PHARMACOLOGICAL MATH COMPUTATION SKILLS

SELF LEARNING MODULE

Bergen Community College Nursing Department

(updated July 2023)

Table of Contents

Objectives

The learner will:

1. List the commonly used units of measure in the metric and household systems.

2. Convert metric weights and volumes within the system.

3. Convert units within the household system.

4. Convert units between the metric and household systems.

5. Calculate medication dosage problems using Ratio / Proportion, Formulas or Dimensional Analysis.

6. Calculate dosages based on weight.

7. Calculate IV infusion drip and pump rates.

8. Calculate IV medication rates.

SYSTEMS OF MEASUREMENTS

Three different systems of measurements have been used in medication administration: the apothecary, household, and metric systems. Currently the metric system is the most widely used. Household measurements are used less often, with the apothecary system, the oldest system of measurement, not used in current practice. Medications are generally ordered and administered based on weight (solids), and volume (liquids).

Metric System

Basic units of weight and volume in the metric system are based on the number “10” as in the decimal system. Metric system uses the basic unit of gram (g) as the unit of weight and liter (L) as the unit of volume. Parts of the basic units are named by adding prefixes that describe multiples or fractions of the standard measure. For example:

deci = 0.1 (one tenth of one unit)
centi = 0.01 (one hundredth of one unit)
milli = 0.001 (one thousandth of one unit)
micro = 0.000001 (one millionth of one unit)

Subunits used in the Metric System include:

Parameter	Unit	Abbreviation	Equivalents
Weight	Gram (basic unit)	g	1g = 1000 mg
	milligram	mg	1mg = 1000 mcg; 0.001 g
	microgram	mcg	1 mcg = 0.001 mg; 0.000001 g
	kilogram	kg	1 kg=1000 g
Volume	Liter (basic unit)	L	1L = 1000 ml
	milliliter	ml	1ml = (1 cc); 0.001 L

Rule: To reduce medication errors, a zero (0) is always placed before the decimal point if the unit is less than one whole unit. For example 0.78 NOT .78

Extra zeroes to the right of the numbers at the end of the decimal point should be deleted. For example 1.01 NOT 1.01000

**Conversion factors are always in multiples of 10.

Rule: To convert from one subunit to another you will either multiply or divide. If you are converting from a larger unit to a smaller unit (liter to ml; kilogram to g; g to mg; mg to mcg), you multiply by the appropriate equivalency (1000) or move the decimal point 3 places to the right.

ie. Convert 2 grams to ___ mg

2 x 1000 = 2000 mg or 2(000). = 2000 mg

Rule: To convert from a smaller unit to a larger unit (mcg to mg; mg to g; g to kilograms; ml to liters), you divide by 1000, or move the decimal 3 places to the left.

Ie. Convert 4000 ml to ___ Liters

4000 ÷ 1000 = 4 L or 4(000). = 4 L

In order to administer the proper medication dose you may need to convert dosages within a system, as noted in the example given above.

Household System

Unit	**Abbreviation**	**Equivalent**
Drop	gtt	15 gtt = 1 ml
Teaspoon	t (tsp)	1 tsp = 5 ml
tablespoon	T (tbs)	1 T = 3 tsp; 15 ml
ounce (fluid)	Oz	1 oz = 2 T; 30 ml
Cup	cup	1 cup = 8 oz; 240 ml
Pint	Pt	1 pt = 2 cups; 16 oz; 480 ml
quart	Qt	1 qt = 4 cups; 2 pts; 960 ml
gallon	gal	1 gal = 4 qts

In order to administer the proper medication dose you may also need to convert dosages between the metric and household systems of measurement. In order to do this you must first know how the measure of a quantity in one system compares with its measure in the other system. The above table depicts some of these equivalencies.

Rule: You always convert to the unit of the medication on hand.

For example, the LIP orders 2 teaspoons of a medication. On hand is a bottle containing 20 ml of the medication. Label reads 1 teaspoon = 5 ml. How much would the nurse administer?

Note: You must convert teaspoon to ml (system of measurement on hand). Your answer then would be in ml. Answer: 10 ml

This answer is simple enough to obtain without going through rigorous calculations, however as the problems get more complex you will need to perform calculations and **all work leading to answers must be demonstrated on level computation exams**, no matter how simple the problem. Subsequent sections will demonstrate how to obtain the answers using ratio and proportion, dimensional analysis, and formulas.

One more conversion to memorize: **2.2 pounds (lbs) = 1 kg**

Other Systems of Measurements

Units - Some drugs are measured in units. Units may be expressed as IU (International Units) or USP (United States Pharmaceutical) units. Common drugs dispensed in units include heparin, insulin and some forms of penicillin.

Milliequivalents - The term milliequivalent pertains to the amount of a solute contained in a solution. Milliequivalent is abbreviated mEq. Drugs dispensed in mEq can be liquid or solid. A common drug dispensed in this manner is potassium chloride (KCL).

Now test yourself on the equivalents and conversions within and between measurement systems. If you get more than 2 answers incorrect go back and review the concepts once more before progressing to the next section.

Equivalents and Conversions

1	7 mg = ______mcg	11.	30 gtt =_____mL
2	1.7 L =_______mL	12.	1.5 tsp =_____mL
3	3.2 g = ______mg	13.	4T =________mL
4	30 ml =______oz	14.	8 kg =______lb
5	200 ml = _____L	15.	10 mg =_____mcg
6	1.5 mg = _____mcg	16.	0.81 L =_____mL
7	0.7 g = ______mg	17.	35 mg =_____g
8	0.3 L = ______mL	18.	280 ml = ____L
9	2T = ________mL	19.	620 mg =____g
10	10ml= ______tsp	20.	6 T (tbs) =___mL

Answers: 1) **7000 mcg** 2) **1700 ml** 3) **3200 mg** 4) **1 oz** 5) **0.2L** 6) **1500mcg** 7) **700 mg** 8) **300 ml** 9) **30ml** 10) **2 tsp** 11) **2 ml** 12) **7.5 ml** 13) **60 ml** 14) **17.61b** 15) **10,000mcg** 16) **810 ml** 17) **0.035 g** 18) **0.28L** 19) **0.62 g** 20) **90 ml**

Ratio and Proportion

Ratio/Proportion problems can be set up in several forms to solve the problem. This module will instruct the student utilizing the fractional form.

