An Introduction to Pharmacology and Drug Doses

Lauren Barker
Correspondence Email: Lauren.Barker@rdeft.nhs.uk

DOSES OF DRUGS IN ANAESTHESIA

Drugs in anaesthesia are commonly expressed in grams, milligrams or micrograms which refer to their mass.

Abbreviations are often used:	
Mass	**Abbrevation**
kilogram	kg
gram	g
milligram	mg
microgram	mcg
nanogram	ng

Examples:

1g flucloxacillin, 500mg thiopentone, 600mcg atropine. The words milli-, micro- and nano- which appear in front of "gram" refer to how many multiples of 10 are present.

- It is possible to convert from grams to nanograms as follows:

1g = 1 000 mg = 1 000 000mcg = 1 000 000 000ng

- To convert, for example, from micrograms to milligrams:

600mcg atropine = 0.6mg atropine

RECOMMENDED OR THERAPEUTIC DRUG DOSES

Recommended or therapeutic doses enable one to calculate the correct dose of drug for the patient undergoing anaesthesia. These doses were previously expressed as mg/kg or mcg/kg but should now formally be written as $mg.kg^{-1}$ or $mcg.kg^{-1}$ and are calculated as follows:

Example:

The dose of atropine is $20mcg.kg^{-1}$

- To calculate the correct dose of drug for a patient, multiply the drug dose by the patient's weight. In a 20kg patient we would give:

$20mcg.kg^{-1} = 20mcg.kg^{-1} \times 20kg =$
$400mcg = 0.4mg$

- To calculate the correct dose of atracurium $(0.5mg.kg^{-1})$ for a 70kg adult.

$0.5mg.kg^{-1} \times 70kg = 35mg$

MAXIMUM DOSES

Maximum doses may refer to local anaesthetic drugs like lignocaine or bupivacaine and indicate the maximum dose of drug that may be given to the patient safely without causing toxicity. In the case of local anaesthetics cardiac arrhythmias or convulsions may result if the maximum dose is exceeded.

OTHER UNITS FOR DESCRIBING DRUGS

Most commonly we describe the amount of drug present by reference to the mass of drug (see above). However drug preparations may also be described by how many particles they contain. This gives an idea of the amount of drug present rather than the mass of the drug.

By convention the amount of a substance is measured in moles (abbreviation: mol). A mole has been defined by the Système International as the quantity of a substance that contains the same number of particles as there are atoms in 12g of carbon-12. There are 6.022×10^{23} atoms present in 12g carbon-12 and this equals one mole. (6.022×10^{23} is the abbreviated way of writing a large number – written in full you would have to move the decimal point to the right 23 times i.e. 6022 followed by 20 zero's).

This dose method is often used for substances such as potassium (K^+) or sodium (Na^+) in the form of millimole (1mole = 1000 millimole - often written as mmol). This method is useful as sodium or potassium are often prepared with chloride and when administered it is helpful to consider only the amount of Na^+ or K^+ that is given. Therefore it is usually described in mmol.

Example:

A solution of normal saline contains 154mmol Na^+ and 154mmol Cl^- in each litre.

Summary

This article explains the internationally recognised formats for describing drugs, their dosage and dilutions. Commonly encountered dilutions of drugs such as epinephrine (adrenaline) and local anaesthetic agents are clarified using examples. The recommended international non-propriety names (rINN) of some of the more commonly encountered anaesthetic and critical care drugs are listed.

Lauren Barker
Consultant Anaesthetist
Royal Devon and Exeter
NHS Foundation Trust
Barrack Road
Exeter EX2 5DW
UK

DRUGS IN CONCENTRATIONS

When a substance is dissolved in a liquid it forms a solution. The volume of a solution is expressed in litres or millilitres. 1litre = 1000ml.

The substance dissolved is known as the solute. The amount of solute in a solution is expressed as a concentration. The amount of solute may be described by its mass (grams or milligrams per litre) or by its amount (moles per litre or millimoles per litre).

