$$

7)

$$\frac{100\text{ mg}}{1\text{ ml}} \times \frac{350\text{ mg}}{X\text{ mL}}$$

$$100X = 350$$

$$\frac{100X}{100} = \frac{350}{100}$$

$$X = 3.5 \text{ or } 4\text{ mL (min. dilution volume)}$$

$$\frac{30\text{ mg}}{1\text{ mL}} \times \frac{350\text{ mg}}{X\text{ mL}}$$

$$30X = 350$$

$$\frac{30X}{30} = \frac{350}{30}$$

$$X = 11.6 \text{ or } 12\text{ mL (max. dilution volume)}$$

Practice Problems—Chapter 15 from pages 396–403

1) 1.17; 1.8–2.3; Yes; 2; 0.5 **2)** 0.51; 41; 0.82 **3)** 0.43; 108 **4)** 2.2 **5)** 0.7 **6)** 350 **7)** 1 of each (one 100-mg capsule and one 250-mg capsule) **8)** 0.8; 2,000 **9)** 2.7 **10)** No **11)** 1.3; 26 **12)** 13 **13)** 1.69 **14)** 1.11 **15)** 0.32 **16)** 1.92 **17)** 1.63 **18)** 0.69 **19)** 1.67 **20)** 0.52 **21)** 560,000 **22)** 1,085; 1.09 **23)** 1.9–3.8 **24)** 8 **25)** 40 **26)** 45; 90; 4.2; 25.8 **27)** 58.8 **28)** 60; 60; 1.9; 43.1 **29)** 22.8 **30)** 10; 33 **31)** 6.2; 37.8 **32)** 10.8; 5.4 **33)** 14; 7 **34)** 3.8; 1.9 **35)** 1,520; 63 **36)** 1,810; 75 **37)** 1,250; 52 **38)** 240; 10 **39)** 1,500–1,875; 250–312.5; Yes; 2.8 **40)** 35; 2.8; 32.2 **41)** 12.3; 1,230; 308; Yes; 6.2 **42)** 23; 6.2; 16.8 **43)** 330–495; 110–165; Yes; 3.3 **44)** 25; 3.3; 21.7 **45)** 1,800–2,700; 300–450; No; exceeds maximum dose; Do not give dosage ordered. **46)** Consult physician before further action. **47)** 25; 2,500,000-6,250,000; 416,667–1,041,667 **48)** Yes; 2.6 **49)** 20; 2.6; 17.4

50) **Prevention:** The nurse made several assumptions in trying to calculate and prepare this chemotherapy quickly. The nurse assumed that the weight notation was the same on the two units without verification. The recording of the weights as 20/.45 was confusing. Notice the period before the 45, which later the physician stated was the calculated BSA, 0.45 m^2. Because no unit of measure was identified, it was unclear what those numbers really meant. Never assume; always ask for clarification when notation is unclear. Also, a child who weighs 20 lb and a child who weighs 45 lb are quite different in size, yet the nurse failed to notice such a size difference. This nurse, though, is probably not used to discriminating small children's weight differences, but should have realized that weight in lb is approximately two times weight in kg. Additionally, the actual volume drawn up was probably small in comparison to most adult dose volumes that this nurse prepares. The amount of 1.6 mL likely seemed reasonable to the nurse. Finally, this is an instance in which the person giving the medication, the physician, prevented a medication error by stopping and thinking what is a reasonable amount for this child and questioning the actual calculation of the dose. Remember, the person who administers the medication is the last point at which a potential error can be avoided.

Solutions—Practice Problems—Chapter 15

1) Household: BSA $(\text{m}^2) = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} = \sqrt{\frac{50 \times 85}{3{,}131}}$

$= \sqrt{\frac{4{,}250}{3{,}131}} = \sqrt{1.357...} = 1.165 \text{ m}^2 = 1.17 \text{ m}^2$

Recommended dosage range:

$1.5 \text{ mg}/\cancel{\text{m}^2} \times 1.17 \cancel{\text{m}^2} = 1.8 \text{ mg}$

$2 \text{ mg}/\cancel{\text{m}^2} \times 1.17 \cancel{\text{m}^2} = 2.3 \text{ mg}$

Ordered dosage is safe.

$\frac{1 \text{ mg}}{1 \text{ mL}} \times \frac{2 \text{ mg}}{\text{X mL}}$

X = 2 mL

Give 2 mL/min

$\frac{2 \text{ mL}}{60 \text{ sec}} \times \frac{\text{X mL}}{15 \text{ sec}}$

$60\text{X} = 30$

$\frac{60\text{X}}{60} = \frac{30}{60}$

X = 0.5 mL (per 15 sec)

2) BSA = 0.51 m^2

$80 \text{ mg}/\cancel{\text{m}^2}/\text{day} \times 0.51 \cancel{\text{m}^2} = 41.6 \text{ mg/day} =$

41 mg/day

$\frac{50 \text{ mg}}{1 \text{ mL}} \times \frac{41 \text{ mg}}{\text{X mL}}$

$50\text{X} = 41$

$\frac{50\text{X}}{50} = \frac{41}{50}$

X = 0.82 mL

3) BSA = 0.43 m^2

$250 \text{ mcg}/\cancel{\text{m}^2}/\text{day} \times 0.43 \cancel{\text{m}^2}$

= 108 mcg/day

4) $\frac{500 \text{ mcg}}{10 \text{ mL}} \times \frac{108 \text{ mcg}}{\text{X mL}}$

$500\text{X} = 1{,}080$

$\frac{500\text{X}}{500} = \frac{1{,}080}{500}$

X = 2.2 mL

6) $0.5 \text{ g}/\cancel{\text{m}^2} \times 0.7 \cancel{\text{m}^2} = 0.35 \text{ g}$

$0.35 \text{ g} = 0.35 \times 1{,}000 = 350 \text{ mg}$

8) BSA = 0.8 m^2

$2{,}500 \text{ units}/\cancel{\text{m}^2} \times 0.8 \cancel{\text{m}^2} = 2{,}000 \text{ units}$

9) $\frac{750 \text{ units}}{1 \text{ mL}} \times \frac{2{,}000 \text{ units}}{\text{X mL}}$

$750\text{X} = 2{,}000$

$\frac{750\text{X}}{750} = \frac{2{,}000}{750}$

X = 2.7 mL

10) Dose amount exceeds child maximum IM volume per injection site; give in 2 injections.

11) Metric: BSA $(\text{m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} =$

$\sqrt{\frac{140 \times 43.5}{3{,}600}} = \sqrt{\frac{6{,}090}{3{,}600}} = \sqrt{1.691...} = 1.3 \text{ m}^2$

$20 \text{ mg}/\cancel{\text{m}^2} \times 1.3 \cancel{\text{m}^2} = 26 \text{ mg}$

12) $\frac{2 \text{ mg}}{1 \text{ mL}} \times \frac{26 \text{ mg}}{\text{X mL}}$

$2\text{X} = 26$

$\frac{2\text{X}}{2} = \frac{26}{2}$

X = 13 mL

13) 1 ft = 12 in

$\frac{1 \text{ ft}}{12 \text{ in}} \times \frac{5 \text{ ft}}{\text{X in}}$

X = 60 in

60 in + 6 in = 66 in

Household: BSA $(\text{m}^2) = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} =$

$\sqrt{\frac{66 \times 136}{3{,}131}} = \sqrt{\frac{8{,}976}{3{,}131}} = \sqrt{2.866...} = 1.693 \text{ m}^2 =$

1.69 m^2

15) Metric: BSA $(\text{m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} = \sqrt{\frac{60 \times 6}{3{,}600}}$

$= \sqrt{\frac{360}{3{,}600}} = \sqrt{0.1} = 0.32 \text{ m}^2$

19) 1 in = 2.5 cm

$\frac{1 \text{ in}}{2.5 \text{ cm}} \times \frac{64 \text{ in}}{\text{X cm}}$

X = 160 cm

Metric: BSA $(\text{m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} =$

$\sqrt{\frac{160 \times 63}{3{,}600}} = \sqrt{\frac{10{,}080}{3{,}600}} = \sqrt{2.8} = 1.67 \text{ m}^2$

22) $500 \text{ mg}/\cancel{\text{m}^2} \times 2.17 \cancel{\text{m}^2} = 1{,}085 \text{ mg}$

$1{,}085 \text{ mg} = 1{,}085 \div 1{,}000 = 1.085 \text{ g} = 1.09 \text{ g}$

24) $6 \text{ mg}/\cancel{\text{m}^2} \times 1.34 \cancel{\text{m}^2} = 8 \text{ mg}$

25) $8 \text{ mg}/\cancel{\text{day}} \times 5 \cancel{\text{days}} = 40 \text{ mg}$

26) Total volume = 30 mL + 15 mL = 45 mL

Flow rate: $\frac{45 \text{ mL}}{30 \text{ min}} \times \frac{\text{X mL}}{60 \text{ min}}$

$30\text{X} = 2{,}700$

$\frac{30\text{X}}{30} = \frac{2{,}700}{30}$

X = 90 mL

$\frac{500 \text{ mg}}{5 \text{ mL}} \times \frac{420 \text{ mg}}{\text{X mL}}$

$500\text{X} = 2{,}100$

$\frac{500\text{X}}{500} = \frac{2{,}100}{500}$

X = 4.2 mL (medication)

30 mL (total solution) − 4.2 mL (med) = 25.8 mL (D_5NS)

Note: Add 4.2 mL med. to Chamber and fill with D_5NS to 30 mL.

27) $4.2\ \text{mL}/\cancel{\text{dose}} \times 2\ \cancel{\text{doses}}/\text{day} = 8.4\ \text{mL/day}$

$8.4\ \text{mL}/\cancel{\text{day}} \times 7\ \cancel{\text{days}} = 58.8\ \text{mL (total)}$

28) Total volume: 45 mL + 15 mL = 60 mL

Flow rate: $\frac{60\ \text{mL}}{60\ \text{min}} = 60\ \text{mL/h}$

$$\frac{75\ \text{mg}}{0.5\ \text{mL}} \times \frac{285\ \text{mg}}{X\ \text{mL}}$$

$75X = 142.5$

$\frac{75X}{75} = \frac{142.5}{75}$

X = 1.9 mL (medication)

Volume of IV fluid: 45 mL − 1.9 mL = 43.1 mL

29) $1.9\ \text{mL}/\cancel{\text{dose}} \times 3\ \cancel{\text{doses}}/\text{day} = 5.7\ \text{mL/day}$

$5.7\ \text{mL}/\cancel{\text{day}} \times 4\ \cancel{\text{days}} = 22.8\ \text{mL (total)}$

30) $$\frac{50\ \text{mg}}{1\ \text{mL}} \times \frac{500\ \text{mg}}{X\ \text{mL}}$$

$50X = 500$

$\frac{50X}{50} = \frac{500}{50}$

X = 10 mL (medication)

$$\frac{65\ \text{mL}}{60\ \text{min}} \times \frac{X\ \text{mL}}{40\ \text{min}}$$

$60X = 2{,}600$

$\frac{60X}{60} = \frac{2{,}600}{60}$

X = 43.3 mL = 43 mL

43 mL (total solution) − 10 mL (med) = 33 mL (D_5 0.33% NaCl)

32) $$\frac{30\ \text{mEq}}{1{,}000\ \text{mL}} \times \frac{X\ \text{mEq}}{360\ \text{mL}}$$

$1{,}000X = 10{,}800$

$\frac{1{,}000X}{1{,}000} = \frac{10{,}800}{1000}$

X = 10.8 mEq

$$\frac{2\ \text{mEq}}{1\ \text{mL}} \times \frac{10.8\ \text{mEq}}{X\ \text{mL}}$$

$2X = 10.8$

$\frac{2X}{2} = \frac{10.8}{2}$

X = 5.4 mL

35) $100\ \text{mL}/\cancel{\text{kg}}/\text{day} \times 10\ \cancel{\text{kg}}$ = 1,000 mL/day for first 10 kg

$50\ \text{mL}/\cancel{\text{kg}}/\text{day} \times 10\ \cancel{\text{kg}}$ = 500 mL/day for next 10 kg

$20\ \text{mL}/\cancel{\text{kg}}/\text{day} \times 1\ \cancel{\text{kg}}$ = 20 mL/day for remaining 1 kg

1,520 mL/day or per 24 h

$\frac{1{,}520\ \text{mL}}{24\ \text{h}} = 63.3\ \text{mL/h} = 63\ \text{mL/h}$

36) $$\frac{1\ \text{kg}}{2.2\ \text{lb}} \times \frac{X\ \text{kg}}{78\ \text{lb}}$$

$2.2X = 78$

$\frac{2.2X}{2.2} = \frac{78}{2.2}$

X = 35.5 kg

$100\ \text{mL}/\cancel{\text{kg}}/\text{day} \times 10\ \cancel{\text{kg}}$ = 1,000 mL/day for first 10 kg

$50\ \text{mL}/\cancel{\text{kg}}/\text{day} \times 10\ \cancel{\text{kg}}$ = 500 mL/day for next 10 kg

$20\ \text{mL}/\cancel{\text{kg}}/\text{day} \times 15.5\ \cancel{\text{kg}}$ = 310 mL/day for remaining 15.5 kg

1,810 mL/day or per 24 h

$\frac{1{,}810\ \text{mL}}{24\ \text{h}} = 75.4\ \text{mL/h} = 75\ \text{mL/h}$

38) $$\frac{1\ \text{kg}}{1{,}000\ \text{mg}} \times \frac{X\ \text{kg}}{2{,}400\ \text{mg}}$$

$1{,}000X = 2{,}400$

$\frac{1{,}000X}{1{,}000} = \frac{2{,}400}{1{,}000}$

X = 2.4 kg

$100\ \text{mL}/\cancel{\text{kg}}/\text{day} \times 2.4\ \cancel{\text{kg}} = 250\ \text{mL/day}$

$\frac{240\ \text{mL}}{24\ \text{h}} = 10\ \text{mL/h}$

39) Safe daily dosage range:

$100\ \text{mg}/\cancel{\text{kg}} \times 15\ \cancel{\text{kg}} = 1{,}500\ \text{mg}$

$125\ \text{mg}/\cancel{\text{kg}} \times 15\ \cancel{\text{kg}} = 1{,}875\ \text{mg}$

Safe single dosage range:

$\frac{1{,}500}{6\ \text{doses}} = 250\ \text{mg/dose}$

$\frac{1{,}875}{6\ \text{doses}} = 312.5\ \text{mg/dose}$

Yes, the dosage is safe.

$1 \text{ g} = 1{,}000 \text{ mg}$

$\frac{1{,}000 \text{ mg}}{10 \text{ mL}} \times \frac{275 \text{ mg}}{X \text{ mL}}$

$1{,}000X = 2{,}750$

$\frac{1{,}000X}{1{,}000} = \frac{2{,}750}{1{,}000}$

$X = 2.8 \text{ mL}$

40) IV fluid volume:

$\frac{53 \text{ mL}}{60 \text{ min}} \times \frac{X \text{ mL}}{40 \text{ min}}$

$60X = 2{,}120$

$\frac{60X}{60} = \frac{2{,}120}{60}$

$X = 35.3 \text{ mL} = 35 \text{ mL}$

35 mL (total) – 2.8 mL (med.) =
32.2 mL (D_5 0.45% NaCl)

45) Safe daily dosage range:

$200 \text{ mg/}\cancel{\text{kg}} \times 9 \cancel{\text{kg}} = 1{,}800 \text{ mg}$

$300 \text{ mg/}\cancel{\text{kg}} \times 9 \cancel{\text{kg}} = 2{,}700 \text{ mg}$

Safe single dosage range:

$\frac{1{,}800}{6 \text{ doses}} = 300 \text{ mg/dose}$

$\frac{2{,}700 \text{ mg}}{6 \text{ doses}} = 450 \text{ mg/dose}$

Dosage is *not* safe; exceeds maximum safe dosage.

Do not give dosage ordered; consult with physician.

47) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{55 \text{ lb}}$

$2.2X = 55$

$\frac{2.2X}{2.2} = \frac{55}{2.2}$

$X = 25 \text{ kg}$

Safe daily dosage:

$100{,}000 \text{ units/}\cancel{\text{kg}} \times 25 \cancel{\text{kg}} = 2{,}500{,}000 \text{ units}$

$250{,}000 \text{ units/}\cancel{\text{kg}} \times 25 \cancel{\text{kg}} = 6{,}250{,}000 \text{ units}$

Safe single dosage:

$\frac{2{,}500{,}000 \text{ units}}{6 \text{ doses}} = 416{,}667 \text{ units/dose}$

$\frac{6{,}250{,}000 \text{ units}}{6 \text{ doses}} = 1{,}041{,}667 \text{ units/dose}$

48) Yes, dosage is safe.

