Chapter 12

Reconstitution of Solutions
Reconstitution

• Process of mixing and diluting solutions
• Some medications supplied in powder form and must be mixed with liquid before administration
Parts of Solutions

SOLUTE (concentrated) + SOLVENT (water) = SOLUTION (diluted)

50 mL + 50 mL = 100 mL

READY TO USE (reconstituted)
Terms

• Solute
  – Substance to be dissolved or diluted
  – Can be either solid or liquid

• Solvent
  – Substance (liquid) that dissolves another substance to prepare solution
  – Often referred to as diluent
Terms

• Solution
  – Resulting mixture of solute plus solvent
Caution

• Before reconstituting injectable drugs, read and follow label or package insert directions carefully
  – Check drug
  – Check diluent dates
Rules

• When reconstituting injectable medications, must determine both type and amount of diluent to be used
  – Sterile water and 0.9 percent NaCl commonly used
  – Some drugs supplied with special diluent
Rules

• When reconstituting injectable medications:
  – Determine volume in mL of diluent to be used
  – Check that route noted on drug label matches route ordered
  – Reconstitute drug and note resulting supply dosage on vial
  – Note if single-dose or multiple-dose vial
Example Drug Label

Directions for reconstitution

Route

Used with permission from Pfizer Inc.
Reconstituting Parenteral Solutions: Single Strength

• Order: Zithromax 400 mg IV daily for 2 days

• Available: Zithromax 500 mg vial for IV infusion
  – Drug is in powder form with directions on label that state, “Constitute to 100 mg/mL with 4.8 mL of Sterile Water for Injection”
Reconstituting Parenteral Solutions: Single Strength

• Procedure:
  1. How much and what type of diluent is needed?
     • 4.8 mL of sterile water
  2. What is the dosage concentration after reconstitution?
     • 100 mg per mL
Reconstituting Parenteral Solutions: Single Strength

• Procedure:
  3. What is the total volume after reconstitution?
     • 5 mL
  4. Given the ordered dose, how many doses are available in the vial?
     • One
Reconstituting Parenteral Solutions: Single Strength

• To reconstitute Zithromax:
  – Chose 5 mL syringe
  – Put 4.8 mL of air in bottle of diluent
    • Sterile water for injection
  – Withdraw 4.8 mL of sterile water
  – Add 4.8 mL of sterile water to Zithromax powder and shake well
Reconstituting Parenteral Solutions: Single Strength

• Note appropriate information on vial label
• Example:

1/10/xx, 0800, reconstituted as 100 mg per mL
Expires 1/17/xx, 0800.
Keep refrigerated. G.D.P.
Reconstituting Parenteral Solutions: Single Strength

• Determine amount needed for dose ordered

1. Convert
   – No conversion needed

2. Think
   – Need 400 mg
   – Have 100 mg per mL
     • Need four times that amount
Reconstituting Parenteral Solutions: Single Strength

3. Calculate

\[
\frac{\text{Dosage on hand}}{\text{Amount on hand}} \times \frac{\text{Dosage desired}}{\text{Amount desired}} = \frac{\text{Dosage on hand}}{\text{Amount on hand}} = \frac{\text{Dosage desired}}{\text{Amount desired}}
\]
Reconstituting Parenteral Solutions: Single Strength

3. Calculate

Cross-multiply

\[
\frac{100 \text{ mg}}{1 \text{ mL}} \times \frac{400 \text{ mg}}{X \text{ mL}}
\]

\[
100 \times X = 400
\]

Simplify

\[
\frac{100 \times X}{100} = \frac{400}{100}
\]

\[
X = 4 \text{ mL}
\]
Reconstituting Parenteral Solutions: Single Strength

• Withdraw 4 mL of reconstituted Zithromax using 5 mL syringe
• Further dilute and give IV
• Since single-dose vial, discard any remaining drug
Reconstituting Parenteral Solutions: Multiple Strength

• Some parenteral powdered medications have directions for preparing several different solution strengths
  – E.g., Penicillin G potassium 1,000,000 units vial
Reconstituting Parenteral Solutions: Multiple Strength

- Reconstitution instructions note four different solution concentrations as determined by amount of diluent added

<table>
<thead>
<tr>
<th>mL Diluent</th>
<th>Units per mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mL</td>
<td>50,000</td>
</tr>
<tr>
<td>10 mL</td>
<td>100,000</td>
</tr>
<tr>
<td>4 mL</td>
<td>250,000</td>
</tr>
<tr>
<td>1.8 mL</td>
<td>500,000</td>
</tr>
</tbody>
</table>
Reconstituting Parenteral Solutions: Multiple Strength

