LEARNING OBJECTIVES

After completing this chapter, the student will be able to:

1. Describe three parenteral routes of administration
2. Define IV, IM, and SC
3. Calculate parenteral doses using ratio and proportion

Pharmacy technicians prepare parenteral medications for use in hospitals, home health care, and long-term care. Parenteral medications are medications that are injected into the body by different routes such as:

- IV (intravenous)
- IM (intramuscular)
- SC (subcutaneous)

Parenteral medications are available as liquids and as powders. A drug in powder form must be reconstituted before it can be injected. The strength or concentration of a medication is usually expressed as a measurement of weight (mg, g, units) in a specified volume (ml, cc). For example, 250 mg/ml or 10,000 units/2 cc.

Calculations must be made to convert the measurement of weight ordered by the physician into a volume. Different size syringes are used to measure this volume for injection, either into the patient or into a solution bag for infusion into the patient.

In pharmacy practice, milliliters (ml) and cubic centimeters (cc) are considered interchangeable.

Ratio and Proportion Calculations

Most pharmacy calculations problems can be solved using the ratio and proportion method. A ratio expresses the relationship between two quantities. For example, 250 mg/ml means there are 250 mg of drug in each ml of solution.

A proportion is an equation that states that two specific ratios are equal. The equation is written with an equals (=) sign between the two ratios. For example, 1:2 = 3:6 (1:2 is the same as 3:6).

A proportion consists of four terms. If three of the terms are known, then the fourth term (designated as X), can be calculated. When using ratio and proportion to solve a problem, each side of the equation must be set up the same—meaning that all units of measurement must be the same. (Do not mix grams and milligrams or liters and milliliters.) Always label values with the units of measurement. For example:

\[
\frac{\text{grams}}{\text{milliliters}} = \frac{\text{grams}}{\text{milliliters}} \quad \text{and} \quad \frac{\text{mg}}{\text{ml}} = \frac{\text{mg}}{\text{ml}}
\]
**Important:** Set up the proportion as ratio of drug available = ratio of drug required. That is, put the known value on the left side and unknown on the right side.

Once a proportion is set up correctly, you can solve the equation by cross multiplying.

**EXAMPLE**

You have on hand a drug with a concentration of 250 mg/ml. How many mg are in 2 ml of the solution?

\[
\frac{250 \text{ mg}}{1 \text{ ml}} = \frac{X}{2 \text{ ml}} \rightarrow X \times 1 \text{ ml} = 2 \text{ ml} \times 250 \text{ mg}
\]

divide each side by 1 ml and cancel out the units

\[
\rightarrow \frac{X \times 4 \text{ ml}}{4 \text{ ml}} = \frac{2 \text{ ml} \times 250 \text{ mg}}{1 \text{ ml}} \rightarrow X = 500 \text{ mg answer}
\]

**EXAMPLE**

How many ml are needed for a 500 mg dose of a drug with a concentration of 250 mg/ml?

\[
\frac{250 \text{ mg}}{1 \text{ ml}} = \frac{500 \text{ mg}}{X} \rightarrow X \times 250 \text{ mg} = 1 \text{ ml} \times 500 \text{ mg}
\]

\[
\rightarrow \text{ divide each side by 250 mg and cancel out the units}
\]

\[
\frac{X \times 250 \text{ mg}}{250 \text{ mg}} = \frac{1 \text{ ml} \times 500 \text{ mg}}{250 \text{ mg}}
\]

\[
\rightarrow X = 2 \text{ ml answer}
\]

**EXAMPLE**

A doctor orders a 500 mg dose of a medication. The medication is available as 1 gram per 2 ml. How many ml are needed?

Change the grams to milligrams so the units of measurement are the same:

Available 1 g/2 ml = 1,000 mg/2 ml

Set up a ratio and proportion problem:

\[
\frac{1,000 \text{ mg}}{2 \text{ ml}} = \frac{500 \text{ mg}}{X} \rightarrow X \times 1,000 \text{ mg} = 500 \text{ mg} \times 2 \text{ ml}
\]

\[
\rightarrow \text{ divide each side by 1,000 mg and cancel out the units}
\]

\[
\frac{X \times 1,000 \text{ ml}}{1,000 \text{ mg}} = \frac{500 \text{ mg} \times 2 \text{ ml}}{1,000 \text{ mg}}
\]

\[
\rightarrow X = 1 \text{ ml answer}
\]
EXAMPLE
How many grams of dextrose are in 20 ml of a solution containing 50 g of dextrose in 100 ml of water?
Set up a ratio and proportion problem:
\[
\frac{50 \text{ g}}{100 \text{ ml}} = \frac{X}{20 \text{ ml}} \implies X \times 100 \text{ ml} = 50 \text{ g} \times 20 \text{ ml}
\]
\[
\implies \frac{X \times 100 \text{ ml}}{100 \text{ ml}} = \frac{50 \text{ g} \times 20 \text{ ml}}{100 \text{ ml}}
\]
\[
\implies X = 10 \text{ g answer}
\]

