

Pharmacy Technician Program

Lecture 22:
PHARMACY
CALCULATIONS for
Technicians
Preparing Injectable
Medications

Coursework 103





PHARMACY CALCULATIONS for Technicians Preparing Injectable Medications

This chapter provides an overview of how to determine volume and calculate the quantity of a drug.



I. Intramuscular and Subcutaneous Injections

Calculating the Volume of an Injectable Solution

Calculating the Quantity of Drug in an Injectable Solution

Calculating Ratio Strength

A. Intramuscular and Subcutaneous Injections

1. Injection is a method of administering medications in which a syringe with a needle or cannula is used to penetrate through the skin or membrane into tissue.



I. Intramuscular and Subcutaneous Injections

B. Terms to Remember

1. **Infusion** - the administration of a large volume of liquid medication given parenterally over a long period.
2. **Parenteral** - administered by injection and not by way of the gastrointestinal system.
3. **There are three types of injections:**
 - a. Subcutaneous (SC)
 - b. Intramuscular (IM)
 - c. Intravenous (IV)



I. Intramuscular and Subcutaneous Injections

4. Terms to Remember

- a. subcutaneous injection - an injection given into the vascular, fatty layer of tissue under the skin
- b. intramuscular injection - an injection given into the muscle tissue
- c. intravenous infusion - the injection of fluid into the veins



I. Intramuscular and Subcutaneous Injections

C. Subcutaneous Injections

1. Given at a 45-degree angle
2. 25 or 26 gauge needle, 3/8 to 5/8 inch length
3. No more than 1.5 mL should be injected into the site to avoid pressure on sensory nerves causing pain and discomfort.

D. Intravenous Injections

1. Intravenous (IV) injections are administered at a 15 to 20 degree angle



I. Intramuscular and Subcutaneous Injections

E. Intramuscular and Subcutaneous Injections

1. Medications given by injection are often ordered by milligram, and the pharmacy or nursing staff must select and prepare an appropriate concentration of medication from available stock.
2. The calculation is similar to the method used for calculating liquid oral solutions.



I. Intramuscular and Subcutaneous Injections

F. Calculating the Volume of an Injectable Solution

1. An important job of the pharmacy staff
2. Use the ratio-proportion method or dimensional analysis method
3. When a small volume (less than 20 mL) is administered, round to the nearest hundredth
4. Larger volumes are rounded to the tenth or whole milliliter



I. Intramuscular and Subcutaneous Injections

G. Volume Example



1. How many milliliters of the medication shown in this label must be prepared to provide 25 mg of medication to a patient?
 - a. Solution 1: Using the ratio-proportion method,



I. Intramuscular and Subcutaneous Injections

a. **Solution 1: Using the ratio-proportion method,**

$$\frac{x \text{ mL}}{25 \text{ mg}} = \frac{1 \text{ mL}}{50 \text{ mg}}$$

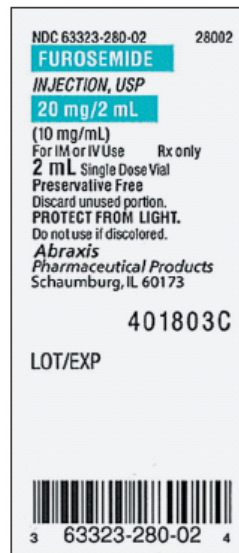
$$x \text{ mL} = \frac{(25 \text{ mg}) \times 1 \text{ mL}}{50 \text{ mg}} = 0.5 \text{ mL}$$

b. **Solution 2: Using the dimensional analysis method,**

$$25 \text{ mg} \times \frac{1 \text{ mL}}{50 \text{ mg}} = 0.5 \text{ mL}$$



- ## I. Intramuscular and Subcutaneous Injections
- ### H. Calculating the Quantity of Drug in an Injectable Solution
1. Ratio-proportion and dimensional analysis methods can be used to determine the amount of a drug in an injectable solution.
 2. Quantity Example





