CHAPTER 10

Access: Intravenous Cannulation

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OVERVIEW

By the end of this chapter you should be able to:

- discuss the indications and contraindications for peripheral cannulation
- understand the anatomy of potential cannulation sites
- identify the correct site and size for a cannula
- understand the potential complications of peripheral cannulation
- describe the technique for insertion of a cannula.

Introduction

Peripheral venous cannulation is one of the most common invasive procedures carried out in hospital. Thousands of cannulae are inserted every day in the UK, mostly by junior doctors or nurses. Peripheral venous cannulation is associated with significant morbidity and mortality – mainly secondary to infection. It has been estimated that an epsiode of bacteraemia occurs for 1 in every 100 peripheral cannulae sited. It is therefore essential not only to be capable of competently putting in a cannula correctly, but also to do this in a safe manner.

Before inserting a cannula it is essential to determine whether or not there is a clinical indication. Studies show that up to one third of cannulae in hospitalised patients are not required or are not being used. Alternatives to cannulation should be considered where possible; for example oral antibiotics instead of intravenous antibiotics, or encouragement of oral fluid intake instead of intravenous fluids.

Indications

- Intravenous fluids.
- Intravenous drugs – continuous or intermittent.
- Blood or blood products.
- Intravenous radio-opaque contrast or sedation.
- Prophylactic use in unstable patients or those undergoing procedures.

ABC of Practical Procedures. Edited by T. Nutbeam and R. Daniels. © 2010 Blackwell Publishing, ISBN: 978-1-4051-8595-0.

Contraindications

Absolute

- Inflammation or infection of overlying skin at proposed cannula site.
- Arteriovenous (AV) fistula in arm of proposed cannula site.
- Previous mastectomy with axillary node surgery or lymphoedema on side of proposed upper limb cannulation.

Relative

- Bleeding tendency.
- Veins of the forearm (elbow to wrist) in those with renal failure who may require AV fistula formation in the future.

Anatomy of veins

Veins consist of three layers: the tunica adventiticia, tunica media, and tunica intima. Veins contain valves, folds of endothelium, which assist with flow of blood back to the heart. Valves can sometimes be identified by palpation of small bulges in the vein. Figure 10.1 shows the anatomy of the veins of the hand.

Cannulae

A cannula is composed of several parts: the needle, catheter, wings, valve, injection port and Luer-Lok™ cap. Most cannulae also contain a 'flashback chamber' giving the practitioner visual confirmation that the cannula has entered the vein. Figure 10.2 shows a labelled diagram of a cannula.

Modern peripheral cannulae are made from polyurethane. This is preferable to older materials such as PVC and Teflon® as the cannulae are more flexible, softer and cause less intimal damage. They are also latex free.

Table 10.1 shows sizes of cannulae, colour, flow rates and uses. Remember that the maximum flow rate is printed on the packaging of most cannulae – important if you are fluid resuscitating!

Choosing the appropriate cannula

Deciding on the appropriate-sized cannula and the appropriate vein will depend on a number of factors. In a resuscitation situation, or if the patient is unstable, the biggest cannula that the

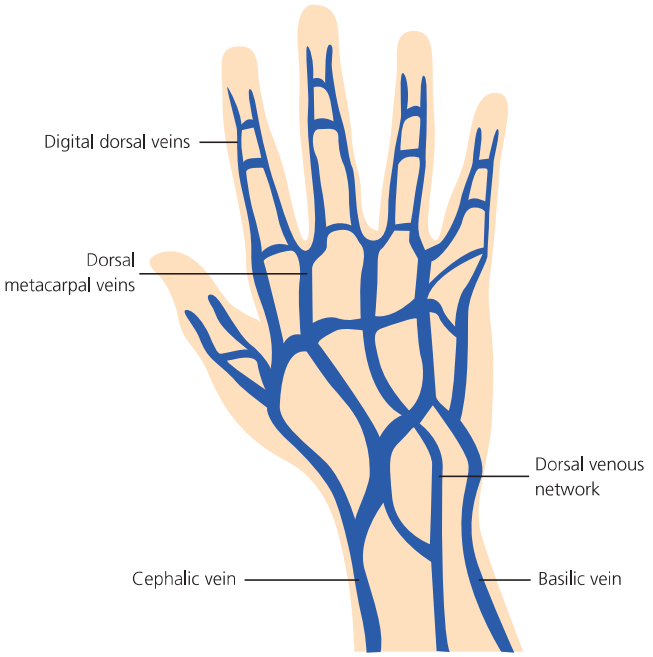

Figure 10.1 Veins of the hand.

