Drug Calculations

Caredemy
Online Training Academy

CAREDEMY
ONLINE SKILLS FOR CARE

Course Name:

- *Drug Calculations*

Course Description:

- *This course will give an overview of calculating drug doses and common miscalculation errors.*

Course Learning Objectives:

At the end of this course, the learner will be able to:

- *Identify several medication errors*
- *Identify why calculation errors occur*
- *Understand drug measurements*
- *Understand converting doses*

Target Audience:

- *Health and social care workers*

Course Requirements:

- *Participants must complete all learning modules and pass the multiple-choice course assessment.*

Core Clinical Framework:

- *This course meets the outcomes of the framework.*

Introduction to Drug Calculations

In our healthcare system, many drugs are given in error. Miscalculations are a factor that contributes to this problem. The administration of medicines is a fundamental nursing skills requiring knowledge and skills to safely calculate drug does and rates of drug administration, administering them to the patient as prescribed. Between 2005-2010, 525,186 incidents were reported with 16% of these causing actual harm. 822 errors resulted in death or severe harm. Medication errors often happen due to wrong dose, delayed or omitted medication, or the wrong medication being administered.

Calculation Errors

Calculation errors are the most frequently cited reason for a wrong dose being administered. These errors can have different contributing factors, but most medication errors are caused by healthcare professionals:

- Misunderstanding the units of measurement for medication
- Using the wrong equipment
- Making mistakes in their calculations, resulting in the wrong dose or rate of medicine being administered

Errors are the result of stress, distractions, or a lack of knowledge or skills. These errors have been identified in general practice, community, acute, learning disability, and mental health clinical areas making calculation a key skill. Awareness of potential risks in certain procedures can help nurses be more vigilant in preventing errors or anticipating them.

Understanding Drug Measurements

Healthcare providers administering medicines must be able to calculate and administer the correct dose of medicine to a patient. Different measures are used for drug dosages in healthcare and may need to be converted to another unit of measurement. Drugs are measured according to either:

- Weight of the drug (ex. Grams, milligrams)
- Volume: (ex. Millilitres, litres)
- Standarised international units
- Strength of the solution when a weight of drug is dissolved in a volume of liquid
- Percentages, when a drug is 100 parts of a product

Unit of Measurement	Abbreviation	Description
Grams	g	Measure weight of the drug
Milligrams	mg	
Micrograms	Do not abbreviate	
Nanograms	Do not abbreviate	
Litres	L (must be uppercase)	Measure the volume of the solutions
Millilitres	ml	
Standardised Units	U or IU	Measure of specific therapeutic effect of a drug
Millimols	mmol	Standarised number of molecules of a substance
Ratio	Ex: 1:1000	Relationship between 2 quantities
Percentages	%	Amount of a substance out of a possible 100

Understanding Drug Measurements

Many medication errors have been made through not converting between different units of measurements correctly, resulting in doses of 10 to 100 times more than prescribed.

Drugs Measured in Units

Drugs are most often prescribed and labelled according to their weight or, for solutions, their strength. This is the weight dissolved or suspended in a specific volume (weight per volume 'w/v')

Some drugs such as insulin are measured in units. Insulin is most commonly supplied as 100 units/ml and administered using an insulin syringe which is calibrated in units. Some manufacturers now produce a 200 unit/ml strength. United should never be abbreviated to U because of the confusion with 0, resulting in an error.

Converting to Different Units of Weight

The main weight measurements are grams, milligrams, micrograms, and nanograms. The relationship between each of these is a factor of 1,000, so conversions require healthcare providers to multiply or divide dosages by 1,000. The prescribed dose is always converted to the units of the available drug dose. This makes it easier to compare the prescription with how the medicine is labelled. For example, if the prescription given is 1.8g, but the available vial of the drug are 600mg, to compare the dosages the same unit of measurement is required. To convert 1.8g to the equivalent milligram dose, it must be multiplied by 1,000 to get 1,800mg. Once the conversion is checked the prescribed dose can be compared with the available dose to calculate how much of the medicine to administer. We would need three 600mg vials to get 1,800mg.

