Dosage Calculation Tutorial

Kent State University Regional Campuses

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Chapter 1

Introduction

Dosage calculation is a mandatory skill for nurses in any clinical setting. Since medication administration is one of the primary roles of clinical nurses, being able to calculate correct dosages is paramount to safe practice. Public and professional literature has documented that improper dosage calculations are a common source of medication errors. Medication errors due to improper dosage calculation can have serious, even fatal, consequences. Careful attention to the calculation and administration of correct dosages must be a priority for nurses. Therefore, strong emphasis is placed on dosage calculation throughout the nursing school curriculum. Also, most healthcare facilities now require nurses to demonstrate competence in dosage calculation before being hired.

1.1 What is dosage calculation?

Literally, dosage calculation means figuring out the correct dose of a medication. Many times the medication dose prescribed for the patient is different from the way the medication is supplied.

For example, an order may be written for the patient to receive *Amoxicillin 500mg*, but the medication that comes from pharmacy is *Amoxicillin 250mg* per tablet. You calculate that the patient needs to take 2 tablets to achieve the full 500mg dose that was ordered. Of course, that calculation is pretty obvious and can be done 'in your head'.

But how about this order: *Morphine 15mg* injection and the supplied medication is *Morphine 1/2 grain per milliliter*. With this situation, you will need to convert the grain (gr) dosage to milligrams (mg) and then calculate the correct dosage. You will also need to be familiar with the calibrations on syringes in order to prepare this medication for administration to the patient.

The above examples point out some of the factors related to dosage calculation which you will be learning in this tutorial. These include:

- Abbreviations used in medication administration
- Systems of measurement
- Basic mathematical calculations
- Formulas for computing drug dosages

1.2 Doesn't the pharmacist do all this?

All too frequently, nursing students do not take dosage calculation seriously because they think the pharmacist does all the calculating. Yes, most facilities now have 'unit dosing' (a system in which each patient receives the medications ordered specifically for them). However, as the examples above point out, the medication supplied is often in a dosage or form that is different from what is ordered. Pharmacists will not calculate each individual dose. That is the nurse's responsibility. You are the person giving the medication; you are the person responsible for the safe, correct administration of that medication!

1.3 I thought the doctor was the one responsible for medication safety?

Of course, the person prescribing the medication has responsibilities for the appropriate, safe use of that medication. However, the person who gives that medication to the patient also has a big responsibility to assure that the medication is safe and therapeutic. Nurses are held accountable for their actions! One of the first steps for assuring safe medication use is to assure that the correct dosage is being given.

1.4 How can I be successful in calculating dosages?

There are 3 big steps to successfully calculating medication dosages.

1. Be competent in basic math skills

2. Know the measurement equivalents and conversions

3. Use calculation formulas correctly

This tutorial will help you become proficient in each of these steps. You will be learning the basic procedure for medication administration in the Foundations of Nursing Agency course and will build on this procedure in other courses. For now, let's concentrate on the knowledge you will need to calculate dosages correctly.

Chapter 2

Basic Math Review

In order to calculate dosages correctly, you will need to use some math skills. The math needed to calculate dosages is not complex! Most of the math you need for calculations was learned in grade school. Most nurses are not proficient in calculus and trigonometry, so relax!

To help you brush up on those math skills, a basic math review is provided for you. It is recommended that all students go through this review, even if you feel confident in your math skills. Practice exercises are included at the end of each section. It is recommended that you be able to score 100% on these exercises. Remember: most students fail dosage calculation tests due to simple math errors!

If you feel that you need additional help with your math skills, please contact your instructor regarding individual tutoring or remediation programs available on your campus.

2.1 Whole Numbers

Most dosage calculation problems can be solved using primarily multiplication and division skills. A review of those skills is presented here, with practice problems following each section. Although calculators are allowed throughout the nursing curriculum and in clinical settings, it is recommended that you develop your critical thinking skills by mentally solving the problems presented.

2.1.1 Multiplying Whole Numbers

Multiplying whole numbers involves memorizing multiplication tables which is typically done in grade school. Complete the exercise below to review your multiplication skills. If you do not achieve 100% on this exercise, practice until you are proficient or see your instructor regarding remediation. (Answers are found on page 54.)

1. $2 \cdot 6 =$
2. $7 \cdot 8 =$
3. $2 \cdot 9 =$
4. $7 \cdot 7 =$
5. $3 \cdot 5 =$
6. $9 \cdot 4 =$
7. $8 \cdot 8 =$
8. $9 \cdot 7 =$
9. $4 \cdot 3 =$
10. $6 \cdot 7 =$
11. $5 \cdot 6 =$
12. $6 \cdot 8 =$

2.1.2 Dividing Whole Numbers

You can check your division by multiplying the answer by the number you used to divide. Multiplying these two numbers should give you the number which you divided. Example: if you divide 12 by 2, your answer is 6. If you multiply 2 and 6, you get 12.

Complete the exercise below to review your division skills. If you do not achieve 100% on this exercise, practice until you are proficient or see your instructor regarding remediation. (Answers are found on page 54.)

1. $14 \div 7 =$
2. $28 \div 4 =$
3. $18 \div 3 =$
4. $35 \div 5 =$
5. $24 \div 6 =$
6. $56 \div 8 =$
7. $48 \div 6 =$
8. $63 \div 7 =$
9. $45 \div 9 =$
10. $72 \div 8 =$
11. $81 \div 9 =$
12. $32 \div 4 =$

2.2 Fractions

Medication dosages are occasionally ordered as fractions (Example: Morphine gr. 1/4). A fraction is a portion of a whole number. The top number in a fraction is called the numerator; the bottom number is called the denominator. In the example above (1/4), 1 is the numerator and 4 is the denominator.

2.2.1 Multiplying Fractions

To multiply fractions, you will need to multiply the numerators, multiply the denominators and then reduce the resulting fraction to its lowest common denominator. For example:

$$\frac{4}{8} \cdot \frac{2}{4} = \frac{8}{32} = \frac{1}{4}$$

The lowest common denominator is found by dividing the numerator and denominator by the largest number that can equally divide both. In the above example (8/32), the numerator and denominator can be equally divided by 8, so the fraction 8/32 can be reduced to 1/4. If the fraction was 9/17, there is no number which equally divides both the numerator and denominator, so 9/17 could not be reduced.

Complete the exercise below to review your skill with multiplication of fractions. Again, if you do not achieve 100% on this exercise, practice until you are proficient or see your instructor regarding remediation. (Answers are found on page 55.)

1. $\frac{2}{3} \cdot \frac{4}{5} =$	4. $\frac{3}{6} \cdot \frac{5}{7} =$	7. $\frac{3}{5} \cdot \frac{3}{8} =$
2. $\frac{4}{9} \cdot \frac{5}{6} =$	5. $\frac{2}{3} \cdot \frac{3}{8} =$	8. $\frac{1}{4} \cdot \frac{1}{2} =$
3. $\frac{1}{5} \cdot \frac{3}{5} =$	6. $\frac{5}{8} \cdot \frac{3}{8} =$	9. $\frac{2}{4} \cdot \frac{1}{6} =$

2.2.2 Dividing Fractions

Fractions can be divided by inverting the fraction after the division sign and then converting the division sign to a multiplication sign. Example: $2/4 \div 1/8$ is converted to $2/4 \cdot 8/1$. By multiplying the fraction you get 16/4, which can be reduced to 4/1 or just 4.

Complete the exercise below to review your skill with dividing fractions. Again, if you do not achieve 100% on this exercise, practice until you are proficient or see your instructor regarding remediation. (Answers are found on page 56.)

1. $\frac{1}{75} \div \frac{1}{150} =$	4. $\frac{3}{4} \div \frac{2}{3} =$	7. $\frac{1}{8} \div \frac{1}{4} =$
2. $\frac{1}{5} \div \frac{4}{5} =$	5. $\frac{1}{125} \div \frac{2}{250} =$	8. $\frac{1}{6} \div \frac{2}{3} =$
3. $\frac{1}{4} \div \frac{1}{2} =$	6. $\frac{1}{6} \div \frac{1}{12} =$	9. $\frac{5}{8} \div \frac{5}{8} =$

2.3 Decimals

Decimals consist of whole numbers (written to the left of the decimal point) and decimal fractions (written to the right of the decimal point). Decimal fractions are written in tenths, hundredths, thousandths, and so on. Note these examples:

- 1.5 is verbalized as “one and five tenths”
- 1.55 is verbalized as “one and 55 hundredths”
- 1.555 is verbalized as “one and 555 thousandths’

Important: Always insert a zero to the left of the decimal point if a whole number is absent. This calls attention to the fact that the number is a decimal. Try writing the following as decimals: (Answers are found on page 56.)