$\frac{200{,}000 \text{ units}}{1 \text{ mL}} \times \frac{525{,}000 \text{ units}}{X \text{ mL}}$

$200{,}000X = 525{,}000$

$\frac{200{,}000X}{200{,}000} = \frac{525{,}000}{200{,}000}$

$X = 2.6 \text{ mL}$

49) $\frac{60 \text{ mL}}{60 \text{ min}} \times \frac{X \text{ mL}}{20 \text{ min}}$

$60X = 1{,}200$

$\frac{60X}{60} = \frac{1{,}200}{60}$

$X = 20 \text{ mL}$

20 mL (total) − 2.6 mL (med.) = 17.4 mL (D_5NS)

Review Set 46 from pages 411-412

1) 40 **2)** 14 **3)** 10 **4)** 19 **5)** 48; consult physician **6)** 16 **7)** 75; 6,000; 6; 1,350; 14 **8)** 6,000; 6; 1,650; 17 **9)** 3,000; 3; 1,800; 18 **10)** Continue the rate at 1,800 units/h or 18 mL/h **11)** 10 **12)** 50 **13)** 4 **14)** 20 **15)** 8

Solutions—Review Set 46

1) $\frac{25{,}000 \text{ units}}{1{,}000 \text{ mL}} \times \frac{1{,}000 \text{ units/h}}{X \text{ mL/h}}$

$25{,}000X = 1{,}000{,}000$

$\frac{25{,}000X}{25{,}000} = \frac{1{,}000{,}000}{25{,}000}$

$X = 40 \text{ mL/h}$

4) $\frac{40{,}000 \text{ units}}{500 \text{ mL}} \times \frac{1{,}500 \text{ units/h}}{X \text{ mL/h}}$

$40{,}000X = 750{,}000$

$\frac{40{,}000X}{40{,}000} = \frac{750{,}000}{40{,}000}$

$X = 19 \text{ mL/h}$

5) $\frac{25{,}000 \text{ units}}{1{,}000 \text{ mL}} \times \frac{1{,}200 \text{ units/h}}{X \text{ mL/h}}$

$25{,}000X = 1{,}200{,}000$

$\frac{25{,}000X}{25{,}000} = \frac{1{,}200{,}000}{25{,}000}$

$X = 48 \text{ mL/h}$

The IV is infusing too rapidly. The physician should be called immediately for further action.

6) $\frac{25{,}000 \text{ units}}{500 \text{ mL}} \times \frac{800 \text{ units/h}}{X \text{ mL/h}}$

$25{,}000X = 400{,}000$

$\frac{25{,}000X}{25{,}000} = \frac{400{,}000}{25{,}000}$

$X = 16 \text{ mL/h}$

7) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{165\text{ lb}}$

$2.2X = 165$

$\frac{2.2X}{2.2} = \frac{165}{2.2}$

$X = 75\text{ kg}$

Initial heparin bolus: 80 units/$\cancel{\text{kg}}$ × 75 $\cancel{\text{kg}}$ = 6,000 units

$\frac{1{,}000\text{ units}}{1\text{ mL}} \times \frac{6{,}000\text{ units}}{X\text{ mL}}$

$1{,}000X = 6{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{6{,}000}{1{,}000}$

$X = 6\text{ mL}$

Initial Heparin infusion rate: 18 units/$\cancel{\text{kg}}$/h × 75 $\cancel{\text{kg}}$ = 1,350 units/h

$\frac{25{,}000\text{ units}}{250\text{ mL}} \times \frac{1{,}350\text{ units/h}}{X\text{ mL/h}}$

$25{,}000X = 337{,}500$

$\frac{25{,}000X}{25{,}000} = \frac{337{,}500}{25{,}000}$

$X = 14\text{ mL/h}$

8) Rebolus: 80 units/$\cancel{\text{kg}}$ × 75 $\cancel{\text{kg}}$ = 6,000 units

$\frac{1{,}000\text{ units}}{1\text{ mL}} \times \frac{6{,}000\text{ units}}{X\text{ mL}}$

$1{,}000X = 6{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{6{,}000}{1{,}000}$

$X = 6\text{ mL}$

Reset infusion rate: 4 units/$\cancel{\text{kg}}$/h × 75 $\cancel{\text{kg}}$ = 300 units/h (increase)

1,350 units/h + 300 units/h = 1,650 units/h

$\frac{25{,}000\text{ units}}{250\text{ mL}} \times \frac{1{,}650\text{ units/h}}{X\text{ mL/h}}$

$25{,}000X = 412{,}500$

$\frac{25{,}000X}{25{,}000} = \frac{412{,}500}{25{,}000}$

$X = 17\text{ mL/h}$

9) Rebolus: 40 units/$\cancel{\text{kg}}$ × 75 $\cancel{\text{kg}}$ = 3,000 units

$\frac{1{,}000\text{ units}}{1\text{ mL}} \times \frac{3{,}000\text{ units}}{X\text{ mL}}$

$1{,}000X = 3{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{3{,}000}{1{,}000}$

$X = 3\text{ mL}$

Reset infusion rate: 2 units/$\cancel{\text{kg}}$/h × 75 $\cancel{\text{kg}}$ = 150 units/h (increase)

1,650 units/h + 150 units/h = 1,800 units/h

$\frac{25{,}000\text{ units}}{250\text{ mL}} \times \frac{1{,}800\text{ units/h}}{X\text{ mL/h}}$

$25{,}000X = 450{,}000$

$\frac{25{,}000X}{25{,}000} = \frac{450{,}000}{25{,}000}$

$X = 18\text{ mL/h}$

11) $\frac{500\text{ units}}{500\text{ mL}} \times \frac{10\text{ units/h}}{X\text{ mL/h}}$

$500X = 5{,}000$

$\frac{500X}{500} = \frac{5{,}000}{500}$

$X = 10\text{ mL/h}$

13) $\frac{125\text{ mg}}{100\text{ mL}} \times \frac{5\text{ mg/h}}{X\text{ mL/h}}$

$125X = 500$

$\frac{125X}{125} = \frac{500}{125}$

$X = 4\text{ mL/h}$

14) $\frac{125\text{ mg}}{250\text{ mL}} \times \frac{10\text{ mg/h}}{X\text{ mL/h}}$

$125X = 2{,}500$

$\frac{125X}{125} = \frac{2{,}500}{125}$

$X = 20\text{ mL/h}$

Review Set 47 from pages 421-422

1) 2; 120 **2)** 1; 60 **3)** 1.5; 90 **4)** 90; 360; 0.4; 24 **5)** 1,050; 0.66; 40 **6)** 142–568 **7)** 0.14–0.57 **8)** Yes **9)** 4 **10)** Yes **11)** 100; 25 **12)** 1 **13)** 0.025 **14)** 25 **15)** Yes

Solutions—Review Set 47

1) $\frac{2{,}000 \text{ mg}}{1{,}000 \text{ mL}} \times \frac{4 \text{ mg/min}}{X \text{ mL/min}}$

$2{,}000X = 4{,}000$

$\frac{2{,}000X}{2{,}000} = \frac{4{,}000}{2{,}000}$

$X = 2 \text{ mL/min}$

$\frac{2 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 120 \text{ mL/h}$

2) $\frac{500 \text{ mg}}{250 \text{ mL}} \times \frac{2 \text{ mg/min}}{X \text{ mL/min}}$

$500X = 500$

$\frac{500X}{500} = \frac{500}{500}$

$X = 1 \text{ mL/min}$

$\frac{1 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 60 \text{ mL/h}$

3) $\frac{2{,}000 \text{ mcg}}{500 \text{ mL}} \times \frac{6 \text{ mcg/min}}{X \text{ mL/min}}$

$2{,}000X = 3{,}000$

$\frac{2{,}000X}{2{,}000} = \frac{3{,}000}{2{,}000}$

$X = 1.5 \text{ mL/min}$

$\frac{1.5 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 90 \text{ mL/h}$

4) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{198 \text{ lb}}$

$2.2X = 198$

$\frac{2.2X}{2.2} = \frac{198}{2.2}$

$X = 90 \text{ kg}$

$4 \text{ mcg/}\cancel{\text{kg}}\text{/min} \times 90 \cancel{\text{kg}} = 360 \text{ mcg/min}$

$\frac{1{,}000 \text{ mcg}}{1 \text{ mg}} \times \frac{360 \text{ mcg/min}}{X \text{ mg/min}}$

$1{,}000X = 360$

$\frac{1{,}000X}{1{,}000} = \frac{360}{1{,}000}$

$X = 0.36 \text{ mg/min}$

$\frac{450 \text{ mg}}{500 \text{ mL}} \times \frac{0.36 \text{ mg/min}}{X \text{ mL/min}}$

$450X = 180$

$\frac{450X}{450} = \frac{180}{450}$

$X = 0.4 \text{ mL/min}$

$\frac{0.4 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 24 \text{ mL/h}$

5) $15 \text{ mcg/}\cancel{\text{kg}}\text{/min} \times 70 \cancel{\text{kg}} = 1{,}050 \text{ mcg/min}$

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{X \text{ mg/min}}{1{,}050 \text{ mcg/min}}$

$1{,}000X = 1{,}050$

$\frac{1{,}000X}{1{,}000} = \frac{1{,}050}{1{,}000}$

$X = 1.05 \text{ mg/min}$

$\frac{800 \text{ mg}}{500 \text{ mL}} \times \frac{1.05 \text{ mg/min}}{X \text{ mL/min}}$

$800X = 525$

$\frac{800X}{800} = \frac{525}{800}$

$X = 0.656 \text{ mL/min} = 0.66 \text{ mL/min}$

$\frac{0.66 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 39.6 = 40 \text{ mL/h}$

6) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{125 \text{ lb}}$

$2.2X = 125$

$\frac{2.2X}{2.2} = \frac{125}{2.2}$

$X = 56.8 \text{ kg}$

Minimum: $2.5 \text{ mcg/}\cancel{\text{kg}}\text{/min} \times 56.8 \cancel{\text{kg}} =$
142 mcg/min

Maximum: $10 \text{ mcg/}\cancel{\text{kg}}\text{/min} \times 56.8 \cancel{\text{kg}} =$
568 mcg/min

7) Minimum:

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{X \text{ mg/min}}{142 \text{ mcg/min}}$

$1{,}000X = 142$

$\frac{1{,}000X}{1{,}000} = \frac{142}{1{,}000}$

$X = 0.142 = 0.14 \text{ mg/min}$

Maximum:

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{X \text{ mg/min}}{568 \text{ mcg/min}}$

$1{,}000X = 568$

$\frac{1{,}000X}{1{,}000} = \frac{568}{1{,}000}$

$X = 0.568 = 0.57 \text{ mg/min}$

8) $\frac{500 \text{ mg}}{500 \text{ mL}} \times \frac{X \text{ mg/h}}{15 \text{ mL/h}}$

$500X = 7{,}500$

$\frac{500X}{500} = \frac{7{,}500}{500}$

$X = 15 \text{ mg/h}$

$$\frac{15\text{ mg}}{60\text{ min}} \times \frac{X\text{ mg}}{1\text{ min}}$$

$60X = 15$

$$\frac{60X}{60} = \frac{15}{60}$$

$X = 0.25$ mg (per min) or 0.25 mg/min

Yes, the order is within the safe range of 0.14–0.57 mg/min.

9) $$\frac{2{,}000\text{ mg}}{500\text{ mL}} \times \frac{X\text{ mg/h}}{60\text{ mL/h}}$$

$500X = 120{,}000$

$$\frac{500X}{500} = \frac{120{,}000}{500}$$

$X = 240$ mg/h

$$\frac{240\text{ mg/h}}{60\text{ min/h}} \times \frac{X\text{ mg}}{1\text{ min}}$$

$60X = 240$

$$\frac{60X}{60} = \frac{240}{60}$$

$X = 4$ mg (per min) or 4 mg/min

10) Yes, 4 mg/min is within the normal range of 2–6 mg/min.

11) Bolus:

$$\frac{2\text{ g}}{30\text{ min}} \times \frac{X\text{ g}}{60\text{ min}}$$

$30X = 120$

$X = 4$ g (per 60 min or 4 g/h)

$$\frac{20\text{ g}}{500\text{ mL}} \times \frac{4\text{ g/h}}{X\text{ mL/h}}$$

$20X = 2{,}000$

$$\frac{20X}{20} = \frac{2{,}000}{20}$$

$X = 100$ mL/h

Continuous:

$$\frac{20\text{ mg}}{500\text{ mL}} \times \frac{1\text{ g/h}}{X\text{ mL/h}}$$

$20X = 500$

$$\frac{20X}{20} = \frac{500}{20}$$

$X = 25$ mL/h

12) $$\frac{1\text{ unit}}{1{,}000\text{ milliunits}} \times \frac{X\text{ units}}{1\text{ milliunit}}$$

$1{,}000X = 1$

$$\frac{1{,}000X}{1{,}000} = \frac{1}{1{,}000}$$

$X = 0.001$ units

$$\frac{15\text{ units}}{250\text{ mL}} \times \frac{0.001\text{ units/min}}{X\text{ mL/min}}$$

$15X = 0.25$

$$\frac{15X}{15} = \frac{0.25}{15}$$

$X = 0.017$ mL/min

$$\frac{0.017\text{ mL}}{1\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$$

$X = 1.02$ mL/h $= 1$ mL/h

13) $$\frac{10\text{ mg}}{1{,}000\text{ mL}} \times \frac{X\text{ mg/h}}{150\text{ mL/h}}$$

$1{,}000X = 1{,}500$

$$\frac{1{,}000X}{1{,}000} = \frac{1{,}500}{1{,}000}$$

$X = 1.5$ mg/h

$$X = \frac{1.5\text{ mg/}\cancel{h}}{60\text{ min/}\cancel{h}} = 0.025\text{ mg/min}$$

14) $$\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{0.025\text{ mg/min}}{X\text{ mcg/min}}$$

$X = 25$ mcg/min

Review Set 48 from pages 424-425

1) 33; 19 **2)** 40; 42 **3)** 25; 32 **4)** 50; 90 **5)** 50; 40 **6)** 100; 100 **7)** 200; 76 **8)** 200; 122 **9)** 17; 21 **10)** 120; 112

Solutions—Review Set 48

1) Step 1. IV PB rate: $\frac{V}{T} \times C = \frac{100\,\cancel{\text{mL}}}{\underset{3}{\cancel{30}}\text{ min}} \times \overset{1}{\cancel{10}}\text{ gtt/}\cancel{\text{mL}} =$

$\frac{100}{3}\text{ gtt/min} = 33\text{ gtt/min}$

Step 2. Total IV PB time: q.4h × 30 min = 6 × 30 min = 180 min; 180 $\cancel{\text{min}}$ ÷ 60 $\cancel{\text{min}}$/h = 3 h

Step 3. Total IV PB volume: 6 × 100 mL = 600 mL

Step 4. Total Regular IV volume: 3,000 mL − 600 mL = 2,400 mL

Step 5. Total Regular IV time: 24 h − 3 h = 21 h

Step 6. Regular IV rate:

$$\frac{2{,}400 \text{ mL}}{21 \text{ h}} = 114 \text{ mL/h}$$

$$\frac{\text{mL/h}}{\text{drop factor constant}} = \text{gtt/min}; \frac{114 \text{ mL/h}}{6} = 19 \text{ gtt/min}$$

2) Step 1. IV PB rate: When drop factor is 60 gtt/mL, then mL/h = gtt/min. Rate is 40 gtt/min.

Step 2. Total IV PB time: q.i.d. × 1 h = 4 × 1 h = 4 h

Step 3. Total IV PB volume: 4 × 40 mL = 160 mL

Step 4. Total Regular IV volume: 1,000 mL − 160 mL = 840 mL

Step 5. Total Regular IV time: 24 h − 4 h = 20 h

Step 6. Total Regular IV rate: mL/h = $\frac{840 \text{ mL}}{20 \text{ h}}$ = 42 mL/h. When drop factor is 60 gtt/mL, then mL/h = gtt/min. Rate is 42 gtt/min.

