Pharmacy Technician Program

Lecture 24: PHARMACY CALCULATIONS for Technicians Preparing Intravenous Medications

Coursework 103
PHARMACY CALCULATIONS for Technicians Preparing Intravenous Medications

This chapter provides an overview of Percentage and Ratio Strengths, IV Flow Rates, Drop Sets, Infusion Rates and IV Piggybacks.
I. Percentage and Ratio Strength

A. A solution is a mixture of two or more substances. Solutions may exist in any of the three states of matter:

1. Gas
2. Liquid
3. Solid
I. Percentage and Ratio Strength

B. A solution can exist in the following combinations

1. Two liquids: mixed drink
2. Gas in liquid: soda water
3. Solid in a liquid: salt water
4. Solid in a solid: fruit and gelatin in jelly
I. Percentage and Ratio Strength

C. Terms to remember

1. Solution- a mixture of two or more substances
2. Solute- the substance dissolved in the liquid solvent in a solution
3. Solvent- the liquid that dissolves the solute in a solution
I. Percentage and Ratio Strength

D. When preparing pharmaceutical solutions, the goal is to mix concentrations that result in accurately measured doses.

E. When comparing two solutions with same components:
   1. The solution containing the smaller amount of solute is considered dilute.
   2. The solution containing the larger amount of solute is considered concentrated.
I. Percentage and Ratio Strength

F. The concentration of one substance dissolved in another substance may be expressed as either percentage or a ratio strength.

G. How the concentration of a solute in the solvent is expressed as a percentage depends on which is a solid and/or which is a liquid. The concentrations can also be expressed as fractions.
I. Percentage and Ratio Strength

1. Weight in weight
   \[(W/W) = \frac{\text{number of grams of the drug}}{100\text{g of the final product}} = \frac{Xg\ drug}{100g\ product}\]

2. Weight in volume
   \[(W/V) = \frac{\text{number of grams of the drug}}{100\text{mL of the final product}} = \frac{Xg\ drug}{100\text{mL product}}\]

3. Volume in volume
   \[(V/V) = \frac{\text{number of milliliters of the drug}}{100\text{mL of the final product}} = \frac{XmL\ drug}{100\text{mL product}}\]
I. Percentage and Ratio Strength

H. Example

A 9% solution means there are 9 parts of the drug in 100 parts of the solution. Express this percentage as w/w, w/v, and v/v.

answer-

w/w = 9g of the drug in 100g of the final product
w/v = 9g of the drug in 100mL of the solution
v/v = 9mL of the drug in 100mL of the solution
I. Percentage and Ratio Strength

1. Important ratios to remember
   a. Percentage strength of w/w solution =
      \[
      \frac{g \text{ of active ingredient}}{100 \text{g of final product}} \times 100
      \]
   b. Percentage strength of w/v solution =
      \[
      \frac{g \text{ of active ingredient}}{100 \text{mL solution}} \times 100
      \]
   c. Percentage strength of v/v solution =
      \[
      \frac{mL \text{ of active ingredient}}{100 \text{mL solution}} \times 100
      \]
I. Percentage and Ratio Strength

2. When the percentage of concentration is known, that percentage can be used to find the amount of the active ingredient.
I. Percentage and Ratio Strength
   a. Example- active ingredient
      i. How many grams of dextrose are in 1L of D5W?

Note: D5W means 5% dextrose in water, or a concentration of 5g/100mL. Remember 1L = 1000mL

\[
\frac{x \text{ g}}{1000 \text{ mL}} = \frac{5 \text{ g}}{100 \text{ mL}}
\]

\[x \text{ g} = 50 \text{ g}\]
I. Percentage and Ratio Strength

3. The percentage of solid solute in a solution is expressed in grams per milliliter

\[
\text{Percentage of w/v solution} = \frac{\text{grams of solute}}{\text{milliliters of solution}} \times 100
\]
I. Percentage and Ratio Strength

a. Example- percentage strength

b. If there are 30g of dextrose in 500mL of the solution, what is the percentage of solution?

\[ x\% \text{ w/v} = \frac{30 \text{ g}}{500 \text{ mL}} \times 100 = 0.06 \text{ g/mL} \times 100 \]

\[ x\% \text{ w/v} = 6\% \text{ w/v} \]

i. This problem can also be solved using the ratio-proportion method

\[ \frac{x \text{ g}}{100 \text{ mL}} = \frac{30 \text{ g}}{500 \text{ mL}} \]

\[ x \text{ g} = 6 \text{ g}, \text{ or } 6\% \text{ w/v} \]
I. Percentage and Ratio Strength
   c. Problem set- Drug Labels

   (page 182-183, problems 7-11, 13 and 14)
I. Percentage and Ratio Strength
I. Percentage and Ratio Strength
II. IV Flow Rates

A. IV flow rate is expressed in milliliters per hour or drops per minute at which medication is flowing through an IV line (also called infusion rate and rate of infusion).

