Preventing and managing complications of CVADs

The range of intravenous (IV) therapies available for the delivery of long-term treatments in patients’ own homes or community settings is continuing to rise. Many of these patients taking complete or partial responsibility for managing their own central venous access device (CVAD) (Braine and Woodall, 2012; Department of Health, 2011; Dougherty, 2008).

Types of long-term CVADs

Skin-tunnelled catheters
Skin-tunnelled catheters have an integral Dacron cuff, which is inserted in the skin tunnel (Fig 1) (Dougherty, 2006).

Injection ports
Injection ports are held in position by suturing to the underlying muscle of the skin pocket in which the port is placed.

The whole device is completely implanted under the skin, with venous access achieved by puncturing the skin overlying the silicone rubber membrane covering the injection port (Fig 2). The needle used to puncture this membrane is a specifically designed non-coring needle, which prevents damage to the self-sealing membrane (Gabriel, 2010; Royal College of Nursing, 2010; Dougherty, 2006).

Peripherally inserted central catheters
Peripherally inserted central catheters (PICCs) are the only long-term CVADs that require ongoing securement to reduce the likelihood of the catheter moving. Historically, this type of securement has involved suturing; however, these sutures can become loose over time and can act as a potential focal point for infection (Gabriel, 2010). The use of self-adhesive anchoring devices that have been developed in recent years has reduced the incidence of device loss due to catheter migration by up to 71%, and has also reduced insertion site infections (Fig 3) (Moureau and Lannucci, 2003; Royer, 2003).

If a PICC comes out, it should not be reinserted into the vein due to the risk of infection (RCN, 2010).

Potential complications

Catheter migration
Premature loss of any vascular access devices is distressing for patients and can lead to delays in treatment if there is no IV access to administer prescribed medications (Gabriel, 2010). The premature loss of a CVAD as a consequence of catheter migration can be especially distressing for...
patients as the insertion procedure is more invasive than that for a peripheral cannula (see part 1). Securing the CVAD appropriately from the outset can minimise the potential for migration into the central venous system (Gabriel, 2010). This can occur for a number of reasons, including the following:

- Disconnection of the catheter from the injection port;
- The external portion of the skin-tunnelled catheter breaking or a lack of tissue ingrowth into the Dacron cuff;
- Insufficient or inappropriate securement of a PICC to the skin;
- The PICC catheter breaking between the securement area and insertion site;
- "Pinch-off syndrome" (POS), which occurs when the catheter becomes trapped between the first rib and the clavicle due to the angle at which the catheter is inserted into the subclavian vein. Over time, the movement of the clavicle causes pressure on the catheter within the subclavian vein, as it is compressed against the first rib. This can result in fracture, resulting in breakage and migration of the CVAD (Gabriel, 2008).

**Infection**

Any infection associated with a CVAD is potentially life threatening as the device is positioned in the central venous circulation system. The majority of patients who need central venous access have serious underlying medical conditions, and many are immunocompromised, which increases the risks associated with infection (Gabriel, 2008). Infection can result from:

- The insertion process;
- Poor maintenance of the insertion site;
- Contamination of the CVAD's hub;
- Contamination of the infusate;
- Microorganisms on the hands of health professionals managing the CVAD (RCN, 2010; Gabriel, 2008).

Catheter-related bloodstream infection (CRBSI) is associated with any vascular access device and can be fatal. This risk can be minimised by using strict aseptic techniques during insertion, maintenance and accessing the CVAD (Pratt et al, 2007).

**Skin cleansing**

Research has shown that a 2% chlorhexidine-based alcohol solution is more effective at decontaminating the access site than povidone-iodine (Gabriel, 2008; European Prevention of Infection Control, 2007; Pratt et al, 2007). Once the device has been placed, ongoing skin care will be needed until the insertion site has healed for skin-tunnelled catheters (usually 10–14 days), and every time the dressing is changed for PICCs (Gabriel, 2010). Chlorhexidine and alcohol-based solutions can also be used as effective decontaminants for cleaning injection hubs or connectors (RCN, 2010; Pratt et al, 2007).

Contamination of infusates is now rare, due to more rigorous control in pharmacy units (Dougherty, 2006). However, care and attention is still required at the point of delivery. Health professionals must check the infusate packaging for any signs of damage, the expiry date, prescription details and patient identity. Immediately before administration, they must thoroughly wash their hands and decontaminate the injection hub/connector, following their organisation’s guidelines (RCN, 2010; Pratt et al, 2007).