1. Four and one tenth ____________________
2. Three and eight thousandths ____________________
3. Five hundredths ____________________
4. Thirty-six hundredths ____________________
5. Eighteen thousandths ____________________
6. Six and twenty-two hundredths ____________________
7. Nine thousandths ____________________

One of the keys to avoiding medication errors is recognizing whether the amount you will give is more or less than the amount supplied. In the following examples, which number is **smaller**? (Answers are found on page 57.)

1. 0.4 or 0.2
2. 0.01 or 0.001
3. 0.75 or 0.075
4. 0.05 or 0.015
5. 2.309 or 2.09

2.3.1 Adding Decimals

Follow these steps when adding decimals:

- Write the numbers in a column, **keeping the decimal points under each other**
- Add numbers, as usual, from right to left
- Put the decimal point in the answer **directly under** the decimal points in the numbers being added.

Example:

$$0.5 + 0.25 = \begin{array}{r} 0.50 \\ \underline{+\,0.25} \\ 0.75 \end{array}$$

Note that a zero was added to the right of 0.5 in order to make the columns line up. Also, it is important that the decimal points line up!

2.3.2 Subtracting Decimals

Follow these steps when subtracting decimals:

- Write the numbers in a column, **keeping the decimal points under each other**
- Subtract the numbers, as usual, from right to left
- Put the decimal point in the answer, **directly under** the decimal points in the numbers being added.

Example:

$$0.55 - 0.25 = \begin{array}{r} 0.55 \\ \underline{-\,0.25} \\ 0.30 \end{array}$$

Be sure to line up the decimal points!

Practice the following problems: (Answers are found on page 57.)

1. $0.45 + 1.2 =$
2. $1.002 + 0.3 =$
3. $0.382 - 0.04 =$
4. $4.8 - 1.33 =$
5. $2.45 + 0.002 =$
6. $14.999 - 0.45 =$

2.3.3 Multiplying Decimals

Follow these steps when multiplying decimals:

- Multiply the decimal numbers as you would whole numbers
- Count the **total number** of decimal places in the numbers being multiplied
- Starting from the right, count off the same number of places in the answer
- If the answer does not have enough places, add zeros to the left.

Example:

$$4.2 \times 0.005 = \begin{array}{r} 4.2 \\ \underline{\times\,0.005} \\ 0.0210 \end{array} \qquad \begin{array}{l} \text{(1 decimal place)} \\ \text{(3 decimal places)} \\ \text{(4 decimal places)} \end{array}$$

Note that a zero was added in order to make 4 decimal places.

2.3.4 Dividing Decimals

Follow these steps when dividing decimals: First, examine the divisor (the number you are dividing by):

- If the divisor is a **whole number**, the decimal point is unchanged. Place the decimal point on the answer line directly above the decimal point in the dividend (the number you are dividing). You may need to use zeros in the answer to note decimal places.

  Example: $1.20 \div 15 =$

$$\begin{array}{rl} & \underline{0.08} \leftarrow \text{ Quotient} \\ \text{Divisor } \rightarrow 15\big) & 1.20 \\ & \underline{1.20} \\ & 0 \leftarrow \text{ Remainder} \end{array}$$

- If the divisor is a decimal, you will need to convert it to a whole number by moving the decimal point to the right. You will then need to move the decimal point in the dividend the same number of places to the right. Immediately place the decimal point directly above on the answer line. Now you can divide as you did above with the whole number.

  Example: $30 \div 5.2 \quad \longrightarrow \quad 5.2\big)\overline{30} \quad \longrightarrow \quad 52\big)\overline{300.0}$

$$\begin{array}{rl} & \underline{5.76} \\ 52\big) & 300.00 \\ & \underline{260} \\ & 400 \\ & \underline{364} \\ & 360 \\ & \underline{312} \\ & 48 \leftarrow \text{ Remainder} \end{array}$$

Remember that you can always check your division by multiplying the quotient by the divisor and adding the remainder. This should be the dividend.

Practice the following problems: (Answers are found on page 57.)

1. $4.25 \times 3.8 =$
2. $0.05 \times 1.004 =$
3. $0.02 \times 0.018 =$
4. $2.65 \div 0.45 =$
5. $0.317 \div 0.02 =$
6. $12.006 \div 4.6 =$

2.3.5 Changing Fractions to Decimals

Fractions can be changed to decimals by dividing the numerator by the denominator. Example: $3/4 = 3 \div 4 = 0.75$

2.3.6 Additional Help with Math

For additional practice with basic math check out `http://www.math.com/students/practice.html`.

Chapter 3

Systems of Measurement and Common Equivalents

Three systems of measurement can be used for medication administration: the metric system, apothecary system, and the household system. You must be able to understand all three systems and convert back and forth among the systems in order to safely calculate dosages and administer medications.

3.1 The Metric System

The metric system is a decimal system of weighing and measuring medications based on units of 10, 100, and 1000. Grams and liters are basic units of measurement in this system. Grams measure *weight* and generally indicate solids; liters measure *volume* and generally indicate liquids. Common units of measurement in medication dosages are grams, milligrams, micrograms and liters and milliliters. Note the relationship between these units of measurement:

$$1 \text{ milligram (mg)} = \frac{1}{1000} \text{ gram (Gm)}$$

and

$$1 \text{ microgram (mcg)} = \frac{1}{1000} \text{ milligram} = \frac{1}{1,000,000} \text{ gram}$$

This is equivalent to

$$1 \text{ milligram} = 1000 \text{ micrograms}$$

and

$$1 \text{ gram (Gm)} = 1000 \text{ milligrams (mg)} = 1,000,000 \text{ micrograms (mcg)}$$

To move between grams, milligrams, and micrograms, the decimal point is moved three positions. To go to the lesser measurement (grams to milligrams to micrograms) the decimal point is moved to the right. To go to the larger measurements (micrograms to milligrams to grams) the decimal point is moved to the left. Consider this example:

$$0.5\,\text{Gm} = 500\,\text{mg} = 500{,}000\,\text{mcg}$$

and

$$0.000005\,\text{Gm} = 0.005\,\text{mg} = 5\,\text{mcg}$$

A microgram is a very tiny unit of measurement! It is used for medications that are so powerful that only a minute dose is required. Because medications are powerful, it is extremely important that calculations are precise. Putting a decimal point in the wrong place could mean that a patient receives ten times or even a thousand times more medication than ordered!

The volume (liquid) measurement is similar but commonly only uses two units, liter and milliliter:

$$1 \text{ millil (ml)} = \frac{1}{1000} \text{ liter (L)}$$

or

$$1 \text{ Liter (L)} = 1000 \text{ milliliter (ml)}$$

Consider this example:

$$0.5\,\text{L} = 500\,\text{ml}$$

and

$$5\,\text{L} = 5000\,\text{ml}$$

3.2 The Apothecary System

The apothecary system is an old measurement system which is gradually being replaced with the metric system. However, since some prescribers continue to order medications using this system, it is necessary for you to understand it and be able to work with it. The most frequent unit of measurement in this system is the grain which is a unit of *weight* measurement. One grain is equal to 60 milligrams, therefore a grain is a more powerful dose than a milligram. Because a grain is a powerful unit, dosages of strong medications are often written as fractions. Example: Morphine 1/4 grain; Nitroglycerin 1/150 grain.

It is necessary to think about relationships between the apothecary and metric systems. Medications may be ordered in the apothecary system, but supplied in the metric system. Knowing how to convert measurements from one system to another is essential.

Consider this:

- 1 grain (gr) = 60 mg
- 5 grains (gr) = 300 mg (since 1 grain is 60 mg, multiply 5 times 60 to get the total number of milligrams)
- 1/4 gr = 15 mg (if 1 grain is 60 mg, multiply 60 by 1/4 to get the number of mg)
- 1/150 gr = 0.4 mg = 400 mcg (again you want to multiply 60 by the fraction, but since the denominator of this fraction is larger than the whole number (60), your answer will be a decimal, in this case 0.4mg. Because this is a small and powerful dosage, the medication may come supplied in micrograms. Moving the decimal point three places to the right, we know that 0.4 mg becomes 400 mcg.)

3.3 The Household System

The household system is the least accurate form of measurement and has generally been replaced with the metric system. However, since much patient care is now delivered in the home and community, patients and families will be using this system. It is therefore necessary for nurses to have an understanding of this system in order to provide care and patient education in these settings.

