BROWN & MULHOLLAND'S

DRUG CALCULATIONS

RATIO AND PROPORTION PROBLEMS FOR CLINICAL PRACTICE

Ann B. Tritak–Elmiger
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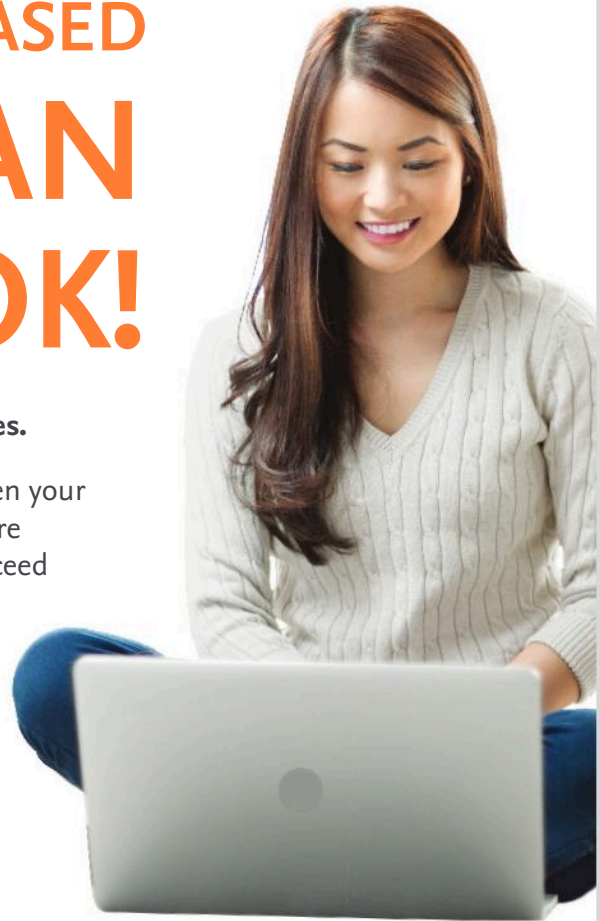
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Approved Abbreviations for Medications*

Abbreviation	Meaning	Abbreviation	Meaning
$\bar{a}$	before	Write out	milliunit
ac	before meals	mL	milliliter
ad lib	as desired; freely	NG, NGT	nasogastric tube
ADE	adverse drug event	NKA	no known allergies
AM, am	in the morning; before noon	NKDA	no known drug allergies
amp	ampule	NPO	nothing by mouth
aq	water	NS	normal saline
bid	twice a day	oz***	ounce
BSA	body surface area	OTC	over the counter
C	Celsius	$\bar{p}$	after
$\bar{c}$	with	pc	after meals
cap or caps	capsule	PCA	patient-controlled analgesia
CD*	controlled dose	per	through, by (route)
comp	compound	per	each (math term)
CR**	controlled release	PO, po	by mouth
dil.	dilute	PM, pm	afternoon; evening
DS	double strength	prn	as needed; when necessary
elix	elixir	q	each, every
ext	external; extract	q2h, q4h, etc.	every 2 hours, every 4 hours, etc.
F	Fahrenheit	qs	as much as needed; quantity sufficient
fl. or fld	fluid	rep.	repeat
g	gram	Rx	give, treatment, prescription
gt, gtt	drop, drops	$\bar{s}$	without
h, hr	hour	SL, subl	sublingual (under the tongue)
ID	intradermal(ly)	sol. or soln.	solution
IM	intramuscular(ly)	SR**	sustained release
inj	injection	stat	immediately, at once
IV	intravenous(ly)	SUBQ	subcutaneous(ly)
IVPB	intravenous piggyback	supp	suppository
kg	kilogram	susp.	suspension
KVO	keep vein open	Syr	syrup
L	liter	tab	tablet
LA**	long acting	tbs., tbsp, or T***	tablespoon
lb	pound	tid	three times a day
liq.	liquid	tinct	tincture
m	meter	TKO	to keep open
m^2	square meter	tsp***	teaspoon
mcg	microgram	ung	ointment
mEq	milliequivalent	vag	vaginal
mg	milligram	XR**	extended release

CLINICAL ALERT!

*This is one example of approved abbreviations. The Joint Commission does not provide a list of approved abbreviations but recognizes that individual organizations may develop a list of standardized abbreviations. Check agency policy.

