Infusion therapy part two: prevention and management of complications


Summary
In the second of two articles, the author identifies common complications associated with intravenous (IV) therapy and discusses preventive measures. Part one, published last week, provided an overview of IV therapy and the types of vascular access devices available.

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Aims and intended learning outcomes
This article aims to improve safety in intravenous (IV) therapy, by identifying potential risks to patients and staff, and discussing management strategies and measures to minimise complications. After reading this article you should be able to:

- Identify common complications associated with IV therapy.
- Summarise the prevention and management of individual complications.
- Identify equipment available and steps that can be taken to minimise potential complications.

Introduction
IV therapy is a common procedure and increasing numbers of patients are requiring vascular access. Complications associated with IV therapy and, in particular, following the insertion of a vascular access device (VAD) can range from phlebitis, infiltration and extravasation to death. Other hazards include sharps injuries and blood-borne infections (Gabriel et al 2005, Royal College of Nursing (RCN) 2005). Effective management of patients with a VAD is essential to prevent complications and improve patient outcomes.

Infection
Infection resulting from the insertion, maintenance and/or use of VADs may have serious consequences for patients, particularly those who are critically ill or immunocompromised. Healthcare professionals are also at risk of infection as a result of sharps injuries.

Catheter-related bloodstream infection is a complication associated with IV therapy and in particular the use of central venous access devices (CVADs), which can lead to death. The main causes of catheter-related bloodstream infection include (Pratt et al 2007):

- Skin micro-organisms at the insertion site of the CVAD.
- Micro-organisms on the hands of healthcare professionals.
- Contamination of the catheter hub.
- Infusate contamination.

Skin micro-organisms at the insertion site of the central venous access device
The skin provides
Preventing infection

The nurse can minimise the potential for infection through good hand hygiene, ensuring that single-use equipment is used only once and by adhering to evidence-based practice.

Vascular access device insertion

Cannulation for the placement of a peripheral VAD is an invasive procedure, which increases the risk of infection. To reduce this risk, the healthcare professional should ensure that the following processes are implemented (RCN 2005, Gabriel 2006, Lavery and Ingram 2006, Casey and Elliott 2007, Pratt et al 2007):

- Hands should be washed with soap and water and dried carefully before and after the procedure.
- Alcohol hand rubs should also be used, but should not be relied on as a substitute for good handwashing technique.
- Protective equipment such as gloves and disposable plastic aprons should be worn.
- Sterile, single-use equipment should be used.
- Equipment should be appropriately disposed of immediately after the procedure.
- Any excess hair on the patient should be removed with scissors or an electric shaver, if necessary, before cannulation.
- The intended venepuncture site should be cleansed with an antimicrobial solution, preferably a chlorhexidine-based alcohol solution, and given time to dry.
- Reinsertion of a used cannula or needle should not be attempted.
- Any blood on the patient’s skin should be removed before stabilisation of the cannula or catheter.
- An appropriate dressing should be applied to the cannula or catheter.

As a result of the increased risk of catheter-related bloodstream infection, maximum sterile precautions should be adopted for the insertion of CVADs. Healthcare professionals should wear sterile gloves and gowns, and large sterile drapes should be used to cover the patient. If there is any risk of blood splashing onto the face of the healthcare worker, a mask, goggles and/or a facial visor should be worn (RCN 2005, Dougherty 2006, Pratt et al 2007).

Managing dressings

Management of the dressing applied to the cannula or catheter is particularly important to prevent the spread of infection. Moisture-permeable transparent dressings not only allow easy observation of the
insertion site for peripheral VADs, midline devices, peripherally inserted central catheters (PICCs) and other types of CVADs, but also provide a waterproof barrier to minimise potential infections. Moisture-permeable transparent dressings for peripheral VADs can remain in situ until the device is removed or resited, unless the integrity of the dressing is compromised, or moisture or blood is observed under the dressing. In these situations the dressing should be removed, the site cleaned and a new dressing applied (RCN 2005). For midline devices, PICCs and non-skin tunnelled catheters, there is usually some slight oozing of blood during the first few hours following insertion. A small piece of sterile gauze can be placed directly over the insertion site and the moisture-permeable dressing applied. This dressing should then be changed the following day, or sooner, if the gauze becomes heavily contaminated. Following the first dressing change, and providing the integrity of the dressing is not compromised or there is no further exudate, it can be left in place for up to seven days, that is, when the next ‘routine’ dressing change should take place, including cleaning of the insertion site and renewal of the stabilisation device (RCN 2005, Gabriel 2006, Pratt et al 2007). If gauze and sterile tape dressings are used they will require a 24-48 hour routine dressing change, or more frequently if they become soiled (RCN 2005). Skin-tunnelled catheters do not require a dressing once the skin tunnel and insertion wounds have healed.

