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Dose Calculations

Primary Care Paramedicine

Module: 07

Section: 03

Objectives

- Section 1: The metric system
  - Define the metric system.
  - Identify and utilize the common metric prefixes, multiples and submultiples.
  - Utilize the “rules” of the metric system.
  - Convert between units of the metric system.
  - Convert between units of the metric system and the customary or apothecary system.
- Section 2: Find the ordered dose
  - Solve a basic order word problem using either the ratio and proportion, cross multiplication or formula methods.

Systems of Measure

- Three common systems still used today
- Each deals with units of mass and volume
  - Metric
  - Apothecary
  - Household

Metric System

- Most commonly used
- Considered the most convenient since based on units of 10
- Basic units are
  - Meter Length
  - Liter Volume
  - Gram (Weight) Mass

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Metric System

	Kilo	Hecto	Deca	Unit	Deci	Centi	Milli
Length	Kilometer km (1000 meters)	Hectometer hm (100 meters)	Decameter dm (10 meters)	**Meter (m)**	Decimeter dm (1/10 meter)	Centimeter cm (1/100 meter)	Millimeter mm (1/1000 meter)
Volume	Kilolitre kL (1000 litres)	Hectolitre hL (100 litres)	Decalitre dL (10 litres)	**Litre (L)**	Decilitre dL (1/10 litre)	Centilitre cL (1/100 litre)	Millilitre mL (1/1000 litre)
Weight	Kilogram kg (1000 grams)	Hectogram hg (100 grams)	Decagram dg (10 grams)	**Gram (g)**	Decigram dg (1/10 gram)	Centigram cg (1/100 gram)	Milligram mg (1/1000 gram)

1 ml = 1 cc
1 kg = 2.2 lbs

1 mcg (µg) = 1/1000 mg = 1/1000000 g

Apothecary System

- Old system of measurement
- Considered to be less precise and convenient
- Basic units are
  - Minim Volume
  - Grain (Weight) Mass

Household System

- Approximate system of measurement
- Basic units are
  - Weight ounces, pounds
  - Volume glass, cup, tablespoon, drop, quart, pint and gallon

1 t = 4 – 5 ml
1 T = 15 – 16 ml
1 pt = 500 ml
1 qt = 1000 ml = 2 pt
1 in = 2.54 cm

Dose Calculations

- As a paramedic you will have to calculate drug doses, infusion rates and strengths of drugs in the field.
- Remember:
  - All units of measure must be converted to the same unit and system
  - The computed dose must be assessed to determine if it is reasonable
  - Use the same method of calculation every time

Concentrations

- Refers to the strength of the drug (how many of one thing is present in something else)
- Ex: 10 mg of drug in 1 ml of solution
- Accomplished by dividing the weight of the drug (solute) by the volume of fluid (solvent) it is in

$$[\,] = \frac{Weight}{Volume}$$

$$= \frac{10\ mg}{1\ ml}$$

$$= 10\,\frac{mg}{ml}$$

Concentrations

- Some drugs are labeled as a percentage
- Refers to # of grams in 100 ml of solution
  - 1% Lidocaine 1 g of Lidocaine in 100 ml
  - 10% $MgSO_4$ 10 g of $MgSO_4$ in 100 ml
  - D_5W 5% Dextrose in water
    - 5 g of dextrose in 100 ml of Water

Concentrations

- How much drug is in 10 ml of 10% $MgSO_4$?

- First calculate the [ ] of the drug

$$10\ \%\ MgSO_4 = \frac{10\ g}{100\ ml} = \frac{10000\ mg}{100\ ml} = 100\ \frac{mg}{ml}$$

- Therefore

$$10\ ml\ x\ 100\frac{mg}{ml} = 1000\ mg = 1\ g$$

Calculations

- Three common types
  - Basic formula (most common)
  - Dimensional analysis
  - Ratios and proportions
  - May also see the ‘T’ method

Dimensional Analysis

- Sets up all conversion factors in one equation and separated by ‘X’
- To solve calculation:
  - Set up the equation
  - Cancel pairs of units of numerator/denominator
  - Multiply the numerators
  - Multiply the denominators
  - Divide the numerator by the denominator

Dimensional Analysis

- Example 1:
  - You are to administer fentanyl 50 mg IM. You have 75 mg of the drug in a 1 ml solution. How many ml will you give?

$$ml = \frac{1\ ml}{75\ mg} X \frac{50\ mg}{1} = \frac{50\ ml}{75} = \frac{2\ ml}{3} = 0.66\ ml$$

Dimensional Analysis

- Example 2:
  - You are to administer 5 mg IV of valium. You have 10 mg of the drug in a 1 ml solution. How many ml will you give?

$$ml = \frac{1\ ml}{10\ mg} X \frac{5\ mg}{1} = \frac{5\ ml}{10} = \frac{1\ ml}{2} = 0.5\ ml$$

Ratio and Proportions

- Compares two numbers and works like a fraction
- Example:
  - Administer morphine 3 mg IV. You have 10 mg in 1 ml of solution. How many ml will you give?

