I.2 Systems of Measurement and Conversions

GOAL *To review the systems of measurement encountered in pharmacy practice and introduce calculation methods used to solve medical math problems.*

OBJECTIVES

This chapter equips students to:

- State the fundamental units of the metric and apothecaries' systems
- Convert each of the basic units of the metric system (meter, liter, and gram) to a higher or lower denomination
- Perform addition, subtraction, multiplication, and division in calculations using metric quantities
- Distinguish measures of weight, volume and length used in the metric, apothecaries', and household systems
- List useful equivalents of length, volume, and weight for the metric, apothecaries', and household systems of measurement; convert among these units (see Tables I.2-2 through I.2-8, at the end of the chapter)
- Solve medical math problems using equivalents of length, volume, and weight in the metric, apothecaries' and household systems
- Solve problems using ratio and proportion
- Understand the importance of showing units of measure (dimensions) consistently when solving medical math problems

KEYWORDS

Apothecaries' system
Avoirdupois system
Conversion
Dimensional analysis
Fluid ounce
Gram

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Importance for Medical Math and Clinical Practice

Sometimes, the most confusing part of solving medical math problems is sorting out what system of measurement to use to solve the problem. It's very common with day-to-day problems to mix units of measure from different systems in laying out the problem's facts. This is not done to confuse students. It happens because caregivers are so familiar with the particular facts of a type of problem that they assume everyone else is equally proficient. They are using intuitive skills that bypass several steps in calculating what a less experienced individual would definitely need to solve the problem. What to do? Staging a problem using a single system of measurement and some fundamental views of natural processes helps. The section below, Dimensional Analysis, and the following few philosophical paragraphs should help illustrate this idea.

Everyone's heard the expression "It's not rocket science" when a discussion turns to finding the simplest method of explaining something or solving a problem. In fact, medical math calculation is not rocket science, but beware: it's also not "only just arithmetic" as some beginning students believe. It's about learning the language of math as it relates to medical sciences. For many, math is not a science; it's a philosophic approach—an art—like gaining language skills. Just like engineers, pharmacists work in a practical world using tools that are good enough to do the job at hand. These tools are not good enough to fully define the theory underlying a physical process. Smashing atoms to release the Higgs boson representing the atomic

KEYWORDS

Household system
Inch
Liter
Measurement equivalent
Meter
Metric prefix
Metric system
Pound
Proportion
Ratio

glue of the Higgs field to explain gravity is an example requiring a level of math sophistication consistent with ultimate theories. Medical math calculation can be done in most cases with proportions.

Pharmacists working to prepare and administer drug doses, however, use more fundamental descriptions of reality. Some believe that the entire physical world is math reality waiting to be discovered. Math is everywhere in nature. As it happens, humans' primitive number sense—that is, humans' response to a quantity of something—possibly is best illustrated by viewing natural phenomena as conforming to simple ratios. Simple ratios, to continue the line of reasoning, are most useful to medical math when expressed in the form of proportionalities. And, yes, ratio and proportion are used perhaps 60% to 70% of the time to solve the kinds of problems encountered in clinical practice.

KEY CONCEPT

Ratios and proportions are used in the majority of medical math calculations.

For example, use of proportionalities allows enlargement or reduction in scale and/or size. This is done constantly in clinical practice. Think of a drug in solution that is given by the intravenous route of administration. The solution is given using a pumping device that delivers a constant volume of solution each minute or hour to a patient. Using proportionality and knowing the total weight of drug in a total volume of solution allows calculation of the weight of drug (the dose) administered each minute or hour. In this example, the word *concentration* describes the weight of drug in the volume of solution. Concentration is the important ratio that, extended through a proportion, allows calculation of the dose. The work in this chapter will clarify the concept.

Concentration poses problems for students. In the example above, the concentration (ratio) might be 12 milligrams of drug per 5 milliliters of solution. This is a *weight per volume* statement of concentration. Problems arise because there are five other expressions of concentration used in clinical practice, and it is a good idea for students to understand these early in the study of medical math. Three of these—expressions of *percentage strength*—can be most troubling. Applying percentage strength nomenclature usually requires some knowledge of the chemical composition and form of the drug product described. The material containing the drug (the *vehicle*) may be liquid or solid.

Please review Table I.2-1 to begin to understand how this works.

KEY CONCEPT

Understanding statements of concentration is *very* important.