A ratio is a comparison of one quantity to another. A comparison when using numbers indicates division and can be expressed in several ways. It can be expressed as a fraction such as, 3/4 or as a ratio 3:4. This can be stated as the ratio 3 to 4.

4 quarters to 1 dollar is a ratio and can be written 4/1 or 4:1.

Other familiar ratios are 60 minutes to 1 hour (60/1); 16 ounces to 1 pound (16/1).

A proportion is an equation of two ratios that are equal.

$$\frac{\text{4quarters}}{\text{1dollar}} = \frac{\text{8 quarters}}{\text{2 dollars}}$$

This proportion can be read as 4 quarters are to 1 dollar as 8 quarters are to 2 dollars In a proportion, the products of cross multiplication are equal. Using the proportion above:

$$\frac{4}{1} = \frac{8}{2} \qquad 4x2 = 8x1 \qquad 8=8$$

Note : To perform calculations using ratio/proportion you must understand the ratio/proportion concept, know system of measurements equivalents and how to do conversions.

There are 4 basic steps to solving the problems:

1. Set up a known ratio.
2. Set up a proportion with known and desired units. Use x for the quantity that is desired or unknown. Label all terms of the ratio including x.
   Be sure the units are the same horizontally.

Example: $\frac{\text{ounces}}{\text{pounds}} = \frac{\text{ounces}}{\text{pounds}}$

3. Cross multiply
4. Solve for the unknown (x)

Example #1. To solve a proportion problem such as 3 lbs = ? ounces:

a. Set up a known ratio of pounds to ounces. 1 lb = 16 oz
b. Make a proportion using the known ratio on one side and the desired ratio on the other. $\frac{\text{1 lb}}{\text{16oz}} = \frac{\text{3 lbs}}{\text{x oz}}$

Make sure the units are the same horizontally, such as lbs on the top and ounces on the bottom of each ratio.

c. Cross multiply. $\frac{1\ lb}{16\ oz} = \frac{3\ lbs}{x\ oz}$ 1(x) = 16 (3)

d. Solve for x.

1 (x) = 16 (3)

x = 48 oz Be sure to label your answer with the correct unit of measurement. Therefore 3 lbs = 48 ounces

Reminder: When a health care provider orders a medication, the dosage available (on hand) may not be in the same measurement unit as prescribed. You must be able to convert, or change within and between systems, to set up the correct ratio and provide the client with the correct dose.

Example #2: To solve the proportion problem, 500 mg = ? grams

a. $\frac{1000\ mg}{1\ gram}$

b. $\frac{1000\ mg}{1\ gram} = \frac{500\ mg}{x\ gram}$

c. 1000x = 500

d. Divide each side of the equation by 1000 to isolate the unknown
X = 0.5 gram

Example #3: 60 mg of medication is ordered. Tablets are available which have 30 mg of medication in each of them. How many tablets are needed to give 60 mg?

a. $\frac{30\ mg}{1\ tablet}$

b. $\frac{30\ mg}{1\ tablet} = \frac{60\ mg}{x\ tablet}$

c. 30x = 60

d. x = 2 tablets (are needed to give 60 mg)

Example #4 Heparin 2500 units subcutaneous is ordered.
On hand: Heparin vial labeled 5000 units per ml.
How many ml will nurse administer?

a. $\frac{5000\ units}{1\ ml}$ b. $\frac{5000\ units}{1\ ml} = \frac{2500\ units}{x\ (ml)}$ c. 5000 x = 2500 d. x = 0.5 ml

Please note: If you set up the proportion incorrectly you will not achieve the correct answer. Incorrect answers will result in incorrect dosages which are medication errors and can potentially harm a client.

Practice the following problems using the Ratio/Proportion method

Round off to the nearest tenth. Label your answers using the correct unit of measurement. Always repeat your calculations to make sure there are no errors. If the answer seems unreasonable recalculate your response.

1. Order: 25 mg by mouth of a medication daily.
   Available: 50 mg scored tablets. What will the nurse administer?

2. Order: 0.75 g by mouth of a medication BID.
   Available: 250 mg tablets. What will the nurse administer?

3. Order: 500 mg by mouth of a medication daily.
   Available: 0.5 g tablets. How many tablets will the nurse administer?

4. Order: Digoxin elixir 0.25 mg by mouth daily.
   Available: 50 mcg per ml? How much will the nurse administer?

5. Order: Acetaminophen elixir 60 mg prn.
   Available: Acetaminophen Elixir 120 mg per ml. How much will nurse administer?

6. Give 24 mg of a medication by mouth TID.
   The solution strength available is 12.5 mg in 1.5ml. How many ml will nurse give?

7. Give 0.3mg of a medication from solution strength of 0.6 mg/0.8ml?
   How much will the nurse administer?

8. Order: 10,000 Unit dosage strength of a medication.
   Available: 8000 units in 1 ml. What will the nurse administer?

9. Ordered: 275 mg of a medication by mouth TID.
   Available: 0.5 g per 2 ml. How much will the nurse administer?

10. Ordered: KCL 15 mEq by mouth daily.
    Available: KCL 20 mEq per 20 ml. What will the nurse administer?

Answers: 1) **0.5 tablet** ; 2) **3 tablets** ; 3) **1 tablet** ; 4) **5 ml** ; 5) **0.5 mL**

6) **2.9 mL** ; 7) **0.4 mL ;** 8) **1.3 ml** ; 9) **1.1 mL** ; 10) **15 mL**

Formula Method

Using a formula method to calculate dosages requires determining the components of the formula from the problem, and substituting the information from the problem into the formula.

Note : To perform calculations using the Formula Method you must know the formula, system of measurements equivalents and how to do conversions.

There are 5 basic steps to solving the problem.

1. Memorize the formula or verify the formula from a resource.
2. Place the information from the problem into the formula in the correct position, with all the terms in the formula labeled correctly, including "x"
3. Check that the strength of the drug ordered and the strength of the drug available are in the same unit of measure. If not a conversion must be done before calculating the dosage.
4. Calculate the dose using the formula:

$$\frac{\text{Dosage ordered}}{\text{Dosage available (on hand)}} \times \text{Quantity (form or unit of measure)} = \text{Dose to be given}$$

Or $\frac{D}{H} \times Q = X$

5. Label your answer correctly. Like the quantity, the dose given will be stated in the dosage form or unit the drug comes in.