Means

$$10\ mg : 1\ ml :: 3\ mg : X\ ml$$

Extremes

- Therefore:

  10 X = 3

  X = 3/10

  X = 0.3 ml

Basic Formula

- W = “desired dose” = Want
- H = “concentration of the drug” = Have
- V = “volume the drug is supplied in” = Volume

$$Dose = \frac{Want\ (W)}{Have\ (H)} X\ Volume\ (V)$$

Calculation # 1

- You are to administer 20 mg of Dimenhydrinate (Gravol) to your patient. The vial in your drug bag contains 50 mg in a 5 ml vial. How many milliliters will need to be administered for this patient?

- Therefore:
  - W = 20 mg
  - H = 50 mg
  - V = 5 ml

Calculation #2

- An adult patient is actively seizing and requires diazepam (valium) with a dose range of 2.5 – 5.0 mg IVP. The drug is supplied in a 2 ml vial that contains 10 mg of medication. What is the amount of solution that will need to be administered to achieve the smallest and largest dose?

Calculation #3a

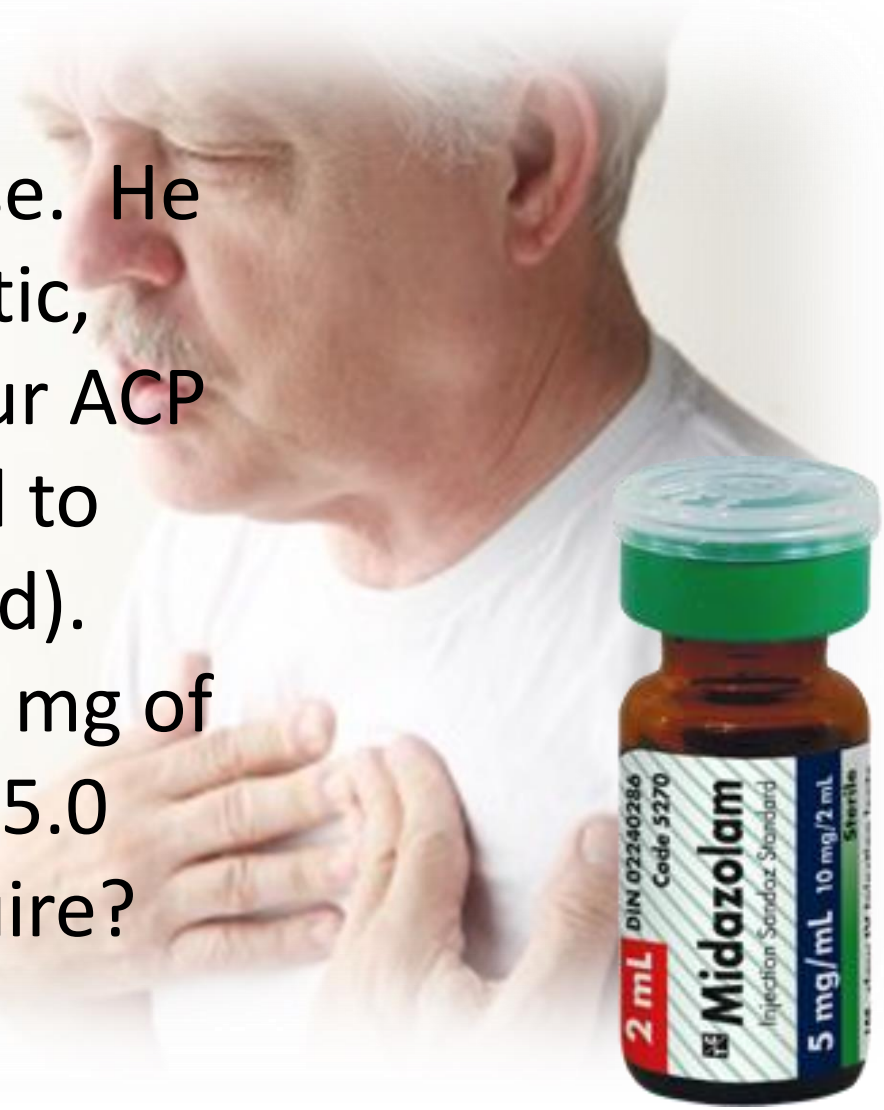
- A 28 y/o male has a fracture to the right tib/fib. His pain is 10/10 and you are providing pain control with morphine sulfate. The dosing range is 2.5 – 5.0 mg IVP. What is the appropriate amount of solution required to achieve the smallest dose?

