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Introduction

Central venous access devices (CVADs) are devices used to gain access to the central circulation. CVADs are used widely in the cancer setting for patients requiring:

- long term treatment limiting the number of venepunctures and protecting the peripheral vasculature (O’Grady et al. 2002; RNAO, 2004)
- continuous infusion of chemotherapy providing a secure method for drug delivery
- access for the administration of:
  - vesicant chemotherapy
  - parenteral nutrition and
  - other hyperosmolar solutions

These infusions could cause damage to the veins and surrounding tissues, and cause thrombus formation if administered via peripheral veins (RNAO, 2004). As CVADs are situated in the central circulation, the large volumes of blood returning to the heart quickly dilute and disperse drugs and solutions.

- apheresis procedures, as the positioning in the central circulation and the lumens of specific CVADs enable large volumes of blood to be withdrawn and returned
- immediate venous access in an emergency situation.

The use of CVADs has increased markedly over the past two decades due to research, development and refinement of the devices, their availability and the increasingly complex needs of patients requiring intensive treatments. Nurses require a high level of knowledge and skill to manage CVADs in the cancer setting.

Development of the CNSA CVAD Principles for Nursing Education and Practice

This document has been developed by the Cancer Nurses Society of Australia Central Venous Access Device Working Party, an expert working party comprising members of the Cancer Nurses Society of Australia (CNSA). This working party was convened by the CNSA National Executive Committee in response to a proposal submitted by members of the Mid North Coast and Northern Rivers CNSA Regional Group, stating the need for standardised practice in use and care of central venous access devices across Australia.
It is intended that the *Cancer Nurses Society of Australia Central Venous Access Devices: Principles for Nursing Education and Practice* will provide nurses and haematology/oncology facilities with principles to guide practice, to develop policy and procedures and associated education and training programs in relation to the management of patients who have central venous access devices.

The development of this resource has included:

- **Literature review and development of the draft practice principles**
  A review of the literature was undertaken by members of the CNSA Central Venous Access Device Working Party to identify the current literature regarding central venous access devices (CVADs) and the care of patients with these devices. The following databases were searched for the purpose of developing this document: CINAHL; Medline; Pubmed; Google Scholar. Documents and guidelines pertaining to CVAD insertion, device management and patient care were accessed through libraries catalogues, professional organisations and government authorities.

- **Expert working party review of the draft document**
  Throughout the development of this document the working party members met by teleconference to discuss the review and the ongoing development of the draft. Draft documents were then distributed to all expert working party members for review and to provide feedback on the quality and relevance of the contents.

- **Review of penultimate draft by critical reviewers**
  The penultimate draft was disseminated to nurse clinicians with expert knowledge and experience with CVADs, who were asked to be critical reviewers, to also provide feedback on the quality and relevance of the contents. These reviewers were not members of the CNSA CVAD working party. Their comments and revisions were incorporated and the final draft was endorsed by the Cancer Nurses Society of Australia National Executive Committee.

See Appendix 1 for a list of acronyms and Appendix 2 for the glossary of terms.
Summary and recommendations

Section One: Educational standards for nurses involved in the management of central venous access devices

Registered nurses who work in oncology and haematology require specific education and training to attain the knowledge, assessment skills and technical expertise required to manage the care for patients who have central venous access devices (CVADs) and the device-related complications that patients may experience (Goodman, 2002).

The nursing role includes: assessing the patient’s vascular access needs; recommending the appropriate device for treatment (in collaboration with medical staff); educating the patient and the family about the device and its care; providing ongoing CVAD management, including the management of complications and the ability to advocate for the patient when necessary (Chernecky et al. 2003).

Competence implies that the individual possesses the ability to perform in several skills areas including patient and family education, problem solving, application of theory to practice, and psychomotor skills, within a given setting or role (Dool, Roehaver & Fulton, 1993).

Recommendations:

Curricula for CVAD education should include: indications for use; device selection; insertion and maintenance techniques; relevant methods of preventing and managing infections and other complications and patient education (Rosenthal, 2004).

Educational programs that advance knowledge, skill and competence and determine performance levels for registered nurses caring for patients with CVADs should be provided by the health care facility (Dool, Roehaver & Fulton, 1993).

CVAD specific policies and procedures, based on the current evidence, should be implemented and these should include an evaluation and review process (CNSA CVAD working party).

Competence should be assessed by an experienced competent RN, guided by a procedural checklist, within the context of actual practice (Dool, Roehaver & Fulton, 1993).

Access to ongoing education should be provided and periodic assessment of knowledge and skill should be undertaken (Rosenthal, 2004; O’Grady et al. 2002).
Section Two: Characteristics of central venous access devices used in cancer settings

Catheter Tip Location

CVADs are positioned within the central venous circulation, typically in the superior vena cava (SVC) (Mauro, 2003).

Positioning in the SVC should be in the lower third of the vessel (Tropp et al. 2006; O’Grady et al. 2002; National Association of Vascular Access Networks, 1998).

Device Characteristics

Most long-term devices used in the cancer setting are made from silicone or polyurethane. Silicone is a soft, biocompatible material (Mauro, 2003; Weinstein, 2001). Catheters made from silicone provide benefits for the patient as the material reduces the adherence of fibrin to the catheter and offers increased biocompatibility (Camp-Sorrell, 2004). Polyurethane is a stronger, firmer material, which allows the walls of the CVAD to be thinner while still providing the same lumen diameter (Mauro, 2003; Weinstein, 2001). This material does soften following insertion in response to body temperature and offers increased biocompatibility and less adherence of fibrin, when compared to other materials (Doughtery, 2006; Camp-Sorrell, 2004).

CVADs have three basic tip configurations:

1. Open-ended catheters are available as single- or multiple-lumen catheters and can be trimmed to fit the person’s anatomy.

2. Valved catheters allow blood to be withdrawn and solutions infused, however when no force is applied to the valve it remains in a closed position, preventing reflux of blood into the catheter (Fox, Roach & Berman, 2002). These catheters cannot be trimmed at the tip.

3. Staggered tip catheters are designed so that simultaneous aspiration and infusion can be performed with limited mixture of drugs and solutions (Rowley & Goldberg, 2005; Mauro, 2003). These catheters cannot be trimmed at the tip.

Catheters can be single or multi-lumen. Multi-lumen catheters have a higher infection rate than single-lumen catheters (Fox, Roach & Berman, 2002).

The length and size of the catheter will influence the ability to infuse solutions. A shorter device with a wide gauge can be used for faster infusion than a longer device (Gabriel et al. 2005).
Categories of CVADs

CVADs are generally classified into two categories:

1. External devices - tunnelled and non-tunnelled catheters
2. Internal devices - implanted ports

1. **External Devices**

Tunnelled catheters are surgically implanted with a section of the catheter positioned in a subcutaneous tunnel between the entry site to the vein and the skin exit site. A tissue ingrowth cuff, positioned just inside the exit site, inhibits the migration of organisms into the catheter tract by stimulating the growth of surrounding tissue, thus sealing the catheter tract (RNAO, 2004; O’Grady et al. 2002; Mermel et al. 2001). Non-tunnelled catheters are those where the exit site is directly above entry into the vein. They do not have a subcutaneous tunnel. These catheters can be single- or multiple-lumen. This category includes peripherally inserted central catheters, which are inserted into the central circulation via a peripheral vein and can remain in place for months (Gabriel et al. 2005; RNAO, 2004). Non-tunnelled central catheters for short-term use can be sited using the jugular veins, the subclavian or femoral veins (Hayden & Goodman, 2005).

2. **Internal Devices**

The implanted port is a long-term CVAD that can remain in place and be functional for years (Camp-Sorrell, 2004). The main feature is that they are totally implanted, with access gained through the skin via a hollow housing/port containing a septum usually produced from self-sealing silicone, connected to a catheter (Camp-Sorrell, 2004).