**The manufacturer acronyms that follow medication names have caused confusion and errors. CD, CR, DR, E-R, LA, SA, SR, TR, XL, XR, XT all refer to various timed-release forms of the drug. They cannot be used interchangeably. Some need to be taken more than once a day; some tablets can be cut, others cannot. Double check the order and the acronym with a current drug reference and the patient medication history to protect the patient from a medication type or dose error.

Do NOT confuse DS—double strength—with other acronyms. DS pertains *only* to strength, not timing of release.

***Abbreviations for ounce, tablespoon, and teaspoon are provided here for information only. Best practice is to use the metric system only (e.g., mL). See Appendix B.

The Joint Commission's Official "Do Not Use" List

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.

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 "ml" or "milliliters" ("mL" is preferred)
µg	Mistaken for mg (milligrams) resulting in one thousand-fold overdose	Write "mcg" or "micrograms"

Institute for Safe Medication Practices (ISMP) List of Error-Prone Abbreviations, Symbols, and Dose Designations

Abbreviation	Write	Abbreviation	Write
AD, AS, or AU	right ear, left ear, or each ear	SC, SQ, sq, or sub q	SUBQ or subcutaneous(ly)
OD, OS, or OU	right eye, left eye, or each eye	ss or SS	single strength, sliding scale, signs and symptoms, or one-half or 1/2
cc	mL for milliliters	SSI or SSRI	sliding scale (insulin)
HS	half-strength	µg	mcg
hs	HS for bedtime	 >	less than more than
qhs	nightly or HS for bedtime	+	plus, and, or in addition to
qn	nightly or HS for bedtime	@	at
q1d	daily		

Please note: This is a partial list. For a more complete list, refer to www.ISMP.org.

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Preface

To Instructors

Drug Calculations: Ratio and Proportion Problems for Clinical Practice was originally designed in the late 1970s as a basic practical resource for nursing students and faculty in classrooms and clinical areas. Additional content was added over the years to be current with the increased roles and responsibilities of the nurse and to be useful for refresher courses, nurses practicing in specialty areas, distance-learning nursing students, and nursing students who must master the material independently.

The current text has been updated to reflect feedback from reviewers, colleagues, and students, and student needs related to current trends in nursing education and practice.

Continuing in This Edition

Ratio and proportion calculations are presented in the second chapter following a math review so that the student has the method reinforced throughout the rest of the text for maximum competence. As with earlier editions, the text presents one calculation method—ratio and proportion—to maximize the teaching and learning time for reinforcement, practice, and mastery within the brief time the student has to devote to this critical subject.

Fraction Cross-Product Multiplication setup of ratio and proportion calculations and the colon setup show color-coded means and extremes examples to ensure correct factor placement.

Chapter objectives are logically organized and reflect the progression of chapter content.

The material is sequential with logical steps and ample practice problems to facilitate mastery of the concepts.

Medication administration "rights" are expanded to include preadministration assessment, reason, and postadministration evaluation.

Examples of cultural responsiveness in the administration of medications are included.

The quizzes and tests are brief and can be completed in one sitting. Answers are worked out.

Each medication problem has a frequently encountered diagnosis attached to make the problem more realistic and help the student assimilate clinical relevance.

A high-alert red flag is attached to the Institute for Safe Medication Practices (ISMP) High Alert Medications to call attention to these medications.

The sample hand-off communication report in Appendix D has highlighted medication-related inclusions.

The Joint Commission (TJC), the ISMP abbreviations, and QSEN patient safety recommendations are emphasized.

Clinical relevance and patient safety measures are included for the benefit of students who are studying independently as well as those in the classroom.

New to This Edition

- Addition of Next Generation National Council Licensure Examination questions (NGN) designed to assess critical thinking, clinical judgment, and decision-making. Questions are based on the National Council State Boards of Nursing (NCSBN) Clinical Judgement Measurement Model cognitive skills aligned with identified student learning outcomes. Each question is associated with

specific chapter content and connects the selected learning outcomes, NGN item type, and cognitive skills with practice-based case studies. Answer keys provide rationale based on the student's responses.

- Vocabulary definitions are updated to reflect current practice.
- Chapters address the *2020 Hospital National Patient Safety Goals of Identifying Patients Correctly, Use Medications Safely, and Prevent Infection.*

To Students

Drug Calculations: Ratio and Proportion Problems for Clinical Practice provides all the information, explanation, and practice you need to competently and confidently calculate drug dosages.