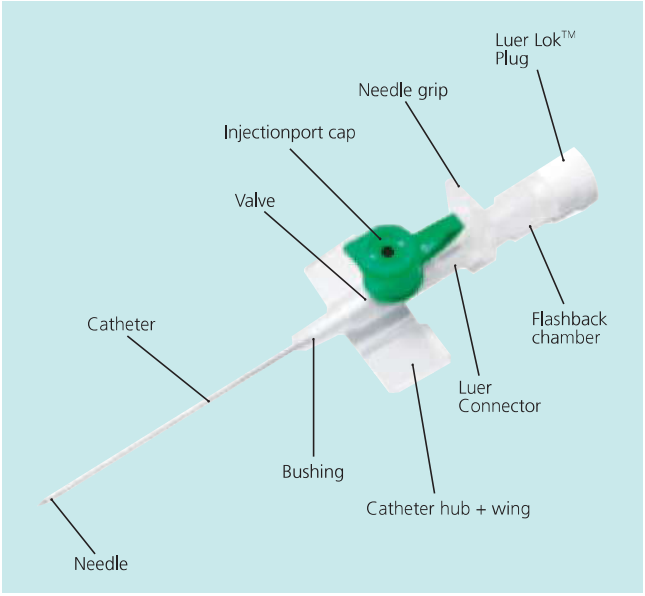

Figure 10.2 Cannula.

practitioner is competent to insert should be put into the patient's largest peripheral vein. This will usually be a 14G or 16G (orange or grey) cannula in the antecubital fossa. These cannulae have the largest radius and therefore the highest flow rate, allowing a large volume of fluid to enter the circulating volume in a short period of time. By doubling the radius of the cannula, the flow through it is increased 16-fold.

A cannula inserted into a large vein is needed in situations where potentially irritant drugs need to be administered and the insertion of a central line is not appropriate. Examples of such drugs include 50% glucose for the treatment of hypoglycaemia and amiodarone for arrhythmias.

An 18G or 20G (green or pink) cannula is appropriate for situations where maintenance fluid or IV drugs are required. 22G (blue) cannulae should be reserved for children or those with very difficult IV access. Blood products should be run through a 18G (green) or bigger cannula to minimise the risk of clotting.

Table 10.1 Cannula sizes and their uses.

Colour	Size	Flow rate		Use
Blue	22G	36 mL/min	2.2L/h	Paediatric or elderly patients with small, fragile veins
Pink	20G	61 mL/min	3.7L/h	IV maintenance fluids, drugs, blood products
Green	18G	90 mL/min	5.4L/h	
White	17G	140 mL/min	6.2L/h	Rapid infusions of fluids, drugs and blood products. Unstable patients, emergency situations
Grey	16G	200 mL/min	12L/h	
Brown/ orange	14G	300 mL/min	18L/h	

Choosing the site of cannulation

Choosing the ideal vein for cannulation should take into consideration factors such as patient comfort and convenience, size of cannula required, and the size, mobility and fragility of the patient's veins. Where possible, the patient's non-dominant hand should be chosen. The back of the hand or lower arm should be chosen in most situations, as it is relatively comfortable, the cannula is unlikely to kink and it is easily inspected and accessed. Cannulation of the hand is also associated with a lower incidence of phlebitis compared with cannulation of veins of the wrist or upper arm. The distal cephalic vein, known as the 'houseman`s vein' because it is often chosen by junior doctors, is normally large and well tethered, making it easy to cannulate. Veins in the antecubital fossa are often large and easy to cannulate, but can be awkward and obstruction of flow through the cannula tends to occur if the elbow is flexed.

Veins on the underside of the arm and wrist are often painful when cannulated so should be avoided if possible. Veins in the foot can be used as a last resort but tend to be painful and inconvenient for the patient and are associated with a higher risk of phlebitis and thromboembolism. Finally, experienced practitioners will occasionally cannulate the external jugular vein, particularly in emergency situations when IV access elsewhere is difficult.

