Administration of medicines

After completing this tutorial, you will be able to:

- Outline the types of clinical problem that hospital pharmacists must solve concerning the safe administration of medicines.
- Describe the different methods by which injectable medicines are given.
- Recognise the issues of concern when patients who need medicines cannot receive them by mouth, or cannot swallow tablets and capsules.

Why this subject matters...

Pharmacists are expected to know about how medicines are given in practice, and the limitations and problems caused by different routes of administration. It's a very practical, but fundamental, side of the pharmacist's role: how to get medicines into every patient in a safe and convenient way.

This tutorial covers concepts that you may not have come across if you haven't worked in a hospital before. It describes common clinical problems and gives you practical troubleshooting tips for resolving administration issues, but it does not give an in-depth description of each method of giving medicines.

Routes available

Most clinical problems that you'll encounter will relate to administration of medicines into the gut ('enteral') or by injection, but remember that there are other routes which you should not overlook. For example, the transdermal route can be a useful alternative if you are running out of suitable methods to give certain medicines (e.g. fentanyl patches for pain in a patient with dysphagia). Similarly, the inhaled route can be used to administer selected drugs other than bronchodilators and corticosteroids (e.g. morphine for dyspnoea, antibiotics for cystic fibrosis, pentamidine for *Pneumocystis jirovecii* pneumonia).
Note that in many clinical situations in hospitals, the administration of medicines can involve unlicensed use. Although medicines cannot be promoted outside the limits of their marketing authorisation, the Human Medicines Regulations 2012 do not prohibit the use of unlicensed medicines. It is recognised that informed use of unlicensed medicines or of licensed medicines for unlicensed purposes (‘off-label’ use) is often necessary – particularly in paediatric patients.

For example, crushing tablets and opening capsules for administration through enteral feeding tubes is unlicensed but common practice. However make sure you have investigated all the appropriate licensed options first (e.g. oral liquids). The MHRA has provided guidance on the use of unlicensed medicines.

**Intravenous medicines**

The intravenous route provides a rapid way of administering drugs, fluids, blood products and parenteral nutrition. There are two basic methods:

1. **Direct intravenous injection** is the administration of a small volume of drug solution into an entry port sited in a vein such as a cannula or ‘Venflon’. Injections can also be made via existing IV infusion administration lines (or ‘giving sets’). The technique of direct injection is sometimes called an ‘IV push’. The term ‘IV bolus’ is widely used as well, but is potentially misleading because it implies that the injection can be given instantly over a few seconds whereas most injections should normally be administered over 2 to 5 minutes.

Direct injection gives therapeutic levels of a drug quickly (e.g. glucose 50% injection for hypoglycaemia), but there can be problems with this technique. For example, injections may damage a vein, particularly if the drug is irritant (e.g. phenytoin). In addition it is impractical if a drug needs to be given slowly or in a large volume.
2. **Intravenous infusion** involves IV administration over a longer time period often using bigger volumes. Plastic tubing (‘IV line’ or ‘giving set’) connects the bag or syringe of drug solution to an entry point in a patient’s vein. The infusion may be *intermittent* (e.g. metronidazole 500mg in 100ml saline over 20 minutes every eight hours) or *continuous* over 24 hours. Continuous infusion is indicated for drugs with a short half-life (e.g. glyceryl trinitrate) or when a constant therapeutic drug level is required (e.g. insulin). Infusions require a drug to be stable in the specified diluent for the duration of administration. They also require the drug to be compatible with the plastic used to make the IV line and infusion bag.

A ‘Y-site’ is the point where two IV lines containing solutions join to run down the same line forming a ‘Y’ shape. One infusion may be described as being ‘piggybacked’ onto the other. The choice of intravenous administration method depends on the drug (e.g. indication, volume of infusion fluid, rate of administration, degree of irritancy, pharmacokinetics) and patient factors (e.g. age, availability of IV access, concurrent disease such as presence of heart failure).

Intravenous injections and infusions may be given via peripheral or central veins. **Peripheral lines** are usually inserted in the hand or arm. They can become blocked or dislodged easily and, because the veins are quite narrow, they are not usually used for irritant drugs (e.g. amiodarone), concentrated solutions in fluid-restricted patients (e.g. potassium) and vasoconstricting drugs (e.g. epinephrine). **Central lines** are preferred for these situations and are inserted into larger veins such as the superior vena cava. Central lines can be used for any intravenous medicine.