Section Three: Patient and family caregiver education

Providing patient and family caregiver education about the care of their central access device, the signs and symptoms of complications of the CVAD and who to contact for assistance can improve patient outcomes (Itano & Taoka, 2005).

**Recommendations:**

Following education, the nurse should assess that the patient and family caregiver can:

- describe the rationale, the risks and the benefits of the device
- demonstrate care of the catheter to a level appropriate for their needs
- list the signs and symptoms of catheter-related complications
- state who to contact if they have concerns and how to contact them (Itano & Taoka, 2005).

Patient and family caregiver education should be documented in the patient record (Camp–Sorrell, 2004).
Section Four: Caring for a person with a central venous access device: pre-insertion

The nurse has a role to advocate for patients in relation to the selection of a device appropriate for them (RNAO, 2004).

Appropriate selection of vascular access can minimise risk and maximise the benefits for patients undergoing intravenous therapy (Camp-Sorrell, 2004; Galloway, 2002; O’Grady et al. 2002).

The use of an algorithm to facilitate a comprehensive assessment to plan for vascular access prior to the initiation of therapy can assist patients and health professionals (RNAO, 2004).

Recommendations:

Written consent for the procedure and the sedation (if sedation planned) should be gained following patient education about the procedure (ANZCA, 2005).

The CVAD insertion technique and insertion site with the lowest risk for complications for the anticipated type and duration of therapy should be selected (O’Grady et al. 2002).

A CVAD with the minimum number of ports or lumens essential for the management of the patient should be selected to reduce the risk of complications (O’Grady et al. 2002).

Antimicrobial prophylaxis should not routinely be given before insertion or during use of a CVAD to prevent catheter colonisation or bloodstream infection (O’Grady et al. 2002).

Optimum aseptic technique during catheter insertion (sterile gown, mask, gloves and large drapes) should be implemented (O’Grady et al. 2002; NICE, 2003; RCN, 2003).

The insertion site should be prepared with 2% chlorhexidine gluconate in 70% alcohol and allowed to air dry before skin penetration (O’Grady et al. 2002; RCN, 2003).

Details of the procedure, the device, tip placement and the condition of the patient should be documented in the patient record, following the insertion (CNSA CVAD working party).
Section Five: Caring for a person with a central venous access device: post-insertion

Caring for the patient with a CVAD includes:

- reviewing patient and family caregiver knowledge and understanding regarding the device
- providing information about the device and its care
- promoting patient comfort
- undertaking procedures to reduce the risk of CVAD-related complications and
- assessing for and managing complications if they occur.

Recommendations:

Proper hand hygiene procedures, before, during and after any CVAD manipulations or procedures, must be implemented to reduce the risk of infection (O’Grady et al. 2002).

Impeccable maintenance practices should be implemented to reduce the risk of CVAD-related complications (CNSA CVAD working party).

Verification of catheter tip placement

The anatomical placement of the catheter tip must be documented in the patient record and checked prior to the initiation of any therapy through the device (RNAO, 2005).

Following catheter insertion, radiological examination (e.g. chest X-ray) should be obtained to: verify catheter placement; detect adverse events and retain as a record of placement (Povoski, 2005).

Prior to infusion of any solution, the integrity of the system should by determined by obtaining a blood return, as this confirms that the CVAD is in the venous system (Dougherty, 2006).

Accessing and de-accessing CVADs

CVADs should be accessed using a sterile technique (Tropp et al. 2006; Camp-Sorrell, 2004).

An implanted port must be accessed using a specially designed non-coring needle (Tropp et al. 2006).

If the non-coring needle is to remain in place, it should be covered with a sterile transparent semi-permeable dressing, which should be changed at least every seven days (Tropp et al. 2006).

Solutions

2% chlorhexidine gluconate and 70% alcohol solution should be used for CVAD site and
catheter care and allowed to air dry before the application of the dressing (RNAO, 2004).

Organic solvents such as acetone or ether should not be applied (O’Grady et al. 2002).

Antimicrobial ointments should not be used at the catheter insertion site (RNAO, 2005; Camp-Sorrell, 2004; O’Grady et al. 2002).

**Injection access caps, administration sets and add-on changes**

All administration lines, extension sets and injection access caps used with CVADs should be sterile, luer-lock design (Tropp et al. 2006).

Needleless access to the catheter and safety non-coring port access needles should be implemented to protect health care practitioners from injury (CNSA CVAD working party).

The injection access cap should be changed for a sterile cap each seven days or earlier if compromised by presence of blood or if the integrity of the cap is compromised (MHRA, 2005; RCN, 2005; Perucca, 2001).

Positive fluid displacement injection caps may be used on CVADs to reduce the risk of occlusion (Rummel, Donnelly & Fortenbaugh, 2001).

Administration sets should not be disconnected (and reconnected at a later time) for the purpose of the patient showering or toileting as this may increase the risk of complications such as infection and catheter occlusion (CNSA CVAD working party).

The type of solution administered can alter the frequency of administration set change. More frequent administration set change is required for fluids that enhance microbial growth (O’Grady et al. 2002).

**Intravenous administration sets being used for:**

- continuous infusions should be changed every 96 hours (Gillies et al. 2005)
- transfusion of blood and fresh or frozen blood products should be changed every eight hours or on completion of administration, whichever occurs first (ANZSBT, 2004).
- infusion of lipids and parenteral nutrition containing lipids should be changed every 24 hours (Gillies et al. 2005; RNAO, 2005)
- parenteral nutrition containing only amino acids and dextrose should be changed every 72 hours (O’Grady et al, 2002)
- fractionated products (IvIG, clotting factors, albumin) should be changed on completion of infusion (RNAO, 2005)
• propofol infusion tubing should be replaced every six or 12 hours, depending on manufacturers’ recommendation (O’Grady et al. 2002).

**DRESSINGS**

Tunneled catheters that have well healed exit sites and implanted port sites that are well healed and not accessed do not require dressings (RNAO, 2005; O’Grady et al, 2002).

CVADs should be dressed with a sterile dressing, using an aseptic technique (RNAO, 2005; O’Grady et al. 2002).

The dressing should be changed if the integrity of the dressing is compromised and at an interval appropriate for the dressing product used (RNAO, 2005; O’Grady et al. 2002).

The choice of dressing may be made according to the clinical situation, including patient allergies and preference (Gillies et al. 2003; O’Grady et al. 2002).

• Gauze dressings should be changed every 48 hours or earlier if integrity of dressing is compromised (RNAO, 2005)
• Transparent semi-permeable dressings should be changed every seven days or earlier if integrity of dressing is compromised (Camp-Sorrell, 2004; RNAO, 2005; O’Grady et al. 2002)

Instruct the patient to cover the exit site and the external catheter and connecting device with a waterproof cover when showering to reduce the risk of introducing organisms into the catheter or exit site (Camp-Sorrell, 2004; O’Grady et al. 2002).

**FLUSHING**

Flushing of CVADs with 10-30mls of 0.9% sterile sodium chloride solution using a “push-pause” positive pressure technique is recommended:

• before and after
  o administration of medication
  o administration of blood and blood products
  o intermittent therapy
• after obtaining blood specimen/s
• when converting from intermittent therapy
• for device maintenance when not in use (RNAO, 2005).
The minimum size syringe used to access or flush CVADs should be 10ml (RNAO, 2005; Camp-Sorrell, 2004).

**LOCKING THE CVAD**

There is limited evidence to inform the appropriate solution and the frequency of flushing and locking.

Heparin should be used only when necessary, and in the lowest concentration and volume possible (RNAO, 2005).

The use of 0.9% sterile sodium chloride solution for locking is effective in maintaining the patency of valved CVADs (RNAO, 2005).

A common concentration for locking implanted ports is 50IU Heparin in 5 ml 0.9% sterile sodium chloride solution (CNSA CVAD Working Party).

Routine flushing and locking is recommended for dormant ports (RCN, 2005; Camp-Sorrell, 2004) with a flushing interval of four to six weekly (Camp-Sorrell, 2004).