EXAMPLE
A physician orders 367.5 mg of a medication t.i.d. The drug is available as 35 mg/1 ml. What is the total in milliliters that the patient will receive in 24 hours?
Set up a ratio and proportion problem:
\[
\frac{35 \text{ mg}}{1 \text{ ml}} = \frac{367.5 \text{ mg}}{X} \implies X \times 35 \text{ mg} = 1 \text{ ml} \times 367.5 \text{ mg}
\]
Divide both sides by 35 mg and cancel out the milligrams:
\[
\implies \frac{X \times 35 \text{ mg}}{35 \text{ mg}} = \frac{1 \text{ ml} \times 367.5 \text{ mg}}{35 \text{ mg}}
\]
\[
\implies X \times 10.5 \text{ ml per dose}
\]
Multiply by 3 for t.i.d.:
\[
\implies 10.5 \text{ ml} \times 3 = 31.5 \text{ ml answer}
\]

Rx
Only solutions may be injected intravenously.
EXAMPLE
If 0.5 ml of insulin is administered to a patient, how many units of insulin were given if the drug concentration is 1,000 units/10 ml?

Set up a ratio and proportion problem:

\[
\frac{1,000 \text{ units}}{10 \text{ ml}} = \frac{X}{0.5 \text{ ml}} \quad \Rightarrow \quad X \times 10 \text{ ml} = 1,000 \text{ units} \times 0.5 \text{ ml}
\]

Divide both sides by 10 ml and cancel out the ml:

\[
\frac{X \times 10 \text{ ml}}{10 \text{ ml}} = \frac{1,000 \text{ units} \times 0.5 \text{ ml}}{10 \text{ ml}}
\]

\[
\Rightarrow \quad X = 50 \text{ units} \quad \text{answer}
\]
1. A TPN requires the addition of 15 units of regular insulin U-100. A 10 ml vial of insulin contains 1,000 units. How many ml of insulin should be added to the TPN?

2. You receive an order for heparin 12,000 units in 250 ml D5W. If the strength of the heparin available is 5,000 units/ml, how many ml of heparin do you use?

3. Calculate the number of milliliters required to prepare the following concentrations:

   a. 25 mEq potassium chloride (stock: 2 mEq/ml KCl)

   b. 37.5 mg methotrexate (stock: methotrexate 50 mg/2 ml)

   c. 1,050 mg fluorouracil (stock: fluorouracil 50 mg/ml)

   d. 62.5 mg doxorubicin (stock: doxorubicin 50 mg/25 ml)

   e. Methicillin 2.5 g (stock: methicillin 1 g/2 ml)

   f. Scopolamine 200 mcg (stock: scopolamine 0.4 mg/ml)

   g. Potassium phosphate 17.6 mEq (stock: 4.4 mEq/ml potassium phosphate)

   h. 200,000 units penicillin (stock: penicillin 500,000 units/ml)
4. If there is 20 mg of a drug in 10 ml of solution, how many liters of solution will contain 1 g of the drug?

5. A vial of penicillin contains 3 million units of the powdered drug. How much diluent is needed to make a solution containing 400,000 units of this drug per cc? (Assume no powder volume.)

6. You have just added 0.2 ml of folic acid to an IV bag. How many mg of folic acid have you added if the stock solution contains 5 mg folic acid per ml?

7. Elixir of digoxin contains 50 mcg per ml. How many mcg are in 0.3 ml of the solution?

8. A physician orders 25 mg of theophylline to be given orally to a pediatric patient. If the elixir of theophylline contains 80 mg per tablespoonful, how many ml of the elixir should be administered?

9. How many ml of vitamin B₁₂ injection (1,000 mcg/ml) must be added to an IV bag to obtain a dose of 0.5 mg of vitamin B₁₂?
10. A physician orders 0.4 mg of a drug. The label on the vial states that the concentration is 500 mcg per 2 ml. How many ml of the drug should be dispensed?

11. The doctor orders Garamycin 70 mg. A 2 ml vial contains 40 mg/ml. How many ml should be dispensed?

12. 7,500 units of a drug are ordered. On hand is a prefilled disposable syringe containing 10,000 units in 1 ml. How many ml should be used?

13. A dose of 65 units of regular insulin is to be added to a TPN bag. You are to use Humulin R (100 units/ml). How many ml would you add?

14. How many ml would you need for a 400 mg dose of chloramphenicol if you had a vial that contained 1 g per 10 ml?

15. Potassium chloride 30 mEq is to be given in 1,000 ml of IV fluid. Available vials contain 40 mEq/20 ml. How many ml of the drug would you use?
16. How many ml of potassium chloride solution (2 mEq/ml) is required to prepare a liter bag of D5W/0.2% NaCl with 25 mEq KCl?