**CVAD dressings**

All CVADs need a dressing immediately after insertion to minimise the risk of infection (Gabriel, 2008). A tunnelled CVAD needs a dressing around the entrance to the skin tunnel until the wound has healed. This should take around 10–14 days depending on the individual patient, with those who are immunocompromised taking longer (Gabriel, 2010).

Once the skin has healed over the insertion site of the injection port pocket, the only dressings subsequently required are to secure the access needle in place when the port is being used (RCN, 2010). PICCs need to have a dressing over them as they are placed directly through the skin overlying the venepuncture site where the catheter accesses the vein (RCN, 2010).

All dressings should be observed regularly and replaced the day after insertion, or earlier if there is any oozing or if the integrity of the dressing is compromised in any way. Provided that the insertion site remains dry, intact dressings can then remain in place for up to seven days (RCN, 2010; Gabriel, 2008).

**Long-term dressings**

If a sterile, moisture-permeable transparent dressing is used for a PICC, it can be left in position for up to seven days, providing its integrity is not compromised and there is no moisture accumulation.
including blood oozing from the insertion site (RCN, 2010). The more frequently the dressing is disturbed and the CVAD insertion site interfered with, the greater the potential for infection (RCN, 2010; Pratt et al, 2007).

**Thrombosis**

The introduction of any vascular access device into a blood vessel has the potential to cause irritation to the inner lining of the vein, which is called the tunica intima (see part 1). This trauma can initiate a chain of events leading to thrombi formation (blood clotting at the site of the injury) (Brewer, 2012; Dougherty, 2006). As the thrombi increase in size, they can obstruct the lumen through which the CVAD is passing or break away and flow through the venous system (Dougherty, 2006).

Patients with particular long-term conditions, such as adenocarcinoma, myeloproliferative disorders and promyelocytic leukaemia, are more susceptible to the development of thrombosis than other groups of patients (Gabriel, 2012).

**Minimising the risk of thrombosis**

Taking into consideration any underlying medical conditions before selecting the most appropriate CVAD can reduce the risk of thrombosis formation. This assessment should include knowledge on the intended therapy, for example how irritating it may be to the tunica intima, for how long the therapy is intended to last, and catheter material of the potential CVAD (see part 1).

**Management of thrombosis**

If a thrombosis is suspected, the patient should have an ultrasound or venogram (Dougherty, 2006). If it is confirmed, there are three possible management strategies (Brewer, 2012; Dougherty, 2006): 
- Administration of a thrombolytic agent, such as urokinase or tissue plasminogen activator (with the aim of dissolving the clot); 
- Removal of the thrombi; 
- Removal of the catheter, followed by administration of anticoagulants.

**Fibrin sheaths**

Trauma to the tunica intima from the CVAD insertion or its long-term irritation can set off a chain of reactive events resulting in fibrin cells becoming attached to the external wall of the CVAD. Over time, which can be as little as 24 hours after insertion, these fibrin sheaths can envelope the CVAD. For the majority of patients this does not cause any significant problems (Dougherty, 2006; Haire and Herbst, 2000). Schelper (2003) found that 97% of all patients who died with a fibrin sheath around their device, which did not appear to have caused any infusion-related problems.

When a fibrin sheath completely envelops a CVAD it can, in rare cases, lead to extravasation or infiltration of the infusate. This is when the infusate exits the CVAD, but is prevented from entering the venous circulation by the sheath. The infusate leaves the device and then backtracks between the outer wall of the CVAD and inner wall of the fibrin sheath, until it reaches an exit point. This could be within the skin tunnel for a skin-tunnelled catheter.

**Persistent withdrawal occlusion**

Persistent withdrawal occlusion (PWO) occurs when a health professional is unable to withdraw from the CVAD, but there are no problems with infusing (Gabriel, 2008). It is linked to the development of fibrin sheaths, the most common cause of PWO. The fibrin forms a tail at the end of the CVAD, acting as a one-way valve. When positive pressure is applied to the device, the tail is pushed away and it is possible to infuse. When negative pressure is applied by aspirating from the CVAD, the tail is pulled up against the tip of the catheter preventing aspiration.

Once diagnosis is confirmed, usually by venogram, management can include the following:
- Administration of antithrombolytics as an infusion; 
- Removal of the CVAD (Dougherty, 2006; Haire and Herbst, 2000).

**Occluded CVADs**

Oclusion is the most common reason for premature removal. Occlusion of CVADs as a consequence of fibrin sheaths, PWO and catheter migration has already been discussed, but there are other causes. These can include (Dougherty, 2006): 
- Extraluminal occlusion (Table 1); 
- Intraluminal occlusion (Table 2).