**Securing the CVAD**

All CVADs should be secured using a method appropriate for the device to enable assessment and monitoring of the site, and prevent dislodgement, migration and catheter damage (RNAO, 2005).

**Removal of a CVAD**

The removal of a CVAD should only be performed by an appropriately educated and trained health care practitioner (RCN, 2005).

If the device is being removed due to suspected or confirmed infection, it is recommended the tip be cut off using a sterile procedure and sent for culturing (Dougherty, 2006).

On removal of the CVAD, the health care practitioner should check the catheter’s integrity to ensure removal of the entire device (Dougherty, 2006).

**New technology**

When changing technology, it is recommended that: catheter-related blood stream infection rates are monitored; approved policies are in place; and
comprehensive, detailed education and clinical skills training supports the change in practice (Health Devices Alerts, 2006).

Section Six: Complications related to central venous access devices and their management

Recommendations:

Many CVAD-related complications can be limited by:

- inserting the smallest gauge CVAD with the least number of lumens possible for the patient’s treatment (O’Grady et al. 2002)
- verifying catheter tip placement in the lower third of the superior vena cava on insertion and routinely over the placement period
- regular and consistent maintenance procedures using strict aseptic techniques (Camp-Sorrell, 2004; Tezak, 2003; Penne, 2002).

The patient and family caregiver should be educated to:

- undertake regular surveillance of their CVAD
- undertake immediate emergency action to minimise risks if a CVAD complication is detected
- report any concerns about the device or their health (CNSA CVAD working party).

All patient concerns about their CVAD should be investigated (CNSA CVAD working party).

Information relating to a CVAD event, including the cause, action taken and outcomes should be documented in the patient’s record (CNSA CVAD working party).

Information relating to CVAD events including incidence, degree, cause, corrective action and outcome should be collected and readily retrievable so that trends and possible causative factors can be identified, rectified and reported (CNSA CVAD working party).

CVAD-related infections

The patient and the family caregiver should be educated to report symptoms of infection, redness, swelling, pain/discomfort or any exudate at the exit or implanted port site (CNSA CVAD working party).

Health care staff should be educated in appropriate infection-control measures to prevent CVAD-related infections (O’Grady et al. 2002).
Appropriate nursing staff levels should be allocated in high acuity patient areas to minimize the incidence of CVAD-related infections (O’Grady et al. 2002). The number of CVAD manipulations should be limited (Rosenthal, 2004; O’Grady et al. 2002).

**Maintenance procedures should include:**

- At minimum, daily site assessment, using inspection and light palpation of the exit site (through the dressing), tunnel or port pocket (Camp-Sorrell, 2004). If tenderness/pain, swelling or exudate the dressing should be taken down, using aseptic technique to enable closer inspection (CNSA CVAD working party).
- Documentation of the assessment of exit site or implanted port site daily (Camp-Sorrell, 2004).
- Regular assessment of patient’s temperature (CNSA CVAD working party).
- Signs and symptoms of suspected infection should be documented and reported to a medical officer to enable further investigation and implementation of appropriate treatment (CNSA CVAD working party).

**Suspected infection should be investigated by:**

- exit site swabs if there are signs of localised infection (Camp-Sorrell, 2004).
- blood cultures from all lumens of the CVAD and peripheral blood cultures if there is suspected catheter infection (Camp-Sorrell, 2004; Mermel et al. 2001).

Multiple-lumen catheters should have each lumen used for the administration of the antibiotic during the course of the treatment (Camp-Sorrell, 2004).

Removal of the CVAD should only be done when there is: persistent tunnel infection over a number of weeks; fungal infection; continued infection despite antibiotic therapy; confirmed CVAD sepsis (Camp-Sorrell, 2004; O’Grady et al. 2002) or if there is a risk of progressive infection in a patient who is immunocompromised (Dougherty, 2006).

**CVAD occlusions**

Line patency on each access, including the observation of blood return and any resistance experienced should be documented to assist in early detection and management (CNSA CVAD working party).

Flushing procedures should be established to reduce the risk of occlusion including: flushing between drugs; flushing with the correct solution, volume and technique and flushing at the correct frequency for the device in use.
Fluids should be infused using a pump and a ‘to keep vein open’ rate should be the least rate of administration to prevent backflow at any time the CVAD is connected (Dougherty, 2006).

**CVAD-related thrombosis**

The risk of CVAD-related thrombus can be reduced by:

- correct placement of catheter and impeccable maintenance practices (Hamilton, 2006; Kuter, 2004; Knutstad et al. 2003; Mayo, 2001)
- educating patients about the signs and symptoms of thrombosis (i.e. redness, swelling, heat, pain/discomfort in any area along the catheter tract) so they can report problems early (Mayo, 2001)
- monitoring patients with higher risks.

**Infiltration and extravasation**

The patient should be educated to report any burning or pain on drug infusion (Sauerland et al. 2006).

Before and during administration of drugs, the patency of the CVAD should be assured by checking for blood return and a free flowing infusion (Dougherty, 2006; Sauerland et al. 2006; Buchanan et al. 2005).

Only educated and clinically competent RNs should administer irritant and vesicant drugs (Sauerland et al. 2006).

Each institution should have a policy for the management of drug extravasation (CNSA CVAD working party).

An extravasation should be documented in the patient record, including: the site of the extravasation; the drug; an estimate of the amount of drug extravasated; the access device in use; all actions taken to minimise damage and to provide patient support; and the outcomes for the patient (CNSA CVAD working party).

An extravasation should be reported as an adverse incident, with the possible cause reported, examined and all actions and patient outcomes reported (CNSA CVAD working party).

**CVAD-related cardiac complications**

Following catheter insertion, radiological verification must be obtained to verify catheter tip placement (Povoski, 2005).

Tip position should be checked radiographically if there are changes in CVAD function, if signs and symptoms of complications are evident or if the catheter has been replaced over a guidewire (RNAO, 2005).
Measure and document the external length of the CVAD on insertion and routinely when suture free devices are in use (CNSA CVAD working party).

There may be some benefit from routine radiological examination of tip location for patients with long term devices (CNSA CVAD working party).

**Catheter damage**

Educate patients and the family caregivers:

- never to use sharp instruments near their CVAD
- to protect their external devices at all times e.g. during sexual, leisure and sporting activities (CNSA CVAD working party).

CVADs with signs and symptoms of pinch-off syndrome should be assessed for damage (Dougherty, 2006).

CVADs that are damaged due to pinch-off syndrome should be removed (Mirza, Vanek & Kapensky, 2004).

Use a 10ml or greater syringe size on all CVAD lumens (Dougherty 2006; Andris & Krzywda, 1999; Hadaway, 1998).

Do not use excessive force when attempting to flush, unblock or inject into a CVAD (Dougherty, 2006; Hamilton, 2006; Andris & Krzywda, 1999; Hadaway, 1998).

For an external fracture of the catheter:

- educate the patient regarding immediate actions to undertake (CNSA CVAD working party)
  - immediately clamping the portion of CVAD remaining outside the skin between the site of damage and the chest wall (Dougherty, 2006)
  - ensuring the CVAD does not migrate into the vein (CNSA CVAD working party)
  - immediately contacting the health care facility (CNSA CVAD working party).

For an internal fracture of the catheter:

- contact a medical officer
- place the patient on the left side in Trendelenburg position
- apply oxygen
- ensure a chest x-ray is performed urgently to confirm catheter fragmentation and location
- if a PICC breaks during removal, immediately tourniquet the arm and
1. Educational standards for nurses involved in the management of central venous access devices

The nurse caring for a patient with a CVAD requires a broad range of knowledge, skills and expertise. The registered nurse’s (RNs) role includes assessing the patient’s vascular access needs, recommending the appropriate device for treatment (in collaboration with medical staff and the patient), educating the patient and the family caregivers about the device and its care and providing ongoing management of the CVAD, prevention of infection and troubleshooting when problems arise (Chernecky et al. 2003).

