# DRUG DOSAGE CALCULATIONS

THE UNIVERSITY OF NOTTINGHAM

SCHOOL OF NURSING

updated Feb 2001

## Mathematics and Drug Administration

### Why is it important?

During your career you will often be called upon to administer or supervise the administration of all types of medicines. As part of the course you will be taught how to do this safely and efficiently. However, the achievement of this aim requires the development of a certain degree of mathematical skill. The required level is not high, but attaining it is necessary to ensure that the safety of patients is not compromised.

During the course your mathematical ability will be examined by means of a series of formative tests. These will demonstrate whether you have the necessary level of mathematical ability to competently administer and supervise the administration of medicines.

The tests have been designed to help you assess your abilities and identify your weaknesses. These can then be addressed by determining an appropriate course of study.

There are two tests within the Common Foundation Programme (CFP) and further, more comprehensive tests of your ability to administer medicines will follow in the branch programmes.

The recognised pass mark for the tests within the CFP programme is 70%. If your mark falls below this figure, you are required to seek tutorial support.

Following each test your paper will be sent to your group tutor and he or she will discuss your performance and if necessary a study strategy will be determined to improve your skills. After completing this course of study you will be required to take a further test to evaluate your progress

### If I need help what do I do?

You may approach your group tutor for help, or he or she may refer you to other tutors (see below) experienced in teaching in this area. Depending upon the demand these tutors will arrange small group tutorials, individual tutorials or a combination of both.

Other sources of help include easy to use computer programmes and books from the Greenfield library.

**Tutors willing to give assistance**.

**Dave Hilton** C Floor – Dave's Office is on C floor room 44, QMC Tel - 44007
**Jill Wakefield** D Floor – Jill's Office is opposite Ward D58.Tel - 43234

# Numeracy and Drug Calculations

This handout covers a variety of numeracy based tasks which nurses and midwives may be required to perform in practice. These include drug calculations and setting drip rates on the controls of intravenous infusion controllers.

The handout covers the following: SI units and conversions, calculating drug quantities in both tablet and liquid form, and calculating intravenous flow rates and drip rates. Exercises are included at the end of each lesson. Answers are on the back page.

## S.I. Units

This is another name for the metric system of measurement. The aim of metrication is to make calculations easier than with the imperial system (which includes ounces, pounds, stones, inches, pints etc). SI stands for *Systeme Internationale* and it is now recognised as the standard system for measurement in most disciplines around the world. It was introduced in the NHS in 1975.

The SI system defines a base unit for a particular measurement (for example the gram for measuring weight) and a prefix (eg kilo, milli) when the actual numbers in the measurement become very large or very small. For example one millionth of a gram could be written as 0.000001g or 1mcg. The second version is easier to read than the first and easier to work with once you understand how to use units and prefixes. It is also less likely to lead to errors, especially when administering drug doses.

The following describes some things that are measured, the name of the S.I unit used and the recognised abbreviation or symbol:

| What we measure | SI unit | symbol |
|---|---|---|
| length | metre | m |
| weight (mass) | gram | g |
| volume | litre | l, L |
| temperature | degree Celsius | $^{o}$C |

The following prefixes are also used:

| Order of size | Prefix | symbol |
|---|---|---|
| one thousand | kilo | k |
| one thousandth | milli | m |
| one millionth | micro | micro, µ |

**Notes**

Although the S.I unit for litre is l, ie a lower case L, this has caused so much confusion because it looks exactly like a 1, ie number one. It is acceptable to use upper case L instead and this is in fact what you will find in Drug Directories such as the British National Formulary (BNF).

Micro is a special case. The Greek symbol µ (micro) is often misread as m (milli) particularly if the handwriting is poor. For micrograms you may use mcg or better still write the word *microgram* out in full.

**Using S.I Units**

When a measurement is very large or very small, using the unit on it's own becomes impractical. If we had a drug that was very potent, a patient may only require a tiny amount. If this was just one millionth of a gram, this could be written as 0.000001g but this can easily be misread. It would be very easy to confuse it with 0.00001g for example.