3) Step 1. IV PB rate: $\frac{V}{T} \times C = \frac{50 \cancel{\text{mL}}}{\underset{2}{\cancel{30}} \text{ min}} \times \overset{1}{\cancel{15}} \text{ gtt/}\cancel{\text{mL}} = \frac{50}{2} \text{gtt/min} = 25 \text{ gtt/min}$

Step 2. Total IV PB time: q.6h × 30 min = 4 × 30 min = 120 min; 120 $\cancel{\text{min}}$ ÷ 60 $\cancel{\text{min}}$/h = 2 h

Step 3. Total IV PB volume: 4 × 50 mL = 200 mL

Step 4. Total Regular IV volume: 3,000 mL − 200 mL = 2,800 mL

Step 5. Total Regular IV time: 24 h − 2 h = 22 h

Step 6. Total Regular IV rate:

$$\frac{2{,}800}{22 \text{ h}} = 127 \text{ mL/h}$$

$$\frac{\text{mL/h}}{\text{drop factor constant}} = \text{gtt/min}; \frac{127 \text{ mL/h}}{4} = 32 \text{ gtt/min}$$

4) Step 1. IV PB rate: 50 mL/h or 50 gtt/min (because drop factor is 60 gtt/mL)

Step 2. Total IV PB time: q.6h × 1 h = 4 × 1 h = 4 h

Step 3. Total IV PB volume: 4 × 50 mL = 200 mL

Step 4. Total Regular IV volume: 2,000 mL − 200 mL = 1,800 mL

Step 5. Total Regular IV time: 24 h − 4 h = 20 h

Step 6. Regular IV rate: $\frac{1{,}800 \text{ mL}}{20 \text{ h}}$ = 90 mL/h or 90 gtt/min (because drop factor is 60 gtt/mL)

5) Step 1. IV PB rate: 50 mL/h or 50 gtt/min (because drop factor is 60 gtt/mL)

Step 2. IV PB time: q.8h × 1 h = 3 × 1 h = 3 h

Step 3. IV PB volume: 3 × 50 mL = 150 mL

Step 4. Total Regular IV volume: 1,000 mL − 150 mL = 850 mL

Step 5. Total Regular IV time: 24 h − 3 h = 21 h

Step 6. Regular IV rate: $\frac{850 \text{ mL}}{21 \text{ h}}$ = 40 mL/h or 40 gtt/min (because drop factor is 60 gtt/mL)

6) Step 1. IV PB rate

$$\frac{50 \text{ mL}}{30 \text{ min}} \times \frac{X \text{ mL}}{60 \text{ min}}$$

$$30X = 3{,}000$$

$$\frac{30X}{30} = \frac{3{,}000}{30}$$

$$X = 100 \text{ mL}; 100 \text{ mL per } 60 \text{ min} = 100 \text{ mL/h}$$

Step 2. IV PB time: q.6h × 30 min = 4 × 30 min = 120 min; 120 $\cancel{\text{min}}$ ÷ 60 $\cancel{\text{min}}$/h = 2 h

Step 3. IV PB volume: 4 × 50 mL = 200 mL

Step 4. Total Regular IV volume: 2,400 mL − 200 mL = 2,200 mL

Step 5. Total Regular IV time: 24 h − 2 h = 22 h

Step 6. Regular IV rate: $\frac{2{,}200 \text{ mL}}{22 \text{ h}} = 100 \text{ mL/h}$

7) Step 1. IV PB rate:

$$\frac{100 \text{ mL}}{30 \text{ min}} \times \frac{X \text{ mL}}{60 \text{ min}}$$

$$30X = 6{,}000$$

$$\frac{30X}{30} = \frac{6{,}000}{30}$$

$$X = 200 \text{ mL; } 200 \text{ mL per } 60 \text{ min} = 200 \text{ mL/h}$$

Step 2. IV PB time: q.8h × 30 min = 3 × 30 min = 90 min; $90 \text{ } \cancel{\text{min}} \div 60 \text{ } \cancel{\text{min}}\text{/h} = 1\frac{1}{2} \text{ h}$

Step 3. IV PB volume: 3 × 100 mL = 300 mL

Step 4. Total Regular IV volume: 2,000 mL – 300 mL = 1,700 mL

Step 5. Total Regular IV time: $24 \text{ h} - 1\frac{1}{2} \text{ h} = 22\frac{1}{2} \text{ h}$

Step 6. Regular IV rate: $\frac{1{,}700 \text{ mL}}{22.5 \text{ h}} = 76 \text{ mL/h}$

8) Step 1. IV PB rate

$$\frac{50 \text{ mL}}{15 \text{ min}} \times \frac{X \text{ mL}}{60 \text{ min}}$$

$$15X = 3{,}000$$

$$\frac{15X}{15} = \frac{3{,}000}{15}$$

$$X = 200 \text{ mL; } 200 \text{ mL per } 60 \text{ min} = 200 \text{ mL/h}$$

Step 2. IV PB time: q.6h × 15 min = 4 × 15 min = 60 min = 1 h

Step 3. IV PB volume: 4 × 50 mL = 200 mL

Step 4. Total Regular IV volume: 3000 mL − 200 mL = 2800 mL

Step 5. Total Regular IV time: 24 h − 1 h = 23 h

Step 6. Regular IV rate: $\frac{2{,}800}{23 \text{ h}} = 121.7 \text{ mL/h} = 122 \text{ mL/h}$

Practice Problems—Chapter 16 from pages 426-432

1) 60 **2)** 5 **3)** 20 **4)** 50 **5)** 1 **6)** 12 **7)** 50 **8)** 63 **9)** 35 **10)** 6; 15 **11)** 60 **12)** 45 **13)** 60 **14)** 24 **15)** Yes **16)** 17; 22 **17)** 100; 127 **18)** 102 **19)** 8 mEq **20)** 2 **21)** 15 **22)** 50; 50 **23)** 75; 75 **24)** 7.4 **25)** 12; 18 **26)** 150; 50 **27)** 2 **28)** 35 **29)** 8 **30)** 63 **31)** 80 **32)** 0.4 **33)** 4 **34)** 4 **35)** 100 **36)** 0.2; 200 **37)** 30 **38)** 200; 50 **39)** 5 **40)** 550 **41)** 2,450 **42)** 19 **43)** 129 **44)** 13; 39 **45)** (Worksheet page 539) 100; 80 **46)** 8,000; 1,000; 8 **47)** 18; 1,800; 100; 18 **48)** 6; 4,000; 4; increase; 200; 2; 20 **49)** Decrease rate by 2 units/kg/h; 18

50) **Prevention:** The nurse who prepares any IV solution with an additive should *carefully* compare the order and medication three times: before beginning to prepare the dose, after the dosage is prepared, and just before it is administered to the patient. Further, the nurse should verify the safety of the dosage using the three-step method (convert, think, and calculate). It was clear that the nurse realized the error when a colleague questioned what was being prepared and the nurse verified the actual order. Also taking the time to do the calculation on paper helps the nurse to "see" the answer and avoid a potentially life-threatening error. The precriber should also write out units and milliunits (U and mU are not permitted abbreviations). The nurse should contact the prescriber to clarify an order when unacceptable notation is used.

STANDARD WEIGHT-BASED HEPARIN PROTOCOL WORKSHEET

Round Patient's Total Body Weight to Nearest 10 kg: 100 kg

DO NOT Change the Weight Based on Daily Measurements

FOUND ON THE ORDER FORM

Initial Bolus (80 units/kg) 8,000 units 8 mL

Initial Infusion Rate (18 units/kg/h) 1,800 units/h 18 mL/h

Make adjustments to the heparin drip rate as directed by the order form.

ALL DOSES ARE ROUNDED TO THE NEAREST 100 UNITS

Date	Time	APTT	Bolus	Rate Change		New Rate	RN 1	RN 2
				Units/h	mL/h			
5/10/XX	1730	37 sec	4,000 units (4 mL)	+200 units/h	+2 mL/h	20 mL/h	G.P.	M.S.
5/10/XX	2330	77 sec		−200 units/h	−2 mL/h	18 mL/h	G.P.	M.S.

Signatures	Initials
G. Pickar, R.N.	G.P.
M. Smith, R.N.	M.S.

Solutions—Practice Problems—Chapter 16

1) Volume control sets are microdrip infusion sets calibrated for 60 gtt/mL.

2) 1 g is ordered and it is prepared as a supply dosage of 1 g per 5 mL. Add 5 mL.

3) $\frac{50\text{ mL}}{60\text{ min}} \times \frac{X\text{ mL}}{30\text{ min}}$

$60X = 1{,}500$

$\frac{60X}{60} = \frac{1{,}500}{60}$

$X = 25$ mL total volume

25 mL total − 5 mL med = 20 mL D_5W

4) $\frac{\text{mL/h}}{\text{drop factor constant}} = \frac{50\text{ mL/h}}{1} = 50$ gtt/min; when drop factor is 60 gtt/mL, then mL/h = gtt/min

5) once (at 1200 hours)

6) $\frac{25{,}000\text{ units}}{250\text{ mL}} \times \frac{1{,}200\text{ units/h}}{X\text{ mL/h}}$

$25{,}000X = 300{,}000$

$\frac{25{,}000X}{25{,}000} = \frac{30{,}000}{25{,}000}$

$X = 12$ mL/h

7) $\frac{100\text{ mg}}{1{,}000\text{ mL}} \times \frac{5\text{ mg/h}}{X\text{ mL/h}}$

$100X = 5{,}000$

$\frac{100X}{100} = \frac{5{,}000}{100}$

$X = 50$ mL/h

8) $\frac{4{,}000\text{ mg}}{500\text{ mL}} \times \frac{500\text{ mg/h}}{X\text{ mL/h}}$

$4{,}000X = 250{,}000$

$\frac{4{,}000X}{4{,}000} = \frac{250{,}000}{4{,}000}$

$X = 63$ mL/h

9) $\frac{20{,}000\text{ units}}{500\text{ mL}} \times \frac{1{,}400\text{ units/h}}{X\text{ mL/h}}$

$20{,}000X = 700{,}000$

$\frac{20{,}000X}{20{,}000} = \frac{700{,}000}{20{,}000}$

$X = 35$ mL/h

10) $\frac{1\text{ L}}{1{,}000\text{ mL}} = \frac{1.5\text{ L}}{X\text{ mL}}$

$X = 1{,}500$ mL

$\frac{1{,}500\ \cancel{\text{mL}}}{4\ \cancel{\text{mL}}/\text{min}} = 375$ min

$375\ \cancel{\text{min}} \div 60\ \cancel{\text{min}}/\text{h} = 6.25 = 6\frac{1}{4}\text{ h} = 6\text{ h }15\text{ min}$

11) $\frac{2{,}000 \text{ mg}}{500 \text{ mL}} \times \frac{4 \text{ mg/min}}{X \text{ mL/min}}$

$2{,}000X = 2{,}000$

$\frac{2{,}000X}{2{,}000} = \frac{2{,}000}{2{,}000}$

$X = 1 \text{ mL/min}$

Which is the same as 60 mL per 60 min or 60 mL/h

12) $\frac{1{,}000 \text{ mg}}{250 \text{ mL}} \times \frac{3 \text{ mg/min}}{X \text{ mL/min}}$

$1{,}000X = 750$

$\frac{1{,}000X}{1{,}000} = \frac{750}{1{,}000}$

$X = 0.75 \text{ mL/min}$

$\frac{0.75 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 45 \text{ mL/h}$

13) $\frac{1{,}000 \text{ mg}}{500 \text{ mL}} \times \frac{2 \text{ mg/min}}{X \text{ mL/min}}$

$1{,}000X = 1{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{1{,}000}{1{,}000}$

$X = 1 \text{ mL/min}$

Which is the same as 60 mL per 60 min or 60 mL/h

14) $5 \text{ mcg/}\cancel{\text{kg}}\text{/min} \times 80\ \cancel{\text{kg}} = 400 \text{ mcg/min}$

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{X \text{ mg/min}}{400 \text{ mcg/min}}$

$1{,}000X = 400$

$\frac{1{,}000X}{1{,}000} = \frac{400}{1{,}000}$

$X = 0.4 \text{ mg/min}$

$\frac{250 \text{ mg}}{250 \text{ mL}} \times \frac{0.4 \text{ mg/min}}{X \text{ mL/min}}$

$250X = 100$

$\frac{250X}{250} = \frac{100}{250}$

$X = 0.4 \text{ mL/min}$

$\frac{0.4 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 24 \text{ mL/h}$

15) $\frac{2{,}000 \text{ mg}}{1{,}000 \text{ mL}} \times \frac{X \text{ mg/h}}{75 \text{ mL/h}}$

$1{,}000X = 150{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{150{,}000}{1{,}000}$

$X = 150 \text{ mg/h}$

$\frac{150 \text{ mg/h}}{60 \text{ min/h}} \times \frac{X \text{ mg}}{1 \text{ min}}$

$60X = 150$

$\frac{60X}{60} = \frac{150}{60}$

$X = 2.5 \text{ mg (per min)} = 2.5 \text{ mg/min}$

within normal range of 1–4 mg/min

16) IV PB flow rate: $\frac{\text{mL/h}}{\text{drop factor constant}} = \frac{100 \text{ mL/h}}{6} =$ 17 gtt/min

Total IV PB time: q.6h × 1 h = 4 × 1 h = 4 h

Total IV PB volume: 4 × 100 mL = 400 mL

Total Regular IV volume: 3,000 mL − 400 mL = 2,600 mL

Total Regular IV time: 24 h − 4 h = 20 h

Regular IV rate: $\text{mL/h} = \frac{2{,}600 \text{ mL}}{20\text{h}} = 130 \text{ mL/h};$ $\frac{\text{mL/h}}{\text{drop factor constant}} = \frac{130 \text{ mL/h}}{6} = 22 \text{ gtt/min}$

17) IV PB rate:

$\frac{50 \text{ mL}}{30 \text{ min}} \times \frac{X \text{ mL}}{60 \text{ min}}$

$30X = 3{,}000$

$\frac{30X}{30} = \frac{3{,}000}{30}$

$X = 100 \text{ mL}; 100 \text{ mL per } 60 \text{ min}$
$= 100 \text{ mL/h}$

Total IV PB time: q.i.d. × 30 min = 4 × 30 min = 120 min; $120\ \cancel{\text{min}} \div 60\ \cancel{\text{min}}\text{/h} = 2 \text{ h}$

Total IV PB volume: 4 × 50 mL = 200 mL

Total Regular IV volume: 3,000 mL − 200 mL = 2,800 mL

Total Regular IV time: 24 h − 2 h = 22 h

Regular IV rate: $\frac{2{,}800 \text{ mL}}{22 \text{ h}} =$ 127 mL/h

18) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{125 \text{ lb}}$

$2.2X = 125$

$\frac{2.2X}{2.2} = \frac{125}{2.2}$

$X = 56.8 \text{ kg}$

$3 \text{ mcg/}\cancel{\text{kg}}\text{/min} \times 56.8\ \cancel{\text{kg}} = 170.4 \text{ mcg/min}$

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{X \text{ mg/min}}{170.4 \text{ mcg/min}}$

$1{,}000X = 170.4$

$\frac{1{,}000X}{1{,}000} = \frac{170.4}{1{,}000}$

$X = 0.17 \text{ mg/min}$

$\frac{50 \text{ mg}}{500 \text{ mL}} \times \frac{0.17 \text{ mg/min}}{X \text{ mL/min}}$

$50X = 85$

$\frac{50X}{50} = \frac{85}{50}$

$X = 1.7 \text{ mL/min}$

$\frac{1.7 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 102 \text{ mL/h}$

19) 1,000 mL − 800 mL = 200 mL infused

$$\frac{40\text{ mEq}}{1{,}000\text{ mL}} \times \frac{X\text{ mEq}}{200\text{ mL}}$$

$$1{,}000X = 8{,}000$$

$$\frac{1{,}000X}{1{,}000} = \frac{8{,}000}{1{,}000}$$

$$X = 8\text{ mEq}$$

20) $\frac{125\text{ mL}}{60\text{ min}} = 2\text{ mL/min}$

21) $\frac{1{,}500\ \cancel{\text{mL}}}{100\ \cancel{\text{mL}}\text{/h}} = 15\text{ h}$

22) $\frac{40\text{ mEq}}{1{,}000\text{ mL}} \times \frac{2\text{ mEq/h}}{X\text{ mL/h}}$

$40X = 2{,}000$

$\frac{40X}{40} = \frac{2{,}000}{40}$

X = 50 mL/h (or 50 gtt/min because drop factor is 60 gtt/mL)

23) $\frac{50{,}000\text{ units}}{1{,}000\text{ mL}} \times \frac{3{,}750\text{ units/h}}{X\text{ mL/h}}$

$50{,}000X = 3{,}750{,}000$

$\frac{50{,}000X}{50{,}000} = \frac{3{,}750{,}000}{50{,}000}$

X = 75 mL/h (or 75 gtt/min because drop factor is 60 gtt/mL)

24) $\frac{5\text{ mg}}{1\text{ mL}} \times \frac{37\text{ mg}}{X\text{ mL}}$

$$5X = 37$$

$$\frac{5X}{5} = \frac{37}{5}$$

$$X = 7.4\text{ mL}$$

25) $\frac{1\text{ unit}}{1{,}000\text{ milliunits}} \times \frac{10\text{ units}}{X\text{ milliunits}}$

X = 10,000 milliunits

$\frac{10{,}000\text{ milliunits}}{500\text{ mL}} \times \frac{4\text{ milliunits/min}}{X\text{ mL/min}}$

$10{,}000X = 2{,}000$

$\frac{10{,}000X}{10{,}000} = \frac{2{,}000}{10{,}000}$

X = 0.2 mL/min (for first 20 minutes)

$\frac{0.2\text{ mL}}{1\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$

X = 12 mL/h

$\frac{10{,}000\text{ milliunits}}{500\text{ mL}} \times \frac{6\text{ milliunits/min}}{X\text{ mL/min}}$

$10{,}000X = 3{,}000$

$\frac{10{,}000X}{10{,}000} = \frac{3{,}000}{10{,}000}$

X = 0.3 mL/min (for next 20 minutes)

$\frac{0.3\text{ mL}}{1\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$

X = 18 mL/h

26) Bolus:

$$\frac{3\text{ g}}{30\text{ min}} \times \frac{X\text{ g/h}}{60\text{ min/h}}$$

$$\frac{30X}{30} = \frac{180}{30}$$

$$X = 6\text{ g/h}$$

$\frac{20\text{ g}}{500\text{ mL}} \times \frac{6\text{ g/h}}{X\text{ mL/h}}$

$20X = 3{,}000$

$\frac{20X}{20} = \frac{3{,}000}{20}$

X = 150 mL/h

Continuous infusion:

$\frac{20\text{ g}}{500\text{ mL}} \times \frac{2\text{ g/h}}{X\text{ mL/h}}$

$20X = 1{,}000$

$\frac{20X}{20} = \frac{1{,}000}{20}$

X = 50 mL/h

29) $\frac{\overset{8}{\cancel{4000}}\text{ mg}}{\underset{1}{\cancel{500}}\text{ mL}} = 8\text{ mg/mL}$

30) $\frac{4{,}000\text{ mg}}{500\text{ mL}} \times \frac{500\text{ mg/h}}{X\text{ mL/h}}$

$4{,}000X = 250{,}000$

$\frac{4{,}000X}{4{,}000} = \frac{250{,}000}{4{,}000}$

X = 63 mL/h

31) $\frac{1\text{ unit}}{1{,}000\text{ milliunits}} \times \frac{80\text{ units}}{X\text{ milliunits}}$

X = 80,000 milliunits

$\frac{80{,}000\text{ milliunits}}{1{,}000\text{ mL}} \times \frac{X\text{ milliunits}}{1\text{ mL}}$

$1{,}000X = 80{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{80{,}000}{1{,}000}$

X = 80 milliunits (per mL) or 80 milliunits/mL

33) $\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{4\text{ mg}}{X\text{ mcg}}$

X = 4,000 mcg

$\frac{4{,}000\text{ mcg}}{1{,}000\text{ mL}} \times \frac{X\text{ mcg}}{1\text{ mL}}$

$1{,}000X = 4{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{4{,}000}{1{,}000}$

X = 4 mcg (per mL) or 4 mcg/mL

36) $\frac{20\text{ mg}}{100\text{ mL}} \times \frac{X\text{ mg}}{1\text{ mL}}$

$100X = 20$

$\frac{100X}{100} = \frac{20}{100}$

X = 0.2 mg (per mL) or 0.2 mg/mL

$\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{0.2\text{ mg}}{X\text{ mL}}$

X = 200 mcg (per mL) or 200 mcg/mL

37) $1 \text{ mcg/}\cancel{\text{kg}}\text{/min} \times 100 \cancel{\text{kg}} = 100 \text{ mcg/min}$

$\frac{20{,}000 \text{ mcg}}{100 \text{ mL}} \times \frac{100 \text{ mcg/min}}{X \text{ mL/min}}$

$20{,}000X = 10{,}000$

$\frac{20{,}000X}{20{,}000} = \frac{10{,}000}{20{,}000}$

$X = 0.5 \text{ mL/min}$

$\frac{0.5 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 30 \text{ mL/h}$

38) IV PB rates:

$\frac{100 \text{ mL}}{30 \text{ min}} \times \frac{X \text{ mL}}{60 \text{ min}}$

$30X = 6{,}000$

$\frac{30X}{30} = \frac{6{,}000}{30}$

$X = 200$ mL (per 60 min)

200 mL per 60 min = 200 mL/h (ampicillin)

gentamycin: 50 mL/h

39) ampicillin: q.6h × 30 min = 4 × 30 min = 120 min; 120 $\cancel{\text{min}}$ ÷ 60 $\cancel{\text{min}}$/h = 2 h

gentamycin: q.8 h × 1 h = 3 × 1 h = 3 h

Total IV PB time: 2 h + 3 h = 5 h

40) ampicillin: 4 $\cancel{\text{doses}}$ × 100 mL/$\cancel{\text{dose}}$ = 400 mL

gentamycin: 3 $\cancel{\text{doses}}$ × 50 mL/$\cancel{\text{dose}}$ = 150 mL

Total IV PB volume: 400 mL + 150 mL = 550 mL

41) 3,000 mL − 550 mL = 2,450 mL

42) 24 h − 5 h = 19 h

43) $\frac{2{,}450 \text{ mL}}{19 \text{ h}} = 129 \text{ mL/h}$

44) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{190 \text{ lb}}$

$2.2X = 190$

$\frac{2.2X}{2.2} = \frac{190}{2.2}$

$X = 86.4 \text{ kg}$

$4 \text{ mcg/}\cancel{\text{kg}}\text{/min} \times 86.4 \cancel{\text{kg}} = 345.6 \text{ mcg/min}$

$\frac{345.6 \text{ mcg}}{1 \text{ min}} \times \frac{X \text{ mcg/h}}{60 \text{ min/h}}$

$X = 20{,}736 \text{ mcg/h}$

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{X \text{ mg}}{20{,}736 \text{ mcg}}$

$1{,}000X = 20{,}736$

$\frac{1{,}000X}{1{,}000} = \frac{20{,}736}{1{,}000}$

$X = 21 \text{ mg/h}$

$\frac{800 \text{ mg}}{500 \text{ mL}} \times \frac{21 \text{ mg/h}}{X \text{ mL/h}}$

$800X = 10{,}500$

$\frac{800X}{800} = \frac{10{,}500}{800}$

$X = 13.1 \text{ mL/h} = 13 \text{ mL/h}$ (initial rate)

$12\text{/mcg/}\cancel{\text{kg}}\text{/min} \times 86.4 \cancel{\text{kg}} = 1{,}036.8 \text{ mcg/min}$

$\frac{1{,}036.8 \text{ mcg}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 62{,}208 \text{ mcg/h}$

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{X \text{ mg}}{62{,}208 \text{ mcg}}$

$1{,}000X = 62{,}208$

$\frac{1{,}000X}{1{,}000} = \frac{62{,}208}{1{,}000}$

$X = 62 \text{ mg/h}$

$\frac{800 \text{ mg}}{500 \text{ mL}} \times \frac{62 \text{ mg/h}}{X \text{ mL/h}}$

$800X = 31{,}000$

$\frac{800X}{800} = \frac{31{,}000}{800}$

$X = 39 \text{ mL/h}$ (after titration)

45) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{225 \text{ lb}}$

$2.2X = 225$

$\frac{2.2X}{2.2} = \frac{225}{2.2}$

$X = 102.27 \text{ kg} = 100 \text{ kg}$ (rounded)

80 units/kg bolus dosage

46) $80 \text{ units/ }\cancel{\text{kg}} \times 100 \cancel{\text{kg}} = 8{,}000 \text{ units}$

1,000 units/mL

$\frac{1{,}000 \text{ units}}{1 \text{ mL}} \times \frac{8{,}000 \text{ units}}{X \text{ mL}}$

$1{,}000X = 8{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{8{,}000}{1{,}000}$

$X = 8 \text{ mL}$

47) $18 \text{ units/}\cancel{\text{kg}}\text{/h} \times 100 \cancel{\text{kg}} = 1{,}800 \text{ units/h}$

$\frac{25{,}000 \text{ units}}{250 \text{ mL}} = \frac{X \text{ units}}{1 \text{ mL}}$

$250X = 25{,}000$

$\frac{250X}{250} = \frac{25{,}000}{250}$

$X = 100$ units (per mL)

$\frac{100 \text{ units}}{1 \text{ mL}} \times \frac{1{,}800 \text{ units/h}}{X \text{ mL/h}}$

$100X = 1{,}800$

$\frac{100X}{100} = \frac{1{,}800}{100}$

$X = 18 \text{ mL/h}$

48) q.6h

$40 \text{ units}/\cancel{\text{kg}} \times 100\ \cancel{\text{kg}} = 4{,}000 \text{ units}$

$$\frac{1{,}000 \text{ units}}{1 \text{ mL}} \times \frac{4{,}000 \text{ units}}{X \text{ mL}}$$

$1{,}000X = 4{,}000$

$$\frac{1{,}000X}{1{,}000} = \frac{4{,}000}{1{,}000}$$

$X = 4$ mL

Increase rate: $2 \text{ units}/\cancel{\text{kg}}/\text{h} \times 100\ \cancel{\text{kg}} = 200 \text{ units/h}$

Increase rate:

$$\frac{100 \text{ units}}{1 \text{ mL}} \times \frac{200 \text{ units/h}}{X \text{ mL/h}}$$

$100X = 200$

$$\frac{100X}{100} = \frac{200}{100}$$

$X = 2$ mL/h

18 mL/h + 2 mL/h = 20 mL/h (new infusion rate)

49) Decrease rate by 2 units/kg/h

$2 \text{ units}/\cancel{\text{kg}}/\text{h} \times 100\ \cancel{\text{kg}} = 200 \text{ units/h (decrease)}$

$$\frac{100 \text{ units}}{1 \text{ mL}} \times \frac{200 \text{ units/h}}{X \text{ mL/h}}$$

$100X = 200$

$$\frac{100X}{100} = \frac{200}{100}$$

$X = 2$ mL/h (decrease)

20 mL/h − 2 mL/h = 18 mL/h (new infusion rate)

Section 4—Self-Evaluation from pages 433-436

1) 0.9% NaCl **2)** 0.9 g NaCl per 100mL **3)** 0.45 g NaCl per 100 mL **4)** 50 **5)** 4.5 **6)** 2.25 **7)** 75 **8)** 6.75 **9)** mL/h **10)** 21 **11)** 83 **12)** 1,940 **13)** 1,536 **14)** Give a total of 3,000 mL IV solution per day to include 5% normal saline (0.9% NaCl) with 20 milliequivalents of potassium chloride added per liter (1,000 mL) *and* an IV piggyback solution of 250 mg Kefzol added to 100 mL of normal saline (0.9% NaCl) over 30 min administered every 8 hours. To administer the order each day, give 900 mL NS with KCl over $7\frac{1}{2}$ hours × 3 administrations and 100 mL NS with Kefzol over $\frac{1}{2}$ hour × 3 administrations **15)** 120 **16)** 200 **17)** Reset rate to 118 gtt/min, if policy and patient's condition permit. **18)** 2.5 **19)** 1,410 **20)** 59 **21)** 120 **22)** 5 **23)** 0.48 **24)** 1.30 **25)** 0.5 **26)** 18.5–37.5 **27)** Yes **28)** 18.5 **29)** 37 mL **30)** 120 **31)** 18.5 **32)** 0.8 **33)** 1.6 **34)** Yes **35)** 1.6 **36)** 18; 2 **37)** 7.5 **38)** 43 **39)** 200 **40)** 43 **41)** 200 **42)** 50 **43)** 12 **44)** 15 **45)** 0.13 **46)** 8 **47)** 80 **48)** 20 **49)** 61 **50)** 38

Solutions—Section 4—Self-Evaluation

4) D_5 0.33% NaCl = 5% dextrose = 5 g dextrose per 100 mL

$$\frac{5 \text{ g}}{100 \text{ mL}} \times \frac{X \text{ g}}{1000 \text{ mL}}$$

$100X = 5{,}000$

$$\frac{100X}{100} = \frac{5{,}000}{100}$$

$X = 50$ g

5) D_5 0.45% NaCl = 0.45% NaCl = 0.45 g NaCl per 100 mL

$$\frac{0.45 \text{ g}}{100 \text{ mL}} \times \frac{X \text{ g}}{1{,}000 \text{ mL}}$$

$100X = 4{,}500$

$$\frac{100X}{100} = \frac{4{,}500}{100}$$

$X = 4.5$ g

10) $\frac{2{,}000 \text{ mL}}{24 \text{ h}} = 83.3 \text{ mL/h} = 83 \text{ mL/h}$

$$\frac{\text{mL/h}}{\text{drop factor constant}} = \text{gtt/min}$$

$$\frac{83 \text{ mL/h}}{4} = 21 \text{ gtt/min}$$

12) $\frac{V}{T} \times C = R\text{: } \frac{400 \text{ mL}}{T \text{ min}} \times 15 \text{ gtt/mL} = 24 \text{ gtt/min}$

$$\frac{400}{T} \times 15 = 24$$

$$\frac{6{,}000}{T} \times \frac{24}{1}$$

$24T = 6{,}000$

$$\frac{24T}{24} = \frac{6{,}000}{24}$$

$T = 250$ min

$250 \text{ min} = 250 \div 60 = 4\frac{1}{6} \text{ h} = 4 \text{ h } 10 \text{ min}$

$$\begin{array}{r} 1530 \text{ hours} \\ +\ 410 \text{ hours} \\ \hline 1940 \text{ hours} \end{array}$$

13) $\frac{V}{T} \times C = R\text{: } \frac{V\text{ ml}}{60\text{ min}} \times 10\text{ gtt/mL} = 32\text{ gtt/min}$

$\frac{10V}{60} \times \frac{32}{1}$

$10V = 1{,}920$

$\frac{10V}{10} = \frac{1{,}920}{10}$

$V = 192\text{ mL/h; } 192\text{ mL/}\cancel{h} \times 8\ \cancel{h} = 1536\text{ mL}$ (administered during your 8 h shift)

15) IVPB total volume: 100 mL × 3 = 300 mL

IVPB total time: 30 min × 3 = 90 min = $1\frac{1}{2}$ h

Regular IV total volume: 3,000 mL − 300 mL = 2,700 mL

Regular IV total time: 24h − $1\frac{1}{2}$ h = $22\frac{1}{2}$ h (22.5 h)

$\frac{2{,}700\text{ mL}}{22.5\text{ h}} = 120\text{ mL/h}$

16) $\frac{100\text{ mL}}{30\text{ min}} \times \frac{X\text{ mL/h}}{60\text{ min/h}}$

$30X = 6{,}000$

$\frac{30X}{30} = \frac{6{,}000}{30}$

$X = 200\text{ mL/h}$

17) $\frac{1{,}200\ \cancel{mL}}{100\ \cancel{mL}/h} = 12\text{ h}$ (total time ordered to infuse 1,200 mL)

$$\begin{array}{rl} 2200 & \text{hours (current time)} \\ -\ 1530 & \text{hours (start time)} \\ \hline 0630 & = 6\text{ h }30\text{ min (elapsed time)} \end{array}$$

$6\frac{1}{2}\ \cancel{h} \times 100\text{ mL/}\cancel{h} = 650\text{ mL}$ (expected to be infused)

After $6\frac{1}{2}$ h, 650 mL should have been infused, with 550 mL remaining. IV is behind schedule.

1,200 mL − 650 mL = 550 mL (should be remaining)

$\frac{\text{remaining volume}}{\text{remaining time}} = \frac{650\text{ mL}}{5.5\text{ h}} = 118\text{ mL/h}$ (adjusted rate)

$\frac{\text{Adjusted gtt/min} - \text{Ordered gtt/min}}{\text{Ordered gtt/min}} = \%\text{ of variation;}$

$\frac{118 - 100}{100} = \frac{18}{100} = 0.18 = 18\%$ (variance is safe)

If policy and patient's condition permit, reset rate to 118 mL/h.

18) $\frac{20\text{ mEq}}{1{,}000\text{ mL}} \times \frac{X\text{ mEq}}{250\text{ mL}}$

$1{,}000X = 5{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{5{,}000}{1{,}000}$

$X = 5\text{ mEq}$

$\frac{2\text{ mEq}}{1\text{ mL}} \times \frac{5\text{ mEq}}{X\text{ mL}}$

$2X = 5$

$\frac{2X}{X} = \frac{5}{2}$

$X = 2.5\text{ mL}$

19) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{40\text{ lb}}$

$2.2X = 40$

$\frac{2.2X}{2.2} = \frac{40}{2.2}$

$X = 18.2\text{ kg}$

$$\begin{array}{lr} \text{1st 10 kg: } 100\text{ mL/}\cancel{kg}\text{/day} \times 10\ \cancel{kg} = & 1{,}000\text{ mL/day} \\ \text{Remaining 8.2 kg: } 50\text{ mL/}\cancel{kg}\text{/day} \times 8.2\ \cancel{kg} = & 410\text{ mL/day} \\ \hline & 1{,}410\text{ mL/day} \end{array}$$

20) $\frac{1{,}410\text{ mL}}{24\text{ h}} = 59\text{ mL/h}$

21) $\frac{1\text{ kg}}{1{,}000\text{ g}} \times \frac{X\text{ kg}}{1{,}185\text{ g}}$

$1{,}000X = 1{,}185$

$\frac{1{,}000X}{1{,}000} = \frac{1{,}185}{1{,}000}$

$X = 1.2\text{ kg}$

1st 10 kg: $100\text{ mL/}\cancel{kg}\text{/day} \times 1.2\ \cancel{kg} = 120\text{ mL/day}$

22) $\frac{120\text{ mL}}{24\text{ h}} = 5\text{ mL/h}$

23) Household:

$\text{BSA (m}^2) = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} = \sqrt{\frac{30 \times 24}{3{,}131}} = \sqrt{\frac{720}{3{,}131}} = \sqrt{0.479...} = 0.48\text{ m}^2$

24) Metric:

$\text{BSA (m}^2) = \sqrt{\frac{\text{ht (cm)} \times \text{wt (kg)}}{3{,}600}} = \sqrt{\frac{155 \times 39}{3{,}600}} = \sqrt{\frac{6{,}045}{3{,}600}} = \sqrt{1.679...} = 1.295\text{ m}^2 = 1.3\text{ m}^2$

26) Minimum safe dosage: $37\text{ mg/}\cancel{m^2} \times 0.5\ \cancel{m^2} = 18.5\text{ mg}$

Maximum safe dosage: $75 \text{ mg}/\cancel{\text{m}^2} \times 0.5 \ \cancel{\text{m}^2} =$ 37.5 mg

28) $\frac{1 \text{ mg}}{1 \text{ mL}} \times \frac{18.5 \text{ mg}}{X \text{ mL}}$

$X = 18.5 \text{ mL}$

29) $\frac{2 \text{ mL}}{1 \text{ mg}} = \frac{X \text{ mL}}{18.5 \text{ mg}}$

$X = 18.5 \times 2 = 37 \text{ mL}$

$2 \text{ mL}/\cancel{\text{mg}} \times 18.5 \ \cancel{\text{mg}} = 37 \text{ mL}$

30) $\frac{18.5 \text{ mg}}{37 \text{ mL}} \times \frac{1 \text{ mg/min}}{X \text{ mL/min}}$

$18.5X = 37$

$\frac{18.5X}{18.5} = \frac{37}{18.5}$

$X = 2 \text{ mL/min}$

$\frac{2 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 120 \text{ mL/h}$

31) Think: At 1 mg/min, 18.5 mg will infuse in 18.5 min.