If the solute has a known chemical formula (e.g. salt - NaCl), then it is preferable to use $mol.l^{-1}$ or $mmol.l^{-1}$. If the solute does not have a defined chemical composition (such as a protein), then $mg.l^{-1}$ or $g.l^{-1}$ is used.

Some solutions such as local anaesthetics and thiopentone that are used in anaesthesia on a daily basis are expressed as a percentage e.g. lignocaine 2% and thiopentone 2.5%.

When using drugs prepared in this way it is necessary to calculate the number of mg in ml of solution. This is easiest done by multiplying the percentage of the solution by 10:

- 2% lignocaine x 10 = $20mg.ml^{-1}$
- 0.5% bupivacaine x 10 = $5mg.ml^{-1}$
- 2.5% thiopentone x 10 = $25 mg.ml^{-1}$

The maths behind this calculation is as follows:
- A 2.5% solution means that there is 2.5g of thiopentone in 100ml:

> 2.5g in 100ml
>
> = 2500mg in 100ml
>
> = 25mg in 1ml ($25mg.ml^{-1}$)

Some solutions such as epinephrine (adrenaline) may be expressed as 1:1000 or 1:10 000 or 1:100 000. This means that in a 1:1000 epinephrine ampoule there is one part epinephrine to 1000 parts solution.

To work out how many milligrams of epinephrine are present:

- 1:1000 solution epinephrine

  = 1g epinephrine in 1000ml solution

  = 1000mg epinephrine per 1000ml solution

  = 1mg per ml

- 1:10 000 solution epinephrine

  = 1g epinephrine in 10,000ml solution

  = 1000mg per 10,000ml

  = 1mg per 10ml which can also be expressed as 100mcg per ml

PREPARING LOCAL ANAESTHETICS WITH EPINEPHRINE

Pre-mixed ampoules of lignocaine 1% and 2% with adrenaline are sometimes not available and it is may be necessary to prepare these solutions locally. A 1:200 000 solution means that there is 1 part adrenaline to 200 000 parts of solution (lignocaine in this instance).

In order to produce a 1:200 000 adrenaline solution, add 0.1ml adrenaline 1:1000 to 20ml lignocaine. The method is as follows:

- Take 1ml of adrenaline 1:1000 - dilute to 10mls with saline.
- Take 1ml of this mix which is now 1ml of 1:10 000 adrenaline. Add 19ml lignocaine.

- Total solution is now 20mls and the original adrenaline has been diluted 200 times = 1:200 000 solution

OTHER UNITS - MILLIEQUIVALENTS (mEq)

Sometimes the term milliequivalent is used in textbooks, although millimoles is the more correct expression. When substances are dissolved in a liquid, they may develop a charge. For example, when salt (NaCl) is dissolved in water, it separates into its two components: Na^+ and Cl^- (these are known as ions). Sodium ions have one positive charge and chloride ions have one negative charge. The word milliequivalent refers to how many ions are present. In this case the number of milliequivalents will be the same as the number of millimoles in solution.

Example:
A plasma sodium concentration of $140mEq.l^{-1}$ equals $140mmol.l^{-1}$.

However, in a magnesium chloride solution ($MgCl_2$) the magnesium ion has two positive charges (Mg^{2+}) so there will be two milliequivalents of magnesium per litre of solution. In this case the number of milliequivalents will not equal the number of millimoles.

CHANGES IN DRUG NAMES

New regulations from the EEC now require the use of the Recommended International Non-proprietary Name (rINN) for drugs. In drugs where there is concern that a name change may pose a serious risk to patients, both the British Approved Name (BAN) and the rINN name will appear on the drug ampoule for at least the next 5 years. In other cases, the new name will appear alone.

Some examples of name changes that will affect anaesthetists are:

UK name	rINN name
adrenaline	epinephrine
noradrenaline	norepinephrine
frusemide	furosemide
lignocaine	lidocaine
thiopentone	thiopental
phenobarbitone	phenobarbital