I.5 Reducing and Enlarging Formulas

GOAL *To discuss calculations needed to adjust the quantity of ingredients required when the needed amount of a product or dose is greater or less than the amount described by a standard formula for the product.*

OBJECTIVES

This chapter equips students to:

- Calculate, given a specified formula, the amount of ingredients required to make a smaller amount or dose of the same product (reduction of formula)
- Calculate, given a specified formula, the amount of ingredients required to make a larger amount or dose of the same product (enlargement of formula)
- Calculate, given a formula with proportional parts, the amount of each ingredient to make a desired quantity or dose of the formula

KEYWORDS

Enlargement
Formula
Parts
Proportion
Reduction
USP/NF

Importance for Medical Math and Clinical Practice

Healthcare practitioners rely on many kinds of formulas. A *formula* is an established, standard model using words or symbols (numbers) to describe a procedure for doing or treating something. Recipes (formulas) for drug products, some very old, can be seen in earlier versions of the United States Pharmacopeia/National Formulary (USP/NF). A chemical formula showing the composition or structure of a chemical compound is another example of a type of formula. A mathematic expression—often an equation—used to calculate some aspect of a patient's biologic status is an example. A written list of ingredients in a drug product is an example. A dosing algorithm for drug therapy is another example. A stock drug product may be prepared according to a formula with the goal of taking aliquots from it to prepare different quantities of that product or to provide doses of that product to be administered according to a dosing formula (schedule).

Sometimes drug dosing is done using injectable drugs in response to a medical emergency, when only minutes separate life from death. The point of having a drug product formula available to initiate treatment is to ensure the care team's rapid response in assisting a patient. Everyone on the team is trained on use of the formula. Here, the idea of a formula includes not only the ingredient(s) in a drug product for injection but also the act of injecting the drug at a specific rate or frequency. These cases will be considered in later

chapters of this book, where math formulas are used to determine very precise doses of, often, single-ingredient products.

Sometimes, patient ease-of-use—not speed—is the primary consideration. In these cases, patients may be served best by splitting a bulk drug product into individually-packaged (unit-dose packaged) quantities that they can handle easily. Or, a patient may require only a small portion of the total amount of a formula for a specific therapeutic application. This chapter focuses on these latter cases where the medical math of formula *enlargement* or formula *reduction* is tuned to cope with drug products having numerous ingredients. The math procedures to accomplish this center on ratios and proportionalities, while not altering the proportions of ingredients stated in a formula.

Maintaining the Proportion of Ingredients in a Formula

- Formulas for pharmaceutical preparations may be based on the preparation of one dosage unit (e.g., 1 capsule) or scaled to quantities of ingredients sufficient to prepare hundreds or thousands of dosage units.
- If a smaller or greater quantity of a specified formula is needed, the formula is reduced or enlarged to calculate the quantities of each ingredient needed while maintaining the correct proportion of one ingredient to another.
  - **Example:** Set up a proportion based on the total quantity of the formula and the desired quantity.

$$\frac{\text{Quantity of ingredient in original formula}}{\text{Total quantity of original formula}} = \frac{X}{\text{Desired quantity of formula}}$$

$$X = \text{Quantiy of ingredient for desired quantity of formula}$$

If a formula for 1,500 mL contains 5 g of ingredient A, how many grams of ingredient A are needed to prepare 50 mL of the formula?

$$\frac{5\text{ g}}{1{,}500\text{ mL}} = \frac{X\text{ g}}{50\text{ mL}}$$

$$X = 0.17\text{ g ingredient A}$$

- Reducing or enlarging formulas by powers of 10 requires moving the decimal point.
  - **Example:** A formula for 1,000 mL contains:

Ingredient A	48 g
Ingredient B	1.3 g
Alcohol qs ad	1,000 mL

If you want to prepare 100 mL, move the decimal point one place left for each of the ingredients. The formula would contain:

Ingredient A	4.8 g
Ingredient B	0.13 g
Alcohol qs ad	100 mL