By using prefixes the same quantity could be written as 1mcg or as 1 microgram, either of which is clearer to read.

By definition, **1 gram = 1000 milligrams** and **1 milligram =1000 micrograms**

Sometimes you may have to convert a quantity from one unit to another. A common example is converting a quantity given in milligrams into grams. Consider the number and the units separately. If the units describing a quantity get bigger, you will have numerically less of them. If the units get smaller you will have more of them. What you need to do is to balance the number and the units.

Here is an example: Convert 500mg into grams

Consider the **500** and the **mg** as two separate parts. The mg is to be changed to g so the *units* are to become one thousand times *bigger*. The number of these units is made one thousand times *smaller* to compensate.

To make a number one thousand times smaller, consider the number as a decimal (ie 500.0) then move the decimal point *three* places to the left, giving .5000 which in its standard form would be rewritten as 0.5

So 500mg can be rewritten as 0.5g

To convert the other way, use the same idea in reverse. If the units get smaller the number gets bigger. Just remember to balance the dimensions of the units against the number of units.

Here are some examples showing conversions in both directions:

| | | |
|---|---|---|
| 300mg = 0.3g | 0.5g = 500mg | 750micrograms = 0.75 mg |
| 2500ml = 2.5l | 0.025m = 25mm | 0.05mg = 50 micrograms |

**Exercise 1**

1 Convert 250mg to g ......................

2 Convert 0.5g to mg ......................

3 Convert 250 mcg to mg ......................

4 Convert 50ml to litres ......................

5 Convert 0.125g to mg ......................

## Dosage Calculations

On a drug round, you may be given the total dose a patient is to receive. The nurse's task will be to find out the amount of drug in each tablet and then to calculate how many tablets to give the patient.

**Example** A patient is prescribed 120mg of Verapamil but the tablets are available as 40mg each. How many tablets are required ? The solution involves finding how many 40s are in 120 or in other words 120 divided by 40.

The formulae is: the number of tablets = $\frac{\text{amount prescribed}}{\text{amount in each tablet}}$

The *prescription* is the total quantity to be given or "what you want".
The *availability* is the quantity in each tablet or "what you've got".
So you can use the following to remember the calculation:

$$\textbf{number of tablets} = \frac{\textbf{what you want}}{\textbf{what you've got}}$$

In our example the answer would be 120mg (what you want) divided by 40mg (what you've got) which gives the answer 3, so the patient would be given three tablets.

Of course if you find it easier to think of it as how many times 40 make up 120 this is OK.

But suppose a patient is prescribed 1.5g of a drug that is available in 500mg tablets. How many tablets do you give now? A very important point about performing drug calculations is that the prescribed amount and the availability must be in the same units. In this case we could either convert the 500 milligrams into grams, or we could convert the 1.5 grams into milligrams.

It is probably easier to convert the grams to milligrams. 1.5g is the same as 1500mg. So the problem is now 1500mg divided by 500mg = 3 tablets.

As a rule it is unlikely that you will have to give a patient more than three or four tablets and usually only one or two. If your calculations suggest otherwise, check again. If you are ever unsure, ask a colleague to double check. Also note that paediatric doses are usually only half the adult dose.

**EXERCISE 2**

1 500mg is prescribed, tablets are 250mg each: how many tablets will you give? ..........

2 50mg is prescribed, tablets are 12.5mg each: how many tablets will you give ? ..........

3 1mg prescribed, tablets are 500micrograms: how many tablets will you give? ..........

4 625mg prescribed, tablets are 1.25g each: how many tablets will you give ? ..........

5 3 tablets each contain 250mg. What is the total dose in milligrams? ..........

## Drugs in Liquid Form

When drugs are in liquid form, the availability is given in terms of the concentration of the solution or suspension. As an example, pethidine hydrochloride is available as 50mg/ml. This means that 50 milligrams of pethidine hydrochloride are dissolved in every millilitre of liquid.