I. Intramuscular and Subcutaneous Injections

3. How many milligrams of medication are in 6 mL of the solution shown in this label?

a. Solution 1: Using the ratio-proportion method,

$$\frac{x \text{ mg}}{6 \text{ mL}} = \frac{20 \text{ mg}}{2 \text{ mL}}$$

$$x \text{ mg} = \frac{(6 \text{ mL}) \times 20 \text{ mg}}{2 \text{ mL}} = 60 \text{ mg}$$

b. Solution 2: Using the dimensional analysis method,

$$6 \text{ mL} \times \frac{20 \text{ mg}}{2 \text{ mL}} = 60 \text{ mg}$$



I. Intramuscular and Subcutaneous Injections

I. Calculating Ratio Strength

1. a:b is read as “a to b”
2. Means there are (a) parts of a pure drug in (b) parts of a liquid solution
3. Units are usually (a) grams: (b) milliliters
4. A 1% solution could be written as 1:100, and the units would be 1 g:100 mL



I. Intramuscular and Subcutaneous Injections

5. Terms to Remember

- a. **ratio strength** - a means of describing the concentration of a liquid medication based on a ratio such as (a) grams: (b) milliliters

6. Ratio Strength Example

- a. How many milliliters are needed to provide 20 mg of a drug if the solution available is 1:500?



I. Intramuscular and Subcutaneous Injections

Begin by converting 20 mg to 0.02 g.

i. **Solution 1: Using the ratio-proportion method,**

$$\frac{x \text{ mL}}{0.02 \text{ g}} = \frac{500 \text{ mL}}{1 \text{ g}}$$

$$x \text{ mL} = \frac{(0.02 \text{ g}) \times 500 \text{ mL}}{1 \text{ g}} = 10 \text{ mL}$$

ii. **Solution 2: Using the dimensional analysis method,**

$$0.02 \text{ g} \times \frac{500 \text{ mL}}{1 \text{ g}} = 10 \text{ mL}$$



I. Intramuscular and Subcutaneous Injections

J. Problem Set Drug Labels

(Page 151-152 Calculate the quantity of drug in the injectable solution using the provided vial labels.)

Problem 1:

How many milliliters of solution are needed to provide 50 mg of lidocaine?

Problem 8:

How many milliliters of solution are needed to provide 250 mg of Ampicillin?



I. Intramuscular and Subcutaneous Injections

Problem 11:

How many milligrams of Ketorolac are contained in 0.5 mL?

Problem 13:

How many milligrams of Lidocaine HCl are contained in 3.75 mL?



II. Other Units of Measure

A. Calculating Milliequivalents/Calculating Units

1. Although most medications are dosed using the metric system (milligrams or grams), some medications are calculated using other units of measure.

2. Examples:

- a. Salts, proteins
- b. Insulin
- c. Penicillin V
- d. Heparin



II. Other Units of Measure

B. Calculating Milliequivalents

1. Many fluids contain dissolved mineral salts, electrolytes.
2. Electrolytes conduct a charge through the solution when they are connected to electrodes.
3. Measured by milliequivalents, which are related to molecular weight



II. Other Units of Measure

4. Terms to Remember

- a. **Electrolytes** - substances such as mineral salts that carry an electrical charge when dissolved in a solution
- b. **Atomic weight** - the weight of a single atom of an element compared to the weight of a single atom of hydrogen
- c. **Molecular weight** - the sum of the atomic weights of all atoms in one molecule of a compound



II. Other Units of Measure

- d. **Millimole (mM)** - molecular weight expressed in milligrams
- e. **Milliequivalent (mEq)** - the ratio of the weight of a molecule to its valence, used to measure the concentration of electrolytes in a volume of solution; also an amount of medication that will provide the patient with a specific amount (equivalent amount) of an electrolyte