Example #1. A medication is available in 1 g/10 ml (1 gram per 10 ml).
The LIP orders 2 g. How many milliliters will be prepared?

a. $\frac{D}{H} \times Q = X$
b. $\frac{2g}{1g} \times 10 \text{ ml} = X \text{ ml}$
c. No conversion is necessary
d. $\frac{20}{1} = X = 20$
e. Answer **20 ml**

Example #2 The LIP orders 0.05 mg of a medication.
The medication is supplied in 50mcg tablets. What dose will the nurse administer?

a. $\frac{D}{H} \times Q = X$
b. $\frac{0.05 \text{ mg}}{50 \text{ mcg}} \times 1 \text{ tablet} = x \text{ tablet}$

c. Conversion is needed. You need to convert to unit on hand.
Therefore convert 0.05 mg to mcg.

Using the rule learned previously, since you are converting from larger to smaller, you move the decimal 3 places to the right or multiply by 1000.

0.050 = 50mcg or 0.05 x 1000 = 50 mcg

$\frac{50 \text{ mcg}}{50 \text{ mcg}}$ x 1 tablet = X

d. $\frac{50}{50}$ = X = 1

e. Answer 1 tablet

Example #3 Ordered: 15 mEq
Available: 10 mEq/ 5 ml
How many mis will the nurse administer?

a. $\frac{D}{H}$ X Q = X

b. $\frac{15 \text{ mEq}}{10 \text{ mEq}}$ X 5 ml = X

c. No conversion is needed.
d. $\frac{75}{10}$ = X = 7.5

e. Answer 7.5 mL

Formulas vary depending on the type of dosage calculation needed. The above formula can be used for basic dosage calculations.

Practice the following problems using the formula method. Round off to the nearest tenth. Label your answers correctly. Always repeat your calculations to make sure there are no errors. If the answer seems unreasonable recalculate your response.

1. A dosage of 80 mg is ordered.
   The dosage strength available is 100 mg in 2 ml.
   The nurse would administer how many ml?

2. Order: 0.4 mg of a medication.
   Available strength is 0.25mg in 1.2 ml. What will the nurse administer?

3. Order: 0.5 g of cephalexin capsules.
   On hand are 250 mg of cephalexin capsules.
   What will the nurse administer?

4. Order: Penicillin G potassium 1,000,000 units intramuscular.
   Available: 500,000 units of medication per ml.
   How much will nurse administer?

5. Order: Digoxin elixir 0.25 mg.
   Available: 50 mcg per ml   How much will the nurse administer?

6. Order: Coumadin 10 mg by mouth daily.
   Available: Coumadin 2.5 mg tablets. What will the nurse administer?

7. Order: 500 mg by mouth of a medication.
   Available: 0.5 g tablets.
   How many tablets will the nurse administer?

8. Give 24 mg of a medication.
   The solution strength available is 12.5 mg in 1.5ml.
   How many ml will nurse give?

9. Order: Levothyroxine 0.2 mg by mouth daily.
   On hand levothyroxine 100 mcg tablets. What will the nurse administer?

10. Order: 200 mcg of a medication by injection.
    Available: 0.2 mg per ml. How much will the nurse administer?

Answers: 1) **1.6 ml** 2) **1.9 ml** 3) **2 capsules** 4) **2 ml** 5) **5 ml**
6) **4 tablets** 7) **1 tablet** 8) **2.9 ml** 9) **2 tablets** 10) **1 ml**

Dimensional Analysis (DA)

Dimensional analysis is considered a common sense approach to calculating medication dosages.

Note : To perform calculations using Dimensional Analysis you must know measurement equivalents and have an understanding of the dimensional analysis concept. You will not need to memorize formulas nor possibly conversions depending on your method used. Dimensional analysis may be used for all types of calculations.

In dimensional analysis an equation (in a fraction format) is set up using the information given in the problem. The goal is to set up the equation to cancel out all units of measure (labels) not needed in the answer (the dose to be administered). In all calculations, the units of measure in the numerator will cancel out the same units of measure in the denominator, and vice versa. The final calculation results in a clearly labeled dose to be administered.

The following steps to DA can be used to solve all dosage calculations. Using Example #1 from the formula method: A medication is available in 1g/10 ml (1 gram per 10 ml). The LIP orders 2 grams. How many milliliters will be prepared?

1. Begin by placing a line across the paper to serve as a division between the numerators and denominators in your problem

2. Determine what unit of measure (label) is needed to administer the medication as prescribed. Set up the right side of the equation so that the label needed for administration is in the correct numerator (and denominator, if applicable) position. Remember the phrase, "Start with the labels needed in the answer" to know what unit of measure is needed to begin setting up calculations using DA.

   1 mL

3. the left side of the equation, place the information given with the same label as the answer in the numerator position. In this case, place the concentration of the supplied medication.

   <u>10 mL   1 mL</u>
   1 g

4. Fill in the remaining data from the problem, placing on either side of the line (as numerators or denominators). Label all factors. Similar labels must be placed on opposite sides of the equation.

   <u>10 mL   I   2 g   I   1 mL</u>
   1 g

5. Continue if necessary by building the calculation until all units of measure not needed in the answer can be cancelled out.

10 mL	2 g	mL
1 g		

6. Multiply all the numerators and divide by the denominator(s) to obtain your answer. Don't round any numbers in an equation until you obtain the final answer.

10 mL	2 g	mL
1 g		

solution: 10 x 2 = 20 /1 = 20 ml

Example #2 The LIP orders 0.05 mg of a medication. The medication is supplied in 50mcg tablets. What dose will the nurse administer?

a. Identify the desired unit needed.
b. Draw your line and place the unit(s) needed in the proper location (numerator or denominator position) on the far right.
c. Fill in the data from the problem. The ultimate desired unit label should be placed on the same line, as noted in (b). Other similar labels are placed on opposite sides of the equation.
d. Begin canceling similar numerator and denominator units until the desired unit remains.
e. a unit does not have a corresponding unit on the other side of the equation, an equivalent needs to be added in order for the cancellation to be possible.
f. Multiply across the numerators and divide by the denominators to obtain your answer.

a b c d

1 tab	0.05 mg	tab
50 mcg		

e f

1 tab	0.05 mg	1000 mcg	tab
50 mcg		1 mg	

= 1 tab

Example #3 Ordered: 15 mEq. Available 10 mEq/5 mL. How many mL will nurse administer?