Solid Oral Doses

For solid oral doses such as capsules or tablets, the calculation is usually straightforward because the prescribed dose can be divided by the available drug dose to figure out how many tablets to administer. If the prescription is for 30mg and the available tablets are 5mg, then the number of tablets to administer would be six.

Strength of Available Solution

If a medicine is a solution of a specific strength, calculations can become complicated. The strength of a medicine solution is expressed as the weight of the drug that is dissolved in a specific volume of solution. For example 125mg/5ml. It will need to be calculated what volume needs to be administered to give the prescribed dose. If 250mg is prescribed, the amount of suspension to administer would be 2 x 125mg, which would be 10ml.

Double-Checking

Double-checking should be completed for all complex calculations. Checking must involve each healthcare provider doing the calculation independently, then checking the answer together. Double-checking can sometimes increase the risk of error because each healthcare provider relies on the other to pick up any error. It is important that each person does the calculation independently before comparing. Once the calculated answer is agreed, this should be related back to the clinical practice to ensure that the answer makes logical sense from your clinical and medical knowledge.

Weight-based Dosages

Medicines are sometimes prescribed according to the weight of the patient in kilograms. This requires an additional calculation to figure out the dose of the patient's weight before the administration dose can be calculated. For example, a prescription drug is 10mg/kg. To calculate the prescription, you must have an accurate weight for the person in kilograms and then multiply this by the dosage specified. For example if the weight of the person was 12kg, then the dose would be 10mg/kg x12kg = 120 mg.

Complexity and Risk

Calculation become more complex when they involve many of the calculations already prescribed. For example: what proportion of an ampoule would you draw up if the drug of 50 nanograms/kg was prescribed intravenously for a child who weighs 8kg and the available ampoules were 1ml, at a strength of 2 micrograms/ml?

1. Calculate the dose for the individual child (50 nanograms/kg x 8kg = 400 nanograms)
2. Convert 2mcg/ml to nanograms/ml (2mcg/ml x 1,000 = 2000 nanograms/ml)
3. Calculate the volume of the drug required = 400/2,000 = 0.2ml

This is considered a high-risk calculation because it has multiple stages where errors can occur. Calculations must be checked carefully with a second provider to reduce the risk of error.

Calculating Infusions

Medications can be prescribed in doses that must be administered continuously for a specified period of time. An infusion is administered at a flow rate that will give the required dosage per hour or minute for the patient. Clinical areas generally have standarised infusion strengths that are always used for specific medications, with the rate varied according to the prescribed dose for the patient. For example, a drug may be prescribed as 500 micrograms/kg/hour and infused using a solution of 500mg in 500ml sodium chloride. To administer the correct dose, the dose for the patient's weight (dose x kg) must be calculated. This is done in steps:

1. Calculate the millilitres//hour by working out what dose is contained in one millilitre of the infusion dosage. Ex.: 500ml/500mg = 1ml/mg
2. Calculate the dosage per weight of the patient and convert this into milligrams. For example, a 45kg patient would be 45kg x 500 micrograms/kg = 22,500 micrograms. Converting into milligrams would be 22.5mg (22,500/1,000)
3. 1ml would administer 1mg of the drug, so 22.5ml would administer 22.5mg. The infusion rate would be set as 22.5ml/hour

Converting Dosages

Other complex calculations can be dose/kg/min. There are formulas to help with these calculations to reduce the number of steps needed to convert dosages into the volume needed per hour.

$$\frac{\text{Dosage per kg} \times \text{patient weight (kg)} \times 60}{\text{What you have available (dosage in syringe)}} \times \text{Volume it is dissolved in} = \text{Rate per hour (ml/hr)}$$

$$\text{Dosage/kg} \times \text{Patient weight (kg)} \;/\; \frac{\text{Dosage in infusion}}{\text{Volume of infusion}} = \text{ml/hr}$$

Percentages

A percentage means ‘out of 100’. The percentage concentration can be defined as the amount of a drug in 100 parts of the product. For example intravenous glucose is often prescribed as 5%. This means that each 100ml of water contains 5 parts glucose. The most common percentage is the weight of the drug in a volume, such as lidocaine which commonly comes in 0.5% to 2%. 1% lidocaine contains 1g of lidocaine in 100ml or 1,000mg in 100ml.