Some drugs may cause pain on injection because of their tonicity, pH, or irritancy (e.g. erythromycin). The vein may become red and inflamed; this is called **phlebitis**. If a medicine liable to cause phlebitis must be given peripherally, then the peripheral line should go into as big a vein as possible – i.e. not a cannula placed in a small vein in the back of a hand.
Intravenous access devices

We discussed intravenous access techniques briefly on the previous page, but we’d now like to look at this in more detail. One of the potentially confusing things that you need to understand as a hospital pharmacist, is the various devices used to deliver intravenous medicines into the body.

People will talk to you about Venflons, Hickman lines, triple-lumen catheters and many others. What do they all mean? On this page we hope to explain for you, using example pictures.

Peripheral intravenous cannula

This is commonly called a 'Venflon' but that is actually a brand name. The cannula is inserted into a vein in the hand or arm and is for short-term use (days). Here is a close-up image:

Common clinical problems

- Calculating the rate of administration of a drug (e.g. phenytoin).
- Advising on the volume and type of infusion fluid suitable for diluting a drug (e.g. vancomycin).
- Determining how best to administer an IV drug in fluid restricted patients (e.g. potassium).
- Choosing between a peripheral or central intravenous line (e.g. dopamine, amiodarone).
- Advising on the safety of mixing drugs in the same syringe, IV bag or line (e.g. cefuroxime and metronidazole)
The needle helps to introduce a small plastic tube through the skin and into a vein; the needle is then removed. The little plastic 'wings' enable the whole device to be securely taped to the skin. The pink plastic tap is a valve that can be turned open and the hole in the top allows a syringe to be connected to e.g. take a blood sample or administer an injection. The white 'luer lock' plug at the end enables intravenous infusion lines to be connected. It’s easier to appreciate the job that the peripheral cannula does when you see a picture of the device in situ:

Notice that the short line connected to the luer lock branches into two so that two separate intravenous infusions can be connected. This meeting of two lines is called a Y-site. Any
medicines in the two infusions will be entirely separate until they reach the Y-site, but they will mix at that point.

In addition to a cannula, or sometimes instead, a patient may be fitted with one or more long lines at a different site. These are lengthy plastic catheters inserted into a vein so that the tip is positioned some way away from the insertion point. Some common examples are described below, with pictures. Note that 'long line' is a fairly imprecise phrase describing a variety of potential set ups. If you are ever unsure what someone means by the term, ask for clarification. It's often especially important for pharmacists to ask if a 'long line' is a peripheral line or a central line.

**Midline intravenous catheter**

This is a long peripheral intravenous catheter generally inserted into an arm vein, but the tip of the catheter sits some distance away e.g. in a bigger vein near the shoulder. In the picture shown here the thin white catheter is inserted fully into the vein until the yellow butterfly is reached, and this is then secured to the skin with tape. The midline catheter requires less frequent site change than a peripheral cannula ('Venflon'), and is less prone to causing phlebitis. However, it is still for short-term use (but often weeks rather than days).

**Short-term central venous access**

This is often achieved by a multilumen central line with separate lumens ('tubes') running the length of the catheter. It is inserted into a neck vein (or occasionally the subclavian vein) and the tip ends up in the distal superior vena cava just outside the heart. As you can see from the photo and diagram of a triple lumen catheter below, the lumens are effectively separate catheters bound together.
So medicines that enter via one lumen **do not mix in the catheter** with medicines administered via one of the other lumens. The lumens exit the catheter at different points along its length and any medicines administered down them are rapidly diluted by the fast-flowing bloodstream. You can get double lumen catheters too, that only have two lumens, and quadruple lumen varieties with four lumens and even quinlumen lines with five lumens. These lines are commonly needed by intensive care and high dependency patients. One advantage of central administration is that irritant or vasoconstrictive drugs can be given more safely because of the wide diameter of the vein and the faster blood flow.

**Longer-term central venous access**

There are a number of ways to achieve this, using an intravenous device that can stay in place for months or more, and three examples are given below.

**PICC line**

This stands for Peripherally Inserted Central Catheter, and although it's inserted at a peripheral location the tip of the catheter resides centrally in e.g. the superior vena cava. A PICC line is intended to stay in place for long periods (months) and is used, for example, for administering prolonged chemotherapy regimens or TPN. These lines are relatively straightforward to insert compared to some of the alternatives below, and can be single, double or triple lumen.

**Totally implantable devices (TIDs)**

These devices are implanted beneath the skin somewhere on the chest wall in a pocket of skin (e.g. near the collar bone) or on/under the upper arm, depending on patient choice. The catheter is fed into a central vein, and the port allowing access to the catheter is positioned just below the skin. When an injection is required a special 'non-coring' needle is inserted through the skin and then through a self-sealing rubbery membrane in the port (called a septum).

