Drug Dose Calculation

Introduction

An important part of nurse's role is to ensure that drug dose is calculated and administered appropriately. This includes administering oral medications and intravenous infusions. It is essential that the nurse has a good knowledge and understanding of basic mathematical and arithmetic skills in relation to drug calculation. Giving medications in the health care set up involves not only what and when to give but also how much to administer. Dosing calculations is just as important as knowing what to give. Medications are available in various forms and it is crucial for nurses to know how to calculate all those at the tip of their fingers. Basically, there are three formulas which help the nurses to work on dose calculation which are volume infusion, bolus and continuous infusion. Also, it depends on the equipment used to deliver medicine. Ideally a needle and syringe are used to draw medicine through ampoule and vial then loaded into fluid bottles readily available or 50cc syringes to start with an infusion.

When the nurse starts intravenous drip it is necessary to use drip chamber and keep a note of how many drops deliver 1ml of fluid. There are two different styles of administration drip sets (gtt/set). One is a macro set that uses larger drops to add to 1 ml. Most macro sets are either 10, 15 or 20 drops to make 1 ml. The other drip set is a micro set, and it either takes 45 or 60 drops to make 1 ml. When giving most medications via continuous infusion, micro drip sets are the preferred method. One easy way to differentiate the two is by looking into the drip chamber. A clinician will see a micro set adapter that looks like a small silver pin coming from the bag end of the chamber. This pin causes the drops to be tiny, hence the term micro set. Some medications that are infused come in a glass vial. If this is the case, make sure to use a drip tubing that has a vent port to allow air into the bottle. Without this air entering the glass vial/bottle, the release of the fluid will eventually cause a suction, and the medication will stop flowing.

Preparing a dose calculation is best done with the use of a calculator, particularly in a stressful situation. If not, errors are likely. One wrong decimal place can become a ten-fold error that can cause life-threatening complications for patients. An excellent way to prepare for standard drip rates and concentrations is to develop a chart with the drip rates already calculated for ease. Caution should also be used when doing so. With different manufacturers and pricing wars, it is very common for a company to change the vial and concentration without notifying providers. If providers become complacent in this situation, the patient could become injured, and the providers might be liable.

Dose calculations should always be performed before the medicine is mixed if the nurse is giving an infusion. Doing the math before mixing allows a person to change the numbers to reach a better drip-rate. It is difficult to count 600 gtt/min using a 60 gtt/set but changing the drip set to a ten gtt/set can decrease your rate to 100 gtt/min and make your treatment more manageable.

The aim of this study is to introduce the basic principles of numeracy and the specifics of calculating drug dosages to help staff nurses gain the knowledge and skills to meet the best standards. This covers basic arithmetic principles and use worked examples to illustrate each area to help develop staff nurses knowledge and understanding. Enrolling for this learning module will help them to learn drug calculation skill and administer and monitor medicines and intravenous therapy which is specially designed to teach precise dosage calculation formulas and methods depending on the requirements of critically ill patients.

Purpose of medication calculation for nurses:

- Drug administration and monitoring is primary duty often performed by nurses.
- Dose of drug depends on the weight of the patient and some other factors which nurses should be well versed.
- Liver function and kidney function has to be assessed before calculating dose of a particular medicine.
- Knowing the skill of drug calculation makes nurse more confident of her abilities as a healthcare professional and she is able to perform her duties more responsibly and with commitment.
- Medication calculation skill also make it possible to correctly interpret the instructions written by a physician.
- This skill allows the nurse to monitor a client for possible side effects of a drug and make decisions in discontinuing the medication in case of a severe reaction.
- Patient assessment becomes easy and alternative therapy can be prescribed by the physician in case of emergency.

10 Rights of Medication Administration.

Understanding the 10 Rights of Drug Administration can help prevent many medication errors. Nurses, who are primarily involved in the administration of medications, benefit from this simplified memory aid to help guide them to administer medications safely.