II. Other Units of Measure

- f. **mEq** - the ability of a molecule to bond, as indicated by its positive or negative charge; represented by a superscript plus or minus sign next to an element's chemical symbol

$$\text{mEq} = \frac{\text{molecular weight}}{\text{valence}}$$



II. Other Units of Measure

C. Calculating Milliequivalents

1. Examples of valence: Na^+ , Cl^- , or Ca^{++}
2. Most commonly plus or minus 1, 2, or 3



II. Other Units of Measure

3. You might be asked to add 28 mEq of sodium chloride to an IV bag. This would require calculating the amount of milliliters of Sodium chloride solution to add to the IV bag, given an available solution (such as 4 mEq/mL).
 - a. Calculations will involve determining the volume of a substance that has an electrolyte as its primary ingredient.



II. Other Units of Measure

4. Milliequivalents Example 1

- a. You need to add 44 mEq of Sodium chloride (NaCl) to an IV bag. Sodium chloride is available as a 4 mEq/mL solution. How many milliliters will you add to the bag?



II. Other Units of Measure

- i. **Solution 1: Using the ratio-proportion method,**

$$\frac{x \text{ mL}}{44 \text{ mEq}} = \frac{1 \text{ mL}}{4 \text{ mEq}}$$

$$x \text{ mL} = \frac{(44 \text{ mEq}) \times 1 \text{ mL}}{4 \text{ mEq}} = 11 \text{ mL}$$

- ii. **Solution 2: Using the dimensional analysis method,**

$$44 \text{ mEq} \times \frac{1 \text{ mL}}{4 \text{ mEq}} = 11 \text{ mL}$$



II. Other Units of Measure

5. Milliequivalents Example 2

- a. You have been instructed to add 15 mL of sodium chloride to a patient's IV bag. Sodium chloride is available as a 4 mEq/mL solution, calculate how many milliequivalents of Sodium chloride will be in 15 mL of solution.



II. Other Units of Measure

- i. **Solution 1: Using the ratio-proportion method,**

$$\frac{x \text{ mEq}}{15 \text{ mL}} = \frac{4 \text{ mEq}}{1 \text{ mL}}$$

$$x \text{ mEq} = \frac{(15 \text{ mL}) \times 4 \text{ mEq}}{1 \text{ mL}} = 60 \text{ mEq}$$

- ii. **Solution 2: Using the dimensional analysis method**

$$15 \text{ mL} \times \frac{4 \text{ mEq}}{1 \text{ mL}} = 60 \text{ mEq}$$



II. Other Units of Measure

D. Calculating Units

1. Insulin
2. Heparin
3. Corticotropin (ACTH)
4. Factor VIII
5. Penicillin
6. Vitamins



II. Other Units of Measure

7. Terms to Remember

a. **Unit** - the amount of activity associated with a medication that has a biological impact on a patient

8. **SAFETY NOTE:** Do not abbreviate international units as IU or U. Always write out “units.”



II. Other Units of Measure

9. Insulin syringes are available in the following standard unit sizes:

- a. 30 units
- b. 50 units
- c. 100 units



II. Other Units of Measure

10. Unit Calculation: Example 1

- a. A patient is to receive a bolus (concentrated) dose of Heparin. If the dose is 7500 units and you have a 10mL vial that contains 5,000 USP Units/mL, how many milliliters will you prepare?



II. Other Units of Measure

- i. **Solution 1: Using the ratio-proportion method,**

$$\frac{x \text{ mL}}{7500 \text{ units}} = \frac{1 \text{ mL}}{5000 \text{ units}}$$

$$x \text{ mL} = \frac{(7500 \text{ units}) \times 1 \text{ mL}}{5000 \text{ units}} = 1.5 \text{ mL}$$

- ii. **Solution 2: Using the dimensional analysis method,**

$$7500 \text{ units} \times \frac{1 \text{ mL}}{5000 \text{ units}} = 1.5 \text{ mL}$$

- b. **SAFETY NOTE: Only insulin syringes should be used to administer or dispense insulin.**



II. Other Units of Measure

11. Unit Calculation: Example 2

- a. A patient is to receive 32 units of regular insulin each morning before breakfast. Insulin comes in a 10mL vial, 100 units/mL concentration. How many milliliters will the patient receive with each dose? How many days will the vial last?