A General Mathematics Self-Assessment is provided as a refresher to identify areas needed for further study. Chapter 1 provides a basic review of all the arithmetic needed to calculate medication dosages. The Ratio and Proportion method of calculating dosages is used throughout the text. Chapter 2 introduces two Ratio and Proportion setups: Using colons and the Fraction Cross-Product (Multiplication). You may use whichever R and P method you prefer. Be sure that you have complete mastery of Chapter 1 and 2 before proceeding with the rest of the text.

Each chapter has a series of quizzes with a Multiple-Choice and Final test at the end of each chapter. Each of the quizzes and tests can be completed in one sitting. Answers with proofs are worked out in the Answer Key at the end of each chapter.

Clinical Alerts in red will point out potential errors that can occur in the clinical setting. Clinical Relevance information is provided to help you connect math to the safe application in the clinical setting. A high-alert medication icon flag is a visual reminder of high-risk drugs identified by the Institute for Safe Medication Practices (ISMP).

Samples of look-alike medications that have caused medication errors are included. Pay close attention to all of the icons and textbox notes. They relate to actual safe and unsafe practice. Tall Man letters distinguish differences between similar names.

Critical Thinking Exercises at the end of each chapter help you understand how medication errors occur and how they might have been prevented. Discuss the exercises with other nursing students to elicit various ways to avoid medication errors.

Multiple-Choice and Comprehensive Finals test your knowledge on all of the chapters studied.

Spend extra review time in the text on any questions that you cannot answer correctly.

Elsevier's Interactive Drug Calculation Application, Version 1

This interactive drug calculations application provides hands-on, interactive practice for the user to master drug calculations. Users can select the mode (Study, Exam, or Comprehensive Exam) and then the category for study and exam modes. There are eight categories that cover the main drug calculation topics. Users are also able to select the number of problems they want to complete and their preferred drug calculation method. A calculator is available for easy access within any mode, and the application also provides history of the work done by the user.

Look for this icon at the end of the chapters. It will refer to *Elsevier's Interactive Drug Calculation Application, Version 1* for additional practice problems and content information.

Acknowledgments

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General Mathematics Self-Assessment

The accurate calculation of medication dosages, a skill that is central to patient safety, builds on a knowledge of fundamental mathematics. Competency and skill in using the basic principles of arithmetic are essential for safe medication administration. To progress in the *Drug Calculations* text, students must know how to solve problems using addition, subtraction, multiplication, division, fractions, decimals, and percentages. Use the problems provided in the following self-assessment to gauge current knowledge. Answers are on page 4. Chapter 1, General Mathematics, provides a refresher for each type of problem in the self-assessment. Consult a text for general mathematics as needed.

Fractions

Change to whole or mixed numbers.

1. $\dfrac{9}{2}$ **2.** $\dfrac{26}{5}$

Change to improper fractions.

3. $8\dfrac{1}{3}$ **4.** $5\dfrac{2}{5}$

Find the lowest common denominator.

5. $\dfrac{4}{11}$ and $\dfrac{1}{8}$ **6.** $\dfrac{2}{5}$ and $\dfrac{5}{9}$

Add.

7. $\dfrac{1}{5}$, $\dfrac{1}{6}$, and $\dfrac{2}{3}$ **8.** $1\dfrac{1}{2} + 3\dfrac{1}{8} + 2\dfrac{1}{6}$

Subtract.

9. $\dfrac{5}{7} - \dfrac{1}{3}$ **10.** $8\dfrac{1}{4} - 3\dfrac{3}{8}$

Multiply and reduce to lowest terms.

11. $\dfrac{1}{6} \times \dfrac{1}{3}$ **12.** $\dfrac{2}{8} \times 1\dfrac{1}{3}$

Divide and reduce to lowest terms.

13. $\dfrac{1}{3} \div \dfrac{2}{5}$ **14.** $1\dfrac{1}{8} \div 2\dfrac{1}{2}$

Reduce to lowest terms (numbers).

15. $\dfrac{4}{120}$ **16.** $\dfrac{3}{7}$

Decimals

Write as decimals.

17. Twelve hundredths   **18.** Three and sixteen thousandths

Add.

19. 3.04 + 1.864   **20.** 25.7 + 3.008

Subtract.

21. 3 − 0.04   **22.** 0.96 − 0.1359

Multiply.

23. 0.05 × 2   **24.** 3 × 0.4

Divide and carry to the third decimal place.

25. 500 ÷ 15   **26.** 20.6 ÷ 0.21

Change to decimals and carry to the third decimal place.