1. **Right Drug:** The first right of drug administration is to check and verify if it's the right name and form. Beware of look-alike and sound-alike medication names. Misreading medication names that look similar is a common mistake. These look-alike medication names may also sound alike and can lead to errors associated with verbal prescriptions. Check out The Joint Commission's list of look-alike/sound-alike drugs.
2. **Right Patient:** Ask the name of the client and check his/her ID band before giving the medication. Even if you know that patient's name, you still need to ask just to verify.
3. **Right Dose:** Check the medication sheet and the doctor's order before medicating. Be aware of the difference between an adult and a pediatric dose.
4. **Right Route:** Check and verify the order (i.e., per oral, IV, SQ, IM)
5. **Right Time and Frequency:** Check the order for when it would be given and when was the last time it was given.
6. **Right Documentation:** Make sure to write the time and any remarks on the chart correctly.
7. **Right History and Assessment:** Secure a copy of the client's history to drug interactions and allergies.
8. **Right Drug Approach and Right to Refuse:** Give the client enough autonomy to refuse the medication after thoroughly explaining the effects.
9. **Right Drug-Drug Interaction and Evaluation:** Review any medications previously given or the diet of the patient that can yield a bad interaction to the drug to be given. Check also the expiry date of the medication being given.
10. **Right Education and Information:** Provide enough knowledge to the patient of what drug he/she would be taking and what are the expected therapeutic and side effects.

Metric System: It is the international system of weights and measures based on meter and gram. It was introduced by Talleyrand. Later it was modified to include meter, kilogram, second (time) and ampere (electricity). Units of metric system are related and rationally derived. It is simpler easier and more accurate to use. Therefore metric system is the most commonly used and widely accepted system of weights and measures. In metric system, the standard unit of measuring weight or mass is kilogram (kg).

When it is needed to use the decimal, it is necessary to be careful so that no mistake is made. Therefore smaller units may be used to avoid decimal. Example: 200mg instead of 0.2 gm.

Units of Capacity (Volume): The standard unit of measuring volume is liter.

Domestic measure: These measures are used to measure the doses of liquids at home. Common domestic measures and their accepted equivalents are teaspoonful, tablespoon, drops and ml.

Imperial system: Imperial system is an old system and is based on units which are not related. It is divided into 2 systems:

1. Avoirdupois system: the standard unit of this system is pound
2. Apothecaries system: also known as troy system is grain.

Percentage solutions and calculations: Percentage solution is the solution in which specific quantity of solute is dissolved in a definite volume of solvent to obtain a solution of definite strength and percentage.

Converting metric units:

Unit	Equivalents
1 mg	1000 mcg
1 gram	1000 mg
1 kg	1000 g
1 litre	1000 ml
1 tsp	5 ml
1 tbsp	15 ml
1 kg	2.2 Ibs
1 oz	2 tbsp
Macro set : 10-15 drops/ml (gtts/ml)	1 ml
Micro set : 60 drops/ml (gtts/ml)	1 ml

Dilution and strengths of solutions:

A drug when dissolved in a solution and the strength of the solution may be expressed as:

- grams per liter
- mg/ml
- ratio strength
- percentage

Drug dose calculation formula:

Standard Method

a) Volume or number of tablets to be given.

$$\frac{\text{Dose required}}{\text{Available dose}} \times \begin{matrix}\text{volume of stock solution or} \\ \text{number of tablets/capsules}\end{matrix}$$

Formula for continuous intravenous infusion:

b) Calculating drops per minute (drops/min or gtts/min)

$$\frac{\text{Volume to be given (mls)} \times \text{drip factor}}{\text{Time (hours)} \times 60 \text{ min}}$$

c) Calculating millilitres per hour (ml/hr)

$$\frac{\text{Total volume (ml)}}{\text{Total time (hours)}} = \text{ml/hour}$$

d) Calculating Infusion time

$$\frac{\text{Total volume to be infused}}{\text{millilitre per hour being infused}} = \text{Infusion time}$$

e) Drug calculation by weight (weight based calculation for inotrope administration)

$$\frac{\text{Patient weight (kg)} \times \text{mcg/kg/min} \times 60 \text{ mins} \times \text{vol of diluent (mls)}}{\text{Total micrograms in bag}} = \text{ml/hour}$$

Methods used for intravenous drug administration along with applied formulas:

Bolus

This method is used when the clinician must obtain a specific amount of medicine out of a container. The answer obtained from the formula will be the amount in ml.