1. To calculate the duration of therapy use the formula

\[
\text{duration of therapy} = \frac{\text{volume of fluid or amount of drug to be infused}}{\text{flow rate}}
\]

Safety Note: When calculating the duration of therapy, always round your answer down to the whole hour.
II. IV Flow Rates

2. Example - Duration of therapy
   a. A 1L IV is running at 125mL/hour. How often will you send up a new bag

   \[
   \text{the time the bag will last} = \frac{\text{volume of fluid}}{\text{flow rate}}
   \]

   \[
   x \text{ hours} = \frac{1000 \text{ mL}}{125 \text{ mL/hour}} = 8 \text{ hours}
   \]
II. IV Flow Rates

i. This problem can also be solved using the dimensional analysis method.

\[
1 \text{L} \times \frac{1000 \text{mL}}{1 \text{L}} \times \frac{1 \text{ hour}}{125 \text{mL}} = 8 \text{ hour}
\]
II. IV Flow Rates

B. Flow rate: a volume or amount of drug to be given over a specific period of time (expressed in milliliters per hour). It can be calculated using the following formula:

\[
\text{flow rate} = \frac{\text{volume of fluid or amount of drug to be infused}}{\text{duration of therapy}}
\]
II. IV Flow Rates

1. Example- Flow rate

The following order is sent to the IV room.

<table>
<thead>
<tr>
<th>Medication</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solu-Cortef</td>
<td>300mg</td>
</tr>
</tbody>
</table>

| Fluid Volume        | 300mL     |
| Time of infusion    | 4 hours   |

What volume of fluid is given per hour, and what amount of drug is given per hour?
II. IV Flow Rates

a. Part I: Determine the volume of fluid given per hour
   \[300 \text{ mL} \div 4 \text{ hours} = 75 \text{ mL/hour}\]

b. Part II: Calculate the amount of drug given per hour
   \[300 \text{ mg} \div 4 \text{ hours} = 75 \text{ mg/hour}\]
III. Drop sets and infusion rates

A. IV sets are designed to administer medication at different rates. The most common sets are:

- 10, or 10 gtt/mL
- 15, or 15 gtt/mL
- 20, or 20 gtt/mL
- 60, or 60 gtt/mL (AKA mini drip set)
III. Drop sets and infusion rates

B. Terms to remember

1. Drop set- The number of drops an IV set takes to make 1mL; also called drip set.
2. Mini-drip set- A drop set at a rate of 60gtt/ mL

The abbreviation gtt comes from the Latin word guttae, which means “drops”. 
III. Drop sets and infusion rates

C. **Drop sets and infusion rates**

Infusion rate measured in drops per minute is calculated with the following formula:

\[ X_{gtt/min} = \left( \frac{\text{volume of fluid}}{\text{delivery time}} \right) \times \left( \text{drop rate of admin. set used} \right) \times 60 \text{ min/hour} \]

**Safety Note:** Round down to a whole drop when a drop per minute calculation results in a partial drop.
III. Drop sets and infusion rates

1. Example- Infusion rate
   a. If an IV is running at 60mL/ hr, what is the rate in drops per minute using a 15 drop set?
      i. Solution 1-
         \[ X_{\text{gtt/ min}} = \frac{60 \text{ mL}}{1 \text{ hour}} \times \frac{15 \text{ gtt}}{1 \text{ mL}} = 15 \text{ gtt/ min} \]
         \[ \frac{60 \text{ min}}{1 \text{ hour}} \]
      ii. Solution 2- Dimensional analysis
         \[ X_{\text{gtt/ min}} = \frac{60 \text{ mL}}{1 \text{ hour}} \times \frac{15 \text{ gtt}}{1 \text{ mL}} \times \frac{1 \text{ hour}}{60 \text{ min}} = 15 \text{ gtt/ min} \]
III. Drop sets and infusion rates

b. If there is a flow rate of 40 gtt/min using a 15-drop set, how many liters will be delivered over 24 hours?

i. Solution 1: Calculate the milliliters given each minute.

\[
\frac{40 \text{ gtt}}{1 \text{ min}} \times \frac{1 \text{ mL}}{15 \text{ gtt}} = \frac{2.67 \text{ mL}}{1 \text{ min}}
\]

i. Then, use this rate to determine how many milliliters will be given in an hour

\[
2.67 \text{ mL} \times 60 \text{ min/hour} = 160.2 \text{ mL/hour}
\]
Finally, calculate the number of milliliters in a day.