Common measurement units used in the household system include teaspoon, tablespoon, and ounce. Metric equivalents for the household measurement units are:

$$1 \text{ teaspoon (tsp)} = 5\,\text{ml}$$

$$1 \text{ tablespoon (Tbs)} = 15\,\text{ml}$$

$$1 \text{ ounce (oz)} = 30\,\text{ml}$$

3.4 Summary

It is important for nurses to be able to convert measurements from one system to another. Learning these equivalents will enable you to successfully calculate dosages and ensure safe medication administration. Learning the equivalents involves simple memorization. A Summary of the Essential Equivalents is provided for your ease in learning. You must take the time to memorize these equivalents! Many errors on dosage calculation tests are due to not knowing equivalents.

3.4.1 Conversion Practice

Complete the exercise below to review your skill with equivalents and converting among measurement systems. If you do not achieve 100% on this exercise, study, memorize, and practice until you are proficient or see your instructor regarding remediation. (Answers are found on page 58.)

1. 3 tsp = ___________ ml
2. 15 ml = ___________ Tbs
3. 1/4 gr = ___________ mg
4. 120 ml = ___________ oz
5. 1/200 gr = ___________ mg
6. 1/2 oz = ___________ ml
7. 2 gr = ___________ mg
8. 8 oz = ___________ ml
9. 120 mg = ___________ gr
10. 0.5 L = ___________ ml
11. 0.5 Gm = ___________ mg
12. 1 mcg = ___________ mg
13. 1 Tbs = ___________ tsp
14. 250 mg = ___________ Gm
15. 1000 mcg = ___________ mg

3.4.2 Summary of the Essential Equivalents

$$1 \text{ gram (Gm)} = 1000\,\text{mg}$$
$$1 \text{ milligram (mg)} = 1000\,\text{mcg}$$
$$1 \text{ liter (L)} = 1000\,\text{ml}$$

$$1 \text{ grain (gr)} = 60\,\text{mg}$$

$$1 \text{ teaspoon (tsp)} = 5\,\text{ml}$$
$$1 \text{ tablespoon (Tbs)} = 15\,\text{ml}$$
$$1 \text{ ounce (oz)} = 30\,\text{ml}$$

Chapter 4

Abbreviations

The healthcare profession uses many abbreviations. Unfortunately, the use of abbreviations and the frequent misinterpretation of them, has lead to many medication errors. **You are encouraged to minimize the use of abbreviations in your practice!**

The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) has published a "**Do Not Use**" list of abbreviations. These abbreviations have been found to be frequently misinterpreted and cause medication errors. Although you may see some of these abbreviations still in use, *you are cautioned not to use them*!

You are also encouraged to begin now to dedicate yourself to clear, legible handwriting. The milliseconds you save by using an abbreviation and/or sloppy handwriting, may cost a patient's life.

Table 4.1: JCAHO "Do Not Use" List

Abbreviation	**Potential Problem**	**Preferred Use**
U (for unit)	Mistaken as 0, 4, or cc	Write "unit"
IU (international unit)	Mistaken as IV or 10	Write "international unit"
Q.D. (once daily)	Mistaken for QOD	Write "daily"
Q.O.D. (every other day)	Mistaken for QD	Write "every other day"
Trailing 0 (e.g. 5.0 mg)	Decimal point is missed	Never write zero after a decimal point. Always use a zero before a decimal point. (e.g. 0.5 mg)
$\boldsymbol{\mu}$ (microgram)	Mistaken for mg	Write "mcg"
H.S. (half strength or hour of sleep)	Unclear interpretation	Write "half strength" or "at bedtime"
T.I.W. (3 times per week)	Mistaken for twice weekly	Write "3 times weekly"
D/C (for discharge)	Interpreted as discontinue whatever medications follow	Write "discharge"
c.c. (cubic centimeter)	Mistaken for "U" when poorly written	Write "ml" (cc and ml are equal measurements)
AS, **AD**, **AU** (left ear right ear, both ears)	Mistaken for eye abbreviations OS, OD, OU	Write out words "left ear," "right ear," etc.

Currently Accepted Abbreviations

Gm (gram)	po (orally)	stat (immediately)
mg (milligram)	R or pr (rectally)	SubQ (subcutaneous)
mcg (microgram)	IM (intramuscular)	IV (intravenous)
gr (grain)	L (liter)	prn (as needed)
q (every)	ml (milliliter)	gtt (drop)

Chapter 5

Calculation Formulas

There are several ways to calculate dosages, just as there are several approaches to mathematical problem solving. This tutorial presents three of the main formulas for dosage calculation. These formulas are offered as reference and examples. If you have learned calculations using another method, feel free to use that method. The main rule is: you should choose a method that is comfortable for you and which assures accuracy.

Most dosage calculations are a matter of common sense. Before you reach for the calculator or choose a formula, think about what you have and what you want. Do you want more than the supplied medication or less? Try to figure out your calculation in your mind before setting it to paper or calculator.

5.1 Basic Formula

This simple formula is often used and is easy to remember. This formula does not include the conversion of differing units of measurement (example grains and milligrams) so those conversions must be made before plugging numbers into the formula. Components of the formula are:

D (desired dose): the dose ordered
H (on-hand dose; supplied dose): dose on label of container
V (vehicle): form and amount of supplied drug.

The basic formula is:

$$\frac{D}{H} \times V = \text{ amount to give}$$

Example:
Ordered dose: Erythromycin 500mg by mouth every 8 hours
Supplied dose: Erythromycin 250 mg
Vehicle: 1 tablet

$$\frac{500}{250} \times 1 = \boxed{2 \text{ tablets}}$$

5.2 Ratio-Proportion Formula

A ratio shows the relationship between numbers; a proportion contains two ratios. You are usually calculating for the quantity of supplied medication that is equal to the prescribed dosage. This formula does not include the conversion of differing units of measurement (example grains and milligrams) so those conversions must be made before plugging numbers into the formula. The formula is:

$$\frac{\text{Dose on hand}}{\text{Quantity on hand}} = \frac{\text{Dose desired}}{X \text{ (quantity desired)}}$$

Example:
Dose on hand (supplied dose): Erythromycin 250 mg
Quantity on hand : 1 tablet
Desired dose (ordered dose): Erythromycin 500 mg

$$\frac{250\,\text{mg}}{1 \text{ tablet}} = \frac{500\,\text{mg}}{X \text{ tablet}}$$

By cross multiplying and solving for X, you have

$$\begin{aligned} 250X &= 500 \\ X &= \boxed{2 \text{ tablets}} \end{aligned}$$

5.3 Dimensional Analysis Formula

The dimensional analysis method calculates dosages using three factors:

1. Drug label factor: the form of the drug dose (V) and the supplied units (H),
2. Conversion factor (C): measurement equivalents,
3. Drug order factor: the desired dose (D).

These three factors are set up in an equation which allows for cross multiplying to solve the problem:

$$\frac{V}{H} \times \frac{C(H)}{C(D)} \times \frac{D}{1} = \text{ amount to administer}$$

As you see, this formula incorporates the conversion of different units of measurement and also includes the factors noted in the basic formula. Because of this, many nurses prefer using this formula.

Example:
Supply: Erythromycin 250 mg per tablet
Order: Erythromycin 0.5 Gm orally every 8 hours

$$\frac{1 \text{ tablet}}{250\,\text{mg}} \times \frac{1000\,\text{mg}}{1\,\text{Gm}} \times \frac{0.5\,\text{Gm}}{1 \text{ tablet}} = \boxed{\text{2 tablets.}}$$

Chapter 6

Calculating Oral Dosages

Medications to be administered by mouth are available in tablets, capsules, and liquids. Most tablets are scored (grooved) which enables them to be broken easily. A tablet that is not scored should not be broken. If there are times when this is the only option, a pill cutter should be used to break the tablet. Capsules with gelatin shells should not be broken or opened to divide the dose. Capsules with a hard shell (caplets) may be broken if scored.

Many medications come in liquid form. When a smaller dose is necessary and is not available in tablet or capsule form, the liquid preparation can be used.

Steps for calculating oral dosages:

1. Check the drug order
2. Check the supplied medication (drug name, dosage, form)
3. Set up the formula for calculation (basic, ratio-proportion, or dimensional analysis)
4. Convert measurements if needed
5. Solve for the quantity to be given

Example: The order for the medication reads: Amoxicillin 0.5 Gm orally every six hours. The supplied medication is Amoxicillin 250 mg per tablet. How much medication would you give?