(Drug ordered / Drug Available) x total mL in vial = mL

Example 1 : The doctor orders injection Amoxicillin 325 mg tid for infection. The stock supply Amoxicillin 250 mg/ml. How many ml has to be administered to deliver correct dose?

Ans. 325 mg/ 250 mg x 1 ml = 1.3 ml

Example 2 : The clinician is to deliver 1 mg of epinephrine (adrenaline) to a patient in a bradycardic rhythm. If using a 1:10,000 epinephrine concentration (1 mg in 10 mL), the formula would indicate that they must draw 10 mL from the vial.

Epinephrine 1:10,000 means 1g : 10,000ml. That is the same as 1000 mg: 10,000ml. Which is the same as 1mg:10ml. That means in an ACLS code situation if you want to give 1mg of epinephrine, you would actually draw 10ml of epinephrine (1:10,000).

Ans. 1 mg / 1000 mg x 10000 mL = 10 mL

Volume Infusion

This method can be used when a patient needs a certain amount of IV fluid over an amount of time in minutes. This fluid can be by itself, or it can have medication mixed in the bag. The overall goal is to give the fluid over a particular time in minutes. The answer to the formula will be in drips per min.

(Volume (mL) x (gtt/set)) / Time (min) = gtt/ min

Example 1 : 250 mL of normal saline over 30 minutes with a ten gtt/set is needed. Plugging these numbers into the formula would tell the clinician that they need to set the drip rate at approximately 83 gtt/min or about 1.5 gtt/sec.

Ans. 250mL x 10 / 30 min = 83 gtt/min

Example 2 : The clinician places 150 mg of amiodarone into a 100 mL bag of D5W with a ten gtt/set. The clinician is going to deliver the entire 150 mg over 10 minutes. The goal has become to give the 100 mL bag over 10 minutes. When you are using the formula with (100 mL x 10 gtt/set) divided by 10 minutes, you get 100 gtt/min or about 1.5 gtts/sec.

Ans. 100mL x 10 / 10 min = 100 gtt/min

Intravenous drip

Millilitre per hour

$$\frac{\text{Total volume (ml)}}{\text{Total time (hours)}} = \text{ml/hour}$$

Example : A physician orders 3000 ml of D5W to be administered over 24 hour period. The nurse determines how many ml per hour will be administered to the client ?

Ans. 3000 ml / 24 hours = 125 ml / hour

Infusion time

$$\frac{\text{Total volume to be infused}}{\text{millilitre per hour being infused}} = \text{Infusion time}$$

Example : A physician orders 1000 ml of RL to infuse at rate of 125 ml / hour. How many hours will it take to infuse 1L RL ?

Ans. 1000 ml / 125 ml / 1 = 8 hours

Continuous Infusion (weight based calculation)

When giving a constant amount of medication every minute for an extended period, continuous infusion calculation can be used.

Example 1 : A patient is ordered to start an IV Dopamine drip at 5 mcg/kg/min. The patient weighs 57 kg. You have a bag of Dopamine that reads 400 mg/250 mL. What will you set the IV pump drip rate (mL/hr) at?

Ans. Step 1. **5 mcg x 57 Kg x 60 min / 400 mg x 250 mL**

Step 2. **5 mcg x 57 Kg x 60 min / 400 mg x 1000 x 250 mL**

Step 3. **17100 mcg / 400000 mcg x 250 mL = 10.7 mL / hour**