Chapter 1

Getting the Lowdown on Nursing Calculations and IV Therapy

In This Chapter

- Understanding the basic maths required for healthcare
- Knowing IV therapy and its correct administration
- Being clear on complications

Intravenous (IV) therapy is one of the most common clinical skills that healthcare professionals perform. It includes administering IV drugs, fluid replacement (including blood and blood products), *cytotoxic* therapy (chemotherapy) and *parenteral nutrition* (which doesn't mean your mum and dad providing a hot meal when you pop home to get your washing done (!) but feeding 'not via the alimentary canal'). Intravenous therapy can also take the form of administering emergency fluids and medications, such as when individuals have sustained huge blood loss, and/or to convert heart arrhythmias back to sinus rhythm.

In this chapter, I describe how this book takes you through the whole IV process – showing you how to walk before you can run. I help you get to grips with the mathematics and formulae necessary to work out the amounts of drugs or fluids to administer through the main routes, including oral, and translating doctors' written instructions (which can be tricky at the best of times!).

This book also describes the types of IV therapy and how they can relate to patients' blood tests obtained by venepuncture (flip to Chapter 11 for more) as well as their medical condition. I explore methods of getting the medications into the IV route as well as looking at the legal and professional aspects of IV therapy and complications associated with specific routes of administration.

Whatever your reason for entering healthcare, you share a common goal with all nurses and other healthcare professionals. You want to make your sick patients better, keep your healthy patients healthy and provide high-quality care to people, including those at their end-of-life journey.

This aim is encompassed within the culture of 'compassionate care' – known as the 6 Cs:

- Care
- Compassion
- Competence
- Communication
- Courage
- Commitment

Practices can, of course, vary among hospitals and clinical areas. Adhere to your own employer's policies and procedures at all times and document all your actions.

Increasing Your Confidence in Healthcare-Related Maths

The Nursing and Midwifery Council (`www.nmc.org.uk`) specifically states that to become a registered nurse, you need to be competent in calculations that involve the following: 'tablets and capsules, liquid medicines, injections, intravenous infusions including unit dose, sub- and multiple unit dose, complex calculation and SI conversion' – quite a mouthful, but not as scary as it sounds.

For this reason, nursing students, midwives, assistant practitioners and any healthcare professionals involved in the administration of medicines undergo vigorous calculations testing throughout their training, in order to be able to perform drug calculations accurately.

As a healthcare care professional, when you want to administer IV drugs you attend a study session to discover the requirements of IV therapy. Usually before attending the session, you undertake a higher-level maths test in order to prove your maths competence. Many individuals like to revise a few of the basics, before progressing to the higher-level maths.

The wise saying (by the poet John Donne if you want to impress your friends!) goes that 'no man is an island'. In the healthcare environment, this quote indicates that a patient isn't just a physiological medical condition, but a living, breathing being with many elements (the *biopsychosocial* approach to care). In short, care isn't just about working out the drug dosage to administer to the patient, to relieve the biological element of her needs; care involves treating the patient holistically.

Beginning with the basics

Much of the maths you need to become conversant with in the healthcare setting involve fractions, decimals and percentages.

Fractions

Like contestants on *The Voice,* fractions come in four forms (that's got you thinking, hasn't it!):

- **Common fractions (also known as vulgar fractions):** For example, 1 tablet needs to be cut into two, equates to 1 tablet ÷ 2 = ½.
- **Decimal fractions:** For example, when needing 0.45 ml (sometimes appears as mL) from 1 ml of liquid medication, 1 is the whole decimal number and 0.45 is a fraction of this whole number (being less than half).
- **Percentage fractions:** For example, administering a 1-litre (1,000-ml) bag of 5% glucose equates to 5 parts of glucose per every 100 parts of fluid.
- **Ratio:** For example, 25 patients are on ward 9B, 10 are being transferred to other wards today, with 5 of the 25 patients being discharged home, equals 25:10:5 or 5:2:1.

Decimals

Decimal numbers are built on the metric system, describing tenths, hundredths and thousandths of a number. For example, 1.25 is equal to one whole unit, plus a fraction of one (25 hundredths).