5 mL	15 mEq	mL
10 mEq		

= 7.5 mL

Solution: $\frac{5 \times 15}{10}$ = 7.5 ml

Practice the following problems using dimensional analysis. Round off to the nearest tenth. Label your answers correctly. Always repeat your calculations to make sure there are no errors. If the answer seems unreasonable recalculate your response.

1. Order: Epogen 1400 units subcutaneous.
   On hand ampules labeled Epogen 2000 units per ml.
   What dose should the nurse administer?

2. Order: Acyclovir suspension 0.8 g by mouth.
   Available a bottle labeled: Acyclovir 200 mg per 5 ml.
   How many ml will the nurse administer?

3. A dosage of 80 mg is ordered. The dosage strength available is 100 mg in 2 ml. The nurse would administer how many ml?

4. Order: 200 mcg of a medication by injection. Available: 0.2 mg per ml. How much will the nurse administer?

5. Order: 0.75 g by mouth of a medication. Available: 250 mg tablets. What will the nurse administer?

6. Order: Pepto-Bismol 1 tablespoon. Available: 120 ml (4 oz) bottle. What dose will the nurse give?

7. Order: Give 0.016 g of a medication. Available: 4 mg/ml. How many ml should the nurse administer?

8. A client is to receive 2 g of a drug.
   Available: 500 mg per 5 ml. Each vial contains 10 ml.
   How many vials would the nurse need?

9. Order: 120 mg dosage of a medication is ordered.
   Available : A solution labeled 80 mg/ml.
   What dose should be administered?

10. The patient is to receive Imuran 125 mg by mouth.
    On hand is a bottle of tablets labeled, Imuran tablets 50 mg.
    How many tablets should the nurse administer?

Answers 1) **0.7 ml** 2) **20 mL** 3) **1.6 mL** 4) **1 mL** 5) **3 tablets** 6) **15 ml** 7) **4 mL** 8) **2 vials** 9) **1.5 mL** 10) **2.5 tablets**

Dosage Calculation in Pediatrics

Dosages for infants and children are usually less than the adult dosages for the same medication. The body mass in children is smaller, and their metabolism is different from adults. Therefore pediatric dosing is most often based on weight and safe dose range. Drug manufacturers sometimes recommend a dosage based on the weight of a child.

When you are in Maternal-Child Health you will learn about these differences and how to administer safe medication dosages to infants and children.

Weight based dosing however is also used in the adult client. In order to calculate dosages accurately you will need to apply the following conversion.

2.2 pounds (lbs) = 1 kg

To convert pounds to kg you divide by 2.2 ------ To convert kg to lbs you multiply by 2.2

Practice problems

Convert the weights (in pounds) to kilograms

1. 55 lb = (55 divided 2.2) = 25 kilograms (kg)
2. 11 lb =
3. 157 lb =
4. 18 lb =
5. 209 lb =

Convert the weight (in kilograms) to pounds

1. 13.6 kg = (13.6x2.2) = 29.92 or 30 lbs
2. 71.4 kg =
3. 24.3 kg =
4. 43 kg =
5. 18.2 kg =

Answers: 1) **25 kg** 2) **5 kg** 3) 71.36 =**71.4 kg** 4) 8.18 = **8.2 kg** 5) **95 kg**

1) **30 lbs** 2) **157 lbs** 3) 53.46 = **53.5 lbs** 4) **94.6 lbs** 5) 40.04 = **40 lbs**

Now apply this knowledge to medication calculation problems:

Example #1. Order: 25 mg/kg of body weight
Available: 5 g/20 ml
How many mis do you give to a 30 lb child?

Ratio & proportion

1. Calculate the child's weight in kilograms (30/2.2 = 13.64 kg)
2. The order reads 25 mg/kg so multiply 25 x 13.64 = 341 mg
3. Set up the ratio and proportion
   $\frac{5\text{ g}}{20\text{ml}} = \frac{341\text{ mg}}{x\text{ ml}}$
4. A conversion must be done because the order is for mg and the medication is available in grams. Convert to the unit on hand (gram). When converting from milligram to gram (smaller to larger, you divide by 1000 or move the decimal 3 places to the left).
   341 mg becomes 0.341g
5. $\frac{5\text{ g}}{20\text{ ml}} = \frac{0.341\text{ g}}{x\text{ ml}}$ Solution: you cross multiply
   5x = 20 x 0.341 = 6.82

6. 5x = 6.82 Solution: Divide by 5 to isolate the x
   6.82/5= 1.364 ml or 1.36 ml = 1.4 ml

7. **Give 1.4 ml to the child weighing 30 lbs**.

Formula Method

1. Calculate the child's weight in kilograms = 13.64 kg (see above)
2. See above. 25 x 13.64 = 341 mg

3. Set up the formula $\frac{D}{H}$ x Q = X ml

   $\frac{341\text{ mg}}{5\text{ g}} \times 20\text{ ml} = X\text{ ml}$

4. Conversion from mg to g is necessary (see above) = 0.341g

5. $\frac{341\text{ g}}{5\text{ g}}$ x 20 ml = X ml Solution: Multiply 0.341 x 20 = 6.82

6. 6.82/5= Xml Solution: Divide 6.82 by 5 = 1.364 ml = 1.36 ml = 1.4 ml

7. **Give 1.4 ml to the child weighing 30 lbs**.

Dimensional Analysis

1. Identify the desired unit needed, and place on the extreme right (as the numerator in this case)

2. Fill in the equation with all information given

3. Cancel out similar labels in numerator and denominator positions

20 mL	25 mg	30 lbs	mL
5 g	kg		

4. If cancellations cannot be done, you need to add equivalents in order for cancellations to be made possible

20 mL	25 mg	30 lbs	1 kg	1 g	mL	= 1.36 or 1.4 mL
5 g	kg		2.2 lbs	1000 mg		

5. Multiply all the numerators and divide by the denominators) to obtain your answer. Don't round any numbers in an equation until you obtain the final answer

6. Give 1.4 ml to the child weighing 30 lbs.

Practice the following problems using your preferred method of calculation Round off to the nearest tenth. Label your answers correctly. Always repeat your calculations to make sure there are no errors. If the answer seems unreasonable recalculate your response.