The photographs overleaf show an example known as a **portacath** with the port at its head. The second photo is an x-ray showing the portacath in position in a patient. Patients who require long-term repeat injections may have a portacath e.g. people with cystic fibrosis or on chemotherapy. These types of device can be left in place for a long time, but are more cosmetically acceptable and pose a lower infection risk.
Tunnelled and cuffed central catheter

One of the most well-known examples of this type of central venous catheter is a Hickman line. It is inserted into the body at a site on the chest wall and is tunnelled under the skin until it reaches the neck. Then it enters a large vein such as the jugular vein, and runs down into the superior vena cava. In our photograph you can see the line running under the skin from its insertion point up towards the incision at the neck where the line will have been pushed into the jugular vein. Macmillan Cancer Support has produced a helpful video for patients about having a tunnelled line inserted which you might like to watch.

Hickman lines are used for long-term venous administration of medicines such as chemotherapy.

Hickman lines, PICC lines, and portacaths might all be used by patients receiving long-term intravenous therapy at home.
On the Medicines Learning Portal site you can see a diagram that illustrates a method by which IV access devices can be selected in practice; it is included courtesy of the originator, Katie Scales, and the Injectable Medicine Guide.

**Flushing intravenous lines**
Intravenous lines must be flushed before and after the administration of medicines to prevent potentially incompatible drugs from mixing. Flushing should also occur at the end of surgical procedures to ensure that perioperative medicines such as anaesthetics are not left in the line when the patient returns to the ward. In patients who have long-term intravenous lines inserted, flushing helps to prevent the line from blocking, maintaining their ‘patency’.

Flushes should be compatible with the medicine being administered; the most commonly used in practice are water for injection and sodium chloride 0.9%.

Listen to Kathryn’s experience of suffering paralysis and respiratory arrest after her intravenous line was not flushed in theatre.
Extravasation

A complication of giving intravenous medicines is **extravasation**. Extravasation occurs when a medicine leaks from a blood vessel and causes injury to the surrounding tissue. The consequences of this leakage depends upon whether the medicine is classed as:

- an **irritant**, meaning it can cause inflammation but not necrosis or
- a **vesicant**, which means it can cause irritation, vascular ulceration, and necrosis

If a **non-irritant** medicine leaks from a blood vessel this is called **infiltration**.

There are a range of risk factors for extravasation including those related to the administration device (such as an inadequately secured cannula), those associated with the administrator (such as lack of familiarity with the device or medicine), and those related to the patient (such as extremes of age or small veins).

Medicine-related risk factors that increase the risk of inflammation and tissue damage include:

- pH of around less than 5 or greater than 9.
- Osmolarity more or less than that of plasma (approximately 290 mOsmol/L). Most injections are formulated to have a similar osmolarity to plasma to reduce the risk of vein irritation but there exceptions.
- Vasoconstrictive potential (extravasation of dopamine can cause ischaemic necrosis, for example).
- Presence of certain excipients (such as alcohol or polyethylene glycol).
- The volume of medicine or fluid that has entered the surrounding tissue.
- Concentration of the medicine or fluid.
- Potential of the medicine to precipitate (such as diazepam).
- Ability to bind to DNA and/or kill replicating cells.

The evidence base for managing extravasation is made up of small trials and case reports. Despite this, the **BNF** has some information on extravasation. In addition, your hospital is likely to have local guidelines if chemotherapy is given there, as these agents are commonly implicated in extravasation injury. Refer to the **Information sources** for more guidance on where to look, but the most important point to remember is that if you are asked about managing a case of extravasation, **act quickly and ask for help** – this is an urgent problem.
Subcutaneous and intramuscular medicines

1. Subcutaneous (SC)

Administration of drugs and fluids by the subcutaneous route may be by direct injection (e.g. insulin, enoxaparin), by intermittent or continuous infusion (e.g. diamorphine, terbutaline) or by implantation (e.g. testosterone). This route can be an option when intravenous access becomes difficult (e.g. elderly or restless patients) and is particularly useful in palliative care.

The subcutaneous compartment can accommodate large volumes of fluid. Subcutaneous administration of fluid (‘hypodermoclysis’) can be a useful method of hydration in patients with terminal illness or following a stroke. The rate of administration should not normally exceed 2 litres in 24 hours at a single site.

The subcutaneous route is normally well tolerated, but pain, oedema and bruising can occur. Irritant drugs should not be given subcutaneously (e.g. prochlorperazine).