**Managing administration sets and add-on devices** Administration sets used for the administration of clear infusates that are in continual use should be changed every 72 hours or when the integrity of the system is compromised, for example, during resiting of a peripheral cannula or when the giving set becomes disconnected (RCN 2005, Pratt et al 2007). If gauze and sterile tape dressings are used they will require a 24-48 hour routine dressing change, or more frequently if they become soiled (RCN 2005). Add-on devices, such as extension sets, filters, needle-free systems or three-way taps, should be changed when the administration set is changed to reduce the potential for infection (RCN 2005).

A single closed (sealed) system will inevitably have less potential entry sites for infection (Hart 1999, National Patient Safety Agency (NPSA) 2007).

**Time out 2**

Identify any add-on systems or devices used in your clinical area. Once you have done this, assess if they are necessary and if they can be dispensed with or replaced to reduce the number of connections attached to patients’ IV systems.

**Preventing sharps injuries** Nearly 100,000 healthcare workers worldwide contract blood-borne infections annually, such as hepatitis B, hepatitis C or human immunodeficiency virus (HIV) (Rapiti et al 2005). It is estimated that the incidence of sharps injuries among healthcare workers in the United States is approximately 30 per 100 hospital beds per annum, with hollow-bore needles responsible for the majority of sharps injuries (Cooley and Gabriel 2004, Lee et al 2005, Hadaway 2006). However, the true extent of sharps injuries among healthcare workers is unknown as a result of poor reporting (Cooley and Gabriel 2004, Trim 2004). Trim (2004) suggested that under reporting of sharps injuries was possibly as high as 91% and occurred for the following reasons:

- Sharps injuries are considered part of the job.
- The patient involved is not deemed to pose a risk.
- Lack of knowledge on how to report a sharps incident.
- Fear of the response from management.
- Pressures of work.

**Time out 3**

Reflecting on your own career, have you experienced a sharps injury? If so, did you report it? If not, what prevented you from doing so? If you have not had a sharps injury, discuss experiences of sharps injuries with colleagues and update yourself on your organisation’s procedure for reporting such injuries.

**Time out 4**

Identify steps taken in your clinical area to reduce the potential for sharps injuries.
The risk of acquiring a blood-borne infection from a percutaneous injury from a needle used on an infected patient is estimated to be as high as 30% for hepatitis B, 3% for hepatitis C and 0.3% for HIV (Rapiti et al 2005).

Most needlestick injuries in the healthcare setting can be prevented. Precautions to reduce the risk of sharps injuries include (RCN 2005, Casey and Elliott 2007, NPSA 2007, Pratt et al 2007):

- Never re-sheath or recap needles.
- Immediate and safe disposal of sharps into appropriate containers.
- Correct use of sharps containers: do not overfill and replace containers as required.
- Convenient access to sharps containers.
- Regular collections of used sharps containers.
- Use of pre-filled syringes where possible.
- Use of needle-free systems where possible.
- Use of cannulae with integral sharps protection (Figure 1).
- Avoidance of suturing where possible.
- Appropriate securement and management of VADs to prevent the need for resiting.
- Ongoing education for staff involved in handling and disposal of sharps.
- Mandatory reporting of all sharps and needlestick injuries.

**Education of healthcare professionals and patients**

Ongoing education is crucial for all healthcare professionals, especially those in rapidly developing areas of care (NPSA 2007). For all staff involved in caring for patients who have VADs, basic and regular education is required to cover areas such as:

- Hand hygiene.
- Adherence to aseptic care.
- Management of VADs.
- Changes and/or developments in equipment.
- Updates on the latest guidelines.

Patients, particularly those receiving home-based treatments, should be provided with appropriate information regarding the management of VADs. Information should cover infection prevention and health and safety, for example, safe disposal of sharps.