1. Order: 20 mg/kg dose of amoxicillin oral suspension for a toddler who weighs 20 lb. How many mg should be administered?

2. Order: Amoxicillin 125 mg for a child weighing 34.32 lb. Available: Amoxicillin suspension 125 mg/ 5 ml. This has been determined to be a safe dose.
   What dose should the nurse give?

3. Order: Prednisolone oral suspension 10 mg every 8 hours. Child weighs 40 lbs. The safe dose range is 0.14 - 2 mg/kg/day divided TID (3x/day) or 4x/day
   a. What is the child's weight in kilograms?
   b. Is this a safe dose?
   c. If yes, and the medication is available in 5mg/ 5 ml, how much will the nurse administer per dose?

4. Order: Phenytoin 75 mg by mouth every 12 hours for a child weighing 66 lb.
   On Hand: Dilantin chewable 50 mg tablets. The recommended oral dose for a child is 5 to 7 mg/kg/day in divided doses every 12 hours.
   a) Child's weight is ______kg.
   b) Is this a safe dose?
   If yes, how much would the nurse give?

5. Order: Phenytoin 50mg every 12 hours for a child weighing 70 lb.
   Available: Dilantin 30 mg/5 ml.
   The recommended daily oral dose for a child is 5 -7 mg/kg/day in divided dosages every 12 hours
   a) Child's weight____kg.
   b) Safe recommended dosages or range for this child is_______.
   c) Is the order safe?
      If Yes, how many ml would the nurse give daily?

Answers: 1) **181.8 mg** 2) **5mL** 3) a. **18.2 kg** b. **Yes** c. **10 mL**
4) a. **30 kg** b. Y**es** c. **1.5 tablets**
5) a. **31.81 kg** b. **159 - 222.67 mg/day** c. **No** (subtherapeutic level)

Intravenous (IV) Fluid and Medication Administration Calculations

Intravenous fluids and medications must be closely monitored. Most large volume IV fluids, and medications administered in small volumes of fluid (intermittent IV Piggy Backs, IVPB's) are administered via an infusion pump. In these situations, the rate of infusion is expressed in milliliters per hour (**ml/hr**). Occasionally fluids may be infusing without an infusion pump or device. In these situations the rate of infusion is expressed as drops per minute (**gtts/min**).

Calculations of IV fluids and medications can be done utilizing Ratio and Proportion, Formula and DA. 3 formats will be used for the following problem. Use the format easiest for you to follow.

Example #1 : An IV is ordered to infuse at a rate of 125 ml/hr using a set calibrated at 10 gtts/ml. Calculate the gtt/min flow rate.

Note: In order to calculate an IV rate in gtts/min you need to know the drop factor. The drop factor is the number of drops it takes to equal 1 ml with a specific type of IV tubing. The drop factor is noted on the tubing package. IV infusion sets are available as macrodrips or microdrips. Macrodrip sets are calibrated at 10,15, or 20 gtts/ml. The calibration used at a health care facility depends on the manufacturer used by the facility, so you must always check the tubing label. Microdrip sets however are universally standard at a calibration of 60gtts/ml.

The following **formula is used in calculating IV drip rates**:

1. $\frac{\text{Volume x drip rate factor (gtts/mL)}}{\text{Hours (in minutes)}}$ = **gtts/min**

2. For the above problem just plug in known factors. $\frac{125 \times 10}{1\ (60)} = \frac{1250}{60} = 20.83$

3. When calculating gtts/min, round off to nearest **whole number**. **21 gtts/min**

Ratio & Proportion

1. Set up a ratio and proportion $\frac{125 \text{ mL}}{60 \text{ min}} = \frac{x \text{ mL}}{1 \text{ min}}$ Be sure units are the same horizontally

2. Cross multiply $\frac{125 \text{ mL}}{60 \text{ min}} = \frac{x \text{ mL}}{1 \text{ min}}$ solution: 60x=125 x=2.08 mL/min

3. Now you must incorporate the drip rate factor $\frac{10 \text{ gtts}}{1 \text{ mL}} = \frac{x \text{ gtts}}{2.08 \text{ mL}}$

   Be sure the units are the same horizontally.

4. Cross multiply $\frac{10\text{gtts}}{1 \text{ ml}} = \frac{x \text{ gtts}}{2.08 \text{ mL}}$ x = 10 (2.08) = 20.8 = 21 gtts/min **Answer 21 gtts/min**

Dimensional Analysis

a. Identify the desired unit needed, and place on the extreme right (as the numerator in this case). $\frac{gtts}{min}$

b. Fill in the equation with all information given & cancel out similar labels in the numerator and denominator positions, leaving the labels required in the answer

$$\frac{125\ \cancel{mL}}{hr} \Big| \frac{10\ gtts}{\cancel{mL}} \Big| \frac{gtts}{min}.$$

c. If any label cannot be cancelled, you need to add equivalents in order for cancellations to be made possible.

$$\frac{1\ \cancel{hr}}{60\ min} \Big| \frac{125\ \cancel{mL}}{\cancel{hr}} \Big| \frac{10\ gtts}{\cancel{mL}} \Big| \frac{gtts}{min} =$$

d. Multiply all the numerators and divide by the denominators to obtain your answer. Don't round any numbers in an equation until you obtain the final answer.

e. Answer 20.83 gtts/min = 21 gtts/min

Example #2. Infuse Rocephin 1 g in 50mL D5W over one half hour IVPB.
Drip rate factor 15 gtts/ml.