II. Other Units of Measure

- i. **Part I: Calculate the volume the patient will receive with each dose by using either the ratio-proportion method or the dimensional analysis method.**



II. Other Units of Measure

Part I, Solution 1: Using the ratio-proportion method,

$$\frac{x \text{ mL}}{32 \text{ units}} = \frac{1 \text{ mL}}{100 \text{ units}}$$

$$x \text{ mL} = \frac{(32 \text{ units}) \times 1 \text{ mL}}{100 \text{ units}} = 0.32 \text{ mL}$$

Part I, Solution 2: Using the dimensional analysis method,

$$32 \text{ units} \times \frac{1 \text{ mL}}{100 \text{ units}} = 0.32 \text{ mL}$$



II. Other Units of Measure

- ii. **Part II: Using the volume per dose just calculated, determine the number of days a single vial will last. In this example, the patient takes a single dose a day.**



II. Other Units of Measure

Part II, Solution 1: Using the ratio-proportion method,

$$\frac{x \text{ days}}{10 \text{ mL}} = \frac{1 \text{ day}}{0.32 \text{ mL}}$$

$$x \text{ mL} = \frac{(10 \text{ mL}) \times 1 \text{ day}}{0.32 \text{ mL}} = 31.25 \text{ days, or } 31 \text{ days}$$

Part II, Solution 2: Using the dimensional analysis method,

$$10 \text{ mL} \times \frac{1 \text{ day}}{0.32 \text{ mL}} = 31.25 \text{ days, or } 31 \text{ days}$$



II. Other Units of Measure

E. Discussion

1. How might a prescriber write “four times daily” on a prescription or order?
 - a. Answer: q6 h or qid



II. Other Units of Measure

F. Problem Set Drug Labels

(Problems 7-10, page 164)

NDC 63323-965-05 96505 **Preservative Free**

POTASSIUM CHLORIDE
For Injection Concentrate, USP

Concentrate Must Be Diluted Before Use

10 mEq (2 mEq/mL)

5 mL Single Dose Vial Rx only

MUST BE DILUTED PRIOR TO IV ADMINISTRATION
Sterile, Nonpyrogenic
Each mL contains: Potassium chloride 2 mEq (149 mg); Water for Injection q.s. HCl and/or KOH may have been added for pH adjustment.
4000 mOsmol/L (calc.)
Contains no more than 100 mcg/L of aluminum.
Usual Dosage: See insert.
Store at 20° to 25°C (68° to 77°F) [see USP Controlled Room Temperature].
Vial stoppers do not contain natural rubber latex.

Abraxis Pharmaceutical Products
Schaumburg, IL 60173

NDC 63323-965-15 96515 **Preservative Free**

POTASSIUM CHLORIDE
For Injection Concentrate, USP

Concentrate Must Be Diluted Before Use

30 mEq (2 mEq/mL)

15 mL Single Dose Vial Rx only

MUST BE DILUTED PRIOR TO IV ADMINISTRATION
Sterile, Nonpyrogenic
Each mL contains: Potassium chloride 2 mEq (149 mg); Water for Injection q.s. HCl and/or KOH may have been added for pH adjustment.
4000 mOsmol/L (calc.)
Contains no more than 100 mcg/L of aluminum.
Usual Dosage: See insert.
Store at 20° to 25°C (68° to 77°F) [see USP Controlled Room Temperature].
Vial stoppers do not contain natural rubber latex.