If the quantity of drug to be given is known, and the concentration of the drug in solution is known, we can calculate the volume of liquid required. This is necessary for drugs in liquid form as prescriptions are usually by weight, whereas the drugs are labelled by concentration.

We can adapt our previous formula for tablets to read:

$$\text{number of measures} = \frac{\text{amount prescribed}}{\text{amount per measure}}$$

The measure is the unit amount of liquid. In this case it is one millilitre.

Example: A drug is available as 25mg/ml and 75mg are required. What volume will be given in ml?

Answer: The amount prescribed is 75mg and the amount per measure is 25mg. Now 75 divided by 25 is 3 so we need three measures. But each measure is one millilitre so we should give 3ml.

Sometimes the drug may be available in other concentrations, such as 10mg/5ml. This is often the case for linctus (syrup) which is usually administered by 5ml teaspoon or beaker. The 5ml is the unit measure so the way to calculate the quantity is exactly as it was in the previous example.

Example: A linctus is available as 25mg/5ml and we need to give the patient 50mg. What volume will be given ?

Answer: The amount prescribed is 50mg and the amount per measure is 25mg so the number of measures is 2. Now each measure is 5ml so the quantity to be given is 2 x 5 = 10ml.

There is a formulae which combines the two stages above to calculate the volume rather than the number of measures:

$$\textbf{volume to be given} = \frac{\textbf{amount prescribed x unit volume}}{\textbf{amount per unit volume}}$$

In the above example, the volume to be given is $\frac{50 \times 5}{25}$ which is 10

**EXERCISE 3**

1. Drug available as 10mg/ml: prescription is for 20mg, how many ml will be given ? ......

2. Drug available as 10mg/2ml: prescription is for 5mg, how many ml will be given ? ......

3. Drug available as 20mg/5ml: prescription is for 40mg, how many ml will be given ? ......

4. Drug available as 10mg/ml: how many mg will there be in 3ml ? ......

5. Drug available as 20mg/5ml: how many mg will be in 7.5ml ? ......

**Intravenous Drips**

The rate of flow of fluid down intravenous infusion lines must be regulated and this is often controlled by a device known as an infusion controller. The controller measures precise volumes of liquid and releases tiny droplets, each of exactly the same volume, down the IV line (tube) at precise intervals. The infusion controller has a keypad or thumb-wheel which allows the operator to alter the flow of liquid. Some controllers require you to set the Flow Rate, which is measured in Millilitres per Hour. Others require you to set the Drip Rate, measured in Drips per Minute. It is important that you know which you are dealing with. This will be written on the machine itself.

To calculate the Flow Rate, this is simply the volume in ml divided by the duration in hours. Both these values will be prescribed.

Example: A patient requires 500ml IVI over twelve hours. What is the flow rate ?
Answer 500 divided by 12 is 41.66ml/hr . If you do not the facility to enter decimals then round to the nearest whole number. The answer would then be 42ml/hr.

On some types of flow controller, the size of each drop of liquid given is governed by the internal mechanics of the controller. It is fixed at the factory and cannot be altered. This constant quantity gives rise to the "drop factor" which is the number of drops which make up every millilitre of fluid delivered. Two common sizes are 20 drops per ml and 15 drops per ml. A special paediatric infusion controller is available which delivers 60 drops per ml.

The Drop Rate is defined by (1) below:

$$\text{Drop rate} = \frac{\text{total drops}}{\text{time in minutes}} \qquad (1)$$

If the total volume of fluid is given in millilitres and the drop factor for the controller is known (written on the machine), the total number of drops which the patient will receive can be calculated by the expression:

$$\text{Total number of drops} = \text{drop factor X volume in ml} \qquad (2)$$

Also, if the time is given in hours, we can calculate the time in minutes from:

$$60 \ \text{X} \ \text{time in hours} \qquad (3)$$

So the formula in expression (1) can be rewritten using expressions (2) and (3) as:

$$\textbf{Drop rate} = \frac{\textbf{drop factor X volume in ml}}{\textbf{60 X time in hours}} \qquad (4)$$

Example: 500ml of 5%dextrose solution is to be given intravenously. The infusion controller has a drop factor 20 drops per ml and you are instructed to ensure that the patient receives this volume in 12 hours. What should the drop rate be set to ?