Basic Formula Method
First convert 0.5 Gm to mg by moving the decimal point 3 places to the right. (0.5 Gm = 500mg) Then

$$\frac{D}{H} \times V \longrightarrow \qquad \frac{500\,\text{mg}}{250\,\text{mg}} \times 1 \text{ tablet } = \boxed{2 \text{ tablets}}$$

Ratio-Proportion Method
First convert 0.5 Gm to mg by moving the decimal point 3 places to the right. (0.5 Gm = 500mg) Then

$$\frac{\text{Dose on hand}}{\text{Quantity on hand}} = \frac{\text{Dose desired}}{X}$$

$$\frac{250}{1} = \frac{500}{X \text{ tablets}}$$

$$\longrightarrow \quad 250X = 500$$

$$\longrightarrow \quad X = \boxed{2 \text{ tablets}}$$

Dimensional Analysis Method

$$\frac{V}{H} \times \frac{C(H)}{C(D)} \times \frac{D}{1} = \text{ amount to administer}$$

$$\frac{1 \text{ tablet}}{250\,\text{mg}} \times \frac{1000\,\text{mg}}{1\,\text{Gm}} \times \frac{0.5\,\text{Gm}}{1} = \boxed{2 \text{ tablets}}$$

6.1 Calculation Practice Problems

6.1.1 Problem Set I

(Answers are found on page 59)

1. Order: Synthroid 200 mcg po daily
   Supply: Synthroid 0.4 mg per tablet
   Give: ________________ tablets

2. Order: Zoloft 25 mg po twice daily
   Supply: Zoloft 50 mg tablets
   Give: ________________ tablets

3. Order: Doxycycline 100 mg po daily
   Supply: Doxycycline 0.2 Gm per tablet
   Give: ________________ tablets

4. Order: Erythromycin Syrup 0.75 Gm po every 6 hours
   Supply: Erythromycin syrup 250 mg/5 ml
   Give: ________________ ml
   You are instructing a patient to take this medicine at home. How many teaspoons would the correct dose be? ________________

5. Order: Digoxin 0.25 mg po daily
   Supply: Digoxin 0.5 mg tablets
   Give: ________________ tablets

6. Order: Aspirin 10 gr po every 4 hours prn
   Supply: Aspirin 300 mg per tablet
   Give: ________________ tablets

7. Order: Prednisone 40 mg po daily
   Supply: Prednisone 5 mg tablets
   Give: ________________ tablets

8. Order: Morphine 15 mg po every 4 hours prn
   Supply: Morphine 1/2 gr per tablet
   Give: ________________ tablets

9. Order: Nitroglycerin 0.4 mg po stat
   Supply: Nitroglycerin 1/150 gr per tablet
   Give: ________________ tablets

10. Order: Amoxicillin 0.5 Gm po every 6 hours
    Supply: Amoxicillin syrup: 250 mg/5 cc
    Give: ________________ cc

6.1.2 Problem Set II

(Answers are found on page 59)

1. Order: Lasix 120 mg po daily
   Supply: Lasix 40 mg tablets
   Give: ________________ tablets

2. Order: Codeine syrup 20 mg po prn
   Supply: Codeine syrup 10 mg/5 ml
   Give: ________________ ml or ________________ tsp

3. Order: Coumadin 7.5 mg po daily
   Supply: Coumadin 2.5 mg tablets
   Give: ________________ tablets

4. Order: Synthroid 0.030 mg po daily
   Supply: Synthroid 10 mcg tablets
   Give: ________________ tablets

5. Order: Azulfidine 4 Gm po today
   Supply: Azulfidine 500 mg tablets
   Give: ________________ tablets

6. Order: Zarontin 0.5 Gm po twice daily
   Supply: Zarontin syrup 250 mg/ml
   Give: ________________ ml

7. Order: Acetominophen 10 gr po every 4 hours prn
   Supply: Acetominophen 300 mg tablets
   Give: ________________ tablets

8. Order: Nitroglycerin 0.3 mg po prn
   Supply: Nitroglycerin 1/200 gr per tablet
   Give: ________________ tablets

9. Order: Zithromax 500 mg daily per feeding tube
   Supply: Zithromax syrup 100 mg/5 ml
   Give: ________________ ml

10. Order: Milk of Magnesia 1 oz po prn daily
    Supply: Milk of Magnesia 30 ml unit dose
    Give: ________________ unit doses

6.2 Case Studies

6.2.1 Case Study 1

(Answers are found on page 63)

A patient is admitted to the skilled care unit in the nursing home for rehabilitation following a hip fracture. The patient has a history of Type II Diabetes and Hypertension. The orders from the physician include:

- Physical therapy for strength and ambulation training 4 times daily.
- Low fat diet with no added salt.
- Metamucil 2 tablespoons po daily
- Glyburide 10 mg po daily before breakfast and dinner
- Blood sugar checks 7 AM and 4 PM
- Lisinopril 10 mg twice daily
- Tylenol 600 mg po every 4 hours for mild pain
- Ultram 100 mg po every 4 hours for severe pain

Pharmacy has supplied the following medication:

- Metamucil packets containing 1 ounce each
- Glyburide 5 mg tablets
- Lisonopril 20 mg tablets
- Tylenol 5 gr tablets
- Ultram 50 mg tablets

1. How many packets of Metamucil will you give to achieve the desired dose?
2. How many tablets of these medications will you give?

   Glyburide ________________

   Lisonopril ________________

   Tylenol ________________

   Ultram ________________
3. If this patient were unable to swallow tablets, what could you do to assure that the medication is given?

6.2.2 Case Study 2

(Answers are found on page 63)

A three year old is seen in the pediatrician's office with fever, loose cough, and wheezing. A diagnosis of bronchitis is made and the following orders were prescribed for home use.

- Robitussin DM 5 ml po every 4 hours prn for cough
- Amoxicillin 250 mg po every 6 hours
- Tylenol 3 gr po every 4 hours prn for fever over 100 degrees
- Encourage 600 ml of fluids every 8 hours
- Avoid milk and other dairy products
- Activity as tolerated
- Call the office if fever persists

The on-sight pharmacy supplied the following medications:

- Robitussin DM syrup
- Amoxicillin syrup 125 mg/5 ml
- Tylenol syrup 100 mg/ml (comes in a bottle with a calibrated dropper)

1. Calculate the proper dosage for these medications:

   Amoxicillin ________________

   Tylenol ________________

2. The mother is unfamiliar with milliliters. Convert the Amoxicillin milliliter measurements into household measurements.

3. How many ounces of fluid should the child be drinking per day?

Chapter 7

Calculating Injectable Dosages

Medications given by injection are called **parenteral medications**. Great care must be taken with injectable medications to assure the correct dosage, method of administration, and site for injection. Injected medications work faster than **non-parenteral** (oral, topical, inhalation, etc) drugs; therefore care and caution must be exercised to prevent untoward effects.

7.1 Injection Routes

Medications given by injection may be given by these methods:

Intradermal (ID): given just under the skin; often used for skin tests such as the Mantoux TB test. Short needles are used for these injections and tiny amount of fluid are injected.

Subcutaneous (SubQ): given into the fatty, subcutaneous layer of skin; usually given with a shorter needle (ex: 1/2 inch). Small amounts of fluid (ex: 1 ml or less) are injected via this route.

Intramuscular (IM): given into the muscle; this is a deeper injection and requires a longer needle, usually at least 1 inch long. As much as 3 ml can be injected into one site.

7.2 Packaging of Injectable Medications

Medications for injection are packaged in a variety of ways:

Vial: glass bottle with rubber top; may contain a single dose or multiple doses. Medication in vials may be supplied as a liquid or as a powder which will need to be mixed (reconstituted) with the appropriate fluid. Medication is removed from the vial by puncturing the rubber top with a needle or plastic tip attached to a syringe and withdrawing the medication into the syringe.

Ampule: glass bottle with pointed top and breakable neck containing liquid medication. To remove medication, the ampule is broken at the neck and a needle attached to a syringe is used to withdraw medication into the syringe.

Pre-filled Cartridges: some medications are supplied in cartridges which must be placed in a holder for injection. Since the supplied dosage of pre-filled medication is often different from the amount ordered, care must be taken to expel the unneeded medication from the cartridge. Some cartridges are designed so that medication can be withdrawn from them, much like a vial.

Pre-filled Syringes: medication for injection may also come packaged in a pre-filled syringe. Again, since the supplied medication is often different from the ordered dose, care must be taken to expel the unneeded medication before injecting into the patient.