The Cancer Nurses Society of Australia promotes that nurses should abide by legislation, guidelines and professional standards relevant to their scope of practice. The Code of Professional Conduct for Nurses in Australia (ANMC, 2003) and the Code of Ethics for Nurses in Australia (ANMC, RCNA & ANF, 2002) require that:

- the nurse is accountable for the provision of safe and competent nursing care; it is the responsibility of each nurse to maintain the competence necessary for current practice
- maintenance of competence includes ongoing participation in professional education to maintain and upgrade knowledge and skills relevant to practice in clinical, management, education or research setting
- a nurse must be aware that undertaking activities that are not within their scope of practice may compromise the safety of the patient.

The scope of practice is based on each nurse’s education, knowledge, competency, extent of experience and lawful authority.

RNs require specific education and training to attain the knowledge, assessment skills and technical tasks required to manage the care for patients who have CVADs. RNs who are knowledgeable and competent in the basic aspects of CVAD care and maintenance are able to ensure specific patient needs are met and optimal health outcomes achieved. However, RNs who work in clinical specialty areas, such as oncology, haematology, radiation oncology, intensive care units, renal units or paediatrics, require a higher level of knowledge and skill to manage CVADs. Patients in these health care settings who require CVADs have complex disease states where optimal patient outcomes rely on appropriate and reliable venous access. Therefore these settings require RNs with comprehensive knowledge and skill with a variety of devices, including how to maintain them, assess and manage complications and the ability to advocate for the patient where necessary. The ability to provide patient and family caregiver’s education is also critical (Goodman, 2002).
The importance of specific CVAD education is also highlighted by research reporting that insufficient education and training of health care professionals in the management of CVADs has been found to contribute to up to 55% of the vascular access device complications that were reported to the United States Food and Drug Administration (RNAO, 2004).

It is recommended that health care professionals have access to ongoing education and that their knowledge and skill is periodically assessed (Rosenthal, 2004; O’Grady et al. 2002). This requires organisational support for educational programs that advance knowledge, skill and competence and determine performance levels for nurses (Dool, Roehaver & Fulton, 1993). Initial education should include content such as indications for use, device selection, insertion and maintenance techniques and relevant methods of preventing infections and other complications (Rosenthal, 2004). Ongoing education should incorporate the latest advances in technology and the current evidence that can guide clinical practice. For example, it has been demonstrated that the reinforcement of infection control practices results in a decreased incidence of catheter-related blood stream infections (Rosenthal, 2004).

It is also recommended that RNs receive education about CVADs during their undergraduate nursing education (RNAO, 2004). Postgraduate continuing education, organisational orientation and continuing professional development programs should also include education about these devices for nurses who plan to work in cancer care settings or other settings where nurses manage and care for patients with CVADs. Educational opportunities should address both theoretical knowledge and clinical application to enable development of competence and accountability.

1.1. Recommended framework for general CVAD education

Educational programs should support both cognitive and behavioural components. A program description and learning objectives are recommended for both components (Dool, Roehaver & Fulton, 1993). These objectives will assist the identification and development of learning strategies to aid learning and skill acquisition.

General education of the management of CVADs should include information and demonstrations related to:

- anatomy and physiology
- types of CVADs and their clinical applications
- infection risks and control measures
- patient care post insertion
- accessing and de-accessing of CVADs
- care and maintenance: site assessment, dressing and equipment changes, flushing and locking procedures
• removal of non-tunnelled devices
• demonstration of clinical skills
• potential complications – prevention, detection and management
• documentation requirements
• communication and advocacy
• patient and carer education
• legal and professional aspects

1.2. Additional components for CVAD education for haematology/oncology nurses

Haematology/oncology nurses should possess the knowledge listed above in greater depth.

In addition, they should be able to describe:

• the various types of CVADs
• the advantages, disadvantages and indications for each
• the criteria for appropriate device selection
  (CNSA CVAD working party).

The haematology/oncology nurse should:

• understand the principles related to the insertion of CVADs. In specific settings, RNs may be educated and trained to insert peripherally inserted central catheters (PICCs) (CNSA CVAD working party)
• possess the knowledge and skill to effectively manage complications (RNAO, 2004; Camp-Sorrell, 2004)
• possess an awareness of the various controversial issues associated with CVAD management, such as areas where there is no reliable evidence to support practice such as flushing solutions and frequencies, use of antibiotic impregnated catheters and patches as this will assist the haematology/oncology nurse make well informed clinical decisions (RNAO, 2004; Camp-Sorrell, 2004)
• be adequately prepared to assist the general or novice nurse in their clinical education needs (RNAO, 2004; Camp-Sorrell, 2004)
• promote practice improvement and research (CNSA CVAD working party).
1.3. CVAD specific competencies

CVAD specific policies and procedures should be developed based on the current evidence. Competencies must be validated before implementation. Evaluation and review processes should also be implemented. Other mechanisms that enhance the competency assessment processes include adequate assessor preparation, monitoring inter-rater reliability and an appeals process (ANF, 2005).

Competence implies that the individual possesses the ability to perform in all relevant skills areas, including patient and family caregiver education, problem solving, application of theory to practice, and psychomotor skills, within a given setting or role. Competence must be assessed by an experienced clinician, preferably using a procedural checklist based upon institutional policy and procedure. Evidence to determine competency can be collected over a period of time and within the context of actual practice (Dool, Roehaver & Fulton, 1993).

It is important that nurses caring for patients with CVADs possess the following:

- effective verbal and written communication skills within a multidisciplinary team (Tropp et al. 2006)
- the ability to educate patients and carers (Tropp et al. 2006)
- the ability to evaluate effectiveness of equipment and awareness of technological advances (Tropp et al. 2006)
- adherence to the nursing standards and guidelines for the care and maintenance of CVADs and the therapies delivered via these devices (Tropp et al. 2006)
- clinical assessment and problem solving skills (CNSA CVAD working party)
- participation in continuing education to sustain and advance knowledge and skills (Tropp et al. 2006)
- the ability to share knowledge and skills with colleagues (Tropp et al. 2006).

Prior to caring for patients with CVADs, the organisation should have a process to assess the nurses’ competence to care for the patient with a CVAD. The assessment of competence in the management of these devices should include theoretical knowledge related to CVADs and the demonstration of the following skills:

- accessing and de-accessing external catheters
- change of dressing, injection ports and intravenous lines
- blood collection from CVADs
- removal of external, non-tunnelled CVADs
- accessing and de-accessing implanted ports
• flushing and locking of devices
• clinical assessment and management of problems associated with CVADs (CNSA CVAD working party).

Nurses working in the haematology/oncology setting should attain competence in advanced CVAD skills such as:

• advanced clinical assessment and management of device complications
• management of a line occlusion
• management of a ruptured device
• insertion of a PICC line (where relevant)
• teaching/supervision of others (CNSA CVAD working party).

The recognition of prior learning and experience should be considered in the requirement for assessment of competence.

CVAD education and competency demonstration should be documented on the nurses’ performance record.

While each health care facility customises CVAD practices to their specific environment, the development of standardised tools to assess competence would enhance the consistency of practice.

1.4. Recommended components of CVAD competency assessments

Each practical procedural checklist should incorporate the following key aspects:

1.4.1. Theoretical aspects

A selection of theoretical questions assists in determining the nurses’ knowledge base and their ability to make appropriate clinical decisions.

Key theoretical aspects that should be covered in the competency assessment include:

• description of the device in use
• rationales for use of specific equipment
• assessment criteria – patient and device
• knowledge of complications associated with CVADs
• rationales for use of specific practices
• clinical assessment of potential complications
• patient education (CNSA CVAD working party).
1.4.2. Practical aspects

Verifies that an appropriate medical order exists for the procedure, where relevant:

- written or verbal orders
- consultation with medical officers where appropriate

Prepares the patient

- assess patient’s individual needs – physical and psychological
- explains interventions to patient and/or carer
- gains informed consent
- positions patient appropriately and comfortably

Performs the procedure

- accesses appropriate resources
- gathers necessary equipment
- maintains infection control practices
- explains all interventions to patient
- performs procedure as per health care facility policy and procedure
- discards all waste appropriately

Evaluates the procedure

- assesses patient outcomes
- appropriately determines subsequent actions

Documents the procedure

- records procedure as per health care facility policy and procedure
- reports significant outcomes where appropriate

Patient education

- ensures the patient is educated regarding outcomes of the procedure and any relevant self-care measures

(Camp-Sorrell, 2004).