Common clinical problems
- Being asked about mixing drugs in the same syringe, particularly in patients with terminal illness.
- Checking the suitability of infusion fluids administered subcutaneously.
2. Intramuscular (IM)

Intramuscular injections are used:

- To ensure compliance (e.g. depot antipsychotics).
- When other routes are less effective (e.g. hydroxocobalamin).
- When other routes may be dangerous (e.g. epinephrine for anaphylaxis).
- When a prolonged duration of action is desired (e.g. depot medroxyprogesterone).
- As a short-term alternative to intravenous administration (e.g. morphine).

The intramuscular route is not always suitable if a rapid onset of action is required. It is also more uncomfortable for the patient and only small volumes can be given (typically no more than 3mL). IM injection of certain drugs may cause pain, abscesses or bleeding (e.g. NSAIDs, iron). The route is avoided in patients with increased bleeding risk (e.g. raised INR, low platelet count) to prevent injection site haemorrhage, and in those with decreased muscle mass.

Common clinical problems

Clinicians may ask you about the IM route as an alternative option to IV where the latter cannot be used. In practice you probably won’t be asked many questions about intramuscular drug administration although this route is more common in some clinical areas than others (notably mental health).
Enteral administration

1. Oral administration

You will often be asked for help in managing oral administration problems. Think laterally and be inventive. For example, if a patient is going to be nil-by-mouth (NBM) prior to surgery but normally takes levothyroxine, it may not matter if they miss one or two doses, as the half-life is about 7 days. Similarly, if the patient takes simvastatin for hypercholesterolaemia missing several doses won’t matter, since atherosclerosis is a chronic process.

However, if the same patient takes carbamazepine for epilepsy, they cannot miss any doses and you need to think about alternative routes, in this case rectal might be a suitable option.

For patients with dysphagia where no licensed liquid formulation exists think about alternative routes or drugs, using injections orally, specials manufacturers, crushing tablets or opening capsules. Some conventional tablets are actually soluble in water (e.g. ciprofloxacin). Note that certain tablets must not be crushed as they can pose dangers. These include: enteric coated tablets (destroys the protective coating), slow release tablets (stops the prolonged action), and chemotherapy drugs (crushing could release cytotoxic dust). Patients with part of their gut removed may still be able to take medicines orally. Establish exactly which section of gut has been removed and check the site of drug absorption.

Common clinical problems

- Advising on the care of NBM patients (e.g. patients undergoing surgery).
- Finding appropriate medicines and/or formulations for patients with dysphagia (e.g. patients with stomatitis or after a stroke).
2. Administration through enteral feeding tubes

Enteral feeding is indicated in patients who cannot ingest food normally but whose gastrointestinal tract is able to digest and absorb sufficient nutrients (e.g. patients with head and neck cancer or following a stroke). A variety of methods are used to deliver enteral feeds:

- **Nasogastric (NG)** tubes are inserted through the nose into the stomach. They are used for short-term feeding only.
- **Percutaneous endoscopic gastrostomy (PEG)** tubes are inserted through the abdominal wall into the stomach via a stoma. They are used for long-term feeding.
- **Jejunostomy** tubes are placed directly into the jejunum through the abdominal wall. They are used when PEG tubes are unsuitable.

*A nasogastric tube in an adult, shown here in black*  
*Courtesy of Nanoxyde, Wikimedia Commons*
Enteral feeding tubes can be used to administer drugs but care must be taken to check that the tube does not **bypass the site of absorption** (e.g. iron is mainly absorbed in the duodenum and jejunal administration will therefore reduce bioavailability).

In addition, drugs can **interact with the feed** (e.g. phenytoin) or cause the tube to block (e.g. insufficiently crushed tablets). NG tubes are long, fine bore tubes which **block** easily. PEG and jejunostomy tubes are shorter with a wider bore.

Enteral feed may be administered as a bolus, intermittent or continuous infusion. Try to administer drugs in the gaps when the tube is not being used for feed, remembering to flush with sterile water before and after each drug.

If a liquid formulation is unavailable then consider using injections orally, changing the drug or route of administration, opening capsules or crushing tablets. However, enteric-coated tablets, modified-release tablets or cytotoxic drugs must not be crushed, as above.

### Common clinical problems

- Advising how to administer drugs through enteral feeding lines (e.g. crushing tablets, availability of liquids, giving injections orally).
- Managing interactions between drugs and enteral feeds (e.g. sucralfate).
- How to unblock enteral feeding tubes.

### 3. Buccal/ sublingual administration

These routes of administration will not generate many clinical problems but they may occasionally be useful to consider in some situations where you’ve exhausted other potential routes or where alternatives are less convenient (e.g. sublingual buprenorphine for heroin withdrawal).
Suggested questions

The types of clinical problem you will encounter involving the administration of medicines are very diverse. So it's impossible to give you comprehensive guidance for every eventuality. However, the following examples may help you:

If asked about administration of a drug intravenously think about: dose, type of infusion fluid, fluid volume, rate of administration, availability of IV access, and whether any other drugs are being given IV.