Step-by-step guide: intravenous cannulation

- **Give a full explanation to the patient in simple terms and ensure they consent to the procedure (if able).**
- **Set up your trolley (Box 10.1 and Figure 10.3).**
- **Prepare your trolley as a sterile field. Wear a plastic disposable apron and non-sterile gloves, and take alcohol hand rub with you.**

Box 10.1 **Equipment for intravenous cannulation**

- Gloves
- Tourniquet (disposable if available)
- 2% chlorhexidine/alcohol wipe
- Cannula
- Gauze
- Sharps bin
- 5 mL 0.9% saline
- 5-mL syringe
- Cannula dressing

Figure 10.3 Equipment required for intravenous cannulation.

1 Position the patient comfortably. It may be helpful to have the arm resting on a pillow.
2 Apply the tourniquet to the upper arm (Figure 10.4a). It should not be so tight as to obstruct arterial blood flow – check by palpating the radial pulse.
3 Ask the patient to clench and unclench the fist. This will promote venous filling.
4 Look and palpate for appropriate veins; they should feel full and bouncy. The site of a vein bifurcation is often ideal as the vein is tethered at this point.
5 Clean the area with an appropriate product: 2% chlorhexidine gluconate in 70% isopropyl alcohol is recommended (Figure 10.4b). Remember to let the solution dry and not to palpate the skin further (no-touch technique).
6 Remove the cap from the cannula and put in a clean, safe, easily accessible place (alternatively the cap can be left in place and removed at the end of the procedure).
7 Hold the skin taut below your insertion site to tether and immobilise the vein.
8 Holding the cannula at a 10–30° angle to the skin and in the direction of the vein, gently advance the cannula through the skin and into the vein (Figure 10.4c).
9 Once a flashback has been seen in the flashback chamber (Figure 10.4d), lower the cannula slightly to ensure the tip is in the lumen of the vein and that the needle does not puncture the posterior wall of the vein, then advance the cannula a further few millimetres. Figure 10.5 shows a diagrammatic representation of this.
10 Withdraw the needle gently and watch for the second flashback in the cannula confirming that it is in the correct position (Figure 10.4e).
11 Slowly advance the cannula fully into the vein holding the wings of the cannula only (Figure 10.4f).
12 Remove the tourniquet.
13 Place a small piece of gauze underneath the open end of the cannula to catch any drops of blood (Figure 10.4g).
14 Occlude the vein proximal to the tip of the cannula with your finger while removing the needle from the cannula (Figure 10.4h).
15 Dispose of the sharp safely before screwing the cap securely on the end of the cannula.
16 Secure the cannula safely with a purpose-made, sterile, semi-permeable transparent dressing (Figure 10.4i).
17 If the dressing allows, label it with the insertion date and time.
18 Flush the cannula via the injection port with 5 mL 0.9% saline (Figure 10.4j). Observe for any swelling or pain proximal to the cannula site which could indicate that the cannula is not correctly positioned.
19 Document the procedure, including the date and time, size of cannula used, site, number of attempts, and any immediate complications.

Taking blood from a cannula

It is possible to take blood out of a newly inserted cannula before the cannula is flushed. This is done with either a purpose-designed Vacutainer™ adapter or a syringe (Figure 10.6). Blood should be taken before the tourniquet is released. Once the cannula has been flushed, it should not be used for blood sampling.

Potential complications

Early complications

Early complications of cannulation are often associated with poor technique and inexperienced practitioners. If the primary flashback does not occur, the vein has probably not been punctured. Re-palpate the vein and withdraw the cannula before re-advancing again. If this is unsuccessful, start again and choose a different site. For tips on finding a suitable vein, see 'Handy hints' box below.

If the secondary flashback (as the needle is withdrawn through the cannula) does not occur, the cannula is no longer in the vein. This may be because the cannula entered the vein and then passed through the posterior wall. By slowly withdrawing you may then get a flashback as it re-enters the vein, in which case you can carefully advance the cannula into the vein. Once the needle has been withdrawn it should not be re-inserted into the cannula. This practice may cause part of the catheter to be sheared off by the needle, therefore entering the systemic circulation.

Cannulation is often a relatively painful experience for the patient. This is more of a problem when larger cannulae are being used or when cannulating children. In these circumstances subcutaneous or topical local anaesthetic can be used.