$\frac{1 \text{ mg}}{1 \text{ min}} \times \frac{18.5 \text{ mg}}{X \text{ min}}$

$X = 18.5 \text{ min}$

33) $2 \text{ mg}/\cancel{\text{m}^2} \times 0.8 \ \cancel{\text{m}^2} = 1.6 \text{ mg}$

36) $\frac{125 \text{ mg}}{1 \text{ mL}} \times \frac{250 \text{ mg}}{X \text{ mL}}$

$125X = 250$

$\frac{125X}{125} = \frac{250}{125}$

$X = 2 \text{ mL}$ (Ancef)

$\frac{40 \text{ mL}}{60 \text{ min}} \times \frac{X \text{ mL}}{30 \text{ min}}$

$60X = 1{,}200$

$\frac{60X}{60} = \frac{1{,}200}{60}$

$X = 20 \text{ mL}$

20 mL (total IV solution) − 2 mL (Ancef) = 18 mL (NS)

37) $\frac{100 \text{ mg}}{1 \text{ mL}} \times \frac{750 \text{ mg}}{X \text{ mL}}$

$100X = 750$

$\frac{100X}{100} = \frac{750}{100}$

$X = 7.5 \text{ mL}$

7.5 mL IV solution to be used with the 750 mg of ticarcillin for minimal dilution.

38) Total IV PB volume: 100 mL × 6 = 600 mL

Regular IV volume: 1,500 mL − 600 mL = 900 mL

Total IV PB time of q.4h × 30 min: 6 × 30 min = 180 min; $180 \ \cancel{\text{min}} \div 60 \ \cancel{\text{min}}/\text{h} = 3 \text{ h}$

Total Regular IV time: 24 h − 3 h = 21 h

Regular IV rate: $\text{mL/h} = \frac{900 \text{ mL}}{21 \text{ h}} = 43 \text{ mL/h}$

or 43 gtt/min because mL/h = gtt/min when drop factor is 60 gtt/mL.

$\frac{\text{mL/h}}{\text{drop factor constant}} = \text{gtt/min}; \ \frac{43 \text{ mL/h}}{1} = 43 \text{ gtt/min}$

39) $\frac{100 \text{ mL}}{30 \text{ min}} \times \frac{X \text{ mL}}{60 \text{ min}}$

$30X = 6{,}000$

$\frac{30X}{30} = \frac{6{,}000}{30}$

X = 200 mL/h or 200 gtt/min (because drop factor is 60 gtt/mL)

40) See #38, Regular IV rate calculated at 43 mL/h.

41) See #39, IV PB rate calculated at 200 mL/h.

42) $\frac{40 \text{ mEq}}{1{,}000 \text{ mL}} \times \frac{2 \text{ mEq/h}}{X \text{ mL/h}}$

$40X = 2{,}000$

$\frac{40X}{40} = \frac{2{,}000}{40}$

$X = 50 \text{ mL/h}$

43) 1 L = 1,000 mL

1 mg = 1,000 mcg

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{25 \text{ mg}}{X \text{ mcg}}$

$X = 25{,}000 \text{ mcg}$

25 mg per L = 25,000 mcg per 1,000 mL

$\frac{25{,}000 \text{ mcg}}{1{,}000 \text{ mL}} \times \frac{X \text{ mcg}}{1 \text{ mL}}$

$1{,}000X = 25{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{25{,}000}{1{,}000}$

$X = 25 \text{ mcg/mL}$

$\frac{25 \text{ mcg}}{1 \text{ mL}} \times \frac{5 \text{ mcg/min}}{X \text{ mL/min}}$

$25X = 5$

$\frac{25X}{25} = \frac{5}{25}$

$X = 0.2 \text{ mL/min}$

$\frac{0.2 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 12 \text{ mL/h}$

44) 1 L = 1,000 mL

1 unit = 1,000 milliunits

$\frac{1 \text{ unit}}{1{,}000 \text{ milliunits}} \times \frac{15 \text{ units}}{X \text{ milliunits}}$

$X = 15{,}000 \text{ milliunits}$

$\frac{15{,}000 \text{ milliunits}}{1{,}000 \text{ mL}} \times \frac{X \text{ milliunits}}{1 \text{ mL}}$

$1{,}000X = 15{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{15{,}000}{1{,}000}$

$X = 15$ milliunits/mL

45) $\frac{15 \text{ milliunits}}{1 \text{ mL}} \times \frac{2 \text{ milliunits/min}}{X \text{ mL/min}}$

$15X = 2$

$\frac{15X}{15} = \frac{2}{15}$

$X = 0.13$ mL/min

46) $\frac{0.13 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 7.8$ mL/h = 8 mL/h

47) $\frac{15 \text{ milliunits}}{1 \text{ mL}} \times \frac{20 \text{ milliunits/min}}{X \text{ mL/min}}$

$15X = 20$

$\frac{15X}{15} = \frac{20}{15}$

$X = 1.33$ mL/min

$\frac{1.33 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$X = 80$ mL/h

48) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{150 \text{ lb}}$

$2.2X = 150$

$\frac{2.2X}{2.2} = \frac{150}{2.2}$

$X = 68.18$ kg = 68.2 kg

$4 \text{ mcg}/\cancel{\text{kg}}/\text{min} \times 68.2\ \cancel{\text{kg}} = 273 \text{ mcg/min}$

$\frac{273 \text{ mcg}}{1 \text{ min}} \times \frac{X \text{ mcg/h}}{60 \text{ min/h}}$

$X = 16{,}380$ mcg/h

$\frac{1 \text{ L}}{1{,}000 \text{ mL}} \times \frac{0.5 \text{ L}}{X \text{ mL}}$

$X = 500$ mL

$\frac{400 \text{ mg}}{500 \text{ mL}} \times \frac{X \text{ mg}}{1 \text{ mL}}$

$500X = 400$

$\frac{500X}{500} = \frac{400}{500}$

$X = 0.8$ mg (per mL)

$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{0.8 \text{ mg}}{X \text{ mcg}}$

$X = 800$ mcg

$\frac{800 \text{ mcg}}{1 \text{ mL}} \times \frac{16{,}380 \text{ mcg/h}}{X \text{ mL/h}}$

$800X = 16{,}380$

$\frac{800X}{800} = \frac{16{,}380}{800}$

$X = 20$ mL/h

49) $12 \text{ mcg}/\cancel{\text{kg}}/\text{min} \times 68.2\ \cancel{\text{kg}} = 818 \text{ mcg/min}$

$\frac{818 \text{ mcg}}{1 \text{ min}} \times \frac{X \text{ mcg/h}}{60 \text{ min/h}}$

$X = 49{,}080$ mcg/h

$\frac{800 \text{ mcg}}{1 \text{ mL}} \times \frac{49{,}080 \text{ mcg/h}}{X \text{ mL/h}}$

$800X = 49.080$

$\frac{800X}{800} = \frac{49{,}080}{800}$

$X = 61$ mL/h

50) $\frac{10{,}000 \text{ units}}{500 \text{ mL}} \times \frac{750 \text{ units/h}}{X \text{ mL/h}}$

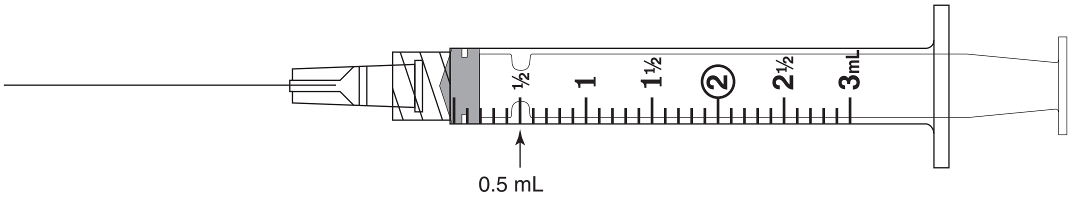
$10{,}000X = 375{,}000$

$\frac{10{,}000X}{10{,}000} = \frac{375{,}000}{10{,}000}$

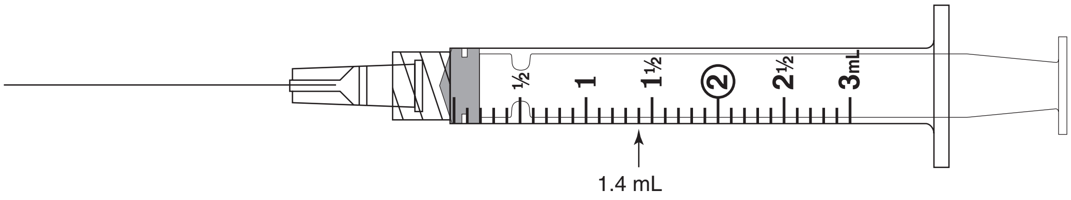
$X = 38$ mL/h

Essential Skills Evaluation from pages 437-450

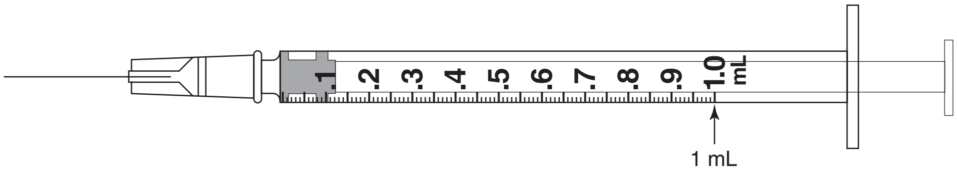
1) 0.5



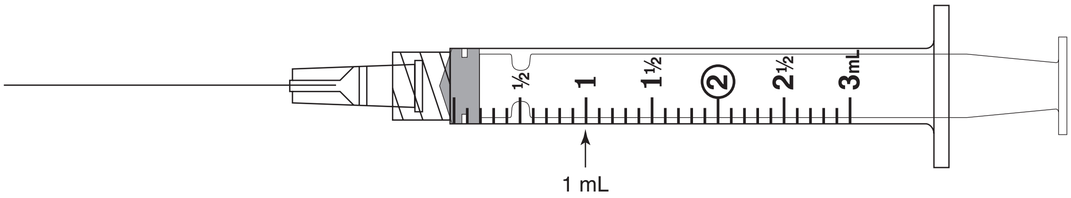
2) 1.4



3) 1, 1, 0.25

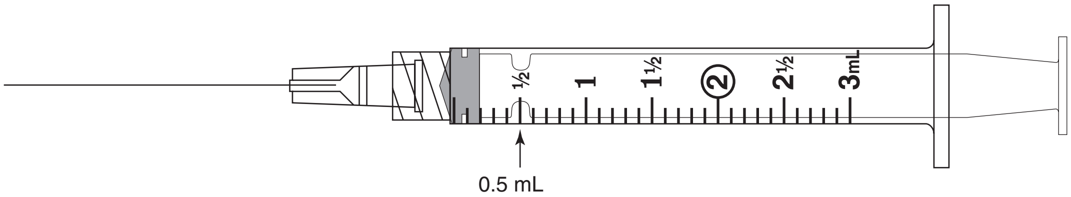


4) 1



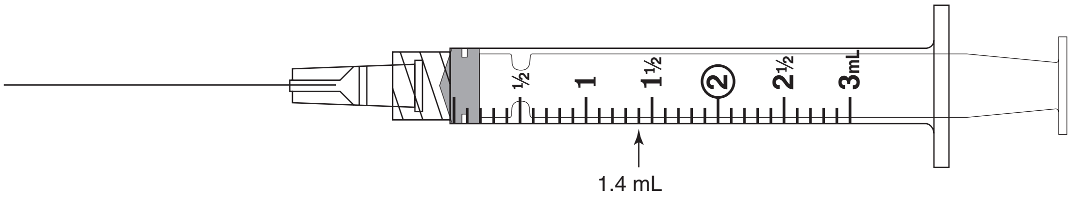
5) $1\frac{1}{2}$

6) 0.5

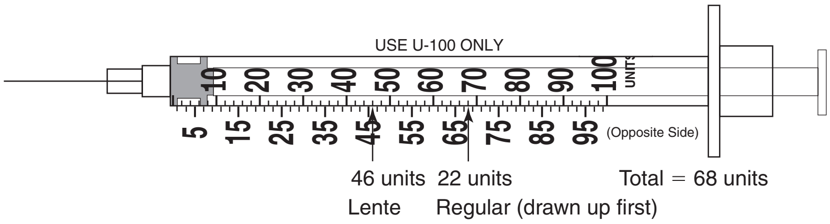


7) $\frac{1}{2}$

8) 1.4

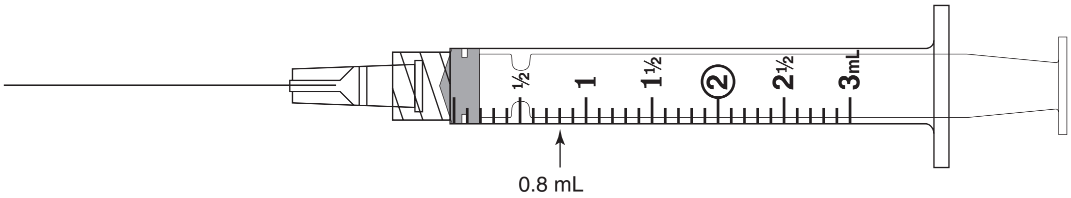


9) 68

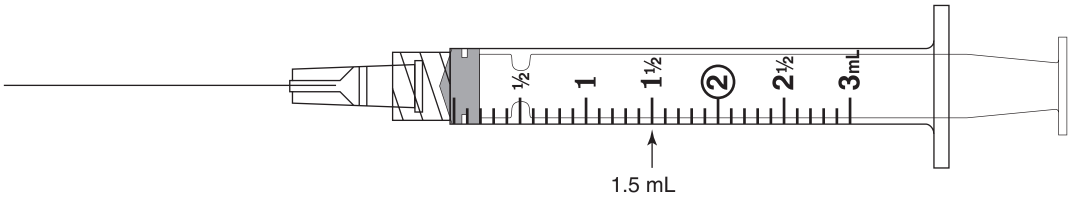


10) 2 **11)** $\frac{1}{2}$ **12)** $1\frac{1}{2}$

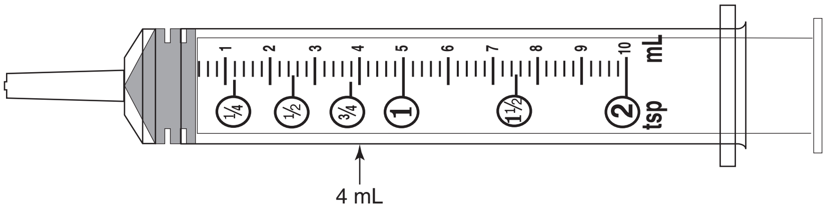
13) 0.8



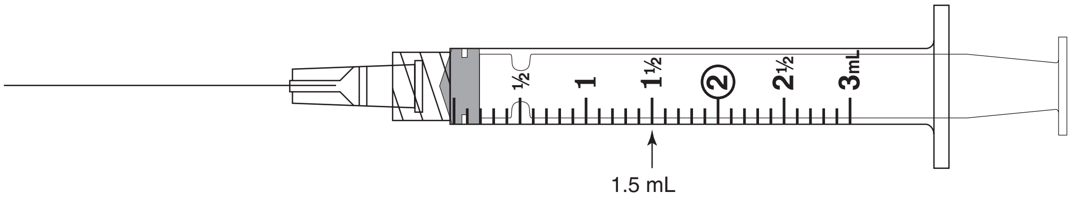
14) 1.5



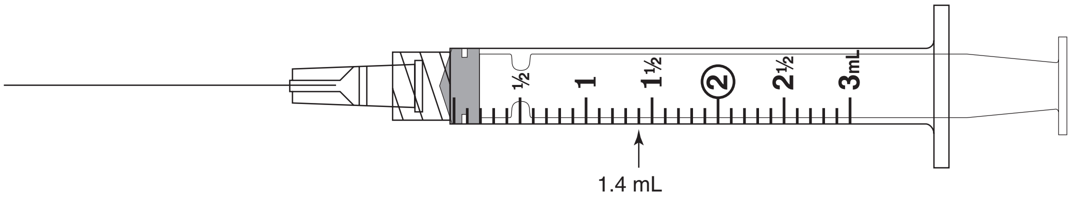
15) 4



16) 1.5



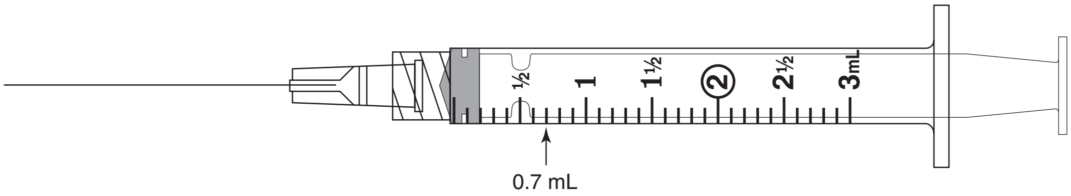
17) 1.4; 75



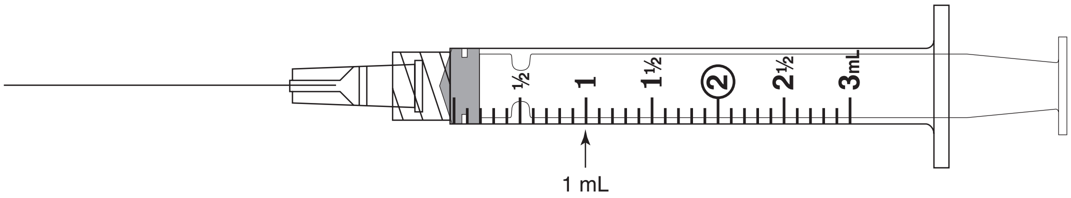
18) Yes. Her temperature is 102.2°F. Tylenol is indicated for fever greater than 101°F every 4 hours. It has been 5 hours and 5 minutes since her last dose.