Calculation #3b

- For some medications, such as morphine, it is suitable to mix the provided medication with saline to achieve an easier concentration of the medication. This make dosing easier for the clinician.
- Using a preload syringe remove 1.0 ml of saline and then add the 1.0 ml of medication
- This now provides 10 mg of the drug in 10 ml of solution (1.0 mg/ml)
- Using the new concertation, how much solution would need to be administered to achieve the larger dose?

Calculation #4

- A patient is in extremis due to dyspnea preceded by two weeks of general malaise. He is lethargic, warm to the touch, diaphoretic, and has an SaO_2 of 80% on 100% O2. Your ACP partner decides to intubate and will need to provide sedation using midazolam (Versed). The vial contains 2 ml of solution with 10 mg of medication. You are asked to administer 5.0 mg IVP. How much solution will this require?



Calculation #5

- A 70 y/o female is c/o dyspnea and has a Hx of CHF and on exam has course crackles in all lungs fields. Your partner will be administering 80 mg of Furosemide (Lasix). How much solution should your partner be administering noting that the medication vial contains 40 mg of drug in 4 ml of solution?

Calculation #6

- You are called for a patient that is experiencing an allergic reaction to bee sting. Your priority is to administer 0.3 mg of epinephrine IM to help alleviate the symptoms. Epinephrine is provided in a 1.0 ml vial that contains 1.0 mg of medication. How much solution should be administered?

Calculation #7

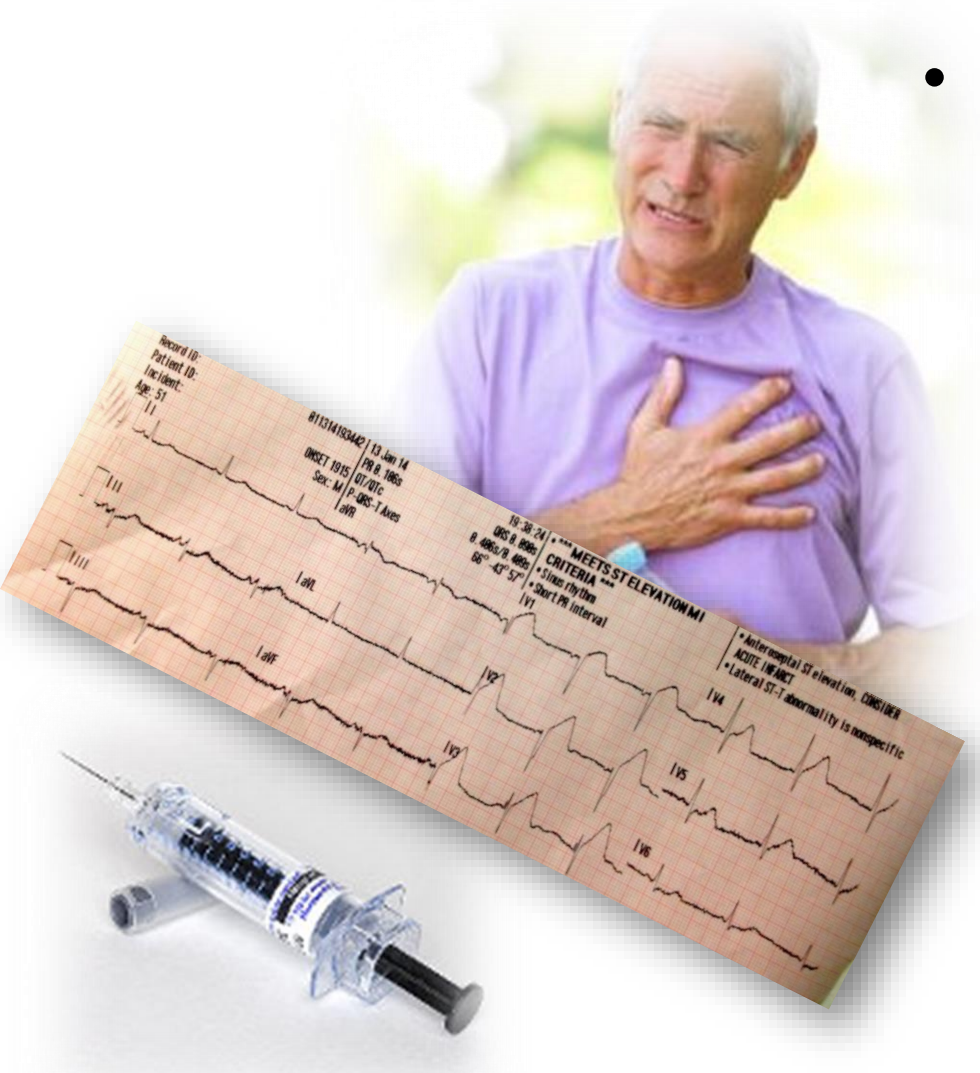
- As the allergic reaction is improving you decide to administer 25 mg diphenhydramine (Benadryl) IM for longer lasting support. The vials contain 50 mg in 1 ml of solution. How much solution should be administered?