7.3 Types of Syringes

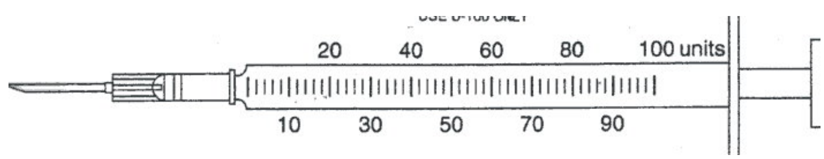
Syringes are available in a variety of sizes. Almost all syringes used in healthcare settings are plastic, intended for single use, and disposable. Syringes may be packaged with a needle; or they may be packaged without a needle and you will need to choose an appropriate needle to attach.

Most healthcare settings also have ‘needleless’ systems in which a plastic tip replaces the needle and can be use for withdrawing medication from the containers. Needleless systems reduce the risk of accidental needle sticks and the risk of exposure to pathogens.

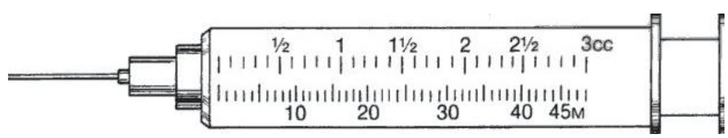
Common syringes used in healthcare settings include:

Tuberculin (TB) syringe: a slender, 1 ml syringe used when the amount of solution to be give is less than 1 ml. This syringe is calibrated in tenths (0.1 ml) and hundredths (0.01 ml).

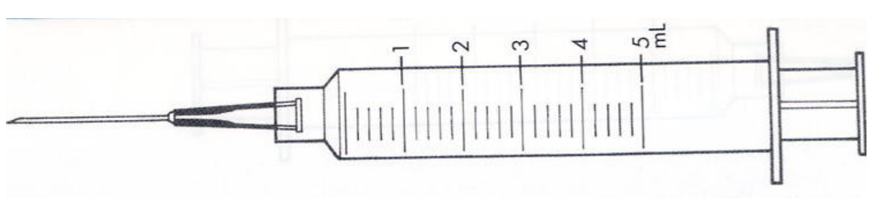
Insulin syringe: a slender syringe designed to be used with insulin administration only. This syringe is calibrated in units; insulin dosages are ordered in units. No other type of syringe should be used for insulin administration.



3 ml syringe: a popular syringe for many types of medication administration. This syringe is calibrated in tenths (0.1 ml).



5 ml syringe: this syringe is usually used when fluid amounts greater than 2 1/2 ml are to be given. This syringe is calibrated in two-tenths (0.2 ml).



7.4 Types of Needles

Just as syringes come in a variety of sizes, so do needles. Needle size includes the *length* of the needle and the *gauge* (diameter of the opening in the needle). Note: as the gauge of the needle increases, the number of the gauge decreases. Example: an 18 gauge needle has a large opening; a 25 gauge needle has a smaller opening.

The choice of what needle to use depends on the type of injection being given, the viscosity of the fluid, body size, and type of medication. The following table notes examples of needle size and length for 3 types of injections.

Type of Injection	**Needle Gauge**	**Needle Length (inches)**
Intradermal	25, 26	3/8, 1/2, 5/8
Subcutaneous	23, 25, 26	3/8, 1/2, 5/8
Intramuscular	18, 20, 21, 22	1, 1 1/2, 2

(adapted from Kee, J. and Marshall, S. (2004) Clinical Calculations St. Louis: Saunders)

7.5 Calculations for Injectables

Injectable dosages can be calculated using the same formulas you used with oral dosages. Medications for injection will be liquid, so your dosages will be expressed in milliliters (ml).
Example: You have an order for Demerol 35 mg IM every 4 hours prn for pain. The medication is supplied as Demerol 50 mg/ml in a pre-filled cartridge. How many milliliters will you give?

Basic Formula Method
First convert 0.5 Gm to mg by moving the decimal point 3 places to the right. (0.5 Gm = 500mg) Then

$$\frac{D}{H} \times V \qquad \longrightarrow \qquad \frac{35\,\text{mg}}{50\,\text{mg}} \times 1\,\text{ml} = \boxed{0.7\,\text{ml}}$$

Ratio-Proportion Method
First convert 0.5 Gm to mg by moving the decimal point 3 places to the right. (0.5 Gm = 500mg) Then

$$\frac{\text{Dose on hand}}{\text{Quantity on hand}} = \frac{\text{Dose desired}}{X}$$

$$\frac{50}{1} = \frac{35}{X \text{ tablets}}$$

$$\longrightarrow \quad 50X = 35$$

$$\longrightarrow \quad X = \boxed{0.7\,\text{ml}}$$

Dimensional Analysis Method

$$\frac{V}{H} \times \frac{C(H)}{C(D)} \times \frac{D}{1} = \text{ amount to administer}$$

(Note: you may choose to omit the conversion part of the formula since the supplied and desired units are both milligrams)

$$\frac{1\,\text{ml}}{50} \times \frac{1\,\text{mg}}{1\,\text{mg}} \times \frac{35}{1} = \boxed{0.7\,\text{ml}}$$

7.6 Giving Insulin Injections

Some points to remember when preparing insulin for injection:

- Insulin is ordered in units.
- Always use an insulin syringe for administering insulin. Insulin syringes are calibrated in units, therefore no calculation is necessary.
- Fill the syringe to the desired unit marking. Example: you are to give 20 units of NPH insulin. You would draw up enough medication to reach the 20 unit marking on the insulin syringe.
- Insulin syringes are to be used for insulin administration ONLY.

Mixing 2 insulins in 1 syringe

Frequently, you will be mixing two types of insulin (Regular and NPH) in one syringe. By mixing the insulins in one syringe, the patient avoids getting 2 injections. Some points to remember about mixing insulins:

- Avoid contaminating one vial with the contents of the other.
- Regular Insulin is fast acting.
- NPH Insulin has a delayed onset of action because a retardant has been added to the solution.
- Always draw up Regular insulin first. (If NPH Insulin is drawn up first, traces of the retardant could enter the Regular Insulin vial and delay the onset of action.)
- Add air to the NPH vial first, then add air to the Regular vial.
- Draw up the Regular Insulin, then add the NPH.
- Be very careful when withdrawing the NPH! You cannot inject medication back into the vial or correct the NPH dosage without altering the Regular dosage.

An excellent visual demonstration for mixing insulins is available on the Becton Dickinson Company (syringe manufacturer) website: http://www.bddiabetes.com/us/demos/injecting.asp. (This demo has both audio and visual components so you will need a computer with speakers.)

7.7 Calculation Practice Problems

7.7.1 Problem Set III

(Answers are found on page 60)

1. Order: Compazine 10 mg IM every 6 hours prn for nausea

   Supply: Compazine 5 mg/ml

   Give: ______________ ml

2. Order: Lasix 40 mg IM now

   Supply: Lasix 10 mg/ml

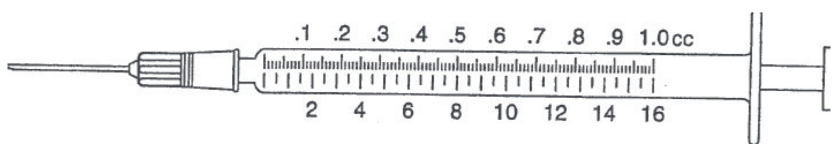
   Give: ______________ ml

3. Order: Heparin 3000 units subq twice daily

   Supply: Heparin 10,000 units in a 2 ml vial

   Give: ______________ ml

   Indicate this amount on the syringe:



4. Order: Atropine 0.4 mg IM one hour pre-operatively

   Supply: Atropine 1/150 gr/ml

   Give: ______________ ml

5. Order: Versed 3 mg IM one hour pre-operatively

   Supply: Versed 5 mg/ml

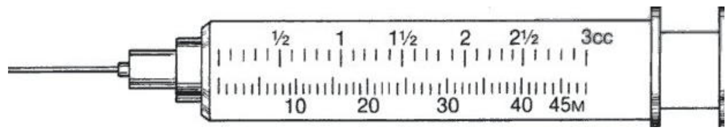
   Give: ______________ ml

6. Order: Phenergan 25 mg IM every 4 hours prn

   Supply: Phenergan 50 mg/2 ml

   Give: ________________ ml

   Indicate this amount on the syringe:



7. Order: Haldol 4 mg IM every 6 hours prn for agitation

   Supply: Haldol 5 mg/ml

   Give: ________________ ml

8. Order: Morphine 1/4 gr IM every 6 hours for pain

   Supply: Morphine 15 mg/ml pre-filled cartridge

   Give: ________________ ml

9. Order: Ancef 0.25 Gm IM every 12 hours

   Supply: Ancef 500 mg/ml

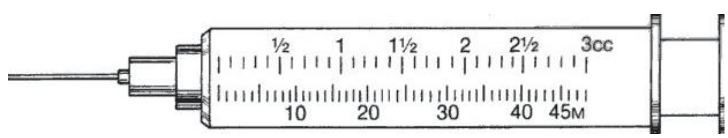
   Give: ________________ ml

10. Order: Valium 7.5 mg IM stat

    Supply: Valium 10 mg/ml

    Give: ________________ ml

    Indicate this amount on the syringe:



7.7.2 Problem Set IV

(Answers are found on page 61)

1. Order: Oxacillin 300 mg IM every 8 hours

   Supply: Oxacillin 2 Gm/5 ml

   Give: ______________ ml

2. Order: AquaMephyton 2.5 mg IM now

   Supply: AquaMephyton 10 mg/ml

   Give: ______________ ml

   Indicate this amount on the syringe:

3. Order: Morphine 1/6 gr IM every 6 hours for pain

   Supply: Morphine 15 mg/ml

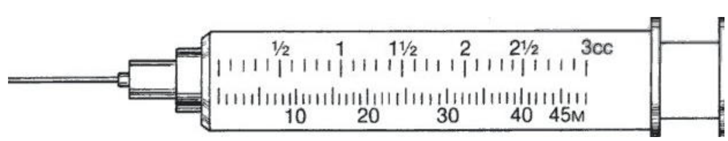
   Give: ______________ ml

4. Order: Meperidine 125 mg IM one hour pre-operatively

   Supply: Meperidine 100 mg/ml in pre-filled cartridge

   Give: ______________ ml

   Indicate this amount on the syringe:



5. Order: Heparin 7500 units subq every 12 hours

   Supply: Heparin 5000 units/ml

   Give: __________ ml

6. Order: Robinul 0.2 mg IM now

   Supply: Robinul 400 mcg/ml

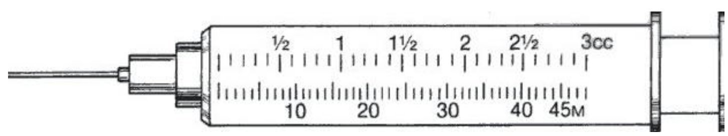
   Give: __________ ml

7. Order: SoluMedrol 80 mg IM daily

   Supply: SoluMedrol 120 mg/ml

   Give: __________ ml

   Indicate this amount on the syringe:



8. Order: Vitamin B-12 30 mcg IM monthly

   Supply: Vitamin B-12 0.05 mg/ml

   Give: __________ ml

9. Order: Vistaril 25 mg IM every 4 hours prn

   Supply: Vistaril 50 mg/2 ml

   Give: __________ ml

10. Order: Fentanyl 0.1 mg IM now

    Supply: Fentanyl 50 mcg/ml

    Give: __________ ml

7.8 Case Studies

7.8.1 Case Study 3

(Answers are found on page 64)

A patient is having surgery to repair a fractured hip. One hour prior to surgery, the patient is ordered to receive the following medications:

- Demerol 40 mg IM
- Phenergan 25 mg IM
- Robinul 300 mcg IM
- Heparin 3000 units subq

Pharmacy has supplied these medications:

- Demerol 50 mg/ml in pre-filled cartridge
- Phenergan 50 mg/ml ampule
- Robinul 0.2 mg/ml vial
- Heparin 10,000 units/2 ml

1. How many ml of these medications will you give?

   Demerol ____________________
   Phenergan ____________________
   Robinul ____________________
   Heparin ____________________

2. Describe how you will prepare (draw up) medications from each of the different supply containers.

3. What kind of syringe will you use for these medications?

Points to consider:

1. Can any of these medications be given together in one syringe?
2. What safety measures will be needed following these injections?
3. What patient teaching can you do regarding these medications?

7.8.2 Case Study 4

(Answers are found on page 65)

A patient is one day post-operative following a bowel resection. The patient is NPO, has an NG tube to low intermittent suction, and is receiving IV fluids. The patient is complaining of nausea and the 7AM Accu check showed a blood sugar of 322. Medication orders include:

- Compazine 7.5 mg IM every 4 hours prn for nausea (Available med: Compazine 20 mg/2 ml)
- Heparin 7500 units subq every 12 hours (Available med: Heparin 5000 units/ml)
- NPH Insulin 22 units subq now
- Regular Insulin on sliding scale per Accu check:
  2 units for accu check 200-250
  4 units for accu check 251-300
  6 units for accu check 300-325
  Call doctor for accu check above 325

1. How many ml of these medications will you give?

   Compazine ________________

   Heparin ________________

2. How will you prepare (draw up) the NPH insulin? What syringe will you use?

3. How many units of Regular insulin will you give?

4. How will you prepare (draw up) the Regular insulin?

5. Can these insulins be mixed in one syringe?

   If so, how many total units will be given?

   Describe how you would prepare the medications in one syringe

Chapter 8

Calculating Intravenous Medications and Drip Rates

8.1 Intravenous Medications

Medications given intravenously (IV) begin to work immediately. Therefore extreme caution must be taken when preparing and administering these medications. **A miscalculation in dosage could be fatal!** Additionally, each intravenous medication has individual guidelines for administration. For example, you will need to know how fast to give the medication and what solutions are compatible with the medication. IV therapy reference books should be available in all medication preparation areas. You may also contact the pharmacist if you need clarification or information.

Medications given intravenously are most commonly given through IV tubing in an established IV entry site (continuous infusion therapy or an intermittent device such as a saline lock). Medications can be given intravenously by three methods:

- **IV Push**: medications are injected with a syringe into IV tubing or intermittent device. Pain medications may be given via this route.
- **IV Piggyback**: medications are added to a small volume of fluid and run concurrently with other IV fluids over a short period of time. Antibiotics are frequently delivered by this method.
- **Continuous infusion**: medications are added to IV fluids and administered as a continuous infusion. Potassium, as an electrolyte replacement, is frequently given via this route.

Since medications for IVinjection are liquid, the calculations you learned for injectable medications are appropriate for calculating intravenous medication dosages as well. Your dosages will be expressed in milliliters (ml).

Example: You have an order for Demerol 25 mg IV every 4 hours prn. From the IV Therapy reference book, you learn that this medication may be given IV push and that it is compatible with the IV solution currently infusing. The supplied medication is Demerol 50 mg/ml in a pre-filled cartridge. Using your chosen method of calculation, you determine that you will give 0.5ml in order to administer the ordered dose . of Demerol 25 mg.

8.2 Intravenous Solutions

IV fluid therapy involves the administration of water, electrolytes, nutrients, blood and blood products, and medications. Careful attention must be given to the rate at which IV fluids are administered regardless of what type of fluid is used or what medications have been added to the fluid. Solutions that are administered too quickly can cause fluid overload; solutions administered too slowly can cause fluid deficit. Either condition can be extremely hazardous to a patient. If medications are present in the solution, the risk of hazard is augmented.

Important: All IV fluid therapy should be checked at least hourly to assure that the correct volume of fluid is being administered and that potential problems are quickly recognized.

8.2.1 Infusion Pumps

Many IV solutions are administered via an **infusion pump**. This device controls the rate of administration to the programmed amount. Infusion pumps deliver solution in *milliliters per hour*. You will therefore, need to be able to calculate ml/hr in order to program the pump correctly.

Example: You receive an order to administer 1000 ml of fluid over 8 hours. The fluid is to run via an infusion pump. How many ml/hr will you program into the machine in order to deliver 1000 ml in 8 hours?

A simple formula may be used for calculating this rate:

$$\frac{\text{Amount of solution}}{\text{Hours to administer}} = \text{ml/hr} = \frac{1000}{8} = \boxed{125\,\text{ml/hr}}$$

8.2.2 Gravity Flow

When infusion pumps are not used, IV fluid flows via gravity. You set the flow rate for these infusions by counting the number of drops per minute in the drip chamber of the tubing. The flow rate is increased or decreased by adjusting the roller clamp on the tubing. While this is an effective method for delivery, the rate of delivery is not as easily controlled as with a pump. Great care must be taken to assure that the flow rate is maintained at the prescribed amount.