160.2 mL/hour × 24 hours = 3844.8 mL,
which is converted to 3.84 L

This problem can also be calculated using the dimensional analysis method.

\[ x \text{ L} = 24 \text{ hours} \times 60 \text{ min/hour} \times 40 \text{ gtt/min} \times 1 \text{ mL/15 gtt} \times 1 \text{ L/1000 mL} = 3.84 \text{ L} \]
III. Drop sets and infusion rates

c. A patient is getting 16 mEq KCl in 250 mL D5W. A 10-drop set is being used. How many milliequivalents are in each drop?

i. Solution 1: Set up a proportion to determine the number of milliequivalent in 1mL.

\[
\frac{x \text{ mEq}}{1 \text{ mL}} = \frac{16 \text{ mEq}}{250 \text{ mL}}
\]

\[x \text{ mEq} = 0.064 \text{ mEq}\]
III. Drop sets and infusion rates

Then, convert this to milliequivalents in each drop, using the given drop set.

\[0.064 \text{ mEq/mL} \times 1 \text{ mL/10 gtt} = 0.0064 \text{ mEq/gtt}\]

ii. Solution 2: Using the dimensional analysis method

\[x \text{ mEq/gtt} = 1 \text{ mL/10 gtt} \times 16 \text{ mEq/250 mL} = 0.0064 \text{ mEq/gtt}\]
IV. Piggybacks (IVPB)

A. A small volume of fluid and medication that is given intravenously in addition to a primary infusion over a short period of time.

1. The volume of an IVPB is usually 40 mL or less.
2. For amounts greater than 40 mL, the flow rate will need to be recalculated
IV. Piggybacks (IVPB)

3. Example- IVPB

a. An order calls for 20 mg of premixed famotidine to be given in 50 mL IVPB Q12 hours. It is to be administered using a 15 drop set and is to be given over 20 minutes. What is the rate of infusion?

\[
\text{gtt/ min} = \frac{\text{volume of fluid gtt/mL}}{\text{time of infusion min}}
\]

\[
= \frac{50\text{mL} \times 15\text{gtt/mL}}{20\text{min}}
\]

\[
= 37.5\text{gtt/ min} \text{ rounded down to 37 gtt/ min}
\]
b. A patient weighing 148lbs is to receive tobramycin 2mg/kg/dose in 50mL IVPB. A 15 drop set has been ordered, and the drug is to be given over 30min. The following label shows the drug to be used. What is the appropriate infusion rate?
IV. Piggybacks (IVPB)

Convert the patient’s weight to kilograms.

\[ 148 \text{ lb} \times 1 \frac{\text{kg}}{2.2 \text{ lb}} = 67.2727 \text{ kg}, \text{ rounded to 67.3 kg} \]

Calculate the tobramycin dose by multiplying the patient’s weight in kilograms by the amount per kilogram in the order

\[ 67.3 \text{ kg} \times 2 \frac{\text{mg}}{\text{kg}} = 134.6 \text{ mg} \]
IV. Piggybacks (IVPB)

Calculate the amount of tobramycin concentrate to be added to the bag.

\[
\frac{X\text{mL}}{134.6\text{mg}} = \frac{1\text{mL}}{40\text{mg}}
\]

\[
X\text{mL} = 3.4\text{mL}
\]

Determine the total volume to be infused

\[
3.4\text{mL concentrate} + 50\text{mL} = 53.4\text{mL}
\]
IV. Piggybacks (IVPB)

Finally, determine the infusion rate

\[
X_{\text{gtt}}/ \text{min} = \frac{53.4 \text{mL} \times 15 \text{gtt}}{30 \text{mL}/ \text{min}}
\]

\[
= 26.7 \text{gtt}/ \text{min} \text{ rounded down to } 26 \text{gtt}/ \text{min}
\]