19) 2 **20)** $\frac{1}{2}$ (one half)

21) Benadryl; 0.7

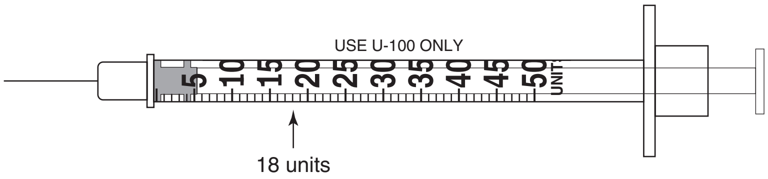


22) Narcan; 1



23) 18.8; 138 **24)** 138 **25)** 8; 2 **26)** 1; 0745, 1145, 1745, 2200

27) 18; subcutaneous



28) 12 **29)** Yes. The usual dosage is 20–40 mg/kg/day divided into 3 doses q.8h, which is equivalent to 45–91 mg per dose for a 15 lb (6.8 kg) child. **30)** 1 **31)** $\frac{1}{2}$ dropperful to the 1 mL line; every 8 hours **32)** 250–500; Yes; 1.7; 25 **33)** 1,000 **34)** Yes **35)** 4.8; dosage is safe **36)** 38 **37)** 280–420 **38)** 13 **39)** 30; No **40)** Do not administer; consult with physician before giving drug. **41)** 1 **42)** 50; 5 **43)** 30 **44)** 2030; 8:30 PM **45)** 200 **46)** 10 **47)** 2,000/10 **48)** 2.5

49)

1/30/XX, 1400, reconstituted as
2 g/10mL. Expires 2/6/XX, 1400.
Keep refrigerated. G.D.P.

50) The importance of checking a medication label at least three times to verify supply dosage cannot be overemphasized. It is also important NEVER to assume that the supply dosage is the same as a supply dosage used to calculate previously. Always read the label carefully. Writing the calculation down will also help improve accuracy.

Solutions—Essential Skills Evaluation

1) $\frac{25 \text{ mg}}{1 \text{ mL}} \times \frac{12.5 \text{ mg}}{X \text{ mL}}$

$25X = 12.5$

$\frac{25X}{25} = \frac{12.5}{25}$

$X = 0.5 \text{ mL}$

2) $\frac{25 \text{ mg}}{1 \text{ mL}} \times \frac{35 \text{ mg}}{X \text{ mL}}$

$25X = 35$

$\frac{25X}{25} = \frac{35}{25}$

$X = 1.4 \text{ mL}$

3) $\frac{250 \text{ mg}}{5 \text{ mL}} \times \frac{50 \text{ mg}}{X \text{ mL}}$

$250X = 250$

$\frac{250X}{250} = \frac{250}{250}$

$X = 1 \text{ mL}$

$\frac{1 \text{ mL}}{60 \text{ sec}} \times \frac{X \text{ mL}}{15 \text{ sec}}$

$60X = 15$

$\frac{60X}{60} = \frac{15}{60}$

$X = 0.25 \text{ mL (per 15 sec)}$

Note: 1 mL syringe is a better choice because measurement of 0.25 mL increments is clearly visible.

4) $\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{0.4 \text{ mg}}{X \text{ mcg}}$

$X = 400 \text{ mcg}$

$\frac{400 \text{ mcg}}{2 \text{ mL}} \times \frac{200 \text{ mcg}}{X \text{ mL}}$

$400X = 400$

$\frac{400X}{400} = \frac{400}{400}$

$X = 1 \text{ mL}$

5) $\frac{5 \text{ mg}}{1 \text{ tab}} \times \frac{7.5 \text{ mg}}{X \text{ tab}}$

$5X = 7.5$

$\frac{5X}{5} = \frac{7.5}{5}$

$X = 1\frac{1}{2} \text{ tab}$

6) $\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{0.125 \text{ mg}}{X \text{ mcg}}$

$X = 125 \text{ mcg}$

$\frac{500 \text{ mcg}}{2 \text{ mL}} \times \frac{125 \text{ mcg}}{X \text{ mL}}$

$500X = 250$

$\frac{500X}{500} = \frac{250}{500}$

$X = 0.5 \text{ mL}$

7) $\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{8}}{\text{X mg}}$

$X = 7.5 \text{ mg}$

$\frac{15 \text{ mg}}{1 \text{ tab}} \times \frac{7.5 \text{ mg}}{\text{X tab}}$

$15X = 7.5$

$\frac{15X}{15} = \frac{7.5}{15}$

$X = \frac{1}{2} \text{ tab}$

8) $\frac{500 \text{ mcg}}{2 \text{ mL}} \times \frac{350 \text{ mcg}}{\text{X mL}}$

$500X = 700$

$\frac{500X}{500} = \frac{700}{500}$

$X = 1.4 \text{ mL}$

9) 46 units + 22 units = 68 units (total)

10) $\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{0.3 \text{ mg}}{\text{X mcg}}$

$X = 300 \text{ mcg}$

$\frac{150 \text{ mcg}}{1 \text{ tab}} \times \frac{300 \text{ mcg}}{\text{X tab}}$

$150X = 300$

$\frac{150X}{150} = \frac{300}{150}$

$X = 2 \text{ tabs}$

11) $\frac{80 \text{ mg}}{1 \text{ tab}} \times \frac{40 \text{ mg}}{\text{X tab}}$

$80X = 40$

$\frac{80X}{80} = \frac{40}{80}$

$X = \frac{1}{2} \text{ tab}$

12) $\frac{250 \text{ mg}}{1 \text{ tab}} \times \frac{375 \text{ mg}}{\text{X tab}}$

$250X = 375$

$\frac{250X}{250} = \frac{375}{250}$

$X = 1\frac{1}{2} \text{ tab}$

13) $\frac{50 \text{ mg}}{1 \text{ mL}} \times \frac{40 \text{ mg}}{\text{X mL}}$

$50X = 40$

$\frac{50X}{50} = \frac{40}{50}$

$X = 0.8 \text{ mL}$

14) $\frac{2 \text{ mg}}{1 \text{ mL}} \times \frac{3 \text{ mg}}{\text{X mL}}$

$2X = 3$

$\frac{2X}{2} = \frac{3}{2}$

$X = 1.5 \text{ mL}$

You will need 2 vials of the drug, because each vial contains 1 mL.

15) $\frac{125 \text{ mg}}{5 \text{ mL}} \times \frac{100 \text{ mg}}{\text{X mL}}$

$125X = 500$

$\frac{125X}{125} = \frac{500}{125}$

$X = 4 \text{ mL}$

16) $\frac{\text{gr } 1}{60 \text{ mg}} \times \frac{\text{gr } \frac{1}{100}}{\text{X mg}}$

$X = 60 \times \frac{1}{100} = \frac{6}{100} = \frac{6}{10}$

$X = 0.6 \text{ mg}$

$\frac{0.4 \text{ mg}}{1 \text{ mL}} \times \frac{0.6 \text{ mg}}{\text{X mL}}$

$0.4X = 0.6$

$\frac{0.4X}{0.4} = \frac{0.6}{0.4}$

$X = 1.5 \text{ mL}$

17) $\frac{50 \text{ mg}}{2 \text{ mL}} \times \frac{35 \text{ mg}}{\text{X mL}}$

$50X = 70$

$\frac{50X}{50} = \frac{70}{50}$

$X = 1.4 \text{ mL}$

$\frac{V}{T} \times C = \frac{\overset{5}{\cancel{100}}\ \cancel{\text{mL}}}{\underset{1}{\cancel{20}}\ \text{min}} \times 15 \text{ gtt}/\cancel{\text{mL}} = 75 \text{ gtt/min}$

18) °F = 1.8°C + 32 = (1.8 × 39) + 32 = 70.2 + 32 = 102.2°F

102.2°F is greater than 101°F; 2400 − 2110 = 0250 or 2 h 50 min; 0215 = 2 h 15 min after 2400; 2 h 50 min + 2 h 15 min = 5 h 5 min

19) $\frac{325 \text{ mg}}{1 \text{ tab}} \times \frac{650 \text{ mg}}{\text{X tab}}$

$325X = 650$

$\frac{325X}{325} = \frac{650}{325}$

$X = 2 \text{ tab}$

20) $\frac{\overset{1}{\cancel{30}}\ \cancel{\text{mg}}}{\underset{2}{\cancel{60}}\ \cancel{\text{mg}}} = \frac{1}{2}$ (one half)

21) $\frac{50 \text{ mg}}{1 \text{ mL}} \times \frac{35 \text{ mg}}{\text{X mL}}$

$50X = 35$

$\frac{50X}{50} = \frac{35}{50}$

$X = 0.7 \text{ mL}$

23) $\frac{80 \text{ mg}}{15 \text{ mL}} \times \frac{100 \text{ mg}}{\text{X mL}}$

$80X = 1{,}500$

$\frac{80X}{80} = \frac{1{,}500}{80}$

$X = 18.75 \text{ mL} = 18.8 \text{ mL}$

50 mL + 18.8 mL = 68.8 mL

$\frac{V}{T} \times C = \frac{68.8\ \cancel{\text{mL}}}{\underset{1}{\cancel{30}}\ \text{min}} \times \overset{2}{\cancel{60}}\ \text{gtt}/\cancel{\text{mL}}$

$= 138\ \text{gtt/min}$

24) 138 gtt/min = 138 mL/h because gtt/min = mL/h when the drop factor is 60 gtt/mL

25) $\frac{62.5\ \text{mg}}{1\ \text{mL}} \times \frac{125\ \text{mg}}{X\ \text{mL}}$

$62.5X = 125$

$\frac{62.5X}{62.5} = \frac{125}{62.5}$

$X = 2\ \text{mL}$

29) $\frac{1\ \text{kg}}{2.2\ \text{lb}} \times \frac{X\ \text{kg}}{15\ \text{lb}}$

$2.2X = 15$

$\frac{2.2X}{2.2} = \frac{15}{2.2}$

$X = 6.8\ \text{kg}$

Minimum dosage: $20\ \text{mg}/\cancel{\text{kg}}/\text{day} \times 6.8\ \cancel{\text{kg}} =$ $136\ \text{mg/day}$

$\frac{136\ \text{mg}}{3\ \text{doses}} \times \frac{X\ \text{mg}}{1\ \text{dose}}$

$3X = 136$

$\frac{3X}{3} = \frac{136}{3}$

$X = 45$ mg (per dose) or 45 mg/dose

Maximum dosage: $40\ \text{mg}/\cancel{\text{kg}}/\text{day} \times 6.8\ \cancel{\text{kg}} =$ $272\ \text{mg/day}$

$\frac{272\ \text{mg}}{3\ \text{doses}} \times \frac{X\ \text{mg}}{1\ \text{dose}}$

$3X = 272$

$\frac{3X}{3} = \frac{272}{3}$

$X = 91$ mg (per dose) or 91 mg/dose

30) $\frac{50\ \text{mg}}{1\ \text{mL}} \times \frac{50\ \text{mg}}{X\ \text{mL}}$

$50X = 50$

$\frac{50X}{50} = \frac{50}{50}$

$X = 1\ \text{mL}$

32) $\frac{1\ \text{kg}}{2.2\ \text{lb}} \times \frac{X\ \text{kg}}{110\ \text{lb}}$

$2.2X = 110$

$\frac{2.2X}{2.2} = \frac{110}{2.2}$

$X = 50\ \text{kg}$

Minimum dosage: $20\ \text{mg}/\cancel{\text{kg}}/\text{day} \times 50\ \cancel{\text{kg}} =$ $1{,}000\ \text{mg/day}$

$\frac{1{,}000\ \text{mg}}{4\ \text{doses}} \times \frac{X\ \text{mg}}{1\ \text{dose}}$

$4X = 1{,}000$

$\frac{4X}{4} = \frac{1{,}000}{4}$

$X = 250$ mg (per dose) or 250 mg/dose

Maximum dosage: $40\ \text{mg}/\cancel{\text{kg}}/\text{day} \times 50\ \cancel{\text{kg}} =$ $2{,}000\ \text{mg/day}$

$\frac{2{,}000\ \text{mg}}{4\ \text{doses}} \times \frac{X\ \text{mg}}{1\ \text{dose}}$

$4X = 2{,}000$

$\frac{4X}{4} = \frac{2{,}000}{4}$

$X = 500$ mg (per dose) or 500 mg/dose

$\frac{300\ \text{mg}}{2\ \text{mL}} \times \frac{250\ \text{mg}}{X\ \text{mL}}$

$300X = 500$

$\frac{300X}{300} = \frac{500}{300}$

$X = 1.7\ \text{mL}$

$\frac{V}{T} \times C = \frac{50\ \cancel{\text{mL}}}{\underset{2}{\cancel{20}}\ \text{min}} \times \overset{1}{\cancel{10}}\ \text{gtt}/\cancel{\text{mL}} = \frac{50\ \text{gtt}}{2\ \text{min}} = 25\ \text{gtt/min}$

33)
IV fluid = 200 mL
gelatin = oz iv = 4 × 30 = 120 mL
water = oz iii × 2 = (3 × 30) × 2 = 90 × 2 = 180 mL
apple juice = pt i = 500 mL
Total = 1,000 mL

34) $\frac{1\ \text{kg}}{2.2\ \text{lb}} \times \frac{X\ \text{kg}}{40\ \text{lb}}$

$2.2X = 40$

$\frac{2.2X}{2.2} = \frac{40}{2.2}$

$X = 18.2\ \text{kg}$

$40\ \text{mg}/\cancel{\text{kg}}/\text{day} \times 18.2\ \cancel{\text{kg}} = 728\ \text{mg/day}$

$\frac{728\ \text{mg}}{3\ \text{doses}} \times \frac{X\ \text{mg}}{1\ \text{dose}}$

$3X = 728$

$\frac{3X}{3} = \frac{728}{3}$

$X = 243$ mg (per dose) or 243 mg/dose; close approximation to ordered dosage of 240 mg/dose; dosage is safe

35) $\frac{250\ \text{mg}}{5\ \text{mL}} \times \frac{240\ \text{mg}}{X\ \text{mL}}$

$250X = 1{,}200$

$\frac{250X}{250} = \frac{1{,}200}{250}$

$X = 4.8\ \text{mL}$

36) $\text{mL/h} = \frac{\overset{150}{\cancel{600}}\ \text{mL}}{\underset{1}{\cancel{4}}\ \text{h}} = 150\ \text{mL/h}$

$\frac{V}{T} \times C = \frac{150\ \cancel{\text{mL}}}{\underset{4}{\cancel{60}}\ \text{min}} \times \overset{1}{\cancel{15}}\ \text{gtt}/\cancel{\text{mL}} = \frac{150\ \text{gtt}}{4\ \text{min}} = 38\ \text{gtt/min}$

37) $\frac{1 \text{ lb}}{16 \text{ oz}} \times \frac{X \text{ lb}}{8 \text{ oz}}$