**Air embolus**

Air embolus can occur when air enters the venous circulation as a result of insertion, removal and/or access of a VAD. The precise incidence of air embolus associated with IV therapy is unknown. Although the occurrence of symptomatic air embolus is believed to be less than 2%, it has an associated mortality rate of up to 30% (Dougherty 2006). The risk of air embolus can be reduced by ensuring that the selected arm of the patient, for the placement of a peripheral cannula, midline catheter, PICC or peripherally placed port, is kept below the level of his or her heart during the insertion or removal procedure. On insertion or removal of any CVAD, the patient should be placed in the supine or Trendelenburg position to minimise the risk of air being drawn into the central venous system (Dougherty 2006) (Figure 2). The incidence of air embolism can also be reduced by the use of Luer-Lok™ connections.
such devices were secured with sutures. However, sutures are uncomfortable and significantly increase the potential for infection, particularly in patients who are immunocompromised and/or require such devices for protracted parenteral therapy (Gabriel 2000, Crnich and Maki 2002). Suturing IV devices also contributes to the risk of needlestick injuries. In the critical care setting, 20% of reported needlestick injuries can be attributed to suturing of CVADs (Gabriel 2005). Crnich and Maki (2002) demonstrated the effectiveness of device-specific, sterile, self-adhesive anchoring devices in minimising both the migration of VADs and the incidence of infection. These device-specific, sterile, self-adhesive pads are applied directly to the patient’s skin, close to the cannulation site. The cannula or catheter then fits into the specific anchoring device and the dressing is applied to the cannulation site in the usual way. Device-specific, sterile, self-adhesive anchoring devices offer a safer alternative to sutures for the securing of midline catheters, PICCs and non-skin tunnelled CVADs. They are also available for peripheral cannulae.

Additional securement is not usually indicated for skin-tunnelled CVADs, once the skin has healed, unless the patient is receiving ambulatory therapy, which can place additional stress on the

Vascular access device migration

A VAD that is not secured at its point of entry into the patient has the potential to migrate. This can result in the premature loss of the device and associated complications such as phlebitis, thrombosis, infection and catheter fracture; the latter three of which can be life threatening (Dougherty 2006, Gabriel 2006). A VAD that is inappropriately secured to the patient’s skin can exert a pistoning effect (moving in and out like a piston) as a result of the VAD’s continual movement in and out of the vein. Friction, caused by the movement of the VAD, can enable bacteria to enter the venous circulation, thus increasing the risk of infection. In addition, the continual movement of the VAD may irritate the lining of the vein, which can result in the development of mechanical phlebitis (Table 1). Peripheral VADs can be secured to the patient’s skin with sterile tape or a dedicated, sterile, self-adhesive anchoring device (Figure 4) and covered by a sterile, transparent, moisture-permeable dressing. The transparency of the dressing allows regular observation of the cannulation site and surrounding area to take place without the dressing being disturbed, thus reducing the potential for infection (RCN 2005).

Midline devices, PICCs and non-skin tunnelled CVADs require additional securement to ensure that they do not migrate. Historically,
Thrombosis

Introduction of a VAD into a vein inevitably causes trauma. Continual irritation of the tunica intima by the VAD triggers the collection of platelets around the site of venepuncture, which can result in the development of thrombi. As the thrombi increase in size they either remain in situ, gradually causing occlusion to the lumen of the vessel, adhering to the VAD, or break away and flow through the venous system (Ryder 1995, Dougherty 2006).

Patients with particular types of malignant conditions such as adenocarcinomas, myeloproliferative disorders and promyelocytic leukaemia are more susceptible to thrombosis than other patient groups (Brothers et al 1988, Wickham et al 1992, Couban et al 2005).

Knowledge of the patient’s condition, intended therapy, the different types of VAD and alternative construction materials will help to reduce the risk of thrombosis formation (Ryder 1995, Gabriel 2006).

Extravasation

Extravasation is the inadvertent administration of a vesicant medication or solution into the tissue surrounding a VAD. A vesicant agent is one that has the potential to cause tissue necrosis if it extravasates (RCN 2005). Necrotic tissue will not heal and usually requires surgical removal followed by skin grafting. The IV device will require resiting, which may delay the patient’s treatment.

**Phlebitis**

Phlebitis is characterised by inflammation of the tunica intima or inner lining of the vein. It can range from slight redness around the insertion site of the patient’s VAD, to a painful and palpable venous cord, which is not only distressing for the patient but will lead to premature loss of the cannula or catheter and, if the result of infection, increase the patient’s hospital stay. There are three main types: mechanical, chemical and infective phlebitis (Richardson and Bruso 1993) (Table 1).

### TABLE 1

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<tr>
<th>Type</th>
<th>Cause</th>
<th>Prevention</th>
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| Mechanical| > Gauge of the vascular access device (VAD) is too large to allow flow of blood around it, which will cause irritation to the wall of the vein.  
           > More common in females as they have smaller veins.  
           > Poor securement of the VAD, resulting in pistoning of the device.      | > Select a VAD with a small gauge to deliver intended therapy.           
           |                                                                        | > Adequate securement of the VAD to minimise potential movement.          |
| Chemical  | > Irritation of the tunica intima by drugs and/or infusates that are:  
           > Acidic.  
           > Alkaline.  
           > High osmolality.  | > Avoid siting the VAD in a vein in the dominant arm and/or in areas of flexion to minimise potential for movement. |
| Infective | > Poor aseptic technique when placing or accessing the VAD.  
           > Inappropriate dressing to protect insertion site.            | > Strict aseptic technique when inserting or accessing the VAD and when changing dressings. |

(Richardson and Bruso 1993, Gabriel et al 2005, RCN 2005)
Infiltration

Infiltration is the inadvertent administration of a non-vesicant medication or solution into the tissue surrounding a VAD (RCN 2005). Infiltration is painful and uncomfortable for the patient. The IV device will require resiting, which could delay the patient’s treatment.

