Drug calculations

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Nurses frequently use various types of mathematical calculation as part of their clinical practice, mainly when administering drugs.

Maintaining accuracy
To minimise the number of errors caused by miscalculating dose, volume or rate of administration nurses must be familiar with and apply a number of mathematical formulae (Trim, 2004).

Many organisations’ policies stipulate that two practitioners must check drugs, particularly those administered intravenously. The NMC (2002) also stipulates that two practitioners should be involved in complex calculations and it is considered good practice for two to be involved in all but the most basic drug calculations.

The use of calculators in applying mathematical formulae is inevitable, particularly for more complex calculations. However, it is important to take extra care when using a calculator to prevent operator or machine error.

Unit conversions
Many calculations require different volumes or weights to be converted into the same unit or value. To convert larger units to smaller the larger is multiplied:
- Kilograms (kg) to grams (g) = kg × 1,000;
- Grams to milligrams (mg) = g × 1,000;
- Milligrams to micrograms (mcg) = mg × 1,000;
- Micrograms to nanograms (ng) = mcg × 1,000;
- Litres (L) to millilitres (ml) = L × 1,000.

To convert smaller units to larger the smaller is divided:
- Grams to kilograms = g/1,000;
- Milligrams to grams = mg/1,000;
- Micrograms to milligrams = mcg/1,000;
- Nanograms to micrograms = ng/1,000;
- Millilitres to litres = ml/1000.

Large infusion rates
To administer fluid volumes over a specified time a gravitational flow administration set may be used, which requires the infusion rate to be administered as ‘drops per minute’. To calculate this the number of drops per ml for the specific set must be ascertained – this is usually identified on its packaging. Generally, crystalloid administration sets operate at 20 drops per millilitre (d/ml) and blood (large-bore) sets operate at 15d/ml.

To calculate the infusion rate in drops per minute the following formula is applied (Fig 1):

\[
\text{Vol required} \times \frac{\text{Set value (d/ml)}}{\text{Duration (hr)}} \times \frac{\text{Minutes (60)}}{1} = \text{infusion rate (drops per minute)}
\]

To calculate ml/hr the following formula is applied (Fig 2):

\[
\frac{\text{Volume to be infused}}{\text{Duration of infusion}} = \text{ml/hr}
\]

Nurses must ensure they have received specific training in the use of the particular infusion device before operating it.

Required drug volume from stock strength
This is a common calculation as many prescribed doses are smaller than the available preparation. In some drugs the stock concentration may depend on the volume of diluent. This is often the case in reconstituting...
antibiotics. The following formula is applied (Fig 3):

\[
\frac{\text{Amount required}}{\text{Stock strength}} = \frac{\text{Stock volume}}{x}
\]

Or more simply

\[
\frac{\text{What you want}}{\text{What you have got}} = \frac{\text{Volume}}{x}
\]

**Calculating weight-related doses**

Occasionally, and particularly in paediatrics, drugs are prescribed based on the patient’s body weight. The prescription may be expressed as millilitres per kilogram (ml/kg) or milligrams per kilogram (mg/kg). The following formula is applied (Fig 4):

\[
\text{Prescribed volume} \times \text{Body weight} = \frac{\text{Prescribed dose}}{\text{Body weight}}
\]

**Concentrations (mg/ml) from solutions**

Some drugs are presented in a percentage concentration (for example, lidocaine, calcium chloride and dextrose in solution). The expression refers to grams per 100ml, so a one per cent solution would be 1g per 100ml and a 50 per cent solution would be 50g per 100ml. The volume always remains constant (Fig 5).

**Concentrations from weight to volume ratios**

Some drugs are expressed as a weight to volume ratio (such as adrenaline and noradrenaline). These could be expressed as 1:1,000 or 1:10,000.

The expression is similar to a percentage except that the weight remains constant (1g) and the volume differs. The volume is in millilitres. Therefore:

- Adrenaline 1:10,000 = 1g in 10,000ml
- Noradrenaline 1:1,000 = 1g in 1,000ml

Once a mg/ml concentration has been calculated, further formulae such as dose or stock strength \(\times\) volume may be necessary to calculate the volume required (Fig 6).