$16X = 8$

$\frac{16X}{16} = \frac{8}{16}$

$X = \frac{1}{2} = 0.5 \text{ lb}$

61 lb 8 ounces = 61.5 lb

$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{61.5 \text{ lb}}$

$2.2X = 61.5$

$\frac{2.2X}{2.2} = \frac{61.5}{2.2}$

$X = 28 \text{ kg}$

Minimum dosage: $10 \text{ mg}/\cancel{\text{kg}} \times 28 \cancel{\text{kg}} = 280 \text{ mg}$

Maximum dosage: $15 \text{ mg}/\cancel{\text{kg}} \times 28 \cancel{\text{kg}} = 420 \text{ mg}$

38) $\frac{80 \text{ mg}}{2.5 \text{ mL}} \times \frac{420 \text{ mg}}{X \text{ mL}}$

$80X = 1{,}050$

$\frac{80X}{80} = \frac{1{,}050}{80}$

$X = 13.1 \text{ mL} = 13 \text{ mL}$

39) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{52 \text{ lb}}$

$2.2X = 52$

$\frac{2.2X}{2.2} = \frac{52}{2.2}$

$X = 23.6 \text{ kg}$

$5 \text{ mg}/\cancel{\text{kg}}/\text{day} \times 23.6 \cancel{\text{kg}} = 118 \text{ mg/day}$

$\frac{118 \text{ mg}}{4 \text{ doses}} \times \frac{X \text{ mg}}{1 \text{ dose}}$

$4X = 118$

$\frac{4X}{4} = \frac{118}{4}$

X = 30 mg (per dose); dosage is too low to be therapeutic and is not safe

41) $\frac{300 \text{ mg}}{30 \text{ mL}} \times \frac{10 \text{ mg}}{X \text{ mL}}$

$300X = 300$

$\frac{300X}{300} = \frac{300}{300}$

$X = 1 \text{ mL}$

42) $10 \text{ mg}/\cancel{\text{dose}} \times 5 \cancel{\text{doses}} = 50 \text{ mg}$

$1 \text{ mL}/\cancel{\text{dose}} \times 5 \cancel{\text{doses}} = 5 \text{ mL}$

43) $\frac{\overset{30}{\cancel{300 \text{ mg}}}}{\underset{1}{\cancel{10}}\,\cancel{\text{mg}}/\text{dose}} = 30 \text{ doses}$

44) $\frac{30 \cancel{\text{doses}}}{5 \cancel{\text{doses}}/\text{h}} = 6 \text{ h}$

$$\begin{array}{rr} 1430 \text{ h} & 2030 \\ +\ 600 \text{ h} & -1200 \\ \hline 2030 \text{ h} & 8{:}30 \text{ PM} \end{array}$$

45) $\frac{100 \text{ mL}}{30 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$30X = 6{,}000$

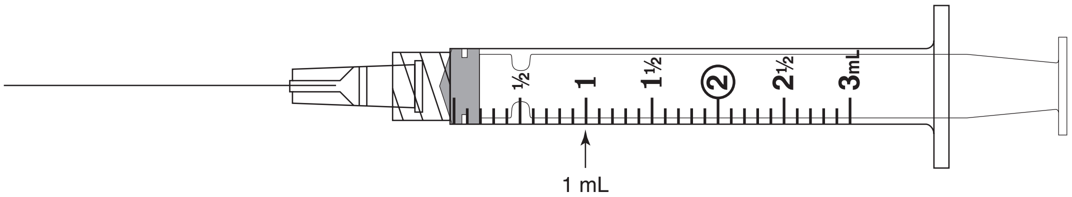
$\frac{30X}{30} = \frac{6{,}000}{30}$

$X = 200 \text{ mL/h}$

Comprehensive Skills Evaluation from pages 451-464

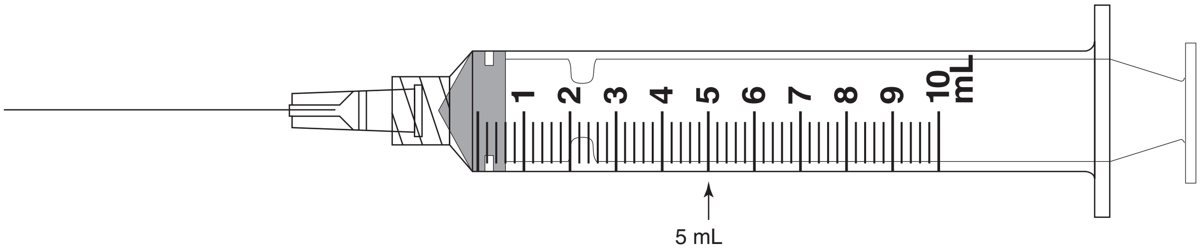
1) 2 **2)** Sublingual. The medication is to be administered under the tongue. **3)** 2; 2; 0.5 **4)** 1

5) 1; 1; 0.25



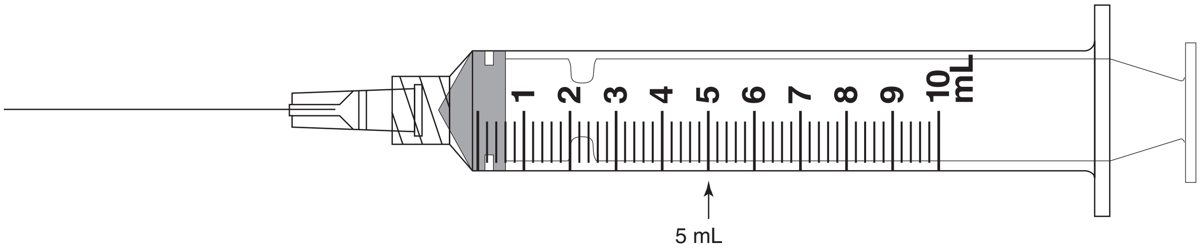
6) $\frac{1}{2}$ **7)** 80

8) 5



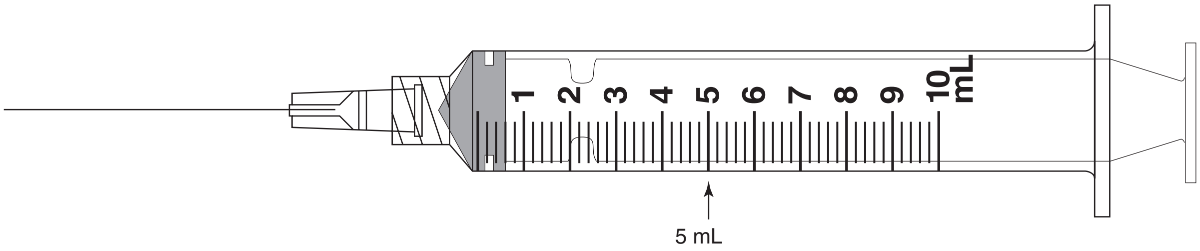
9) 0.8 **10)** 1,920 **11)** 0500; 9/4/XX **12)** 2 **13)** 80 **14)** all: nitroglycerin, furosemide, digoxin, KCl, and acetaminophen

15) 5



16) 30

17) Dosage ordered is safe; 5

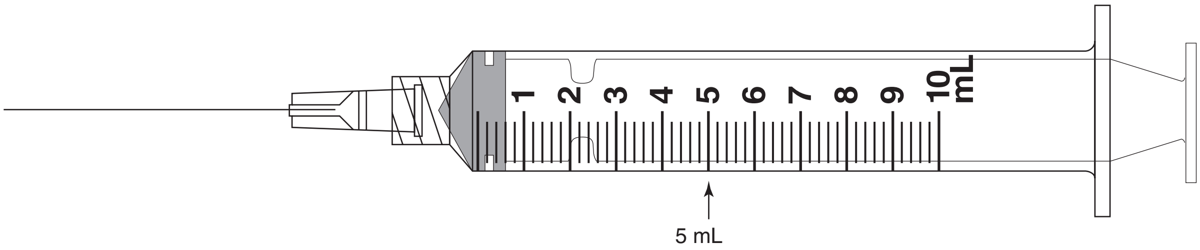


18) 19 **19)** 30,000; 30 **20)** 60 **21)** Yes, the recommended dosage for this child is 225 mg/day in 3 divided doses or 75 mg/dose. This is the same as the order; 2; 23; 40 **22)** 12 **23)** Yes, safe dosage for this child is 300 mg/dose, which is the same as the order; 6; 44; 1,200 **24)** 5; 2.5 **25)** 19

26)

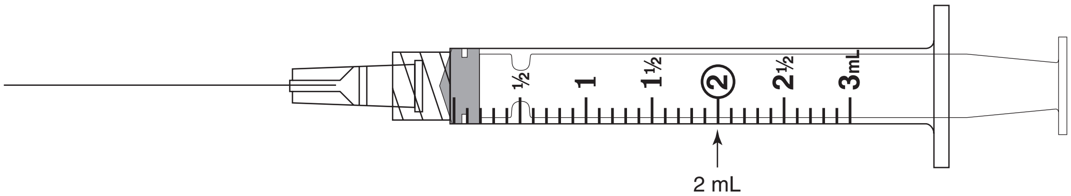
2/6/xx, 0800, reconstituted as 1 g in
10 mL (100 mg/mL). Expires 2/7/xx, 0800.
Keep at room temperature. G.D.P.

27) 5; 45



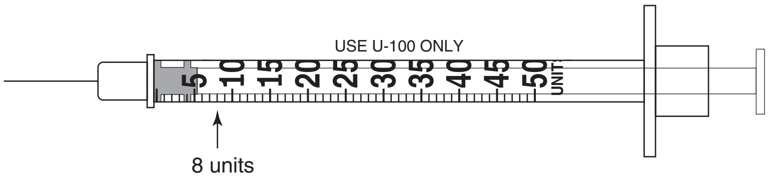
28) 65

29) 2; 60

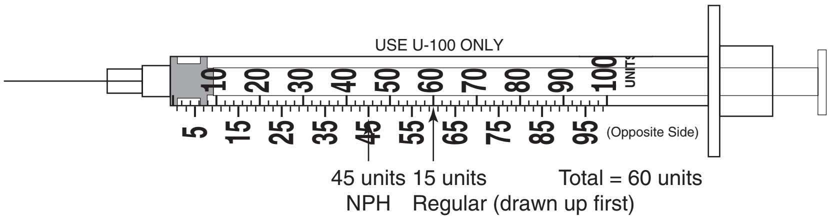


30) 56.8; 4,544; 4.5; 1,022; 10 **31)** Decrease rate by 2 units/kg/h; 908; 9

32) 8; 0.08



33) 60



34) 20 **35)** 720; 960 **36)** 730; 30 **37)** 1.43 **38)** 14.3–28.6; Yes; 0.5; 56; 5.6; 1.4 **39)** 50; 4.5 **40)** 8; 4 **41)** 2.2; 47.8

42) Yes; the minimal amount of IV fluid to safely dilute this med is 13.5 mL. The order calls for 50 mL total, or 47.8, almost 48 mL of IV fluid. **43)** 1,600,000; Yes, the minimum daily dosage is 1,500,000 units/day and the maximum is 2,500,000 units/day. The ordered dosage falls within this range; 1.8; 500,000; 0.8

Reconstitution label

1/14/xx; 0800, reconstituted as
500,000 units/mL. Expires 1/21/xx; 0800.
Keep refrigerated. G.D.P.

44) 101 **45)** 2145 **46)** 0.5; 0.5; 0.13 **47)** 7.5 **48)** 200

49) **Prevention:** Either the route or the frequency of this order is missing or is unclear. If the student actually gave this medication in the eye, it would cause a severe reaction. The medication particles could scratch the eyes, or cause a worse reaction, such as blindness.

To prevent this from occurring, the student/nurse should always ensure that each medication order is complete. Every order should include the name of the drug, the dose, the route, and the time (with the patient, prescriber, and licensure identified). When any of these are missing, the order should be clarified. Further, the "od" abbreviation is obsolete and prohibited by JCAHO. The student nurse should also look medications up and know the safe use for each medication ordered. Had this student looked Lanoxin up in a drug guide, the student would have discovered that the medication is never given in the eye.

50) **Prevention:** The student nurse took the correct action with this order. The nurses who had given the medication previously should have looked up the medication if they were unfamiliar with it to safely identify whether it was ordered by an appropriate route, correct dose, and correct time. There was also an error made by the pharmacist who supplied the medication to the nursing unit. It is extremely important to be familiar with the medications being given. If there's a question or any doubt, the medication should be looked up in a drug guide and/or the prescriber questioned. Also, close reading of the label and matching it to the order is also extremely important. Remember the Six Rights of medication administration.

Solutions—Comprehensive Skills Evaluation

1) $\frac{6.5\text{ mg}}{1\text{ cap}} \times \frac{13\text{ mg}}{X\text{ cap}}$

$6.5X = 13$

$\frac{6.5X}{6.5} = \frac{13}{6.5}$

$X = 2$ cap

3) $\frac{10\text{ mg}}{1\text{ mL}} \times \frac{20\text{ mg}}{X\text{ mL}}$

$10X = 20$

$\frac{10X}{10} = \frac{20}{10}$

$X = 2$ mL

$\frac{40\text{ mg}}{2\text{ min}} \times \frac{20\text{ mg}}{X\text{ min}}$

$40X = 40$

$\frac{40X}{40} = \frac{40}{40}$

$X = 1$ min Give 2 mL over 1 min

$\frac{2\text{ mg}}{60\text{ sec}} \times \frac{X\text{ mg}}{15\text{ sec}}$

$60X = 30$

$\frac{60X}{60} = \frac{30}{60}$

$X = 0.5$ mL; Give 0.5 mL over 15 sec

4) $\frac{20\text{ mcg}}{1\text{ tab}} \times \frac{20\text{ mcg}}{X\text{ tab}}$

$20X = 20$

$\frac{20X}{20} = \frac{20}{20}$

$X = 1$ tab

5) $\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{0.25\text{ mg}}{X\text{ mcg}}$

$X = 250$ mcg

$\frac{500\text{ mcg}}{2\text{ mL}} \times \frac{250\text{ mcg}}{X\text{ mL}}$

$500X = 500$

$\frac{500X}{500} = \frac{500}{500}$

$X = 1$ mL

0.25 mg: 1 mL added to 4 mL NS = 5 mL total

$\frac{\overset{1}{\cancel{5}}\text{ mL}}{\underset{1}{\cancel{5}}\text{ min}} = 1$ mL/min

$\frac{1\text{ mL}}{60\text{ sec}} \times \frac{X\text{ mL}}{15\text{ sec}}$

$60X = 15$

$\frac{60X}{60} = \frac{15}{60}$

$X = 0.25$ mL (per 15 sec)

6) $\frac{1\text{ mg}}{1{,}000\text{ mcg}} \times \frac{0.125\text{ mg}}{X\text{ mcg}}$

$X = 125$ mcg

$\frac{250\text{ mcg}}{1\text{ tab}} \times \frac{125\text{ mcg}}{X\text{ tab}}$

$250X = 125$

$\frac{250X}{250} = \frac{125}{250}$

$X = \frac{1}{2}$ tab

Daily; means you will need $\frac{1}{2}$ tab per 24 h.

7) $\frac{\text{mL/h}}{\text{drop factor constant}} = \text{gtt/min}$

$\frac{80\text{ mL/h}}{1} = 80$ gtt/min or

80 mL/h = 80 gtt/min (because drop factor is 60 gtt/mL)

8) $\frac{2\text{ mEq}}{1\text{ mL}} \times \frac{10\text{ mEq}}{X\text{ mL}}$

$2X = 10$

$\frac{2X}{2} = \frac{10}{2}$

$X = 5$ mL

9) The total fluid volume is:

$1{,}000 \text{ mL } (D_5 \tfrac{1}{2} \text{ NS}) + 5 \text{ mL (KCl)} = 1{,}005 \text{ mL}$

$$\frac{10 \text{ mEq}}{1{,}005 \text{ mL}} \times \frac{X \text{ mEq/h}}{80 \text{ mL/h}}$$

$1{,}005X = 800$

$$\frac{1{,}005X}{1{,}005} = \frac{800}{1{,}005}$$

$X = 0.8 \text{ mEq/h}$

10) $80 \text{ mL/}\cancel{\text{h}} \times 24 \cancel{\text{h}} = 1{,}920 \text{ mL}$

11) $\frac{1{,}000 \cancel{\text{mL}}}{80 \cancel{\text{mL}}\text{/h}} = 12.5 \text{ h} = 12 \text{ h } 30 \text{ min}$

1630 hours + 12 h 30 min later = 0500 hours the next day

12) 1 g = 1,000 mg

$$\frac{500 \text{ mg}}{1 \text{ tab}} \times \frac{1{,}000 \text{ mg}}{X \text{ tab}}$$

$500X = 1{,}000$

$$\frac{500X}{500} = \frac{1{,}000}{500}$$

$X = 2$ tabs

13) Order is for 80 mL/h—this is the setting for the controller.