Answer: $$\text{Drop rate} = \frac{\text{20 drops per ml X 500ml}}{\text{60 X 12 hours}} = 13.89$$

Note that it is necessary to round to the nearest whole number, because infusion controllers which are calibrated to operate in drops per minute do not have the facility for decimals, so the answer would be 14 drops per minute.

**EXERCISE 4**

Find the drop rate for these questions:

1. If a patient requires 250ml in 6 hours what is the *flow* rate (give your answer to two decimal places)

....................

2. If a patient requires 1000ml in 12 hours what is the flow rate (give your answer to two decimal places)

....................

3. If a patient is to be given 500ml by IVI using a controller with a drip factor of 20drops/ml over 6 hours, what would you set the drip rate to (round to the nearest whole number)

....................

4. If a patient is to be given 750ml by IVI using a controller with a drip factor of 20drops/ml over 12 hours, what would you set the drip rate to (round to the nearest whole number)

....................

5. A patient is to be given 1000 ml by IVI using a controller with a drip *factor* of 15 drops/ml. The infusion starts at 8.00am and every four hours the patient is given a 1hr rest. If the drip *rate* was set at 25 drops per minute, how much liquid would be left at 3.00pm ?

....................

**Answers to exercises**

**EXERCISE 1**

| | |
|---|---|
| 1 | 0.25g |
| 2 | 500mg |
| 3 | 0.25mg |
| 4 | 0.05 l |
| 5 | 125mg |

**EXERCISE 2**

| | |
|---|---|
| 1 | 2 tablets |
| 2 | 4 tablets |
| 3 | 2 tablets |
| 4 | 1/2 tablet |
| 5 | 750mg |

**EXERCISE 3**

| | |
|---|---|
| 1 | 2ml |
| 2 | 1ml |
| 3 | 10ml |
| 4 | 30mg |
| 5 | 30mg |

**EXERCISE 4**

| | |
|---|---|
| 1 | 41.67ml/hr |
| 2 | 83.33ml/hr |
| 3 | 28 drops/min |
| 4 | 21drops/min |
| 5 | 400ml |

## Suggested Books

The mathematics texts identified below are all available in the Greenfield Medical library.


Dison, N. (1992) **Simplified Drugs and Solutions for Nurses 10th Edition** St Louis, C V Mosby

Duff, D. (1985) **A Metric Guide for Health Professionals on Dosages and Solutions** Toronto, W B Saunders

Erickson, B., Todd, C. (1991) **Dosage Calculations** Pennsylvania, Springhouse Corporation

Gatford, J. (1998) **Nursing calculations** Edinburgh, Churchill Livingstone

Gray, D. (1994) **Calculate with Confidence** St Louis, C V Mosby

Hart, L. (1977) **The Arithmetic of Dosages and Solutions** St Louis, C V Mosby

Jefferies, P. (1983) **Mathematics in Nursing** London, Balliere Tindall

Lapham, R., Agar, H. (1995) **Drug Calculations for Nurses: a step by step approach** London, Arnold

Oliver, G. (2000) **Dosage calculations** Springhouse Philaelphia, Springhouse

Pirie S (1985) **Maths for Nursing** London, Balliere Tindall


## Computer Programmes

There are a number of packages available on the network. One package comprises of lessons, exercises and a simulated ward round. To run it, log on to the network and follow the route shown below:

**School & Departmental > Medicine & Health Sciences > CAL > New Maths Test**

If you experience any problems with accessing the computer packages contact Dave Hilton on QMC (0115 9249924) ext 44007 or email dave.hilton@nottingham.ac.uk

These resources are available for you to become the safe practitioner you want to be. Please do not be afraid to make use of them.