I.8 Concentrating and Diluting Solutions or Mixtures

GOAL *To demonstrate calculations for combining liquids and solids with resultant changes to the strengths of the active ingredients contained.*

OBJECTIVES

This chapter equips students to:

- Define the processes of dilution and concentration and use a common equation relating quantities and strengths
- Calculate the resulting strength of a solution or mixture when a given amount and strength of solution or mixture is diluted with a given amount of inert substance
- Calculate the resulting strength of a liquid when an amount of inert diluent is evaporated from that liquid
- Describe the function of stock solutions
- Given the strength of a stock solution or mixture, calculate the amount of stock needed to prepare a specified amount and strength of diluted product
- Calculate the amount of active ingredient needed to prepare a stock solution given the volume and strength resulting after diluting a portion of that stock solution
- Use the alligation methods to perform calculations involving the mixing of solids or liquids with differing percent strengths of an active ingredient

KEYWORDS

Active ingredient
Admixture
Alligation
Diluent
Inert substance
Mixture
Solute
Solution
Solvent
Stock liquid or solid
Strength

Importance for Medical Math and Clinical Practice

The language used to describe the concepts important in this chapter can be more confusing than the math itself. To reduce confusion as much as possible, the word *strength* is used to describe the various statements of amount or weight of an active substance contained in an inert carrier substance (the vehicle or diluent for the active ingredient). A student may not know whether a substance described in a problem is a liquid or solid material, and this may entangle a student especially if the description of the system describing the strength (w/v, w/w, or v/v) is lacking. Example problems are presented using several expressions of strength so students can gain experience with the variety of applications for this chapter's material.

The distinction between various kinds of liquid products or solid/semisolid products is also confusing. For example, solutions, suspensions, emulsions, and others are liquids. And, solutions can be described as true solutions or colloidal solutions. Fortunately, the strength descriptions of percent or ratio can apply to all of them. For a true solution, the dissolved active ingredient is known as the solute, while the inert carrier is known as the solvent. Solid or semisolid products are often referred to as mixtures rather than solutions, but, unfortunately, some formulations may incorporate weights instead of volumes for various liquids in the products.

Admixtures, generally, are combinations of solutions having differing strengths of a single active

ingredient. The differing strengths serve as stock solutions from which a volume of each (*aliquot* is often the descriptive term) can be taken to prepare a product having a strength somewhere between the stock solution strengths. The utility of doing this is evident in clinical practice for the production of nutritive solutions for enteral or parenteral feeding of patients.

The difficulties of the language used can be overcome with experience. So, please be patient with this chapter. It is intended to describe problems most generally representing the state-of-the-art methods for combining liquids and solids. In this chapter *concentration* and *dilution* are reserved for combinations resulting in increased strength or decreased strength, respectively. Concentration of a liquid or mixture is not done in clinical practice, although it is instructive that the idea of concentration can illustrate a clinical process, such as reducing as much as possible the water content of a drug given to a fluid-restricted patient. *Concentration*, typically, is a basic chemical process to isolate and identify chemicals in the chemistry laboratory.

The importance of understanding that the patient or caregiver must perform the further dilution of a product should not be overlooked as a needed part of clinical practice. For convenience and avoiding dispensing gallons or pounds of final product, you must instruct the patient or caregiver how to dilute certain products.

Lastly, knowing that a product is hyper-, iso-, or hypotonic is important for the clinical care of a patient. This knowledge and the clinical need to administer such a solution as therapy can be life-saving. The topics of tonicity and osmolarity are discussed in Chapter 9. For the purposes of this chapter, it is important only to know that the combination of solutions can contribute to the tonicity of a product.

KEY CONCEPT

The amount of an ingredient doesn't change, but its concentration does upon dilution.

Quantity and Strength

- If the weight of an active ingredient in a solution or mixture remains constant, any change in the total quantity of the liquid or mixture is inversely proportional to the mixture's strength. Adding more diluent will decrease the strength. Removing diluent will increase the strength.
- The weight (amount) of an active ingredient does not change during dilution or concentration, only the strength of the mixture changes; for example.

  Weight = Weight

  (5%)(100 mL) = (1%)(500 mL)

  (0.05)(100 mL) = (0.01)(500 mL)

  5 g = 5 g