27. $\dfrac{24}{44}$ **28.** $9\dfrac{1}{8}$

Percentages

Find the percentages.

29. 25% of 300   **30.** 1% of 50

Change the decimals to fractions and reduce to lowest terms.

31. 0.005   **32.** 0.05

Change the fractions to a decimal and a percentage.

33. $\dfrac{3}{4}$ **34.** $\dfrac{1}{8}$

Rounding

Round the decimals (35–39) in the chart below.

	Decimal	Nearest Whole Number	Nearest Hundredth	Nearest Tenth
35.	0.8734			
36.	0.842			
37.	0.553			
38.	0.689			
39.	2.75			

Answer the questions.

40. What is 25% of 2? Ans: fraction _____ Ans: decimal _____

41. What is $\frac{1}{4}$ of 2? Ans: fraction _____ Ans: decimal _____

42. What is 75% of 2? Ans: fraction _____ Ans: decimal _____

43. Divide 0.5 by 0.25:

44. Divide 0.2 by 0.1:

45. Divide $\frac{1}{100}$ by $\frac{1}{200}$:

Answer Key

General Mathematics Self-Assessment

1. $4\frac{1}{2}$ **2.** $5\frac{1}{5}$ **3.** $\frac{25}{3}$ **4.** $\frac{27}{5}$

5. 88   **6.** 45   **7.** $1\frac{1}{8}$ **8.** $6\frac{19}{24}$

9. $\frac{8}{21}$ **10.** $4\frac{7}{8}$ **11.** $\frac{1}{18}$ **12.** $\frac{1}{3}$

13. $\frac{5}{6}$ **14.** $\frac{9}{20}$ **15.** $\frac{1}{8}$ **16.** $\frac{3}{7}$

17. 0.12   **18.** 3.016   **19.** 4.904   **20.** 28.708

21. 2.96   **22.** 0.8241   **23.** 0.1   **24.** 1.2

25. 33.333   **26.** 98.095   **27.** 0.545   **28.** 9.125

29. 75   **30.** 0.5   **31.** $\frac{5}{1000} = \frac{1}{200}$ **32.** $\frac{5}{100} = \frac{1}{20}$

33. 0.75   75%   **34.** 0.125 $12\frac{1}{2}$%

	Decimal	Nearest Whole Number	Nearest Hundredth	Nearest Tenth
35.	0.8734	1	0.87	0.9
36.	0.842	1	0.84	0.8
37.	0.553	1	0.55	0.6
38.	0.689	1	0.69	0.7
39.	2.75	3	2.75	2.8

40. $\frac{1}{2}$ (0.5)   **41.** $\frac{1}{2}$ (0.5)   **42.** $1\frac{1}{2}$ (1.5)   **43.** 2

44. 2   **45.** 2

General Mathematics

Objectives
- Define the term *fraction*, including parts of a fraction.
- Reduce fractions to lowest terms.
- Understand the value of fractions.
- Convert improper fractions and mixed numbers.
- Create equivalent fractions and compare values.
- Add, subtract, multiply, and divide fractions and mixed numbers.
- Compare decimal values.
- Round decimals.
- Add, subtract, multiply, and divide decimals.
- Convert decimals, fractions, and percentages.

Introduction

The Quality and Safety Education for Nurses (QSEN) project centers on the knowledge, skills, and attitudes necessary for nurses to provide safe, high-quality, evidence-based, patient-centered care as part of the interprofessional team (http://qsen.org). Proficiency in general mathematical calculations is an essential step toward safe medication administration, one means of ensuring quality patient outcomes.

This chapter provides a thorough and easy-to-follow review of the arithmetic needed for accurate medication dose calculations. Many examples, practice problems, and answers related to fractions, decimals, rounding, and percentages are offered. Your ability to avoid medication errors and solve medication dose-related problems starts with competence in basic arithmetic. If you need further review, refer to a basic mathematics text. Mastery of these concepts is essential before you proceed to the following chapters and medication-related calculations.