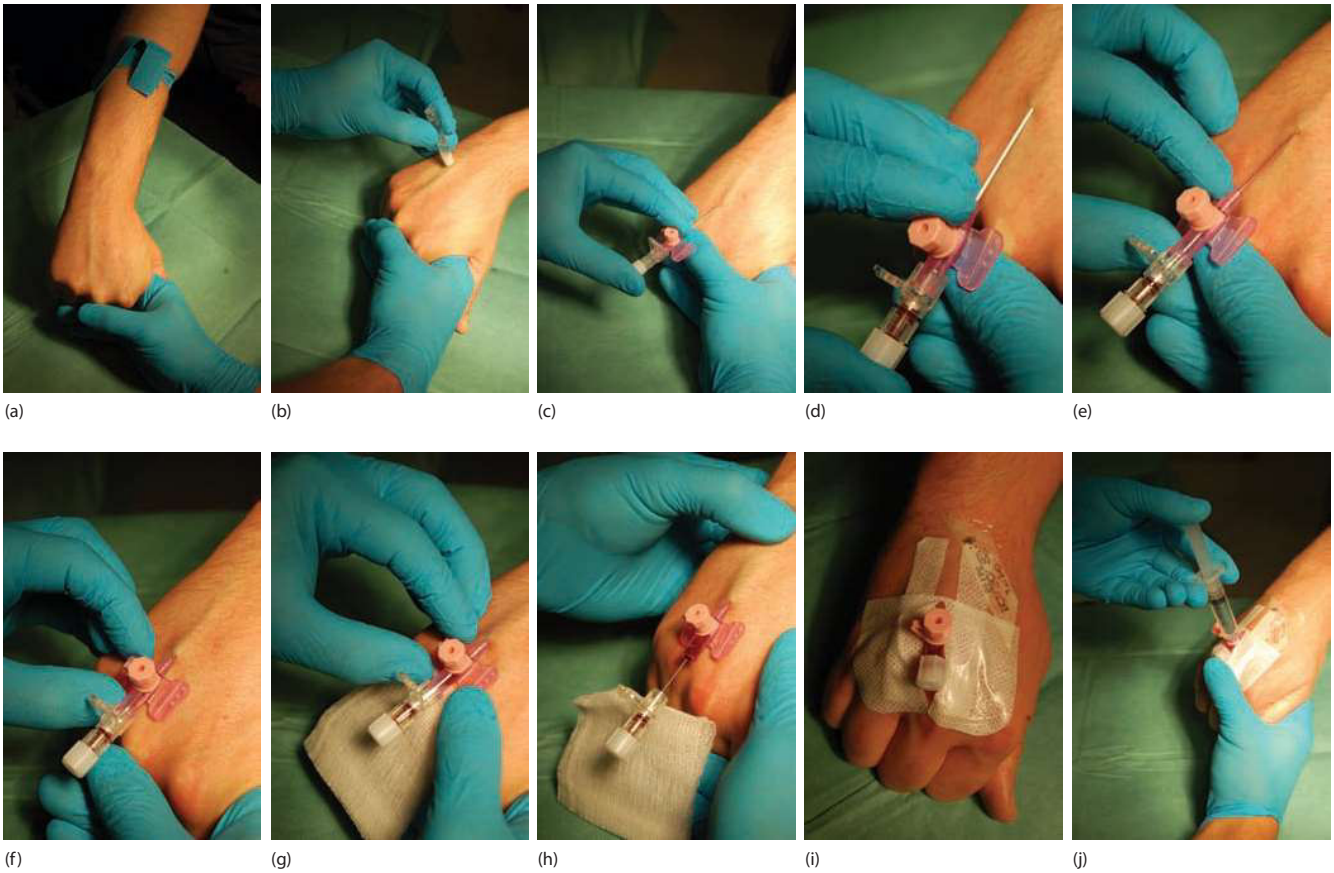

Figure 10.4 Step-by-step guide: intravenous cannulation. (a) Tourniquet on the forearm. (b) Sterilising the insertion site with 2% chlorhexidine gluconate in 70% isopropyl alcohol. (c) The insertion angle of 10–30°. (d) The first flashback seen in the hub of the cannula. (e) Secondary flashback in the cannula itself. (f) The cannula fully inserted. (g) Gauze underneath the cannula to prevent blood spillage. (h) Removing the needle from the cannula. (i) The cannula fully dressed and dated (the insertion point can be easily observed through the dressing). (j) The cannula is flushed with 0.9% saline.

