I.7 Concentration Statements

GOAL *To review and summarize calculations involving concentrations (strengths).*

OBJECTIVES

This chapter equips students to:

- Define percent weight in volume (w/v), percent volume in volume (v/v), and percent weight in weight (w/w)
- Calculate amounts of ingredients for drug products and doses using w/v, v/v, and w/w concepts
- Define ratio strength concentrations for solids in liquids, liquids in liquids, and solids in solids
- Interconvert percent strengths and ratio strengths
- Calculate the ratio strength of solution, given the weight of solute and the volume of solution
- Express percent and ratio strengths as concentrations of milligrams per milliliter
- Define milligram percent (mg%) and solve calculations involving mg%
- Define parts per million (PPM) and parts per billion (PPB) and solve calculations using PPM and PPB

KEYWORDS

Concentration
Milligram percent
Parts per billion (PPB)
Parts per million (PPM)
Percent strength
Ratio strength
Volume in volume (v/v)
Weight in volume (w/v)
Weight in weight (w/w)

Importance for Medical Math and Clinical Practice

Chapter I.7 serves three purposes:

1. It reviews and summarizes fundamentals for calculating amounts of ingredients in drug products using percentage concentrations (strengths) of those ingredients.
2. It provides descriptions of calculations using ratio strengths, parts per billion, parts per million, and milligram percent.
3. It addresses the utility of converting the various strength statements into the units of milligrams (mg), or sometimes micrograms (mcg) per milliliter, to facilitate the dosing of drug products in clinical practice.

As such, Chapter I.7 can be the starting point for users of this book who have experience with medical math and don't necessarily need the practice offered in the first chapters.

Many statements of concentration exist because many disciplines contribute to drug therapy. It is important to understand how to convert these into a concentration expression that is closely associated with how the drugs are actually dosed. Stating strengths of drug products in mg or mcg/mL offers this clinical utility—especially for emergency situations where timeliness of dosing is vital. Here, it is important to distinguish between orders for preparing drug products and orders to dose those drugs. Percentage strengths are often used in prescriptions to define the ingredients contained therein. Orders to dose drugs (the *sig* line in a prescription, for example) are often written in mL or mg (mcg) per dose to be taken. Also, a few words are needed at this point about the time between repeated doses (the dosing interval). Everyone's familiar with taking a pain

reliever. The dose may be repeated every 4 to 6 hours as needed for relief. If the drug being dosed is given continuously—by injection into a vein because of the critical nature of the particular therapy—the utility of having the drug concentration stated as mg (mcg)/mL of active ingredient becomes very clear indeed.

Think of this example. An important drug must be given continuously by the intravenous (IV) route at 3 mg per minute. Suppose we make a sterile solution of this drug by adding a 2-g container of it to a total of 500 mL of 5% dextrose injection—a standard vehicle (diluent) for IV dosing. This, of course, would be a 0.4% solution (0.4 g of drug in each 100 mL). It is also a 4 mg/mL solution (2,000 mg in 500 mL = 4 mg/mL). So, which strength statement is the most clinically useful? If we need 3 mg/min infused IV, stating the concentration as 4 mg/mL allows a rapid calculation that ¾ of 1 mL will provide the needed dose each minute. This is why pumps designed to give IV drugs deliver mL/min flow rates. For completeness, some drugs needed for emergency IV use are given in doses of micrograms per minute (mcg/min). It's important to state the concentration of these drugs in solutions as mcg/mL. For example, an IV solution with 200 mg of drug in 250 mL of 5% dextrose has a concentration of 0.8 mg/mL, which is 800 mcg/mL.

This chapter displays three methods for doing calculations previously discussed: formulas, proportions, and dimensional analysis. This is done for users who start to work with this chapter, but displaying these methods also helps other users who started with the first chapter to validate the procedure(s) most comfortable for them.

Percent Concentrations

The three statements of percent concentration in medical math apply the fundamental concept of percent, which represents the number of parts of drug (often referred to as the *solute*) contained in a total of 100 parts of product. This means, for example, that 4 parts of a drug in 100 total parts of a product has a strength of 4%. The statements of percent concentration, then, specify the physical nature of that product. Remember that 1 mL of solution or liquid is assumed to be 1 g for percent calculations.

Percent weight in volume (% w/v): the number of grams of drug in 100 mL of a solution or liquid.

Percent volume in volume (% v/v): the number of mL of a drug in 100 mL of a solution or liquid.

Percent weight in weight (% w/w): the number of grams of drug in 100 g of a product.

Percent Weight in Volume

- **Example:** A 2% (w/v) solution would be expressed as 2 g of solute in 100 mL of solution or product. Sufficient diluent would be added to the 2 g to make a total of 100 mL.
  - **Weight of active ingredient in a specific volume, given its percent strength w/v**
    - To obtain the number of grams of solute needed to prepare a required number of mL of a liquid preparation with a given percent strength (note that % w/v strength is stated as its decimal equivalent in actual calculations):

      g of drug = volume (mL) × % w/v strength