If you are advising about whether drugs may be put down enteral feeding tubes, ask about the type of tube, where the end of the tube is, and the feeding regimen. Think about alternative administration routes or drugs. Some patients who need a tube can still take medicines by mouth, so remember to check this.

If the enquiry is about a patient who is NBM prior to surgery establish the drugs and doses, and how long they are likely to be NBM. Again think about alternative administration routes or alternative drugs.

Similarly if a patient becomes dysphagic, ask about the drugs and doses, and when/whether their swallow is expected to improve.
Information sources

The **BNF** and **SPCs** are good places to start for most straightforward administration questions. The BNF will show you the range of dosage forms available, and the SPC will give detailed advice about administration. For enquiries specific to children, start with the **BNF for Children**. Many SPCs are on the **electronic Medicines Compendium**, but you may also have to use the **MHRA** website or that of the **European Medicines Agency**. If you’re unfamiliar with all the features of the eMC we have a learning module about it [here](#).

Your Trust or other employer will have local policies and procedures related to the administration of medicines, particularly injections. Be familiar with the basic content of these documents and know how to find them.

Many healthcare organisations use the **Injectable Medicines Guide** to help ensure the safe administration of intravenous medicines. You will need your organisation’s username and password to access this site. The tutorial on **injection compatibility** will also assist you in managing enquiries on this topic. If you’re asked specifically about administering medicines to patients who are fluid-restricted then the UKCPA Critical Care Group’s guidance on **Minimum Infusion Volumes** is one of the first resources to check.

For questions about **extravasation**, evidence is often lacking but a good starting point is the **Cardiff and Vale Treatment Summary**. If you are asked about extravasation of chemotherapy, then consult your Trust’s policy. Try to have familiarised yourself with these resources before you need them, as extravasation enquiries are always urgent.

For help with administering drugs through **ental feeding lines** try **Drug Administration via Enteral Feeding Tubes** (Pharmaceutical Press) and the **NEWT Guidelines**. These sources can differ in the advice they give, so ideally you should check both. You’ll need a user name and password to log into either site. Don’t forget Stockley’s Drug Interactions for interactions between enteral feeds and medicines.

[Last updated: 21 January 2020]
The UKCPA's *Handbook of Perioperative Medicines* provides guidance on managing your patient’s medicines around surgery. As above, use this with any local policies your Trust may have.

If you think you might need to recommend the use of a special medicine, then the RPS have produced guidance on the *prescribing of specials* which can help you with decision making. Trying to establish exactly where drugs are absorbed in the gastrointestinal tract is notoriously difficult. However, pharmacology textbooks can be a good starting point, as can SPCs (look at section 5). Manufacturers medical information departments may be able to help with these questions, and others related to administration of medicines.

Be careful about conducting a general internet search on this subject. If you do, you may like to look at our brief guide to *evaluating websites about medicines*.

**Presenting your answer**

Once you’ve asked sufficient questions, gathered the information required and assessed it, you’ll need to provide an answer. We can offer you some *general guidance on answering clinical problems*. 
Next steps in learning...

One subject that you will be asked about quite a lot as a pharmacist is the crushing, opening or splitting of oral dosage forms. Specialist Pharmacy Service has a helpful guide to the pharmaceutical issues you need to consider.

A situation in which you may need to advise on this subject is when administering medicines via enteral tubes. There is a review of some of the factors that healthcare professionals need to think about in an article from the American Journal of Hospital Pharmacy, that you can read or browse online but you need to register with the MedScape site first for access. Note that it is a US publication so some of the brandnames etc are different to the UK.

There is also a practical guide to administering medicines via enteral feeding tubes from the British Association for Parenteral and Enteral Nutrition (BAPEN).

An important aspect of drug administration that can lead to errors, is the calculations that are sometimes required. If you are uncertain about your competence in this area, then there is a tutorial on drug calculations on this site that offers various online resources to help you, as well as a quiz.

There are many different types of inhaler on the market, but pharmacists should be able to advise on their correct usage. The Asthma UK website has advice on correct usage, and also a series of videos showing how many of the devices should be used (see bottom of webpage).

You may be asked about covert administration of medicines. CPPE has a workshop on managing and optimising care for patients who might lack mental capacity which includes covert administration.

There is a BMJ learning package on prescribing, preparing, and administering injectable medicines safely. You need to register with the site to gain access.