• Order: Penicillin G potassium 300,000 units IM every 6 h for adult patient
• Available: Penicillin G potassium 1,000,000 unit vial
• Given the reconstitution concentrations on the previous slide, which should you use when preparing to administer the ordered dose?
Reconstituting Parenteral Solutions: Multiple Strength

• Consider:
  – Dose ordered
  – Patient receiving dose
Reconstituting Parenteral Solutions: Multiple Strength

• Consider:
  – Volume and concentration that results with each noted diluent volume
    • Smaller the amount of diluent added, stronger the resulting solution concentration
    • Consider maximum recommended volumes for injection by patient and parenteral route
Reconstituting Parenteral Solutions: Multiple Strength

• Considering previously mentioned factors, adding 4 mL of diluent results in reasonable volume and medication concentration
  – Results in concentration of 250,000 units per mL
  – How many mL are needed to deliver ordered dose of 300,000 units?
Reconstituting Parenteral Solutions: Multiple Strength

1. Convert
   - No conversion necessary

2. Think
   - 250,000 units in 1 mL
   - Need 300,000 units
     * Slightly more than what is available in 1 mL
3. Calculate

Cross-multiply

\[
\frac{250,000 \text{ units}}{1 \text{ mL}} \times \frac{300,000 \text{ units}}{X \text{ mL}}
\]

Simplify

\[
\frac{250,000 \times X}{250,000} = \frac{300,000}{250,000}
\]

\[X = 1.2 \text{ mL}\]
Reconstituting Parenteral Solutions: Multiple Strength

• Rule
  – When reconstituting multiple-dose injectable medications:
    • Label reconstituted drug noting resulting supply dosage
      – In previous example, 250,000 units per mL
    • Verify length of drug potency and storage directions
      – Label on penicillin G potassium notes that solution “may be kept in refrigerator for one (1) week”
Reconstituting Parenteral Solutions: Multiple Strength

• Complete label of reconstituted multiple-dose vial, noting:
  – Date and time of preparation
  – Supply dosage
  – Length of potency
    • Expiration date
Reconstituting Parenteral Solutions: Multiple Strength

• Complete label of reconstituted multiple-dose vial, noting:
  – Storage directions
  – Own initials
Different IM and IV Reconstitution Instructions

• Reconstitution instructions can differ in amount and/or type of diluent based on administration route
• Must carefully check route ordered and related reconstitution directions
Reconstitution of Non-Injectable Solutions

• Examples:
  – Nutritional formulas
  – Irrigating solutions

• Usually need to dilute liquid concentrate to weaker solution
Solution Concentration

• Amount of solvent used determines final solution concentration or strength

• Fraction expresses strength of solution made from liquid concentrate
  – Numerator
    • Number of parts of solute
Solution Concentration

• Fraction expresses strength of solution made from liquid concentrate
  – Denominator
    • Number of parts of solution
  – Difference between denominator (final solution) and numerator (parts of solute) is number of parts of solvent
Solution Concentration Example

• $\frac{1}{3}$ strength nutritional formula
  – 1 part concentrate
  – 3 parts total solution
  – $3 - 1 = 2$ parts solvent
    • Water
Calculating Solutions

• To prepare solutions:
  1. Apply ratio-proportion to find amount of solute (X)

\[
\text{Solution strength} = \frac{X \text{ amount of solute}}{\text{Quantity of desired solution}}
\]

  2. Quantity of desired solution – Amount of solute = Amount of solvent
Solution Calculation Example

• Physician orders patient’s wound irrigated with $\frac{2}{3}$ strength hydrogen peroxide and normal saline solution every four hours while patient is awake
Solution Calculation Example

• 60 mL per irrigation for three irrigations during 12-hour shift
  – Prepare $60 \text{ mL} \times 3 \text{ irrigations} = 180 \text{ mL total solution}$

• How much stock hydrogen peroxide and normal saline is needed?
Solution Calculation Example

1. Convert
   - No conversion necessary
2. Think
   – Need $\frac{2}{3}$ strength
     • 2 parts solute (concentrated hydrogen peroxide) to 3 total parts solution
     • Amount of solvent is $3 - 2 = 1$ part saline
     • For 180 mL of solution, need $\frac{2}{3}$ as solute (120 mL) and $\frac{1}{3}$ as solvent (60 mL)
Solution Calculation Example

3. Calculate

\[\frac{2}{3} \times \frac{X \text{ mL}}{180 \text{ mL}} = \text{Solute}\]

\[3 \times X = 360\]

\[\frac{3 \times X}{3} = \frac{360}{3}\]

\[X = 120 \text{ mL}\]
Solution Calculation Example

• $180 - 120 = 60$
• 120 mL of full strength hydrogen peroxide and 60 mL of normal saline are needed to make desired solution.