15) $$\frac{10 \text{ mg}}{1 \text{ mL}} \times \frac{50 \text{ mg}}{X \text{ mL}}$$

$10X = 50$

$$\frac{10X}{10} = \frac{50}{10}$$

$X = 5 \text{ mL}$

16) $$\frac{2{,}000 \text{ mg}}{500 \text{ mL}} \times \frac{2 \text{ mg/min}}{X \text{ mL/min}}$$

$2{,}000X = 1{,}000$

$$\frac{2{,}000X}{2{,}000} = \frac{1{,}000}{2{,}000}$$

$X = 0.5 \text{ mL/min}$

$$\frac{0.5 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$$

$X = 30 \text{ mL/h}$

17) $$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{110 \text{ lb}}$$

$2.2X = 110$

$$\frac{2.2X}{2.2} = \frac{110}{2.2}$$

$X = 50 \text{ kg}$

Minimum: $5 \text{ mcg/}\cancel{\text{kg}}\text{/min} \times 50 \cancel{\text{kg}} = 250 \text{ mcg/min}$

Maximum: $10 \text{ mcg/}\cancel{\text{kg}}\text{/min} \times 50 \cancel{\text{kg}} = 500 \text{ mcg/min}$

Ordered dose is safe.

$$\frac{80 \text{ mg}}{1 \text{ mL}} \times \frac{400 \text{ mg}}{X \text{ mL}}$$

$80X = 400$

$$\frac{80X}{80} = \frac{400}{80}$$

$X = 5 \text{ mL}$

18) $$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{X \text{ mg/min}}{500 \text{ mcg/min}}$$

$1{,}000X = 500$

$$\frac{1{,}000X}{1{,}000} = \frac{500}{1{,}000}$$

$X = 0.5 \text{ mg/min}$

$$\frac{400 \text{ mg}}{250 \text{ mL}} \times \frac{0.5 \text{ mg/min}}{X \text{ mL/min}}$$

$400X = 125$

$$\frac{400X}{400} = \frac{125}{400}$$

$X = 0.31 \text{ mL/min}$

$$\frac{0.31 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$$

$X = 19 \text{ mL/h}$

19) $$\frac{500 \text{ mcg}}{1 \text{ min}} \times \frac{X \text{ mcg/h}}{60 \text{ min/h}}$$

$X = 30{,}000 \text{ mcg/h}$

$$\frac{1 \text{ mg}}{1{,}000 \text{ mcg}} \times \frac{X \text{ mg/h}}{30{,}000 \text{ mcg/h}}$$

$1{,}000X = 30{,}000$

$$\frac{1{,}000X}{1{,}000} = \frac{30{,}000}{1{,}000}$$

$X = 30 \text{ mg/h}$

20) $$\frac{2{,}000\text{mg}}{500 \text{ mL}} \times \frac{4 \text{ mg/min}}{X \text{ mL/min}}$$

$2{,}000X = 2{,}000$

$$\frac{2{,}000X}{2{,}000} = \frac{2{,}000}{2{,}000}$$

$X = 1 \text{ mL/min}$

$$\frac{1 \text{ mL}}{1 \text{ min}} \times \frac{X \text{ mL/h}}{60 \text{ min/h}}$$

$X = 60 \text{ mL/h}$

21) $$\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{33 \text{ lb}}$$

$2.2X = 33$

$$\frac{2.2X}{2.2} = \frac{33}{2.2}$$

$X = 15 \text{ kg}$

$15 \text{ mg/}\cancel{\text{kg}}\text{/min} \times 15 \cancel{\text{kg}} = 225 \text{ mg/min}$

Maximum:

$$\frac{225 \text{ mg}}{3 \text{ doses}} \times \frac{X \text{ mg}}{1 \text{ dose}}$$

$3X = 225$

$$\frac{3X}{3} = \frac{225}{3}$$

$X = 75$ mg (per dose)

The order is safe.

$$\frac{75 \text{ mg}}{2 \text{ mL}} \times \frac{75 \text{ mg}}{X \text{ mL}}$$

$75X = 150$

$$\frac{75X}{75} = \frac{150}{75}$$

$X = 2 \text{ mL}$

25 mL (total IV solution) − 2 mL (Kantrex) = 23 mL ($D_5 \frac{1}{2}$ NS)

25 mL (total solution) + 15 mL (flush) = 40 mL (total in 1 h)

40 mL over 1 h is 40 mL/h.

22) $\frac{125 \text{ mg}}{100 \text{ mL}} \times \frac{15 \text{ mg/h}}{X \text{ mL/h}}$

$125X = 1{,}500$

$\frac{125X}{125} = \frac{1{,}500}{125}$

$X = 12$ mL/h

23) $\frac{1 \text{ kg}}{2.2 \text{ lbs}} \times \frac{X \text{ kg}}{66 \text{ lbs}}$

$2.2X = 66$

$\frac{2.2X}{2.2} = \frac{66}{2.2}$

$X = 30$ kg

$40 \text{ mg}/\cancel{\text{kg}}/\text{day} \times 30\ \cancel{\text{kg}} = 1{,}200 \text{ mg/day}$

$\frac{1{,}200 \text{ mg}}{4 \text{ doses}} \times \frac{X \text{ mg}}{1 \text{ dose}}$

$4X = 1{,}200$

$\frac{4X}{4} = \frac{1{,}200}{4}$

$X = 300$ mg (per dose)

$\frac{500 \text{ mg}}{10 \text{ mL}} \times \frac{300 \text{ mg}}{X \text{ mL}}$

$500X = 3{,}000$

$\frac{500X}{500} = \frac{3{,}000}{500}$

$X = 6$ mL

50 mL (total IV volume) − 6 mL (Vancocin) = 44 mL ($D_5 \frac{1}{2}$ NS); $50 \text{ mL}/\cancel{\text{h}} \times 24\ \cancel{\text{h}} = 1{,}200$ mL

24) $\frac{20 \text{ mEq}}{1{,}000 \text{ mL}} \times \frac{X \text{ mEq}}{250 \text{ mL}}$

$1{,}000X = 5000$

$\frac{1{,}000X}{1{,}000} = \frac{5{,}000}{1{,}000}$

$X = 5$ mEq

$\frac{2 \text{ mEq}}{1 \text{ mL}} \times \frac{5 \text{ mEq}}{X \text{ mL}}$

$2X = 5$

$\frac{2X}{2} = \frac{5}{2}$

$X = 2.5$ mL

25) Select smallest quantity diluent (19 mL) to obtain most concentrated solution because 50 mL IV fluid is ordered for each Prostaphlin dose.

27) $\frac{1{,}000 \text{ mg}}{10 \text{ mL}} \times \frac{500 \text{ mg}}{X \text{ tab}}$

$1{,}000X = 5{,}000$

$\frac{1{,}000X}{1{,}000} = \frac{5{,}000}{1{,}000}$

$X = 5$ mL

50 mL (total IV volume) − 5 mL (Prostaphlin) = 45 mL D_5W

28) 50 mL (total IV solution) + 15 mL (flush) = 65 mL (total)

65 mL over 60 min is 65 mL/h

29) $\frac{5{,}000 \text{ units}}{1 \text{ mL}} \times \frac{10{,}000 \text{ units}}{X \text{ mL}}$

$5{,}000X = 10{,}000$

$\frac{5{,}000X}{5{,}000} = \frac{10{,}000}{5{,}000}$

$X = 2$ mL

$\frac{10{,}000 \text{ units}}{500 \text{ mL}} \times \frac{1{,}200 \text{ units/h}}{X \text{ mL/h}}$

$10{,}000X = 600{,}000$

$\frac{10{,}000X}{10{,}000} = \frac{600{,}000}{10{,}000}$

$X = 60$ mL/h

30) $\frac{1 \text{ kg}}{2.2 \text{ lb}} \times \frac{X \text{ kg}}{125 \text{ lb}}$

$2.2X = 125$

$\frac{2.2X}{2.2} = \frac{125}{2.2}$

$X = 56.8$ kg

$80 \text{ units}/\cancel{\text{kg}} \times 56.8\ \cancel{\text{kg}} = 4{,}544$ units

$\frac{1{,}000 \text{ units}}{1 \text{ mL}} \times \frac{4{,}544 \text{ units/h}}{X \text{ mL}}$

$1{,}000X = 4{,}544$

$\frac{1{,}000X}{1{,}000} = \frac{4{,}544}{1{,}000}$

$X = 4.544$ mL = 4.6 mL

$18 \text{ units}/\cancel{\text{kg}} \times 56.8\ \cancel{\text{kg}} = 1{,}022.4$ units = 1,022 units

$\frac{25{,}000 \text{ units}}{250 \text{ mL}} \times \frac{1{,}022 \text{ units/h}}{X \text{ mL/h}}$

$25{,}000X = 255{,}500$

$\frac{25{,}000X}{25{,}000} = \frac{255{,}500}{25{,}000}$

$X = 10$ mL/h

31) Decrease rate by 2 units/kg/h

$2 \text{ units}/\cancel{\text{kg}}/\text{h} \times 56.8\ \cancel{\text{kg}} = 113.6$ units/h = 114 units/h

1,022 units/h − 114 units/h = 908 units/h

$\frac{25{,}000 \text{ units}}{250 \text{ mL}} \times \frac{908 \text{ units/h}}{X \text{ mL/h}}$

$25{,}000X = 227{,}000$

$\frac{25{,}000X}{25{,}000} = \frac{227{,}000}{25{,}000}$

$X = 9$ mL/h

32) $\frac{100\text{ units}}{1\text{ mL}} \times \frac{8\text{ units}}{X\text{ mL}}$

$100X = 8$

$\frac{100X}{100} = \frac{8}{100}$

$X = 0.08\text{ mL}$

33) 15 units + 45 units = 60 units

34) U 100 insulin: 100 units/mL

$\frac{100\text{ units}}{1\text{ mL}} \times \frac{300\text{ units}}{X\text{ mL}}$

$100X = 300$

$\frac{100X}{100} = \frac{300}{100}$

$X = 3\text{ mL}$

Total IV volume: 150 mL (NS) + 3 mL (insulin) = 153 mL

$\frac{300\text{ units}}{153\text{ mL}} \times \frac{X\text{ units/h}}{10\text{ mL/h}}$

$153X = 3{,}000$

$\frac{153X}{153} = \frac{3{,}000}{153}$

$X = 19.6\text{ units/h} = 20\text{ units/h}$

35) $\frac{1\text{ oz}}{30\text{ mL}} \times \frac{8\text{ oz}}{X\text{ mL}}$

$X = 240\text{ mL}$

$\frac{1}{4} \times \frac{240}{X\text{ mL}}$

$X = 960$ mL (total volume of reconstituted $\frac{1}{4}$ strength Isomil)

960 mL total solution − 240 mL (solute or Isomil) = 720 mL (solvent or water)

36) $\frac{1\text{ kg}}{2.2\text{ lb}} \times \frac{X\text{ kg}}{16\text{ lb}}$

$2.2X = 16$

$\frac{2.2X}{2.2} = \frac{16}{2.2}$

$X = 7.3\text{ kg}$

$100\text{ mL}/\cancel{\text{kg}}/\text{day} \times 7.3\ \cancel{\text{kg}} = 730\text{ mL/day}$

$730\text{ mL}/\cancel{\text{day}} \div 24\text{ h}/\cancel{\text{day}} = 30\text{ mL/h}$

37) $\frac{1\text{ ft}}{12\text{ in}} \times \frac{5\text{ ft}}{X\text{ in}}$

$X = 60\text{ in}$

60 in + 2 in = 62 in

Household:

$\text{BSA (m}^2) = \sqrt{\frac{\text{ht (in)} \times \text{wt (lb)}}{3{,}131}} = \sqrt{\frac{62 \times 103}{3{,}131}} =$

$\sqrt{2.039...} = 1.43\text{ m}^2$

38) $10\text{ mg}/\cancel{\text{m}^2} \times 1.43\ \cancel{\text{m}^2} = 14.3\text{ mg}$

$20\text{ mg}/\cancel{\text{m}^2} \times 1.43\ \cancel{\text{m}^2} = 28.6\text{ mg}$

Yes, the order is safe.

Concentration: 40 mg per 80 mL

$\frac{40\text{ mg}}{80\text{ mL}} \times \frac{X\text{ mg}}{1\text{ mL}}$

$80X = 40$

$\frac{80X}{80} = \frac{40}{80}$

$X = 0.5$ mg (per mL) or 0.5 mg/mL

$\frac{0.5\text{ mg}}{1\text{ mL}} \times \frac{28\text{ mg}}{X\text{ mL}}$

$0.5X = 28$

$\frac{0.5X}{0.5} = \frac{28}{0.5}$

$X = 56\text{ mL}$

$\frac{56\text{ mL}}{10\text{ min}} \times \frac{X\text{ mL}}{1\text{ min}}$

$10X = 56$

$\frac{10X}{10} = \frac{56}{10}$

$X = 5.6$ mL per min or 5.6 mL/min or 5.6 mL per 60 sec

$\frac{5.6\text{ mL}}{60\text{ sec}} \times \frac{X\text{ mL}}{15\text{ sec}}$

$60X = 84$

$\frac{60X}{60} = \frac{84}{60}$

$X = 1.4$ mL (per 15 sec)

39) Dextrose:

$\frac{5\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{1{,}000\text{ mL}}$

$100X = 5{,}000$

$\frac{100X}{100} = \frac{5{,}000}{100}$

$X = 50\text{ g}$

NaCl:

$\frac{0.45\text{ g}}{100\text{ mL}} \times \frac{X\text{ g}}{1{,}000\text{ mL}}$

$100X = 450$

$\frac{100X}{100} = \frac{450}{100}$

$X = 4.5\text{ g}$

40) $\frac{20\text{ mEq}}{1{,}000\text{ mL}} \times \frac{X\text{ mEq}}{400\text{ mL}}$

$1{,}000X = 8000$

$\frac{1{,}000X}{1{,}000} = \frac{8{,}000}{1{,}000}$

$X = 8\text{ mEq}$

$\frac{40\text{ mEq}}{20\text{ mL}} \times \frac{8\text{ mEq}}{X\text{ mL}}$

$40X = 160$

$\frac{40X}{40} = \frac{160}{40}$

$X = 4\text{ mL}$

41) $\frac{250\text{ mg}}{1\text{ mL}} \times \frac{540\text{ mg}}{X\text{ mL}}$

$250X = 540$

$\frac{250X}{250} = \frac{540}{250}$

$X = 2.16\text{ mL} = 2.2\text{ mL}$

50 mL − 2.2 mL = 47.8 mL (IV fluid). Note: Add the med to the chamber, and then add IV fluid up to 50 mL.

42) $\frac{40 \text{ mg}}{1 \text{ mL}} \times \frac{540 \text{ mg}}{X \text{ mL}}$

$40X = 540$

$\frac{40X}{40} = \frac{540}{40}$

$X = 13.5 \text{ mL}$

43) 400,000 units/dose × 4 doses/day = 1,600,000 units/day

Minimum: 150,000 units/~~kg~~/day × 10 ~~kg~~ = 1,500,000 units/day

Maximum: 250,000 units/~~kg~~/day × 10 ~~kg~~ = 2,500,000 units/day

Reconstitute with 1.8 mL for a concentration of 500,000 units/mL. This concentration is selected because it will be further diluted.

$\frac{500{,}000 \text{ units}}{1 \text{ mL}} \times \frac{400{,}000 \text{ units}}{X \text{ mL}}$

$500{,}000X = 400{,}000$

$\frac{500{,}000X}{500{,}000} = \frac{400{,}000}{500{,}000}$

$X = 0.8$ mL (penicillin)

44) 100 mL (NS) + 0.8 mL (penicillin) = 100.8 or 101 mL to be infused in 60 min or 1 h. Set IV pump at 101 mL/h.

45) The primary IV will infuse for 8 hours. The IV PB will infuse for 30 minutes. Therefore, the primary IV will be interrupted by the IV PB and then will resume. The IV will be completely infused in 8 hours and 30 min.

(1315 + 8 h 30 min = 1315 + 0830 = 2145)

46) $\frac{50 \text{ mg}}{1 \text{ mL}} \times \frac{25 \text{ mg}}{X \text{ mL}}$

$50X = 25$

$\frac{50X}{50} = \frac{25}{50}$

$X = 0.5 \text{ mL}$

Give 0.5 mL/min or

$\frac{0.5 \text{ mL}}{60 \text{ sec}} \times \frac{X \text{ mL}}{15 \text{ sec}}$

$60X = 7.5$

$\frac{60X}{60} = \frac{7.5}{60}$

$X = 0.13$ mL (per 15 sec)

47) $\frac{2{,}000 \text{ mg}}{10 \text{ mL}} \times \frac{1{,}500 \text{ mg}}{X \text{ mL}}$

$2{,}000X = 15{,}000$

$\frac{2{,}000X}{2{,}000} = \frac{15{,}000}{2{,}000}$

$X = 7.5 \text{ mL}$

48) $\frac{100 \text{ mL}}{30 \text{ min}} = \frac{X \text{ mL/h}}{60 \text{ min/h}}$

$30X = 6{,}000$

$\frac{30X}{30} = \frac{6{,}000}{30}$

$X = 200 \text{ mL/h}$

Index