See Appendix 3: Cancer Nurses Society of Australia Central Venous Access Device Competency Assessment Tool. This competency assessment tool lists theoretical and practical aspects of CVAD care that nurses should achieve to gain competency in the management of patients with these devices.
1.5. Enrolled nurses involvement in CVAD care

Currently, more Enrolled Nurses (ENs) are being employed in the acute care setting. CVAD management activities/procedures would be considered as advanced scope of practice for ENs. While Australian ENs are limited by law in relation to the administration of medications via intravenous routes, other aspects of CVAD management may be considered. This aspect would depend on the guidelines for advancing scope of EN practice set down by the registering body in each State or Territory. For example, in Queensland, if the change in scope of practice meets all of the following six principles outlined by the Queensland Nursing Council (QNC) (2005), it would be possible for an EN to perform the activity/procedure. However, if the context of the activity/procedure changes, then the principles must be reapplied.

Principles for advancing the scope of practice of Enrolled Nurses:

1. Delegation is the responsibility of the RN based on assessment of the patient’s needs.
2. The delegation by the RN will:
   a. benefit the patient
   b. is lawful
   c. is appropriate for the context
   d. is consistent with service provider policies
3. There has been appropriate consultation and planning
4. The EN:
   a. agrees to accept the activity/procedure
   b. has the appropriate education
   c. is assessed as competent
   d. understands their degree of accountability
5. An RN has assessed the education and competence of the EN
6. The service provider is aware of their responsibility for policy and resources to ensure:
   a. ongoing education and competence of the EN
   b. supervision of the EN
   c. evaluation of the outcomes of the activity/procedure
   (QNC 2005).

Prior to delegating CVAD management activities/procedures to ENs, it is essential to consult with the State or Territory registering body, to ascertain if these duties can be legally performed.
Recommendations:

Curricula for CVAD education should include: indications for use; device selection; insertion and maintenance techniques; relevant methods of preventing and managing infections and other complications and patient education (Rosenthal, 2004).

Educational programs that advance knowledge, skill and competence and determine performance levels for registered nurses caring for patients with CVADs should be provided by the health care facility (Dool, Roehaver & Fulton, 1993).

CVAD specific policies and procedures, based on the current evidence, should be implemented and these should include an evaluation and review process (CNSA CVAD working party).

Competence should be assessed by an experienced competent RN, guided by a procedural checklist within the context of actual practice (Dool, Roehaver & Fulton, 1993).

Access to ongoing education should be provided and periodic assessment of knowledge and skill should be undertaken (Rosenthal, 2004; O’Grady et al. 2002).
2. Characteristics of central venous access devices used in cancer settings

Although there is an array of venous access devices, all CVADs are alike in that they are positioned within the central venous circulation, typically in the superior vena cava (Mauro, 2003). Positioning in the superior vena cava (SVC) should be in the lower third of the vessel (Tropp et al. 2006; O’Grady et al. 2002; National Association of Vascular Access Networks, 1998). This tip location allows the catheter to float freely within the vein lumen and lie parallel to the vessel wall, resulting in a reduction in complications such as thrombus and infection (Schuster et al. 2000; National Association of Vascular Access Networks, 1998). Positioning within the middle to upper SVC is associated with increased risk for catheter related thrombosis (Tropp et al. 2006; O’Grady et al. 2002). The catheter tip should not advance into the right atrium, as cardiac complications may develop (National Association of Vascular Access Networks, 1998). The central circulation is accessed via a peripheral vein or the internal/external jugular or subclavian vein.

For older children and adults, when viewing a chest X-ray, the central catheter tip is positioned above the carina, which can be used as an anatomical landmark to suggest that the catheter tip is outside the pericardial sac. The carina is used as a landmark in central venous catheter placement (Schuster et al. 2000). When viewing a chest X-ray the catheter tip should be positioned approximately at the fourth anterior intercostal space (Povoski, 2005).

Insertion of CVADs is often guided by radiological image intensification. Recent studies have indicated that patient safety could be improved by combining ultrasound guided puncture and ECG-guided positioning (Ralf et al. 2006; Schummer et al. 2005). See Figure 1 for the correct site for tip positioning in the SVC.

![Figure 1](http://www.bardaccess.com/pdfs/nursing/ng-hick-leon-brov.pdf)
2.1. Device characteristics

2.1.1. Composition

Most CVADs used in the cancer setting are made from silicone or polyurethane. Silicone is a soft, flexible, biocompatible material and many long-term catheters are made from this material (Mauro, 2003; Weinstein, 2001). Catheters made from silicone provide benefits for the patient as the material reduces the adherence of fibrin to the catheter and offers increased biocompatibility (Camp-Sorrell, 2004). Due to the flexibility, special insertion techniques are required, however once positioned these catheters are often more comfortable than other devices.

Polyurethane is a stronger, firmer material, which allows the walls of the CVAD to be thinner while still providing the same lumen diameter (Mauro, 2003; Weinstein, 2001). This material does soften following insertion in response to body temperature and offers increased biocompatibility and less adherence of fibrin, when compared to other materials (Camp-Sorrell, 2004). Generally devices made from polyurethane are comfortable for the patient.

Devices used for short-term, emergency access, inserted via the jugular or subclavian veins can be manufactured from Teflon®. These more rigid catheters present a higher risk of fibrin aggregation and thrombus formation (Rosenthal, 2004; Weinstein, 2001). These devices are stiffer and less comfortable for the patient.

2.1.2. Catheter tip configuration

CVADs have three basic tip configurations.

1. Open-ended catheters
   - Available in single-, double- or triple-lumen; can be trimmed to fit the person’s anatomy

2. Valved catheters
   - There are two types of catheters that have specifically designed valves to prevent blood flow back into the catheter.
     a. slit-valve tip Groshong® catheter has a closed tip with one or two slits proximal to the tip, depending upon whether the device is single or double lumen. This slit-valve allows blood to be withdrawn and solutions infused, however when no force is applied to the valve it remains in a closed position, preventing reflux of blood into the catheter (Fox, Roach & Berman, 2002).
     b. pressure activated safety valve (PASV) which is at the tip of the catheter.

These catheters cannot be trimmed at the tip.
3. Staggered tip catheters

Designed so that simultaneous aspiration and infusion can be performed with limited mixture of drugs and solutions (Mauro, 2003). This tip configuration also reduces the recirculation of blood during apheresis procedures (Rowley & Goldberg, 2005). These catheters cannot be trimmed at the tip.

2.1.3. Lumen configurations

Catheters can come in single- or multi-lumen configurations. In general, multi-lumen catheters have a higher infection rate than single-lumen catheters (Fox, Roach & Berman, 2002). Although some short-term catheters may have as many as five lumens, the most common lumen configuration used in the cancer setting is the double-lumen catheter, as these devices meet the needs of most patients without adding extra infection and thrombus risk by having additional lumens. Lumens usually have different coloured hubs to assist identification and labelling of the lumen. Double-lumen catheters usually have a red lumen designated as ‘arterial’ and a blue lumen designated as ‘venous’. This is based on the function of the catheter if used in dialysis or apheresis procedures. Blood withdrawal is recommended through the proximal lumen designated as ‘arterial’ and return is recommended via the distal ‘venous’ lumen (Owen & Brecher, 1997). This reduces recirculation and mixing of blood (Owen & Brecher, 1997).