Some calculations require a conversion from the older imperial system of measurement into the metric system. An example is weighing scales showing stones and pounds instead of kilograms. In such cases, you need to know the conversion factors, such as 1 kilogram = 2.2 pounds. Chapter 8 shows how to conduct these conversions.

Chapter 2 covers the metric units and system and Chapter 3 takes you through your fractions and decimals basics.

Percentages

A percentage is a common way of expressing an amount relating to a whole. In healthcare you need to know information such as how much of a drug is in a solution, such as 0.9% sodium chloride in 1 litre of fluid (Chapter 5 has all the gen on solution concentrates).

You work this amount out as follows: $(0.9 \div 100) \times 1{,}000$ ml = 9 grams. You now know that 9 grams of sodium chloride are in a 1-litre bag of fluid.

Chapter 4 takes you through your percentages calculations, as well as other basics, such as averages and ratios.

Choosing to Use Bundles

Often you're required to work with quite complicated and complex mathematics in order to administer the correct amount of medication to the patient.

One method that can help with this task is the *bundle system* (which is where you break down the numbers into smaller units).

Imagine that 10 milligrams of a drug is presented as 5 millilitres. The patient is prescribed 2.5 milligrams of the drug and you need to find out how much this amount equates to in millilitres. You do so simply by breaking down the dose into smaller units:

- 10 mg = 5 ml
- 5 mg = 2.5 ml
- 2.5 ml = 1.25 ml

Therefore, the patient requires 1.25 millilitres of the drug.

(By the way, this example is also an example of the useful examples I provide throughout this book – as examples!)

Working out the tablet/capsule drug dosages

When a patient is prescribed, say, 300 milligrams of a medication presented as 300 milligrams per tablet, you know to administer one tablet. Simple. Sometimes, however, the maths can get a little more complicated, which is where the formula method or approach comes in useful.

Here's one useful formula that you encounter throughout this book:

What you want ÷ what you've got

In other words, the prescribed amount divided by how the drug is presented in its packaging.

A patient requires 45 milligrams (that's what you want) of a drug presented as 135 milligrams per tablet (that's what you've got). Therefore, you use the above formula:

45 ÷ 135 = 0.33 mg, which equates to one third of the tablet

You can reverse-check this answer by multiplying 45 by 3 = 135 milligrams.

Chapter 8 takes you through the safety precautions of administering medications, because you'd never break a tablet into a third – the resulting tablet part may not be an accurate third. Plus, Chapter 9 discusses the process by which pills work in the body when taken orally.

Calculating liquid drug dosages

Liquid medications, including those required for injection (see Chapter 10), are presented in liquid format (or need to be reconstituted in liquid). You measure them into a pot, oral syringe or injectable syringe, using the same formula as for tablets and capsules (see the preceding section), but you have to add the extra aspect of 'volume'. So the formula becomes:

(What you want ÷ What you've got) × Volume

For a prescribed dose of 250 milligrams of amoxicillin, from an ampoule containing 125 milligrams in 5 millilitres, you add the numbers into this formula:

(250 mg ÷ 125 mg) × 5 ml = 10 ml

In order to work out these drug dosages, good practice is to get someone to check your answer independently where possible and to use a calculator for the more complex calculations.

Chapter 8 goes through the common oral and injectable formulae for working out drug dosages, and Chapter 12 looks at the more advanced ones.

Monitoring Your Patients

As a healthcare professional, you need to measure and record details of your patients' conditions. This information relates to their vital signs, prescriptions, fluid levels and any indications of deterioration. You need to know the important methods and documents for recording these details inside out.

Visiting the realm of vital signs: Physiological measurements

When a patient's respiratory rate and heart rate rise, you need to investigate the reason why and provide an appropriate treatment. For example, you may need to administer analgesics and/or anti-emetics if the patient is in pain or feeling sick. In other words, you need to apply nursing calculations in all aspects of the patient's care, not just when administering medications. The *physiological measurements* – or vital signs (see Chapter 7) – are often abbreviated to TPR and BP (meaning temperature, pulse and respirations and blood pressure).