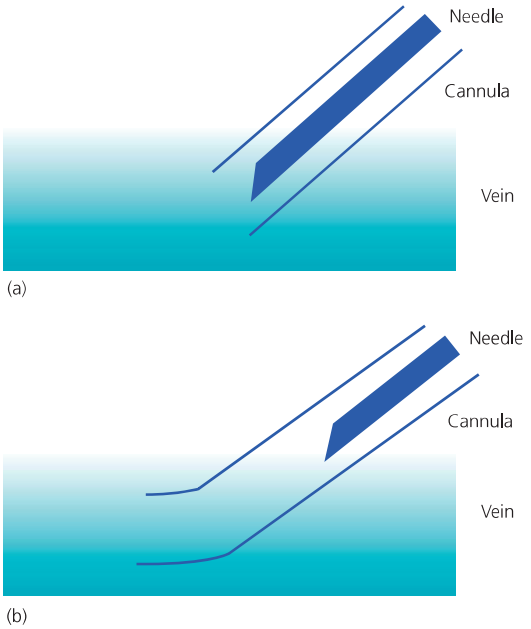

Figure 10.5 Diagrammatic representation of cannulation. (a) The needle and cannula enter the lumen of the vein. The primary flashback is seen. (b) The needle is withdrawn and the cannula advanced into the lumen. The secondary flashback is seen.

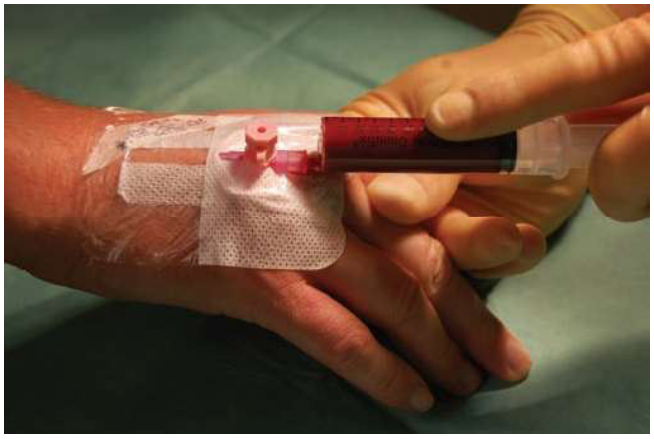

Figure 10.6 Taking blood out of a cannula. Blood is withdrawn from the cannula using a 10-mL syringe.

Haematoma formation is a common complication of cannulation. A collection of blood forms in the soft tissue following leakage of blood from a venous puncture site. Haematoma is a common feature of failed cannulation or accidentally displaced cannulae. It is often more severe in those who are anticoagulated or have deranged clotting. The cannula must be removed

and pressure applied to the area for at least 3 minutes to reduce bruising.

Occasionally it is possible to 'hit a valve'. This may manifest in difficulty threading the cannula up the vein. Careful palpation of the vein to locate the valves may help avoid this problem; valves can be felt as small bulges. It may also be possible to advance the cannula while flushing it with normal saline. This may cause the valve to open to allow the cannula through.

Rarely, an artery can be cannulated accidentally. This may have catastrophic consequences if unrecognised and the cannula is used to administer drugs. It is more likely to occur when cannulating veins in the antecubital fossa or the cephalic vein. At these sites either the brachial artery or an anatomical variant of the radial artery may be cannulated. Arterial cannulation is more likely in overweight patients, where the veins are very deep and difficult to palpate, or in very thin patients. It is usually obvious as the blood is redder than expected and pulsatile. If there is any doubt the cannula should be removed immediately and pressure applied for at least 5 minutes.

Needlestick injuries can occur when cannulating. Self-blunting or retractable cannula are available, minimising the risk of needlestick injuries, and should be used where possible. For further information on needlestick injuries refer to Chapter 3.

Late complications

Phlebitis is inflammation of the vein and can be due to chemical or mechanical irritation, or infection. Thrombophlebitis occurs when phlebitis is associated with formation of a thrombus within the vessel. Phlebitis and thrombophlebitis are extremely common, occurring in up to 35% of cannulations. They present with erythema, swelling, warmth, tenderness, and occasionally a palpable venous cord. Risk factors include the length of time the cannula is in situ, infusion of irritant drugs or fluids, and which material the cannula is manufactured from.

The vast majority of infective phlebitis is superficial and requires no treatment other than removal of the cannula. Oral antibiotics may be considered. Occasionally, systemic sepsis can occur, with an incidence of 1 per 3000 peripheral cannulae in one large study. Between 1997 and 2002, 6.2% of hospital-acquired bacteraemias were caused by peripheral IV cannulae.