1. $\frac{\textbf{Volume x drip rate factor (gtts/ml)}}{\textbf{Hours (in minutes)}}$ **= gtts/min**

2. For the above problem just plug in the known factors. Please note the 1 g of Rocephin is an unnecessary factor in the calculation of the problem. You just need to know the volume; drip rate factor and time in minutes.

$$\frac{50\ mL \times 15}{30\ min} = 25\ gtts/min$$

3. Answer 25gtts/min

Ratio and Proportion

a. $\frac{50\ mL}{30\ min} = \frac{x\ mL}{1\ min}$ cross multiply 30x = 50 x = 1.66 mL

b. $\frac{15\ gtts}{ml} = \frac{x\ gtts}{1.66\ ml}$ cross multiply x = 24.9 = 25 gtts/min

c. answer 25 gtts/min

Dimensional Analysis

a. Identify the desired unit needed, and place on the extreme right (as the numerator & denominator in this case). Then Fill in the equation with all information given & cancel out similar labels in the numerator and denominator positions, leaving the labels required in the answer

$$\frac{50\ mL}{30\ min} \mid \frac{15\ gtts}{mL} \mid \frac{gtts}{min}.$$

b. Multiply all the numerators ana divide by the denominator(s) to obtain your answer
c. Answer 25 gtts/min

Example #3: 1,000 mL of D5 0.9 NS is ordered to infuse over 8 hours.
An infusion pump is to be used. At what rate should the nurse set the pump?
Reminder: Infusion pumps are always set at mL/hr.
Formula: $\frac{1000\ mL}{8\ hrs}$ = answer 125 mL/hr

Ratio & Proportion:

a. $\frac{1,000\ mL}{8\ hrs} = \frac{x\ mL}{1\ hr}$
b. 8x = 1000
c. Answer x = 125 ml/hr

Dimensional Analysis:

a. $\frac{1,000\ mL}{8\ hours} \mid \frac{mL}{hr}$

b. answer 125 ml/hr

Example #4: Infuse Rocephin 1 g in 50 mL D5W over one half hour IVPB.
An infusion pump is to be used. At what rate should the nurse set the pump?
Reminder: Infusion pumps are always set at mL/hr
Reminder: 1 g of Rocephin is an unnecessary factor in the calculation of the problem. You just need to know the **volume and time**.

Formula: $\frac{50\ mL}{0.5\ hr}$ = 100 mL/hr

Ratio & Proportion:

a. $\frac{50\ mL}{30\ min} = \frac{x\ mL}{60\ min}$
b. 30 x = 3000
c. x = 100 mL/hour

Dimensional Analysis

$$\frac{60\ min}{1\ hour} \mid \frac{50\ mL}{30\ min} \mid \frac{mL}{hr}. = 100\ mL/hr$$

Practice IV Problems

Select one calculation method and complete the following: Label your answers correctly. Always repeat your calculations to make sure there are no errors. If the answer seems unreasonable recalculate your response.

1. You are to set the IV pump to deliver 300 mL over 6.5 hours.
   What ml/hr would you set?

2. Order: Aldomet 125 mg IVPB.
   The medication is diluted in 100 mL of D5W.
   Using a microdrip set calculate the flow rate to deliver the volume in 2 hours.

3. The patient is to receive 1.5 mL of D5W per minute.
   The infusion set has a macro drop factor of 10 gtt/ml.
   The nurse should set the drop rate at _______ gtt/min.

4. The LIP ordered 1500 mL of D5 NS to run for 24 hours.
   The drop rate factor is 10 gtt/ml.
   How many mL/hr should infuse?

5. Order: 75 mL/hr.
   IV set has a drop factor of 60 drops/mL (microdrip tubing).
   How many gtts/min should infuse?

6. The LIP orders 1000 mL of D5W to run for 12 hours.
   IV set available has a drop factor of 15 drops per mL.
   How many drops per minute deliver this amount?

7. Order: Ancef 500 mg IVPB in 50 mL of D5W.
   Infuse over 1 hour.
   At what rate will the nurse set the infusion pump?

Answers: 1) 46 mL/hr
2) 50 micro gtts/min
3) 15 gtt/min
4) 62.5 mL/hr
5) 75 micro gtts/min
6) 20.83 or 21 drops per minute
7) 50 mL/hr

Critical Care Calculations

There are situations in which a medication is added to a specific volume of intravenous fluid and is then ordered to be infused at the rate at which a desired effect is obtained. This is referred to as titration of the medication. These medications require close and continuous monitoring. As with all medications accurate dosages are essential. The pharmacist mixes the solution and may indicate an infusion rate on the solution bag, but it is the nurse's responsibility to ensure that the indicated rate is correct. As is also noted, in some instances the rate of infusion may be ordered to be changed based on the client's response. It is critical for the nurse to remember that these are potent medications and any error can result in immediate harm to the client.

Example #1 Order Infuse heparin 1000 units/hr from a solution of 20,000 units in 500 ml of D5W. At what rate will the nurse infuse the medication?

Note: An infusion pump is always used for the administration of these medications. Reminder: The answer will be in mL/hr

****Use of Dimensional analysis may be the simplest way to approach these problems:

a. Identify the desired unit needed, and place on the extreme right (as the numerator & denominator in this case). Fill in the equation with all information given & cancel out similar labels in the numerator and denominator positions, leaving the labels required in the answer

$$\frac{1000\ \text{units}}{\text{hour}} \;\Big|\; \frac{500\ \text{mL}}{20{,}000\ \text{units}} \;\Big|\; \frac{\text{mL}}{\text{hr}}$$

b. Multiply all the numerators and divide by the denominator(s) to obtain your answer

$$\frac{1000\ \text{units}}{\text{hour}} \;\Big|\; \frac{500\ \text{mL}}{20{,}000\ \text{units}} \;\Big|\; \frac{\text{mL}}{\text{hr}} = 25\ \text{mL/hr}$$

c. Answer 25 mL/hr

Ratio and Proportion

a. $\frac{20{,}000\ \text{units}}{500\ \text{mL}} = \frac{1000\ \text{units}}{x\ \text{mL}}$

b. 20,000 x = 500,000

c. x = 25 mL/hr

Formula

$$\frac{1000\text{units}}{20000\ \text{units}} \times 500\ \text{mL} = 25\ \text{mL/hr}$$

In the upper Nursing Levels you will be responsible for calculating dosage drips for more complex problems. The following is an example of such a problem which can be solved in the following manner.

Example #2. Dobutamine has been ordered for a patient weighing 84.9 kg at 2.5 mcg/kg/min. The solution strength is 500mg dobutamine in 250 ml of D5W. At what rate should the medication be infused?

