Medication incidents accounted for 11% of all patient incidents reported to the National Reporting and Learning System (2012) in England and Wales between June 2010 and June 2011. Although 90% of the 141,387 incidents were reported as causing no harm to the patient, 2,535 caused severe harm and 50 caused the patient’s death. Medication errors are most frequently due to the wrong dose, omitted or delayed medication or the wrong medication being administered (National Patient Safety Agency, 2009a). The most frequently cited wrong-dose error stems from calculation error.

Common errors by nurses include the following:
- Not understanding the units of measurements for medication, for example “nanograms” and “micrograms”;
- Using the wrong equipment to measure dosages;
- Making slips in calculations that result in the wrong dose or rate of medicine being administered (NPSA, 2009a; 2009b).

These errors can be the result of nurses not having the right knowledge or skills, or of other factors, such as distractions or stress. Medication errors occur across acute, community, general practice, learning disabilities and mental health clinical areas, so key calculation skills are applicable to all nurses (NRLS, 2012).

Units of measurement
Nurses need to understand the measurements used for drug dosages and be able to convert between these different units of measurement (Fig 1). Drugs are generally measured in one of three ways:
- According to the drug’s weight (grams, milligrams and micrograms for example);
- The volume (millilitres and litres);
- Standardised international units and strength of solutions when a weight of a drug is dissolved in a volume of liquid (for example milligrams per millilitre).

A number of medication errors have been made through not converting between different units of measurement correctly, resulting in doses of 10 or 100 times that prescribed (NPSA, 2009b). A number of fatalities have occurred when nurses have not understood how to measure insulin units, mistakenly measuring this in millilitres and administering large doses of insulin (NPSA, 2010).

Drugs are commonly prescribed or manufactured according to their weight, or the strength of a specific volume (weight per volume or “w/v”). The main weight measurements that nurses must be familiar and confident converting between are grams, milligrams, micrograms and nanograms. The relationship between each of these measurements is 1000. Conversions require nurses to multiply or divide dosages by 1000. It is important that conversions are checked carefully, through repeating the calculation or asking a colleague if unsure.

Once the conversion has been checked the prescribed dose can be compared with the available dose to calculate how much of the medicine to administer. For tablets, this type of calculation is usually quite straightforward, as the prescribed dose can be divided by the available drug dose to work out how many tablets to give. For example, if the prescription is 30mg prednisolone and the tablets available are 5mg, then the number of tablets to administer would be six. When the available dose is a solution with a specific strength, then calculations can become more complicated. Solutions are frequently used in children’s nursing – for example medication may be a suspension (for children who find swallowing a tablet difficult) and this may be partly responsible for the higher rate of errors in children’s nursing (NPSA, 2009b).

Double-checking
Nurses use different methods to calculate the volume to administer solutions or ampoules depending on a variety of factors, and do not necessarily stick to one method (Wright, 2008). The most important thing is finding a method that you feel comfortable and confident with.

The evidence is beginning to suggest that methods used to manipulate the known weight/volume strength in order to find the required weight/volume strength could be less error-prone (Wright, 2008). Whatever method you use, it is important to be able to explain your methods and how you arrived at an answer so you can participate in double-checking calculations with colleagues.

Double-checking is recommended for all complex calculations (Nursing and Midwifery Council, 2010). Checking must involve each nurse separately doing the calculation and then both checking the
answer together. There is some evidence that double checking can increase the risk of error as each nurse relies on the other to pick up any error (Alsulami et al, 2012). This is why it is important that you both do the calculation separately before comparing. Once the calculation answer is agreed it is important that you relate this back to clinical practice, to ensure that the answer makes sense using your clinical and medicine knowledge. For example, is this an appropriate volume for this medicine, this route or the age of the patient?

Medication dosages can also be prescribed according to the weight of the patient in kilograms, and require an additional calculation to work out this dosage before the administration dose can be calculated. Children’s nursing has a lot of dose per weight prescriptions since dosages depend on the size of the child.

Medications can also be prescribed in doses that need to be administered continuously for a specified period of time. An infusion is, therefore, administered at a volume that will give the required dosage per hour or minute for the patient. To administer the correct dose we need to calculate the dose for the patient (dose x kg weight) and then calculate how many millilitres of the infusion need to be administered per hour to give the prescribed dose.

**Conclusion**

It is imperative that you are secure in all the basic calculation skills before moving on to more complex calculations. Remember also that the more steps to the calculation, the more possibility of error, so more care, checking and double checking with colleagues are required. Drug calculation is a core nursing skill and vital for patient safety. NT

**References**


National Patient Safety Agency (2009a) Safety in Doses: Improving the Use of Medicines in the NHS. tinyurl.com/nrpsafetydoses


National Reporting and Learning System (2012) Quarterly Data Workbook up to September 2011. tinyurl.com/nrlsquartmar12


**TEST YOUR KNOWLEDGE**

Can you answer these questions? To check if you are correct go to our learning unit at nursingtimes.net/drugcalculations

1. Which of the following ways of writing dosages could increase the risk of error?
   A. 6IU Humulin M1
   B. 500µg digoxin
   C. 50 nanograms alfacalcidol
   D. 1.80g benzylpenicillin

2. Jane has been prescribed digoxin 0.25mg. The volume should be 125mcg. How many tablets do you need to administer to Jane?
   A. 4 tablets
   B. 1 tablet
   C. 2 tablets
   D. ½ tablet

3. Joan has been prescribed dopamine 2mcg/kg/min. The usual infusion strength for your clinical area is dopamine 80mg/50ml, infused via a syringe pump. Joan’s weight is 52kg. What rate per hour (ml/hr) would you set this pump for so Joan receives the correct dose?
   A. 3.9ml/hr
   B. 0.39ml/hr
   C. 39ml/hr
   D. 1.95ml/hr

4. Justin has been prescribed gentamicin 3mg/kg gentamicin IM in three divided doses. Justin’s weight is 68kg. The available gentamicin vials are 80mg/2ml. A colleague has drawn up 3.25ml ready for injection and asks you to check this. Is this correct?
   A. Yes.
   B. No, the administering volume should be 1.7ml
   C. No, the administering volume should be 2.55ml
   D. No, the administering volume should be 0.85ml

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