Contamination can occur when skin flora is introduced at cannula insertion or by the introduction of other organisms via the cannula hub or injection port. The commonest organisms responsible for infective phlebitis are coagulase-negative staphylococcus and *Staphylococcus aureus* (40–45% of which are methicillin-resistant *Staphylococcus aureus*).

The risk of cannula site infection can be minimised by using an aseptic technique (particularly important in patients who are immunosuppressed), regular inspection, and minimal time in situ (no cannula should be left in situ for more than 72 hours). A high index of suspicion is vital in any patient with a cannula in situ who becomes septic with no obvious cause. Finally, it is important to assess each patient's clinical indication and avoid cannulation where possible.

Thromboembolism can occur, where blood clots on the cannula or vein wall before breaking off and being carried into the heart and pulmonary circulation. There is also a small risk of air embolism, especially if care is not taken to prime all administration equipment appropriately.

Extravasation, or 'tissueing', is a common problem, occurring in up to a quarter of those receiving intravenous infusions. This occurs when infusion fluid or drug leaks into the subcutaneous tissues surrounding the vein, normally when the cannula is dislodged from the vein or the tip is sitting in the vessel wall. Extravasation presents with localised pain and swelling. Careful monitoring of the cannula site is needed, especially in those who cannot communicate efficiently, such as children, the elderly or those with reduced consciousness.

Care of cannula site

Once inserted, the cannula should be secured appropriately, using a purpose-made adhesive dressing. This should be transparent around the cannula site to allow direct inspection when looking for any signs of phlebitis. It may be necessary to apply a loose-fitting bandage over the cannula to increase its security, especially in a confused or agitated patient. In this case it is vital that the bandage is regularly removed to actively look for any evidence of phlebitis.

The cannula site should be inspected every 8 hours as a minimum, and a phlebitis scale used, such as the Visual Infusion Phlebitis score (VIP score – see Table 10.2). If phlebitis is noted, this

Table 10.2 Visual Infusion Phlebitis (VIP) score. Developed by Andrew Jackson, Consultant Nurse Intravenous Therapy and Care, Rotherham General Hospitals NHS Trust.

0	IV site appears healthy	No signs of phlebitis • Observe cannula
1	One of the following is evident: • Slight pain near IV site • Slight redness near IV site	Possible signs of phlebitis • Observe cannula
2	Two of the following are evident: • Pain near IV site • Erythema • Swelling	Early stages of phlebitis • Resite cannula
3	All of the following are evident: • Pain along path of cannula • Erythema • Induration	Medium stage of phlebitis • Resite cannula • Consider treatment
4	All of the following are evident and extensive: • Pain along path of cannula • Erythema • Induration • Palpable venous cord	Advanced stages of phlebitis or start of thrombophlebitis • Resite cannula • Consider treatment
5	All of the following and evident and extensive: • Pain along path of cannula • Erythema • Induration • Palpable venous cord • Pyrexia	Advanced stage of thrombophlebitis • Initiate treatment • Resite cannula

should be documented, and the cannula either removed or closely observed (in cases of mild phlebitis). A doctor's opinion should be sought and antibiotics considered if infection is present.

All cannulae should be removed after 72 hours, regardless or whether or not they look infected. The risk of infection rises rapidly with time beyond this. Cannulae no longer in use should be removed as soon as possible to prevent complications.

Summary

Intravenous cannulation is a very common, simple procedure and makes up a large part of the 'bread and butter' work for most junior doctors. However, it is often a life-saving procedure and can occasionally be very challenging. Venous cannulation is associated with a number of complications, resulting in considerable morbidity, prolonged hospitalisation and even death. It is vital that healthcare practitioners are competent at cannulation, including cannulation in emergency situations, and that you are aware of the potential problems and how to manage them.

Handy hints/troubleshooting

- Always have a good look at both hands before deciding on the best vein.
- Veins in the antecubital fossa are often easiest (but more uncomfortable for the patient and the cannula will often kink).
- Make sure the area is as well lit as possible, even in the middle of the night.
- Remember, a good vein is one you can feel but not always see!
- Ask the patient to hang his or her hand down and to clench and release the hand.
- Tapping the vein gently will vasodilate the vein and make it stand out.
- If you're really struggling, try putting the hands in warm water or applying a GTN patch – both act as vasodilators, giving you a bigger target!

Further reading

Centers for Disease Control and Prevention. (2002) *Guidelines for the Prevention of Intravascular Catheter-related Infections.* MMWR Recommendations and Reports 51, RR-10, 1–29.

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