Dimensional Analysis

a. Identify the desired unit needed, and place on the extreme right (as the numerator & denominator in this case). Then Fill in the equation with all information given & cancel out similar labels in the numerator and denominator positions, leaving the labels required in the answer

$$\frac{2.5\text{ mcg}}{\cancel{\text{kg}}\text{/min}} \;\Big|\; 84.9\ \cancel{\text{kg}} \;\Big|\; \frac{250\text{ mL}}{500\text{ mg}} \;\Big|\; \frac{\text{mL}}{\text{hr}}$$

b. If any label cannot be cancelled, you need to add equivalents in order for cancellations to be made possjble.

$$\frac{60\ \cancel{\text{min}}}{1\text{ hour}} \;\Big|\; \frac{1\ \cancel{\text{mg}}}{1000\cancel{\text{mcg}}} \;\Big|\; \frac{2.5\ \cancel{\text{mcg}}}{\cancel{\text{kg}}\text{/}\cancel{\text{min}}} \;\Big|\; 84.9\text{ kg} \;\Big|\; \frac{250\text{ mL}}{500\ \cancel{\text{mg}}} \;\Big|\; \frac{\text{mL}}{\text{hr}}$$

c. Multiply all the numerators and divide by the denominator(s) to obtain your answer.

d. **Answer 6.36 mL/hr**

Formula method

a. The following formula can be used for these critical care problems:

$$\frac{\textbf{volume x time (in min) x weight (in kg) x dose}}{\textbf{mg} \quad \textbf{x} \quad \textbf{1000}}$$

b. Place the information from the problem into the formula in the correct position.

$$\frac{250\text{ mL} \times 60 \times 84.9\text{ kg} \times 2.5\text{ mcg}}{500\text{ mg} \times 1000} = 6.3675 = 6.36\text{ mL/hr}$$

Practice Problems

Select one calculation method and complete the following: Label your answers correctly. Always repeat your calculations to make sure there are no errors. If the answer seems unreasonable recalculate your response.

1. The order is to administer lidocaine at a rate of 30mL/hr using a concentration of 4 mg/mL.
   Determine how many mg/min the client is receiving.

2. Order: Heparin 25,000 units in 1000 mL of 0.9NS to infuse at a rate of 1000 units per hour.
   How many mL/hr will be set on the infusion pump?

3. The LIP has ordered a pre-diluted solution of theophylline 500mg in 250mL D5W to be infused at a rate of 750 mcg per minute.
   How many mL/hr will deliver this dosage?

4. The LIP orders 3 mcg/kg/min of Nipride.
   Available: 50 mg of Nipride in 250 mL D5W.
   Client's weight is 60 kg.
   How many mL/hour should the pump be set to deliver?

5. A patient in a critical care unit has an order for a dobutamine drip at 7 mg/hr for a systolic blood pressure less than 90 mm Hg. The patient's SBP is 86/54 mmHg. The dobutamine IV drip is provided from pharmacy as 1000mg dobutamine in 500 mL Dextrose 5% Water.
   What rate does the nurse set the IV pump?

Answers: 1) 2 mg/min 2) 40 mL/hr 3) 22.5 mL/hr 4) 54 mL/hr 5) 3.5 mL/hr

Forms of Medications and Nursing Considerations

Solid Preparations

1. **Buccal tablet** - tablet that is placed in the buccal cavity (the area between the gum and cheek). These tablets are designed to dissolve rapidly for absorption.
2. **Caplet** - solid, compressed powder or granules in the shape of a capsule, sometimes coated for easy swallowing.
3. **Capsule** - gelatin coated powder or granules that dissolve in stomach acids or occasionally in the intestine. They are often sealed for protection from altering the use or content of the drug.
4. **Enteric coated tablet** - tablets covered with a substance that delays the dissolution of drugs that may cause nausea or vomiting if they come into contact with the stomach lining. Enteric coated medications are dissolved not by gastric acids but by the alkaline secretions in the upper part of the intestine.

Do not crush these tablets

5. **Gelcap** - soft gelatin shell manufactured in one piece with drug in a liquid form inside the shell.
6. **Lozenge (Troche)** - a medication contained in a candy or fruit base. Meant to be dissolved in the mouth.
7. **Powder** - fine particles made from grinding a solid.
8. **Sublingual tablet** - tablet designed to dissolve rapidly for absorption by the capillaries under the tongue. Instruct client not to swallow or chew the tablet and not to take the tablet with water.
9. **Tablet** - compressed powder or granules, of different shapes or sizes. Some tablets are “scored" for breaking in half or in quarters. Tablets break up quickly into a powder in the stomach.
   Tablets that are scored in halves or quarters may be cut into these portions. It is understood that there is equal distribution of the medication in each portion. Tablets that are not scored should not be split or divided because you cannot ensure equal distribution of the medication. Tablets should not be divided by crushing. Tablets may be crushed if the entire tablet is to be administered, usually in a small amount of semi solid food.

10. **Time - release capsule or tablet** - contains granules that are released slowly for prolonged action. **These products should never be opened, broken up, or crushed. Rapid release could result in rapid absorption and overdose**.

Liquid Preparations

1. **Elixir** - aqueous solution with alcohol, sweetened and flavored. Alcohol is able to dissolve volatile oils and other substances not soluble in aqueous solutions. Elixirs must be used with caution with diabetics and those with ETOH (ethanol, alcohol) abuse.

2. **Emulsion** - water and oil mixtures. These preparations may be diluted with water just prior to administration. **Emulsions should be not be taken by individuals with difficulty swallowing.**
3. **Fluid extract** - highly concentrated preparations made by evaporating the alcoholic solvents of plants until a syrupy mass is left.
4. **Suspension** - undissolved particles of one or more medicinal agents mixed with a liquid vehicle for oral administration. **Shake well before each use.**
5. **Syrup** - aqueous solutions of sugar to which flavors are added. **Syrups must be used with caution in clients with diabetes.**

6. **Tincture** - an alcoholic or hydroalcoholic solution, usually using prepared plants with solvents containing alcohol.

Liquid topical/Respiratory

1. **Aerosol** - a liquid spray containing measured amounts of medication delivered by bulb nebulizers or oral inhalers and rapidly absorbed into the bloodstream.
2. **Metered dose inhaler (MDI)** - a handheld aerosol that delivers a fine mist of medication to the respiratory tract

Local Preparations

1. Dermal cream - a skin cream allowing a slow, sustained release of medication. **Caution: It can be absorbed through the skin of others if touched.**
2. Dermal patch - a skin patch permitting a slow, sustained release of medication, absorbed through the skin over a period of hours or days. **Wear gloves when applying; Inspect skin; rotate sites to avoid skin irritation; make sure old patch is removed**

3. Liniment - drug combined with oil, soap, alcohol, or water applied locally to produce a feeling of heat.
4. Suppository - a medicated mass designed to melt at body temperature and used for introduction into the rectum, urethra or vagina.