When administering medications to patients, you need to look at the whole picture and understand that the prescription chart isn't something to follow blindly. For example, you don't administer anti-hypertensive medication to a patient who's hypotensive, or give a drug when you've just found out that the patient previously suffered an allergic reaction to it (for details about adverse reactions, check out Chapter 13). You use your noggin (brain) to work out that you need to discuss this issue with the doctor.

Interpreting the prescription chart

Before administering medications, you need to be familiar with the abbreviations on the prescription chart. In the community (anything out of the hospital setting), this chart is often called the *Medication Administration Records and Requests* document (or MARRs sheet).

Whatever the specific document you use, understanding the instructions is vital.

Another factor when reading the prescription chart is whether the medication has been prescribed using the correct *non-proprietary* name (that is, the chemical or generic name) or the *proprietary* name (the brand or trade name). To avoid confusion, drugs should be prescribed using the approved generic name. For example, salbutamol (albuterol) is the drug's non-proprietary name, whereas its proprietary name is Ventolin.

Generally speaking, don't use too many abbreviations, apart from the approved ones, because different clinical areas sometimes use different abbreviations. For example, DOA can mean 'dead on arrival' in an emergency unit but 'date of admission' in a ward unit. Unsurprisingly, patients object to being declared dead when they've just arrived for a 15-minute cataract procedure!

Chapter 6 looks at interpreting instructions.

Finding out about the fluid chart

The *fluid chart* is an important document, which when completed correctly establishes the patient's fluid balance. The *fluid balance* (see Chapter 7) relates to the difference between the amount of fluid taken into the body and the amount excreted or lost.

Accurately monitoring a patient's fluid balance is crucial to a patient's well-being, because the body works within narrow parameters and is always striving for *homeostasis* (balance). In other words, any water loss needs to be replaced in order for the body's water volume to remain constant.

Completing a fluid chart is simply about recording the amount of all drinks, IV fluids and so on going into the patient's body. You then add up all the fluid that has left the body, taking this amount away from the input amount. The result is the fluid balance.

When the intake is greater than the output amount, a *positive balance* is recorded, but if the intake amount is less than output the fluid balance is recorded as *negative.* The balance is usually viewed over a couple of days, because sometimes the body is playing 'catch-up'.

Sometimes, when you're rushed off your feet, you can tally up these figures inaccurately. As a result, the patient may be prescribed more or less fluids wrongly, which can have an adverse effect on the person's well-being.

Reading the NEWS chart

Many healthcare settings use the National Early Warning Score (NEWS) observation chart as a 'surveillance' system to identify and monitor patients deteriorating. The reason is simple: picking up these signs saves lives.

Research shows that 80 per cent of NHS patients across the UK experiencing a cardiac arrest had physiological abnormalities present 12–24 hours prior to the cardiac arrest.

The NEWS charts are colour-coded in order to demonstrate the severity of the patient's condition – a high NEWS score indicates a severe illness. No point knowing how many pills to give your sick patient if you don't observe the poor soul deteriorating! Chapter 7 shows you how to use these charts.

Administering IV Therapy

Intravenous therapy is medics' chosen route when they need to deliver fluids and medications as quickly as possible to the patient. IV therapy is also used in order to give substances that can't be administered by any other route. For example, unless you're a vampire, a blood transfusion is administered via the IV route as opposed to the oral route (sink your teeth into Chapter 17 for more details).

Getting under the skin of the IV route

Doctors use a variety of methods of administering drugs via the IV route. The most common types of IV administration include the following:

- **Peripheral IVs:** The tip of these devices sits in the vein, usually in the hand or arm. These short-term devices are used to deliver IV drugs or fluids (flip to Chapter 16 for details).
- **IV bolus push:** When a specific dose of a medication is given via a bolus through a peripheral or central device (see Chapter 15).
- **Central lines:** These devices are placed in the chest, neck, groin, leg, arm or scalp. The catheter is sited in the veins of the central venous system, such as the superior vena cava or inferior vena cava (Chapter 16 has all about central lines).