Weight Specific Dosing

- Some medications require a dose based on the patients weight (typically in kilograms).
- May be a bolus or an infusion
  - 1.5 mg/kg of Lidocaine bolus in an arrest protocol
  - 5 µg/kg/min of Dopamine

- To calculate the dose multiply the dose in units (g, mg, µg) by the pt's weight in kg.

Calculation #8



- Your pt is a 60 y/o female who presents with chest pain and is being treated by you and your ACP partner for a STEMI. As part of the clinical practice guideline you are to administer 1.0 mg/kg of Lovenox (Enoxaparin) to the patient SQ. The medication is provided in a 1.0 ml preloaded syringe with a concentration of 100 mg/ml. She weighs 110 lbs. How much of this medication would be required?

Dose Calculations

IV CALCULATIONS

Calculating Flow Rates

$$Drops/\min(\frac{gtts}{min}) = \frac{Volume\ to\ be\ administered\ (ml)\ X\ Drip\ Set\ (\frac{gtts}{ml})}{Time\ to\ be\ infused\ (min)}$$

Drip Set (gtts/ml)	Drops to achieve 1 ml of solution	Factor
10 (macro)	10	6
15	15	4
20	20	3
60 (micro)	60	1

Calculations

- Your patient is to receive 1000 ml of normal saline (NS) over a 12 hour period using a microdrip (60 gtt/ml) administration set. The formula will now look like this:

$$Drops/\min(\frac{gtts}{min}) = \frac{Volume\ to\ be\ administered\ (ml)\ X\ Drip\ Set\ (\frac{gtts}{ml})}{Time\ to\ be\ infused\ (min)}$$

$$= \frac{1000\ ml\ X\ 60\ gtts/ml}{720\ min}$$

$$= 83.33\ gtts/min$$

Now Add Medications

- A physician orders 2 mg/min of Lidocaine to your patient. She orders 2 g of lidocaine to be added to 500 ml NaCL. Using a 60 gtt/ml set, calculate the gtt/min.

Calculation

Step 1: Calculate the concentration of the drug in the solution

$$[\,] = \frac{Mass}{Volume}$$

$$= \frac{2.0\ g}{500\ ml}$$

$$= \frac{2000\ mg}{500\ ml}$$

$$= 4\ mg/ml$$

Step 2: Calculate the Desired Dose of the medication needed

$$Dose = \frac{Want}{Have} \times Volume$$

$$= \frac{2.0\ mg/min}{2000\ mg} \times 500\ ml$$

$$= \frac{1000\ mgml/min}{2000\ mg}$$

$$= 0.5\ ml/min$$

Calculation

Step 3: Calculate the Drip Rate based on the calculated Desired Dose

$$Drops/\min\left(\frac{gtts}{min}\right) = \frac{Volume\ to\ be\ administered\ (ml)\ X\ Drip\ Set\ \left(\frac{gtts}{ml}\right)}{Time\ to\ be\ infused\ (min)}$$

$$= \frac{0.5\ ml\ X\ 60\ gtts/ml}{1\ min}$$

$$= 30\ gtts/min$$

A Variation to the Same

$$Drops/\min(\frac{gtts}{min}) = \frac{Volume\ (ml) \times Ordered\ \left(\frac{mg}{min}\right) X\ Drip\ Set\ (\frac{gtts}{ml})}{On\ Hand\ (mg)}$$

$$= \frac{500\ ml \times 2\ \frac{mg}{ml} X\ 60 \frac{gtts}{ml}}{2000\ mg}$$

$$= 30\ gtts/min$$

Calculation #9

- Your pt is a 40 y/o, 220 lb male who is one week post operative bowel surgery, released from hospital 3/7 ago, responsive but lethargic. His SaO_2 is 95% on RA, HR 124 Reg and Weak, BP 70/40.
- Your interventions of airway management and a bolus of NaCl and have not shown a hemodynamic change. The CPG requires the ACP to begin an infusion of dopamine.
- The medication is provided in a premixed bag containing 800 mg of drug in 500 ml of saline.
- What is the concentration of the medication and at what drip rate should it be administered to achieve the dose of 5 µg/kg/min using a micro drop set?