Non-patent vascular access devices

Dougherty (2006) defined patency as the ability to infuse through a catheter and aspirate blood from a catheter. A non-patent VAD is one of the most common causes of premature device removal, which is uncomfortable for the patient and uses up valuable healthcare resources. The appropriate management and care of the patient’s VAD will not only add to the longevity of the device, but will also help to ensure that the patient’s parenteral therapy is not delayed while waiting for a new device to be inserted. Before administration of any parenteral medicine or commencement of an infusion, the patency of the VAD should be checked with a ‘flush’ of 0.9% sodium chloride (RCN 2005). If the nurse is unable to ‘flush’ the VAD or resistance is encountered, the device should not be used until a further assessment has been made (RCN 2005).

Flushing peripheral cannulae

To minimise the potential for VAD occlusion, the peripheral cannula should be flushed with 0.9% sodium chloride after the administration of medicines or infusions, and at regular intervals when the device is not in use (RCN 2005, Dougherty 2006, NPSA 2007). Although the frequency of routine flushing of the peripheral cannulae to minimise the risk of occlusions is still undetermined, the positive pressure or turbulent flush technique has been proved to be highly effective (RCN 2005).

Positive pressure flushing is achieved by maintaining pressure on the plunger of the syringe as it is removed from the injection cap. Turbulent flushing is achieved by a rapid push/pause technique when injecting 0.9% sodium chloride (RCN 2005, Dougherty 2006, Gabriel 2006). In practice a positive pressure flush technique can be difficult to master, but some manufacturers have developed injection caps that will automatically do this. Positive pressure devices add to the longevity of a VAD, and are also needle free, thus reducing the potential for needlestick injuries.

In the event that the nurse is unable to flush the patient’s peripheral VAD or resistance is encountered, the following questions should be asked:

- How long has the VAD been in place?
- Is the patient complaining of any discomfort arising from the VAD?
- What does the insertion site and its surrounding area look like?
- When was the device last used? Were there any documented problems or does the patient recollect any problems?
- What medication or infusions were last administered and could they have resulted in precipitation, for example, blockage of the internal lumen of the VAD?
- Is there external kinking or pressure to connecting IV tubing?
- Can the patient’s prescribed therapy now be given orally instead of intravenously?

If the answer(s) to the above questions do not solve the problems of inability to flush the device or resistance to flushing, then it may then be appropriate to resite the cannula so that the patient’s treatment can be continued.

Flushing midline catheters and central venous access devices

Midline catheters and CVADs should be flushed with 0.9% sodium chloride, using a positive pressure and turbulent flush technique, with twice their prime volume (the capacity of the internal lumen) following the administration of drugs and/or infusates. If the device has more than one lumen, each lumen will require positive pressure and turbulent flushing to minimise the risk of occlusion. Although it is generally accepted that 0.9% sodium chloride is the acknowledged flush solution for peripheral cannulae when the devices are not in continual use, there is still no conclusive evidence to support the use of either 0.9% sodium chloride or heparinised saline for CVADs.

The National Institute for Clinical Excellence (2003) supported the use of heparinised saline for maintaining patency in CVADs, but drew no conclusions about the...
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recommended strength of the heparin. The commonly used concentration is 10iu per ml, but individual catheter manufacturers will provide advice for their products (Dougherty 2006). Manufacturers of valved catheters recommend the use of 0.9% sodium chloride on a weekly basis for each lumen of the CVADs, when not in continual use. The manufacturers of open-ended or non-valved devices supply product specific information relating to the flush solution and frequency for their products (RCN 2005, Dougherty 2006). For implantable injection ports, individual manufacturers provide specific information on the flush solution to be used and its frequency.

Conclusion
Appropriate management of patients’ VADs is essential to reduce complications associated with IV therapy. Healthcare professionals should demonstrate a working knowledge of local policy and guidance relating to VAD insertion and management to reduce IV-related incidents. This will provide quality care for patients and will help to reduce NHS expenditure on IV devices and management of related complications NS

References


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