- **Infusion pumps, syringe drivers and patient controlled analgesia (PCA) pumps:** These electronic devices are set to infuse fluids or medications via an automatic pump intermittently or continuously. Syringe drivers generally administer smaller controlled doses of medication over a prescribed duration. PCAs give patients control over their analgesic administration, because they can self-administer their medication. (Check out Chapter 14 for more on these devices.)
- **Volumetric pumps:** These devices administer medications such as sodium chloride 0.9% via an administration set to a peripheral device sited in, for example, the patient's arm. Depending on the infusate, the administration set delivers 20 drops per millilitre for clear fluids and 15 drops per millilitre for blood and thickened fluids. A microdrip system infuses smaller amounts of fluids per hour. (Pop to Chapter 14 for more on volumetric pumps.)
- **Continuous and intermittent infusions:** Continuous infusions deliver medications or fluids at a constant rate, whereas intermittent infusions deliver medications or fluids at specific times and at designated intervals (see Chapter 15).

Appreciating the advantages of IV administration

The IV route has many advantages over other routes of drug administration. You can:

- Achieve a rapid response of the medication if a patient is having a cardiac arrest
- Provide a constant therapeutic effect, such as via continuous infusion
- Still give medication if the patient is nil by mouth (NBM)
- Still administer the medication if the patient is unable to undergo an intramuscular injection, due to being a haemophiliac
- Give medications that may not be absorbed via the oral route
- Administer medication to unconscious patients
- Correct fluids and electrolyte imbalances promptly

Looking Out for the Complications of IV Therapy

Make no mistake about it, despite all the advantages of IV therapy that I lay out in the preceding section, the process isn't without its complications. Here are some potential complications that you may face and how to deal with them.

Understanding the disadvantages of IV administration

The IV route has the following disadvantages as a means of fluid and drug administration:

- Side effects to the drug usually more immediate and severe
- Risk of embolism
- Risk of microbial contamination/infection
- Risk of infiltration
- Risk of extravasation
- Risk of phlebitis
- Increased risk of fluid overload
- Risk of speed shock
- Problems with compatibility/stability of medicines

Chapters 18 and 19 give more information around these topics.

Preventing infection

One of the major risks of using the IV route is, of course, infection. Handwashing with liquid soap and water is the single most important means of preventing the spread of infection. Washing with liquid soap and water is often referred as the gold standard of infection control.

Using the *aseptic non-touch technique* (ANTT) is the evidence-based method of administering IV medications. It ensures that asepsis is achieved on the key parts of the equipment that come into direct or indirect contact with the liquid infusion during preparation and administration of the medication.

When preparing medications for patients, the healthcare professional identifies all the key parts and then protects them at all times using the non-touch technique.

Here's the ten-step overview of the ANTT in relation to IV therapy:

1. **Gather together all the equipment.**
2. **Clean the *aseptic field* – the area you working from (injection tray and so on).**
3. **Clean your hands and put on an apron and non-sterile gloves.**
4. **Prepare the medicines and equipment, protecting key parts at all times using the non-touch technique.**
5. **Go to the patient and prepare the access device, after gaining the patient's consent.**
6. **Administer medicines – protecting key parts at all times.**
7. **Dispose of any sharps immediately.**
8. **Remove gloves and apron.**
9. **Wash hands.**
10. **Document your actions.**

Chapter 18 looks at the infection control aspects of IV therapy.

Dealing with pain on IV injection

Before administering IV medications through a peripheral line, you need to undertake an inspection of the site.

If the patient doesn't complain of pain during the cannula *flush* (which isn't a hand at poker, but when you clean out the line – see Chapter 14), but does so on the administration of the drug, this pain may be due to the following reasons:

- **Hypertonicity:** Where medicines have a higher osmolarity than plasma, which can cause fluids to pass out of blood cells, resulting in cell *lysis* (breaking down of the cell).
- **Rapid administration:** Inappropriate rapid infusion or insufficient dilution of irritant medications can cause damage to the blood vessels, resulting in pain.

Here's a list of drugs that are known to cause pain on injection:

- Dextrose solutions above 10 per cent dilutions
- Erythromycin
- Phenytoin
- Potassium infusions
- Sodium bicarbonate 8.4 per cent
- Tetracycline
- Vancomycin

Chapter 16 looks at access devices and pain. For more on pain management in general and morphine in particular, move gingerly to Chapter 20.