**Phlebitis**

Inflammation of the tunica intima is called phlebitis. There are three types (RCN, 2010): 
- Mechanical; 
- Chemical; 
- Infective.

**Mechanical phlebitis**

Mechanical phlebitis is rare in recipients of skin-tunnelled catheters and ports as the catheter accesses the central venous system through one of the larger venous blood vessels. This results in a large volume of blood flowing around the catheter, giving it little opportunity to irritate the tunica intima. However, PICCs access the venous system through the cephalic, median cubital or basilic veins in the arm, which have much smaller lumens, leaving less space between the external wall of the catheter and the
tunica intima. This can result in irritation to the tunica intima from the PICC itself, which can give rise to phlebitis, a consequence of continual (mechanical) irritation (Gabriel, 2008).

The potential for mechanical phlebitis can be reduced by ensuring the gauge size of the selected PICC is small enough to fit the lumen of the patient’s veins. A catheter constructed from silicone rubber is softer and more flexible than one constructed from polyurethane but has thicker walls and therefore a narrower internal lumen, so has slower flow rates (part 1).

Mechanical phlebitis can be treated with warm compresses over the insertion site. For many patients, this will relieve the discomfort, and the phlebitis should settle within a few days after the insertion (RCN, 2010).

Chemical phlebitis
Chemical phlebitis is a consequence of irritation of the tunica intima by acidic, alkaline or high-osmolality drugs or infusates. It is rare to see this type of phlebitis in patients with a CVAD because the catheter tip terminates in the central venous system, which means the infusates are diluted rapidly in the large volume of blood flowing through the vessels (Gabriel, 2008).

Infective phlebitis
Infective phlebitis results from blood vessels being irritated by infection, which usually tracks along the tunica intima from the insertion site of the vascular access device. Strict aseptic technique during insertion and every time the device is handled will minimise the risk of infective phlebitis developing (Gabriel, 2008).

Air embolus
An air embolus can occur when air enters the venous circulation during insertion, access or removal of a CVAD (Dougherty, 2006). For the insertion and removal of injection ports or skin-tunnelled catheters, the patient should be placed in the supine or Trendelenburg (supine with the feet 15-30° higher than the head) position to reduce the risk of this happening. Patients with PICCs should have the catheterised arm below the level of the heart during insertion and removal (Gabriel, 2008).

The risk of an air embolus can be reduced further by using a valved catheter. In the absence of a negative or positive pressure, the valves remain closed, preventing air from entering the CVAD (see part 1) (Gabriel, 2013; 2008).

### Table 1. EXTRALUMINAL OCCLUSION

<table>
<thead>
<tr>
<th>Cause</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twisted IV tubing or external length of PICC or skin-tunnelled catheter</td>
<td>Untwist tubing/catheter and secure</td>
</tr>
<tr>
<td>Dressing too tight over PICC</td>
<td>Replace dressing so as not to constrict PICC</td>
</tr>
<tr>
<td>Pinch-off syndrome (POS) – skin-tunnelled catheter or injection port catheter is compressed between first rib and clavicle</td>
<td>Remove and replace CVAD</td>
</tr>
<tr>
<td>Thrombosis overlying CVAD resulting in constriction of the CVAD lumen</td>
<td>If unable to be medically managed or removed in radiology, remove and replace CVAD</td>
</tr>
<tr>
<td>Pressure of cardiac pacemaker on CVAD within blood vessel</td>
<td>Remove and replace CVAD, taking into consideration position of pacemaker</td>
</tr>
</tbody>
</table>

### Table 2. INTRALUMINAL OCCLUSION

<table>
<thead>
<tr>
<th>Cause</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clotted blood</td>
<td>Treat by instilling urokinase/tissue plasminogen activator as per organisational policy</td>
</tr>
<tr>
<td>Drug/infuse precipitation</td>
<td>Identify drug/infuse involved and discuss possible antidotes with local pharmacy and clinician in charge of the patient’s care, as per organisation policy.</td>
</tr>
<tr>
<td>Fat clot from total parenteral nutrition</td>
<td>Consider instilling alcohol to dissolve clot as per organisational policy and following discussion with clinician in charge of the patient’s care</td>
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**Conclusion**
Placing a foreign body into a vein has the potential to cause many problems, which can be fatal if left unrecognised and untreated. The potential for complications can be reduced through awareness of these problems and thorough patient assessment before placing a long-term CVAD. **NT**

**References**


**Central Venous Access Devices**

1. Long-term central venous access device selection
2. Preventing and managing complications of CVADS

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For articles on intravenous therapy, go to http://www.nursingtimes.net/ivtherapy