2.1.4. Catheter sizes

The length and size of the catheter will influence the ability to infuse solutions. A shorter device with a wide gauge will infuse more quickly than a longer device (Gabriel et al. 2005). Catheter sizes are measured in ‘gauge’ or ‘French’. Gauge sizes range from 13 to 28 gauge, with the smaller number indicating the larger size lumen (Camp-Sorrell, 2004). French size indicates the outside diameter of the catheter measured in millimetres, multiplied by three (Camp-Sorrell, 2004), therefore the larger the French size, the larger the catheter lumen size.

2.1.5. Radiopaque availability

Many catheters have a radiopaque stripe down the length of the catheter or dots at the catheter tip to assist radiological confirmation of correct placement of the device (Camp-Sorrell, 2004).

2.2. Types of devices

CVADs are generally classified into two categories:

1. External devices - tunnelled and non-tunnelled catheters
2. Internal devices - implanted ports
2.2.1. External CVADs

**Tunneled catheters**

Tunneled catheters are venous access devices that can remain in place for months to years. These catheters were developed to be positioned with a section of the catheter positioned in a subcutaneous tunnel, providing a distance between the entry into the vein and the exit site on the skin (Mermel et al. 2001). Figure 2 depicts a tunneled catheter, the Hickman ® Catheter.


Features of these catheters and the positioning of the devices reduce the risk of systemic infection. These include manufacture:

- from polyurethane or silicone or a combination of the two
- with cuffs, which are attached to the shaft of the catheter.
  - a tissue ingrowth (Dacron®) cuff on the catheter is positioned inside the tunnel close to the exit site. This cuff provides catheter stability as granulation occurs around the cuff (RNAO, 2004). The tissue ingrowth cuff also minimises the risk of infection as it forms a barrier to ascending infection from the exit site along the catheter tunnel (O’Grady et al. 2002).
  - some devices also have a second antimicrobial cuff which is impregnated with silver ions. The cuff acts as a physical barrier to bacteria and it also releases an antimicrobial agent for approximately one month following insertion (Camp-Sorrell, 2004).
- with coating with silver sulfadiazine and chlorhexidine or minocycline-rifampin to reduce the risk of central line related blood stream infections (Garland, Henrickson & Maki 2002). The routine use of antibiotic impregnated catheters, intended to reduce the likelihood of infection, remains controversial (O’Grady et al. 2002).
External tunnelled catheters come in single-, double- or triple-lumen configurations (RNAO, 2004). In the double- and triple-lumen devices, the lumens may have differing sizes and volumes. For example, the 12.5 Fr triple-lumen Hickman® Catheter has lumen volumes: 1.6 ml red lumen; 0.7 ml white lumen and 0.7 ml blue lumen (www.bardaccess.com/pdfs/brochures/bro-hick-bro-leon.pdf). The large lumens in these catheters allow a flow rate to approximately 3500 ml/hour if required (Camp-Sorrell, 2004). The differing sizes of lumens are depicted in Figure 3.

![Lumen Diameters for Silicone Catheters](image)

**Advantages of using a tunnelled catheter:**
- provides reliable long term venous access (Camp-Sorrell, 2004)
- preserves the peripheral veins
- reduces risk of infection due to the tunnelled feature (O’Grady et al. 2002)
- can be used immediately after placement confirmation following insertion (Camp-Sorrell, 2004)
- provides the ability to rapidly infuse large volumes of fluids (Camp-Sorrell, 2004; Cowley, 2004)
- can be repaired in the event of damage to the external segment of the catheter

**Disadvantages of using a tunnelled catheter:**
- poses risk of haemothorax, pneumothorax, air embolus and arrhythmias on insertion (Dougherty, 2006; Hamilton, 2006)
- poses risk of infection or thrombosis (Dougherty, 2006; Hamilton, 2006)
- requires routine care
- can fall out or be accidentally pulled out
- may affect patient’s body image
**Non-tunneled catheters**

Non-tunneled catheters are those where the exit site is directly above entry into the vein. They do not have subcutaneous tunnel. These catheters can be single- or multiple-lumen. They are diverse in their uses and features.

There are several indications for the use of non-tunneled catheters in the cancer setting, including:

- administration of infusions and medications over weeks to months e.g. PICCs
- emergency situations where reliable venous access is required for a short term period, or for central haemodynamic monitoring - usually only used for days (Fox, Roach & Berman, 2002)
- cell separation/apheresis procedures over a short time period.

**Peripherally inserted central catheters**

Peripherally inserted central catheters (PICCs) are used frequently in the cancer setting. PICCs are non-tunneled catheters inserted via a peripheral vein, usually through the basilic, median cubital or cephalic veins and advanced along the upper arm to have the tip located in the lower third of the SVC (Gabriel et al. 2005). These devices can be inserted by an appropriately educated and trained nurse or medical practitioner.

PICCs can be used for all infusion therapies for weeks to approximately a year (RNAO, 2004). However, PICCs with smaller gauges may pose problems with blood or platelet administration, leading to slow flow rates and possible occlusion (Australian and New Zealand Society of Blood Transfusion Inc & RCNA, 2004).

PICCS are catheters generally made from silicone or polyurethane. They can be single- or double-lumen, 16-28 gauge and up to 65 centimetres in length. Flow rates for these devices vary, with a 4 Fr (18ga) Groshong® catheter suggested to have a flow rate of approximately 1000 ml/hour via an infusion pump (http://www.bardaccess.com/specs-grosh-picc.html). The priming volumes of these devices vary related to the lumen size and the final length when inserted. Figure 4 depicts a non-tunneled Groshong® Dual Lumen NXT PICC Catheter.

Figure 4

A Groshong® Dual Lumen NXT PICC Catheter
Reproduced with permission © C.R. Bard, Inc.

Central Venous Access Devices:
Principles for Nursing Practice and Education

- Easily gripped, winged, Luer-Lock connector
- Equal sized lumens
- Clearly marked lumen and French sizes enhance identification
- Enhanced extension leg strength
- Flexible suture wings help stabilize catheter
- Incremental depth markings allow easy determination of insertion depth and tip location
- Greater radiopacity allows clinician to view catheter throughout procedure
- Reverse taper enhances strength
- Thin-wall design allows for increased flow rates
- Statlock® device compatible

- Negative pressure opens valve inward, permitting blood aspiration.
- Positive pressure opens valve outward, allowing infusion.
- At neutral pressure, valve remains closed, reducing risk of air embolism, blood reflux and clotting.
Advantages of using a PICC:

- reduced risk of haemothorax, pneumothorax, air embolus and arrhythmias compared with centrally inserted catheters (Todd, 1998)
- reduced risk of catheter related blood stream infections (RNAO, 2004)
- less invasive procedure for insertion and removal (Cowley, 2004)
- generally well accepted by patients.

Disadvantages are mostly due to the narrower lumen of the PICC and include:

- increased risk of occlusion
- unsuitable for rapid flow infusions
- PICCs smaller than 4 Fr pose some problems administering blood products (Camp –Sorrell, 2004) and blood collection
- higher risk of catheter tip migration and accidental removal compared to other CVADs.

Catheters used in critical care situations

In emergency or critical care situations, short-term non-tunnelled central catheters can be sited using the jugular, subclavian or femoral veins (Hayden & Goodman, 2005). These catheters can be multiple-lumen, where each lumen opens into the circulation at a different position along the catheter, permitting simultaneous infusion of drugs and solutions that would otherwise be considered incompatible (Gabriel et al. 2005).

These catheters can be made of silicone, polyurethane or Teflon®. In emergency situations, polyurethane catheters are often used as they are stiffer and this assists placement (Fox, Roach & Berman, 2002). Figure 5 shows a short term non-tunnelled central venous catheter.
**Devices used for apheresis procedures**

Venous access is an important factor in the success of apheresis procedures as consistent flow rates of large volumes of blood and/or fluid is required (American Association of Blood Banks, 2003; McDiarmid, Bredeson & Huebsch, 1999). Peripheral access can be used for infrequent procedures, however if frequent procedures are required or peripheral access is limited, a specialised catheter is likely to be necessary (Clough, 2002).