Parenteral Forms

1. Intra Venous (IV) - injected into a vein
2. Intramuscular (IM) - injected into muscle
3. Subcutaneous - injected into the subcutaneous layers of the skin
4. Intradermal - injected into the upper skin layers (dermis and epidermis)

Other Forms

Otic - in the ear
Ophthalmic - in the eye
Nasal [gtts, inhalers] - into the nose

Math Practice Exam #1

Note: Use your preferred method of math computation

1. Order Cefaclor 0.5 grams PO BID. Available is 250 mg tablets.
   How many tablets will the nurse give?
2. Order Codeine 60 mg PO x1 dose. Available is 30 mg tablets.
   How many tablets will the nurse give?
3. Order Amoxicillin 100 mg PO TID. Available is 250 mg/mL
   How many mL will the nurse administer?
4. Order: Tylenol 650 mg PO q6hr prn mild pain. Available is 325 mg tablet.
   How many tablets will the nurse give?
5. Order: Cardizem 60 mg PO TID. Available is 30 mg tablets.
   How many tablets will the nurse give?
6. Order: Prednisone 5 mg PO BID. Available is 2.5 mg tablets.
   How many tablets would the nurse give?
7. Order: Tagamet 0.4 g PO BID. Available is 200 mg tablets.
   How many tablets will the nurse give?
8. Order: Allopurinol 450 mg PO daily. Available is 300 mg tablets.
   What will the nurse administer?
9. Order Motrin 600 mg PO TID. Available is 200 mg tablet.
   How many tablets will you give?
10. Order: Fluorouracil 12mg/kg/day. Patient weighs 132 lbs.
    How many mg/day to give?
11. Order Cefaclor 20 mg/kg PO BID. Child weighs 31 lbs. Available is 125 mg/5ml.
    How many mL will the nurse administer?
12. Order Zantac 0.4 g PO BID. Available is 400mg tablets.
    How many tablets will the nurse give?

Answers: 1) 2 tablets 2) 2 Tablets 3) 0.4 mL 4) 2 tablets 5) 2 tablets 6) 2 tablets
7) 4 tablets 8) 1.5 tablets 9) 3 tablets 10) 720 mg 11) 11.3 mL 12) 1 tablet

Math Practice Exam #2

1. Give Heparin 2500 units Sub-Q. Available is Heparin 10,000 units/mL.
   How many mL should the nurse administer?

2. Heparin 4000 units sub-Q. Available is Heparin 10,000 units/mL.
   How many mL should the nurse administer?

3. Order: Toradol 60 mg IM stat. Available is 30 mg/mL.
   How many mL will the nurse administer?

4. Order: Cefprozil 15 mg/kg/day PO in 2 divided doses. Child weighs 33 lbs.
   Available is 125 mg/5mL.
   How many mL will be administered per day?
   How many mL per dose?

5. Give Heparin 7500 units Sub-Q stat. Available is 10,000 units/mL.
   How many mL will the nurse administer?

6. Order: Atropine sulfate 0.5 mg Sub-Q. Give 1 dose. Available is 0.4mg/mL.
   How many mL will the nurse give?

7. Procaine Penicillin 400,000 units IM q8h. Available is 300,000 units/mL.
   What will the nurse administer?

8. Give Oxacillin 250 mg IM q6h. Available is 500 mg/mL.
   How many mL will the nurse administer?

9. Give Digoxin 0.25 mg PO daily. Available is Digoxin 0.5 mg/2mL.
   What dose will the nurse give?

10. Thorazine 50 mg IM stat. Available is Thorazine 25 mg/mL.
    How many mL will the nurse give?

Answers: 1) 0.25 mL 2) 0.4 mL 3) 2 mL 4) 9 mL, 4.5 mL 5) 0.75 mL 6) 1.25 mL
7) 1.3 mL 8) 0.5 mL 9) 1 mL 10) 2 mL

Math Practice Exam #3

1. Order: 100 mL of IV fluids (0.9% NS) to be infused in 30 minutes. Available is 100 ml bag 0.9% NS and IV tubing with a drip factor of 10 drops/mL. The nurse will regulate the IV rate at how many drops/min?

2. Give 1 liter of 0.9% NS q9hr. Available is 1000 mL 0.9% NS bag and IV tubing with a drip factor of 15 drops/ml. How many drops/min will the nurse regulate the IV?

3. Order: 1.5 liter of Lactated Ringers q4hr. Available is 1.5 L of Lactated Ringers and IV tubing with a drip factor of 10drops/ml. The IV should be regulated at how many drops/min?

4. Give 2 liters of IV NS q5hr. The IV tubing drip factor is 10. The nurse will regulate the IV at how many drops/min?

5. Give 1 liter of D5W q8h. The IV tubing drip factor is 10 drops/mL. How many drops/min to regulate the IV rate?

6. Give 100 mL of 0.45% NS in 1 hr. IV tubing drip factor is 15 drops/ml. An infusion pump will be utilized. The nurse will set the pump at what rate?

7. Order: 500 mL of 0.9%NS to infuse over 3.5 hr. Available is 500 mL NS bag with IV tubing drip factor of 10. The nurse will set the pump at how many mL/hr?

8. Give 1 L of 0.9% NS q7hr. At what rate will the nurse set the infusion pump?

9. Give 100 mL of D5W over 2 hr. Available is 100 mL bags and a microdrip tubing. How many drop/min will you regulate the IV rate?

10. Give 100 mL of NS in 30 minutes. IV tubing drip factor is 15 drops/mL. An infusion pump will be used. What rate will the nurse set on the pump?

Answers: 1) 33 gtts/min 2) 28 gtts/min 3) 63 gtts/min 4) 67 gtts/min 5) 21 gtts/min
6) 100ml/hour 7) 143 mL/hour 8) 143 mL/hr 9) 50 gtts/min 10) 200 mL/hr