Calculating IV flow rates for gravity flow infusions is a bit more complicated than with a pump. In this calculation, you will also need to consider the drop factor (drops/ml) of the tubing being used to administer the fluid. The drop factor of tubing may vary according to the type of solution to be administered, the rate to be infused, the clinical situation, and the company which manufactures the tubing. *The drop factor for each tubing is noted on the container in which it is packaged.*

Example: You receive an order to administer **75 ml** of fluid per **hour**. Your tubing has a drop factor of **10 gtts/min**. Since your drop factor is noted in ml per minute, you will need to convert your delivery time to minutes also.

$$\frac{\text{Amount of fluid} \times \text{gtts/min(drop factor)}}{\text{Time (in minutes)}} = \text{gtts/min to deliver}$$

$$\frac{75 \text{ (Amount of fluid)} \times 10 \text{ (gtt factor)}}{60 \text{ (time in minutes)}} = 12.5 \text{ or } 13 \text{ gtts/min}$$

Now consider this example: Administer Gentamycin 40 mg in 50 ml fluid over 20 minutes using 10 drop tubing. What information in this order is not needed for your calculation?

Yes, the type and amount of medication is irrelevant to the calculation. In order to figure the correct rate, you need to know the **amount of fluid**, the **drop factor**, and the **time**. Do not get distracted or confused by information that is not relevant to the calculation!

8.3 Calculation Practice Problems

8.3.1 Problem Set V

Remember: not all information in the order is needed for your calculation!

(Answers are found on page 62)

1. A patient is to receive 1 Liter of IV fluid over 12 hours.

   The drop factor for the tubing is 15 gtts/ml.
   You will set the flow rate at ______________ gtts/min.

2. Administer Ancef 1 Gm in 50 ml of fluid over 1/2 hour.

   The drop factor is 10.

   You would give ______________ gtts/min.

3. The physician orders 250 ml of fluid to infuse over 6 hours.

   The drop factor is 60.

   You would give ______________ ml/hr and ______________ gtts/min.

4. Give 2000 ml of fluid over 24 hrs.

   Drop factor is 10.

   Give ______________ ml/hr and ______________ gtts/min

5. You are to run 100 ml of fluid in 1/2 hour.

   You would set the infusion pump to run at ______________ ml/hr.

6. You are to give 600 ml of fluid over 12 hours with a drop factor of 20.

   You would give ________________ gtts/min.

7. Administer 0.5 Liter of fluid over 6 hours.

   Drop factor is 60.

   Give ________________ ml/hr and ________________ gtts/min.

8. Give Kefzol 500 mg in 100 ml of fluid over 20 minutes.

   The drop factor is 15.

   Give ________________ gtts/min.

9. You are to give 2 Liters of fluid over 24 hours.

   You would set the infusion pump to run at ________________ .

10. Administer Cephalexin 400 mg in 100 ml of fluid to run over 20 min.

    Drop factor is 15.

    At what rate would you set the infusion pump? ________________

8.4 Continuous Medication Infusions

Some medications need to be administered in small doses by continuous infusion. This type of therapy delivers a steady rate of medication to the patient thus providing a constant therapeutic effect. Heparin and Aminophylline are examples of medications which may be administered by this method. These medications should always be infused using an infusion pump.

Example: 25,000 units of heparin are added to 500 ml of Normal Saline. The dosage of heparin ordered by the physician is 800 units/hour. Since the infusion pump is programmed in ml/hr, you will need to figure out at what rate to set the pump in order to deliver 800 units/hour.

You can do this calculation using a ratio/proportion formula:

$$\frac{\text{Total drug}}{\text{Total volume}} = \frac{\text{Hourly drug}}{\text{Hourly volume}}$$

$$\frac{25000\,\text{units}}{500\,\text{ml}} = \frac{800\,\text{units}}{X\,\text{ml}}$$

$$\longrightarrow \quad 25000X = 400000$$

$$\longrightarrow \quad X = \boxed{16\,\text{ml/hr}}$$

You can also use this formula to figure the units per hour. If you knew that the IV was running at 16 ml/hr and that your infusion contained 25,000 units/500 ml, then solve for units per hour as follows:

$$\frac{\text{Total drug}}{\text{Total volume}} = \frac{\text{Hourly drug}}{\text{Hourly volume}}$$

$$\frac{25000\,\text{units}}{500\,\text{ml}} = \frac{X\,\text{units}}{16}$$

$$\longrightarrow \quad 500X = 400000$$

$$\longrightarrow \quad X = \boxed{800\,\text{units}}$$

8.5 Calculation Practice Problems

8.5.1 Problem Set VI

(Answers are found on page 62)

1. The concentration of heparin in an IV infusion is 20,000 units in 500 ml.

   The infusion running at 12 ml/hr.

   How many units is the patient receiving? ______________ units/hr

2. Heparin concentration is 30,000 units in 1000 ml.

   You are ordered to give 900 units per hour.

   At what rate will you sent the IV pump? ______________

3. Heparin concentration is 10,000 units in 500 ml.

   You are to give 500 units per hour.

   You would set the pump at ______________ ml/hr.

4. Heparin concentration is 20,000 units in 500 ml.

   The pump is set at 15 ml/hr.

   The patient is receiving ______________ units/hr.

5. You are to give 600 units of heparin per hour.

   Each liter of solution contains 25,000 units.

   You will set the pump to run at ______________ ml/hr.

8.6 Case Studies

8.6.1 Case Study 5

(Answers are found on page 66)

A patient is admitted to the hospital with an oral temperature of 101 degrees, dyspnea, persistent cough productive of thick cream colored sputum, and coarse crackles all lobes. A diagnosis of pneumonia is made. Physician orders include:

- IV 1000 ml every 8 hours
- Vital signs every 4 hours
- CBC, sputum for C & S, Chest X-ray, ABG's
- Bedrest, high fowler's position
- Oxygen @ 3 L per NC
- Clindamycin 400 mg IVPB in 100 ml to run over 1/2 hour
- Demerol 20 mg IV Push every 4 hours prn

1. How many milliliters of fluid will the patient receive each hour? __________ ml/hr. With a drop factor of 15, how many drops per minute will you set? __________ gtts/min.

2. At what rate will you set the IV pump to administer the Clindamycin? __________

3. If the Clindamycin were infusing by gravity with 10 drop tubing, how many drops per minute would you give? __________ gtts/min

4. The supply on hand is Demerol 50 mg/ml. How many ml will you give to administer the ordered dose? __________ ml

8.6.2 Case Study 6

(Answers are found on page 66)

A patient is admitted with a Deep Vein Thrombosis of the right lower leg. The extremity is warm to touch, edematous, and with erythema around the calf. The patient is complaining of pain rated as 7 on a scale of 1–10. Physician orders include:

- Bedrest with right leg elevated
- Warm, moist heat to extremity via Aqua K pad
- Lasix 30 mg IV Push twice daily
- Heparin 1200 units per hour per continuous infusion
- Morphine 7.5 mg IV Push every 4 hours prn

1. Your heparin concentration is: Heparin 25,000 units per 500 ml. At what rate will you set the pump to deliver the ordered dose?

2. Morphine is supplied as 1/4 gr/ml in a pre-filled cartridge. How much will you give to administer the ordered dose? ________________

3. The Lasix vial reads 10 mg/ml. How much Lasix will you give? ________________ ml

Points to consider: Can the Lasix and/or Morphine be injected into the same tubing in which the heparin is running?