Length, lumen size and wall thickness all affect the blood flow, therefore a shorter, stiffer catheter is recommended (Rowley, Hsu & Goldberg, 2005). In the cancer setting these catheters generally access the SVC. At times, such as in the setting of SVC obstruction, access can be gained via the femoral vein into the inferior vena cava.

These devices can be:

- tunnelled catheters and inserted for longer periods of time (e.g. Apheresis Hickman® Catheter)
- an implanted port with dual-port design which is accessed with 14 or 16 gauge high flow non-coring needles (e.g. A2 Port®). These devices are inserted for long periods of time
- non-tunnelled catheters and inserted for shorter periods of time (e.g Vascath® /MedComp®).

**Indications for insertion of a long-term device for apheresis:**

- therapeutic apheresis procedures on a regular basis over a longer term
- collection of progenitor blood cells with plans for high dose chemotherapy and reinfusion of cells
- haemodialysis for management of renal failure or tumour lysis syndrome.

**Indications for insertion of a short-term catheter for apheresis:**

- patient requiring cell separation/apheresis procedures such as white cell depletion or progenitor blood cell collection (without plans for high dose chemotherapy and reinfusion in the near future).

External apheresis catheters can be double- or triple-lumen and have a staggered tip configuration. Note that the third lumen is too small for apheresis procedures and is used for other concurrent therapies. The main difference when managing apheresis catheters, in comparison to other central catheters, is that they usually require a higher concentration of heparin to maintain patency of the lumen, when the lumen is not in use ([www.bardaccess.com/pdfs/nursing/ng-hick-leon-brov.pdfs](http://www.bardaccess.com/pdfs/nursing/ng-hick-leon-brov.pdfs)).
Advantages of using a CVAD for apheresis procedures:

- facilitates an efficient apheresis procedure
- avoids use of large bore (14–16 ga) peripheral cannulas
- preserves peripheral vasculature.

Disadvantages of using a CVAD for apheresis procedures:

- haemorrhage or pneumothorax on insertion (Owen & Brecher, 1997)
- temporary non-tunnelled catheters are usually made of a rigid material which can be more uncomfortable for the patient (Camp Sorrell, 2004)
- risk of thrombus (Owen & Brecher, 1997)
- risk of infection (Mc Diarmid, Bredeson & Huebsch, 1999)
- requires use of larger concentrations of heparin to maintain patency of the catheter (Camp Sorrell, 2004).

2.2.2. Internal CVADS

Implanted Ports

Implanted ports are long term CVADs that can remain in place and be functional for years (Camp-Sorrell, 2004). They are also tunnelled catheters, however the main feature is that they are totally implanted. The port body is a hollow housing of plastic, stainless steel or titanium containing a septum usually produced from self-sealing silicone, connected to a silicone or polyurethane catheter. The catheter is positioned in the central circulation and tunnelled to the port body, which is positioned in a subcutaneous pocket. The port septum can be accessed percutaneously using a non-coring needle up to 3600 times (Camp-Sorrell, 2004). The port body has holes to enable suturing to the subcutaneous tissue to stabilise the device. Figure 6 shows a non-coring huber point needle accessing a port.

![Figure 6](http://portadvantage.com/documents/Bard-Patient-Info-Bro.pdf)
**Features of Implanted Ports**

Ports can be produced as one-piece or two-piece devices.

One-piece devices usually have an open-ended catheter and can be trimmed at the distal catheter end to the length required for correct positioning. Two-piece devices enable the catheter to be trimmed to the correct length at the proximal end before attaching to the port body. A locking connector secures the catheter to the port body.

Implantable ports can be single- or double-lumen devices, having single or double ports.

Ports made of plastic are ideal for patients requiring magnetic resonance imaging or radiation therapy as it reduces chance of interference, thereby enhancing the reliability of diagnostic tests and efficacy of radiation therapy.

The majority of ports used in the cancer setting are those that are manufactured to be located on the chest wall.

Peripheral ports are less common and these are smaller than the standard port described above. Peripheral ports are generally located in the upper arm accessing the venous system via the cephalic vein (Camp-Sorrell, 2004). Figures 7 and 8 show single- and dual-lumen ports.

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**Figure 7**

An M.R.I. Vital Port® Systems Port  
Reproduced with permission  
© William A. Cook Australia Pty Ltd

**Figure 8**

Dual Chamber Titanium Vital Port® System  
Reproduced with permission  
© William A. Cook Australia Pty Ltd
Advantages of using an implanted port:

- these devices are generally acceptable to patients as they are fully implanted (Cowley, 2004), causing minimal restrictions to patient lifestyle; for example, patients maintain the ability to swim once the insertion site has adequately healed
- provides long-term venous access suitable for intermittent access (O’Grady et al. 2002)
- preserves peripheral veins
- reduces risk of infection in comparison to external devices (O’Grady et al. 2002)
- requires less maintenance than external catheters, when not in use (Dougherty, 2006; RNAO, 2004)
- less potential for catheter to migrate or fall out.

Disadvantages of using an implanted port:

- invasive insertion procedure with a risk of haemothorax, pneumothorax, air embolus and arrhythmias
- minor surgical procedure for insertion and removal (RNAO, 2004)
- reduced volumes of fluid can be infused in comparison to the external tunneled devices (up to approximately 1000 ml/hour)
- disconnection of the catheter from the port body in two-piece devices causing extravasation (the risk of this occurring has decreased since the introduction of the locking connector)
- inability to be repaired if damaged (Dougherty, 2006)
- use of the device requires needling through the skin (RNAO, 2004)
- specific needles are required for accessing the port
- needle can become dislodged from the septum causing extravasation (Dougherty, 2006)
- risk of infection or thrombosis
- patient discomfort or inconvenience e.g. the port body may be positioned in an area that interferes with lying on their side or clothing straps
- risk of needle-stick injury to staff (Dougherty, 2006).
3. Patient and family education

Provision of patient and family caregiver education about the care of their access device, the signs and symptoms of complications of the CVAD and who to contact for assistance can improve patient outcomes (Itano & Taoka, 2005).

Assisting the patient and their family to participate in their care is an important nursing intervention that requires deliberate and planned interaction between the nurse and the patient (Sahlsten et al. 2005).

Factors that can affect learning should be considered, for example, physical condition, age, educational level, emotional state and family caregiver ability (Camp-Sorrell, 2004) and cultural or language background.

Patient and family caregiver education should commence before the device is inserted and be expanded over time and repeated as necessary. Clarification should be sought to assess patient and family caregiver understanding of the education.

Following education, the patient and family caregiver should be able to:

- describe the rationale, the risks and the benefits of the CVAD
- demonstrate care of the CVAD to a level appropriate for their needs
- list the signs and symptoms of CVAD related complications
- know who to contact if they have concerns and how to contact them (Itano & Taoka, 2005).

Initial patient and family caregiver education should include:

- indications for the CVAD
  - for example,
    - safety
    - ability to have treatment as an outpatient
    - protection of their peripheral veins related to the type of medications they will receive
    - their increased comfort as they will not require multiple needle sticks if they have poor venous access (Camp-Sorrell, 2004).
- the options for vascular access device (RNAO, 2004).
- a description of the suggested CVAD, explaining:
  - the device itself
  - method for intravenous delivery of medications and other prescribed products for their treatment
• potential complications of the CVAD (Camp-Sorrell, 2004)
• any changes required in their routine activities of daily living and other lifestyle activities (Macklin et al. 2003) e.g. protecting the CVAD from damage when playing with children or pets
• the role of the cancer care team in managing the CVAD
• their role in caring for the device
• availability of ongoing support and to a 24-hour phone contact if they have questions/concerns.

If possible let the patient and family caregivers see the device suggested and talk to another patient who has that particular CVAD.