17. How many ml of aminophyllin solution (500 mg/20 ml) is needed to prepare 350 mg aminophyllin in 100 ml D5W?

18. LevOTHroxine comes in 500 mcg vials. If the powder is diluted with 10 ml of sterile water, how many ml are required to provide 0.1 mg?

19. You receive an order for 0.2 g of Tigan IM. You have a 5 ml vial labeled 100 mg/ml. How many ml are required?

20. Cleocin IV comes as 600 mg/4 ml. How many ml are needed to make a piggy-back of 750 mg in 100 ml of 0.9% sodium chloride injection?

21. An injection solution is available in a 2.9 mg/5 ml concentration. A patient’s required dose is 5.22 mg in 500 ml 0.9% sodium chloride solution. How many ml of the injection solution are needed?
22. A drug concentration is 0.05 mg/ml in 5 ml vials. A patient requires a 0.25 mg dose. How many ml are used for this dose?

23. A single IM dose of 2.4 million units of penicillin G is ordered by the physician. The concentration of the injection suspension is 600,000 units per ml in 1 ml, 2 ml, and 4 ml vials. How many ml of the suspension are required?

24. Clonidine injection is available as 10 ml vials containing 100 mcg/ml. A patient order is for 0.2 mg daily in 2 equal doses. How many ml will be needed for each dose?

25. A patient is given 10.8 ml of phenytoin as a loading dose. Phenytoin is available as 50 mg per ml in 2 ml and 5 ml vials. What is the dose in mg that the patient received?

26. Droperidol is available as a 2.5 mg/ml injection. A patient needs a 4 mg slow IV push. How many ml are used?

27. A drug is available as 120 mcg/0.6 ml. The dose required is 100 mcg per day. How many ml will be drawn?
28. A patient needs 11 million units of a drug in a single dose. The drug is available as 6 million units per ml in a 3 ml vial. How many ml will the patient receive?

29. A patient requires 30 units of oxytocin by IV infusion in 1,000 ml of fluid. Oxytocin is available as 10 units per ml. How many ml will the patient need?

30. A patient needs a 1 g dose of streptomycin. The drug is available in a 2.5 ml vial, concentration 400 mg/ml. How many ml does the patient need?

31. A 500 ml TPN needs the addition of 33 mEq of sodium chloride. The label on the vial of concentrated sodium chloride injection has the following information: 30 ml single dose, 234 mg/ml, 4 mEq/ml, and 23.4%. How many ml should be added to the TPN bag?

32. Digoxin injection is available in a concentration of 0.5 mg in a 2 ml vial. The physician orders a 150 mcg dose in 150 ml of D5W. How many ml will the patient need?

33. Tobramycin injection is available in a concentration of 80 mg per 2 ml. The patient received 1.5 ml in 100 ml of normal saline. What was the dose in mg that the patient received?

34. Humulin R 78 units are to be added to a 1 liter TPN. The 10 ml vial of Humulin R contains 100 units/ml. How many ml are required?
35. Morphine sulfate 8 mg is ordered by the physician. The label on the morphine sulfate vial reads 15 mg (1 ml fill in 2 ml size). How many ml will the patient receive?

36. Atropine sulfate injection 0.4 mg per ml is available in the pharmacy. The doctor orders 0.8 mg. How many ml will complete this order?

37. A patient requires potassium chloride 7 mEq in a 1,000 ml bag of Lactated Ringer’s solution. The pharmacy has on hand potassium chloride for injection 40 mEq in 20 ml vials. How many ml will be needed in the IV bag?

38. A patient is ordered Novolin R 54 units. The Novolin R available is 1,000 units in a 10 ml vial. How many ml will the patient require?

39. Aminophyllin injection is available in a 20 ml vial containing 500 mg (25 mg/ml). The physician orders a dose of 400 mg. How many ml will be needed to fill this order?

40. 500 ml of D5W with 8,000 units of heparin is ordered for a patient. A 5 ml vial of Heparin contains 10,000 units per ml. How many ml are needed for this patient?

41. A patient order is for digoxin 0.54 mg. The injection solution is available as 250 mcg per ml. How many ml will be needed to fill the order?
42. An injectable medication is available as 2 mg/ml in 1 ml and 10 ml vials. The patient order is for 0.5 mg in 50 ml NS IVPB t.i.d. What is the total amount in ml of drug that the patient will receive per day?

43. A physician order reads 3 million units of penicillin q4h. The reconstituted powder is available as 500,000 units/ml. What will be the total ml needed for 24 hours?

44. Regular insulin is ordered for an obese patient. The drug is available in 10 ml vials containing 1,000 units. The initial dose for the patient is 108 units in four equal doses. How many ml will be given for a single dose?

45. Ninety-six millimols (96 mmols) of potassium phosphate is to be added to an infusion over 4 to 6 hours. Potassium phosphate is available as 3 mmol/ml in 5 ml, 15 ml, and 50 ml vials. How many ml are needed for this infusion?