Chapter 9

Answers

9.1 Answers to Basic Math Review

9.1.1 Multiplying Whole Numbers

(From page 9)

1. 12
2. 56
3. 18
4. 49
5. 15
6. 36
7. 64
8. 63
9. 12
10. 42
11. 30
12. 48

9.1.2 Dividing Whole Numbers

(From page 9)

1. 2
2. 7
3. 6
4. 7
5. 4
6. 7
7. 8
8. 9
9. 5
10. 9
11. 9
12. 8

9.1.3 Multiplying Fractions

(From page 10)

1. 8/15
2. 10/27
3. 3/25
4. 15/42
5. 1/4
6. 15/64
7. 9/40
8. 1/8
9. 1/12

9.1.4 Dividing Fractions

(From page 11)

1. 2
2. 1/4
3. 1/2
4. 1 1/8
5. 1
6. 2
7. 1/2
8. 1/4
9. 1

9.1.5 Writing Decimals

(From page 11)

1. 4.1
2. 3.008
3. 0.05
4. 0.36
5. 0.018
6. 6.22
7. 0.009

9.1.6 Which is smaller?

(From page 12)

1. 0.2
2. 0.001
3. 0.075
4. 0.015
5. 2.09

9.1.7 Adding/Subtracting Decimals

(From page 13)

1. 1.65
2. 1.302
3. 0.342
4. 3.47
5. 2.452
6. 14.549

9.1.8 Multiplying/Dividing Decimals

(From page 15)

1. 16.15
2. 0.0502
3. 0.00036
4. 5.88
5. 15.85
6. 2.61

9.2 Conversion Practice

(From page 19)

1. 15 ml
2. 1 Tbs
3. 15 mg
4. 4 oz
5. 0.3 mg
6. 15 ml
7. 120 mg
8. 240 ml
9. 2 gr
10. 500 ml
11. 500 mg
12. 0.001 mg
13. 3 tsp
14. 0.25 Gm
15. 1 mg

9.3 Answers to Calculation Practice Problems

9.3.1 Problem Set I

(From page 28)

1. 1/2 tablet
2. 1/2 tablet
3. 1/2 tablet
4. 15 ml; 3 teaspoons to be taken at home
5. 1/2 tablet
6. 2 tablets
7. 8 tablets
8. 1/2 tablet
9. 1 tablet
10. 10 cc

9.3.2 Problem Set II

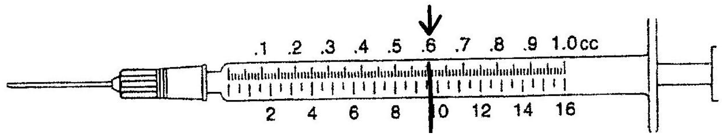
(From page 29)

1. 3 tablets
2. 10 ml or 2 tsp
3. 3 tablets
4. 3 tablets
5. 8 tablets
6. 2 ml
7. 2 tablets
8. 1 tablet
9. 25 ml
10. 1 unit dose

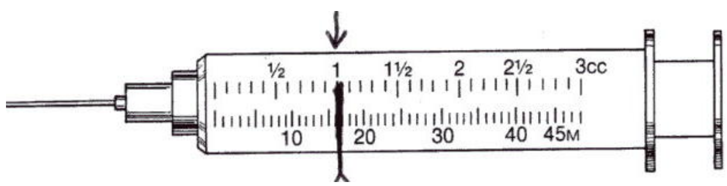
9.3.3 Problem Set III

(From page 39)

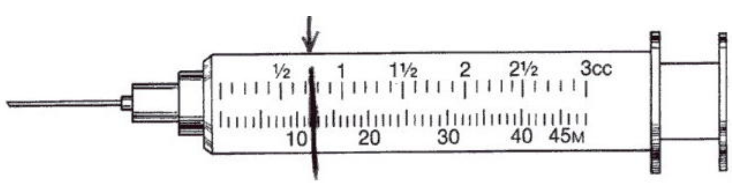
1. 2 ml
2. 4 ml
3. 0.6 ml



4. 1 ml
5. 0.6 ml
6. 1 ml



7. 0.8 ml
8. 1 ml
9. 1/2 ml
10. 0.75 ml

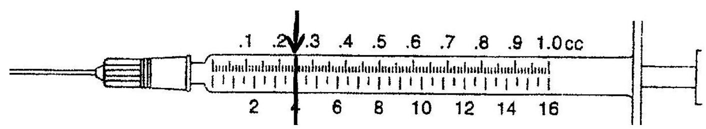


9.3.4 Problem Set IV

(From page 41)

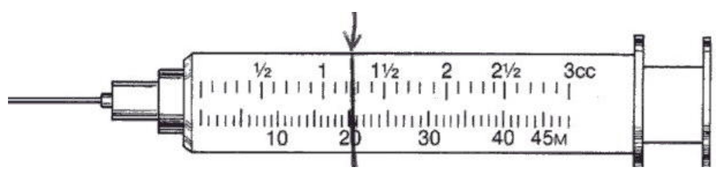
1. 0.75 ml

2. 0.25 ml



3. 0.6 ml

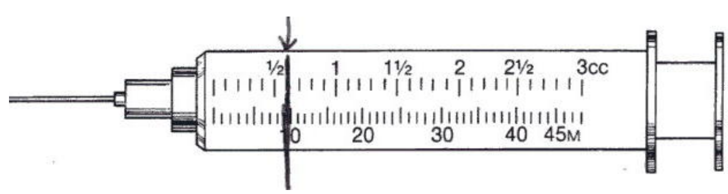
4. 1.25 ml



5. 1.5 ml

6. 1/2 ml

7. 0.6 ml



8. 0.6 ml

9. 1 ml

10. 2 ml

9.3.5 Problem Set V

(From page 48)

1. 20–21 gtts/min
2. 16–17 gtts/min
3. 41 ml/hr and 41–42 gtts/min
4. 83 ml/hr and 14 gtts/min
5. 200 ml/hr
6. 16–17 gtts/min
7. 83 ml/hr and 83 gtts/min
8. 75 gtts/min
9. 83 ml/hr
10. 300 ml/hr

9.3.6 Problem Set VI

(From page 51)

1. 480 units/hr
2. 30 ml/hr
3. 25 ml/hr
4. 600 units/hr
5. 24 ml/hr

9.4 Answers to Case Studies

9.4.1 Case Study 1

(From page 31)

1. 1 packet

2. 2 tablets Glyburide; 1/2 tablet Lisonopril; 2 tablets Tylenol; 2 tablets Ultram

3. If the patient was unable to swallow tablets, you could check with the pharmacy about liquid preparations for the meds. You could also ask about crushing the meds and putting them in applesauce or some other food item.

9.4.2 Case Study 2

(From page 32)

1. 10 ml Amoxicillin; 1.8 ml Tylenol

2. The Amoxicillin dose is 10 ml which is equivalent to 2 tsp. The Tylenol dose is 1.8 ml. You would tell the mother to use the dropper which comes with the liquid medication to measure the correct dosage.

3. 20 oz

9.4.3 Case Study 3

(From page 43)

1. 0.8 ml Demerol; 1/2 ml Phenergan; 1.5 ml Robinul; 0.6 ml Heparin

2. The Demerol can be given as a pre-filled cartridge by attaching it to a cartridge holder. You could also withdraw medication from the cartridge into a 3 ml syringe.

   To draw up the Phenergan, break the ampule at the neck and withdraw the medication using a filtered needle.

   To withdraw from the vial, wipe the top of the vial, inject air into the vial (an amount equal to what you will be withdrawing), then invert the vial and withdraw the medication into the syringe.

3. Demerol, Phenergan, and Robinol can be mixed; they could all be given in a 3 ml syringe.

   Dosages under 1 ml are more easily measured with a TB syringe; the heparin could be given with the TB syringe or with a 3 ml syringe.

Points to consider:

1. Yes, the Demerol, Phenergan, and Robinol can be mixed in one syringe. Be sure to check your compatibility charts if you are considering mixing medications.

2. Safety precautions include: side rails up, call bell in reach, instructing the patient not to get out of bed.

3. Patient teaching includes telling the patient that these medications will make the person sleepy and cause dry mouth. It is helpful to tell patients that these medications may not put them completely asleep; the anesthesia will put them completely asleep. Safety measures should be emphasized: side rails up, no getting out of bed unless staff is present, use call bell to get assistance.

9.4.4 Case Study 4

(From page 44)

1. 0.75 ml Compazine; 1.5 ml Heparin

2. Always use an insulin syringe to give insulin!

   Wipe the top of the vial with alcohol; with the vial resting on a flat surface, inject air into the vial in an amount equal to the dose; invert the vial and withdraw the medication into the syringe.

   Most facilities require you to verify the insulin amount in the syringe with another nurse.

3. 6 ml units

4. The procedure for drawing up the Regular insulin is the same as for the NPH insulin noted in question 2.

5. Yes, insulins can be mixed in one syringe. Total units to be given is 28.

   (a) Wipe the tops of both vials with alcohol.

   (b) Inject air into the NPH vial; inject air into the Regular vial.

   (c) Invert the Regular vial and withdraw the medication—make sure you have the correct amount and that no air bubbles are present. You cannot adjust the dosage after the NPH is added.

   (d) Invert the NPH vial and withdraw into the syringe. Your total dosage should be 28 units.

   (e) Verify the withdrawn dosages with another nurse.

9.4.5 Case Study 5

(From page 52)

1. 125 ml/hr and 31 gtts/min
2. 200 ml/hr
3. 33 gtts/min
4. 0.4 ml

9.4.6 Case Study 6

(From page 53)

1. 24 ml/hr
2. 0.5 ml
3. 3 ml

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