Abraxis Pharmaceutical Products
Schaumburg, IL 60173

NDC 63323-965-10 96510 **Preservative Free**

POTASSIUM CHLORIDE
For Injection Concentrate, USP

Concentrate Must Be Diluted Before Use

20 mEq (2 mEq/mL)

10 mL Single Dose Vial Rx only

MUST BE DILUTED PRIOR TO IV ADMINISTRATION
Sterile, Nonpyrogenic
Each mL contains: Potassium chloride 2 mEq (149 mg); Water for Injection q.s. HCl and/or KOH may have been added for pH adjustment.
4000 mOsmol/L (calc.)
Contains no more than 100 mcg/L of aluminum.
Usual Dosage: See insert.
Store at 20° to 25°C (68° to 77°F) [see USP Controlled Room Temperature].
Vial stoppers do not contain natural rubber latex.

Abraxis Pharmaceutical Products
Schaumburg, IL 60173

NDC 63323-965-20 96520 **Preservative Free**

POTASSIUM CHLORIDE
For Injection Concentrate, USP

Concentrate Must Be Diluted Before Use

40 mEq (2 mEq/mL)

20 mL Single Dose Vial Rx only

MUST BE DILUTED PRIOR TO IV ADMINISTRATION
Sterile, Nonpyrogenic
Each mL contains: Potassium chloride 2 mEq (149 mg); Water for Injection q.s. HCl and/or KOH may have been added for pH adjustment.
4000 mOsmol/L (calc.)
Contains no more than 100 mcg/L of aluminum.
Usual Dosage: See insert.
Store at 20° to 25°C (68° to 77°F) [see USP Controlled Room Temperature].
Vial stoppers do not contain natural rubber latex.

Abraxis Pharmaceutical Products
Schaumburg, IL 60173



II. Other Units of Measure

Select the vial that is needed to fill each order with the required number of mEq of potassium chloride, and then calculate the volume to be withdrawn from the selected vial for the order.

- a. Add 14 mEq Potassium chloride to the patient's IV solution.
- b. Add 19 mEq Potassium chloride to the patient's IV solution.



II. Other Units of Measure

- c. Add 27 mEq Potassium chloride to the patient's IV solution.
- d. Add 50 mEq Potassium chloride to the patient's IV solution.



II. Other Units of Measure

(Problems 13 and 14, page 165)

NDC 63323-088-61 8181 Maxivial® Sterile, Nonpyrogenic

SODIUM CHLORIDE
INJECTION, USP
CONCENTRATED
PHARMACY BULK PACKAGE—
Not for Direct Instusion

23.4% 4 mEq/mL
FOR IV USE ONLY
AFTER DILUTION

100 mL Rx only

Preservative Free
Each vial contains Sodium chloride 23.4 mg.
Water for Injection, U.S. pH may have been adjusted
with hydrochloric acid.
8000 mEq/mL 4000 mEq/L

Proper use of a pharmacy bulk package: Swab
the top of the vial with an alcohol swab and
use aseptic technique to withdraw the contents
of the vial promptly utilizing a suitable
sterile dispensing set. If prompt fluid transfer is
not possible, a maximum time of 4 hours from the
time of initial entry is allowed to complete the
transfer. The vial should be discarded if the
contents are not used within 4 hours after initial
cannulation.

Contains no more than 200 mcg/L of aluminum.
Usual Dosage: See insert.
Use only if solution is clear and seal intact.
Store at 20° to 25° (68° to 77°F) (See USP Controlled
Room Temperature). Do not permit to freeze.
Abraxis
Pharmaceutical Products
Schaumburg, IL 60193

VIAL ENTRY:
Date _____
Time _____

LOT/EXP 401933F

SAMPLE

3 63323-088-61 3

75 50 25 100 100

Approx. mL (4 mEq/mL) 23.4% SODIUM CHLORIDE INJECTION, USP

(Problem 21 and 26, page 166)

Lovenox® (enoxaparin sodium injection) **Rx ONLY**

80mg/0.8mL [100mg/mL]