Fractions

A fraction is part of a whole number. The fraction $\frac{6}{8}$ means that there are 8 parts to the whole number (bottom number, or denominator), but you want to measure only 6 of those parts (top number, or numerator).
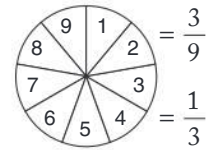

$$= \frac{6}{8}$$

$$= \frac{3}{4}$$
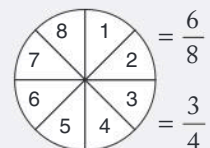
The fraction $\frac{6}{8}$ can be reduced by dividing both the numbers by 2.

$$\frac{6 \div 2}{8 \div 2} = \frac{3}{4} \quad \text{numerator} \atop \text{denominator}$$

The fraction $\frac{3}{9}$ means that there are 9 parts to the whole number.

Example The fraction $\frac{3}{9}$ can be reduced by dividing both numbers by the same number.

$$\frac{3 \div 3 = 1}{9 \div 3 = 3} \quad \text{numerator} \atop \text{denominator}$$

$$\frac{3}{9} = \frac{3}{9} = \frac{1}{3}$$

remember The whole number of the fraction is always the denominator.

Value of Fractions

RULE The denominator determines the number of parts into which the whole number is divided. The smaller the denominator of a fraction, the greater the fraction's value if the numerators are the same.

Example Which would you rather have, $\frac{1}{6}$ or $\frac{1}{9}$ of your favorite candy bar? $\frac{1}{6}$ is greater than $\frac{1}{9}$. It represents a larger part of the whole unit.

$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$	$\frac{1}{6}$

= 6 parts   Each $\frac{1}{6}$ part is **larger** than the $\frac{1}{9}$ part.

$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$	$\frac{1}{9}$

= 9 parts   Each $\frac{1}{9}$ part is **smaller** than the $\frac{1}{6}$ part.

Answers on page 32

WORKSHEET 1A | **Value of Fractions**

Answer the following questions by circling the correct answer.

1. Would you rather own $\frac{1}{10}$ or $\frac{1}{20}$ of a lottery ticket?

2. Would you rather have 2 out of 7 or 2 out of 14 days off?

3. If you had a choice of a bonus of $\frac{1}{20}$ or $\frac{1}{30}$ of your annual salary, which would you prefer?

4. Which would be the *greater* incidence of a disease, 1 out of approximately every 100,000 people $\left(\frac{1}{100,000}\right)$ or 1 out of approximately 250,000 people $\left(\frac{1}{250,000}\right)$?

5. If a tablet was ordered for a patient at grain $\frac{1}{4}$ and you had tablets labeled grain $\frac{1}{8}$, would you need to give *more* or *less* than what is on hand?

6. Which is **greater?** $\frac{1}{5}$ or $\frac{1}{8}$

7. Which is **smaller?** $\frac{1}{100}$ or $\frac{1}{150}$

8. Which is **greater?** $\frac{1}{250}$ or $\frac{1}{300}$

9. Which is **smaller?** $\frac{1}{7}$ or $\frac{1}{9}$

10. Which is **smaller?** $\frac{1}{50}$ or $\frac{1}{200}$

Changing Improper Fractions to Whole or Mixed Numbers

An improper fraction has a numerator that is larger than the denominator, as in $\frac{8}{4}$.

Steps for Changing Improper Fractions to Whole or Mixed Numbers

1. When the top number (numerator) is larger than the bottom number (denominator), divide the bottom number (denominator) into the top number (numerator).
2. Write the remainder as a fraction and reduce to lowest terms.

Examples

$\frac{8}{4} = 8 \div 4 = 2$ *This is a whole number.*

$\frac{16}{6} = 16 \div 6 = 2\frac{4}{6} = 2\frac{2}{3}$ This is a *mixed number* because it has a whole number plus a fraction.

right

Answers on page 32

WORKSHEET 1B | Changing Improper Fractions to Whole or Mixed Numbers

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

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

2. $\frac{10}{2} =$

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

4. $\frac{14}{9} =$

5. $\frac{34}{6} =$

6. $\frac{100}{20} =$

7. $\frac{9}{4} =$

8. $\frac{120}{64} =$

9. $\frac{18}{3} =$

10. $\frac{41}{6} =$

Changing Mixed Numbers to Improper Fractions

Steps for Changing Mixed Numbers to Improper Fractions

1. Multiply the whole number by the denominator of the fraction.
2. Add this to the numerator of the fraction.
3. Write the sum as the numerator of the fraction; the denominator of the fraction remains the same.

Examples

$2\frac{3}{8} = \frac{8 \times 2 + 3}{8} = \frac{19}{8}$ Numerator Denominator

$4\frac{2}{5} = \frac{5 \times 4 + 2}{5} = \frac{22}{5}$ Numerator Denominator