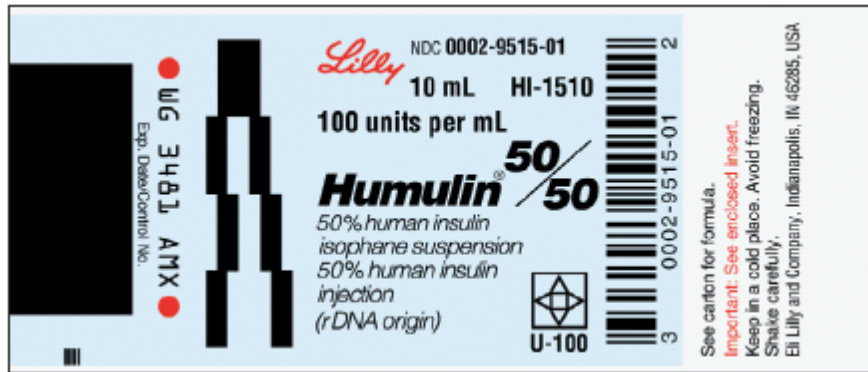
Lot _____

Exp NDC 0075-0622-80

sanofi-aventis U.S. LLC
50081229



III. Solutions Using Powders



- A. In preparing solutions, the active ingredient is discussed in terms of weight, but it also occupies a certain amount of space.
1. This space is referred to as the powder volume (pv).



III. Solutions Using Powders

2. Terms to Remember

- a. **powder volume (pv)**- the space occupied by dry pharmaceuticals, calculated as the difference between the final volume and the volume of the diluting ingredient, or the diluent volume; the amount of space occupied by lyophilized (freeze-dried) medication in a sterile vial, used for reconstitution



III. Solutions Using Powders

3. Solutions Using Powders

a. powder volume = final volume – diluent volume

or $pv = fv - dv$



III. Solutions Using Powders

4. Powder Volume: Example 1

A dry powder antibiotic must be reconstituted for use. The label states that the dry powder occupies 0.5 mL. Using the formula for solving the powder volume, determine the diluent volume. You are given the final volume for three different examples below with the same powder volume.



III. Solutions Using Powders

Final Volume

2 mL

5 mL

10 mL

Powder Volume

0.5 mL

0.5 mL

0.5 mL

$$dv = fv - pv$$

$$(1) dv = 2 \text{ mL} - 0.5 \text{ mL} = 1.5 \text{ mL}$$

$$(2) dv = 5 \text{ mL} - 0.5 \text{ mL} = 4.5 \text{ mL}$$

$$(3) dv = 10 \text{ mL} - 0.5 \text{ mL} = 9.5 \text{ mL}$$



III. Solutions Using Powders

5. Powder Volume: Example 2

You are to reconstitute 1 g of dry powder. The label states that you are to add 9.3 mL of diluent to make a final solution of 100 mg/mL. What is the powder volume?



III. Solutions Using Powders

a. **Step 1. Calculate the final volume. The strength of the final solution will be 100 mg/mL. Since you start with 1 g = 1000 mg of powder, for a final volume x of solution, it will have strength 1000 mg/x mL.**

i. **Solution 1: Using the ratio-proportion method,**

$$\frac{x \text{ mL}}{1000 \text{ mg}} = \frac{1 \text{ mL}}{100 \text{ mg}}$$

$$x \text{ mL} = \frac{(1000 \text{ mg}) \times 1 \text{ mL}}{100 \text{ mg}} = 10 \text{ mL}$$



III. Solutions Using Powders

- ii. **Solution 2: Using the dimensional analysis method,**

$$1000 \text{ mg} \times \frac{1 \text{ mL}}{100 \text{ mg}} = 10 \text{ mL}$$

- ii. **Final Step. Using the calculated final volume and the given diluent volume, calculate the powder volume.**

$$pv = fv - dv$$

$$pv = 10 \text{ mL} - 9.3 \text{ mL} = 0.7 \text{ mL}$$