Education at time of insertion should include:
• a general explanation of the procedure
  The patient is usually positioned in the Trendelenburg position which distends veins in the upper body and reduces the risk of air embolism while the CVAD (non-tunnelled and tunnelled catheters and implantable ports) is being inserted (Camp-Sorrell, 2004)
• the risks of the procedure
• the staff who will be inserting the device
• seeking the patient’s and family caregiver’s understanding of your teaching and discussion
• time allocated for them to ask questions.

Education following insertion should include:
• care for the device appropriate to their needs (Camp-Sorrell, 2004)
• activity restrictions as necessary (Camp-Sorrell, 2004)
• signs and symptoms to report, including:
  o tenderness or swelling at exit site or along catheter tract
  o infection
  o phlebitits
  o chest pain
  o changes in heart rate
  (Itano & Taoka 2005).
• contact details of health professionals, 24 hours a day, if they have concerns
• seeking the patient’s and family caregiver’s understanding of your teaching and discussion
• time allocated for them to ask questions.
The patient should have information about their access device which includes:

- type of device (RNAO, 2004)
- number of lumens (RNAO, 2004)
- date of insertion (RNAO, 2004)
- tip location (RNAO, 2004)
- whether the device has a valved or open tip (RNAO, 2004)
- internal length (RNAO, 2004)
- external length (if applicable) (RNAO, 2004)
- contact numbers for assistance (RNAO, 2004)
- length of needle required to access the implanted port (CNSA CVAD working party).

(Although this information from the patient should be used in conjunction with nursing assessment as the needle length may change with weight gain or loss).

Written resources may assist patients and their families to understand the use and management of these devices and assist them if adverse events occur by advising them of appropriate actions to take. Education should be repeated as necessary and expanded over time.

An education checklist can assist to ensure that patients and their families receive appropriate education about CVADS.

**Recommendations:**

Following education, the nurse should assess that the patient and family caregiver can:

- describe the rationale, the risks and the benefits of the device
- demonstrate care of the device to a level appropriate for their needs
- list the signs and symptoms of catheter-related complications
- state who to contact if they have concerns and how to contact them (Itano & Taoka, 2005).

Patient and family caregiver education should be documented in the patient record (Camp–Sorrell, 2004).
4. Caring for the person with a central venous access device: pre-insertion

4.1. Selecting the appropriate CVAD for the person with cancer

Selection of a CVAD for the person with cancer is a collaborative process between the medical practitioner, the nurse, the patient, and other members of the health team. An important nursing role is to advocate for patients in relation to the selection of the appropriate device (RNAO, 2004), as selection of the most suitable vascular access can minimise risk and maximise the benefits for patients undergoing intravenous therapy (Camp-Sorrell, 2004; Galloway, 2002; O’Grady et al. 2002).

The use of an algorithm to facilitate a comprehensive assessment to develop a plan for vascular access prior to the initiation of therapy (RNAO, 2004) can assist patients and health professionals. See Appendix 4 for an algorithm to guide decision making regarding device selection.

The type of CVAD, insertion technique and insertion site with the lowest risk for complications for the anticipated type and duration of therapy should be selected (O’Grady et al. 2002).

A CVAD with the minimum number of ports or lumens essential for the management of the patients should be selected to reduce the risk of complications (NICE 2003; O’Grady et al. 2002).

Criteria to be considered when choosing a venous access device should include:

- patient assessment
  - the need for emergency access
    - i.e. rapid temporary access required in emergency situations (Cowley, 2004); short-term access via a non-tunneled central venous line can enable the rapid infusion of fluids, blood products and medications and allow monitoring of central venous pressure; access is usually only for days to weeks (if adherence to aseptic procedure cannot be ensured [i.e. if inserted in a medical emergency] replace the catheter as soon as possible and within 48 hours of insertion) (O’Grady et al. 2002).
circulatory status
e.g. this may include axillary node dissection (Todd, 1998), lymphoedema (RNAO, 2004), prior damage to peripheral veins, or poor venous integrity

medical history as certain conditions may influence the device choice / placement e.g. previous thrombosis, previous CVADs (Gabriel et al. 2005)

obesity can cause difficulty palpating and accessing peripheral veins

cognitive status
i.e. the patient’s mental status and level of cooperation should be assessed (RNAO, 2004)

the ability of the patient and family caregiver to care for the device (RNAO, 2004; Fox, Roach & Berman, 2002)

social assessment considering children, animals and employment as physical activities the patient undertakes can increase the risk of dislodgement, phlebitis or infection (Dougherty, 2006)

• prescribed therapy
  duration and frequency of access for therapy, blood drawing (Galloway, 2002; Gabriel et al. 2005)
  setting where therapy will be provided i.e. as an outpatient / inpatient (Hamilton, 2004; Fox, Roach & Berman, 2002)
  irritating or vesicant drugs or solutions (Galloway 2002; Gabriel et al. 2005)
  need for blood sampling (Fox, Roach & Berman, 2002)
  number of lumens required for delivery of therapy (Gabriel et al. 2005)
  apheresis procedures and number and frequency planned (Clough, 2002)
  likely need for rapid fluid resuscitation
  likely need delivery of supportive therapies e.g. blood products, parenteral nutrition (Povoski, 2005)

• patient’s personal preference
  body image / cosmetic reasons / sexual activity and intimacy
  e.g. it is more difficult to hide a PICC from public view, while an implanted port is hidden from view (Macklin et al. 2003)
  lifestyle choices (Camp-Sorrell, 2004) e.g. implanted ports are the preferred option for people who wish to continue swimming
  tolerance of needle sticks

• device availability (RNAO, 2004)
• availability of experienced health care personnel for insertion of the device
• availability of experienced health care personnel to manage the device.
Patients that require continuous treatment over days to weeks that may be delivered over several cycles would likely be recommended a peripherally inserted central catheter (Camp-Sorrell, 2004).

Patients that require treatment over months, yet unlikely to have periods of prolonged neutropenia, are likely to be recommended an implanted port. This treatment may be intermittent treatment or treatment that is delivered by continuous infusion over weeks (Camp-Sorrell, 2004).

Patients that require treatment over months and who are likely to require infusion of blood products, antibiotics and possible fluid resuscitation are likely to be recommended a tunnelled multi-lumen catheter. This includes patients with haematological disorders or malignant disease that may cause in prolonged nadir of blood counts after therapy (Camp-Sorrell, 2004).

The ideal venous access for the collection of peripheral blood progenitor cells (PBPC) remains unresolved. The literature suggests that some institutions favour the use of large lumen CVADs to provide the consistent flow rate of large volumes of blood suitable for a successful PBPC collection (Hanh et al. 1995; Stephens et al. 1995). It has been identified that many patients can undergo PBPC collection (McDiarmid, Bredeson & Huebsch, 1999) and therapeutic procedures (Stegmayr & Wikdahl, 2003) successfully via peripheral access. The number and frequency of the apheresis procedures needs to be considered when selecting access (Clough, 2002). These factors highlight the need for patient assessment by a health professional experienced in vein selection to identify the appropriate access route for the planned procedure/s.

There are several catheters on the market that are designed specifically for apheresis or dialysis procedures and these include non-tunnelled or tunnelled catheters (Clough, 2002). The tunnelled catheters are designed to remain in place for long periods of time enabling multiple apheresis procedures, administration of chemotherapy, reinfusion of peripheral blood progenitor cells following treatment and the administration of other supportive treatments as required. A short-term non-tunnelled catheter may be inserted for a person who is undergoing PBPC collection only, with another short-term catheter inserted at a later time for the PBPC reinfusion (McDiarmid, Bredeson & Huebsch, 1999). Implanted ports with dual-port design accessed with 16 gauge non-coring needles can be used for apheresis.
4.2. Patient care: insertion of the CVAD

4.2.1. Patient education

Patient and family caregiver education should include:

- the options for vascular access device should be discussed with the patient and the family caregivers (RNAO, 2004).
- a description of the suggested CVAD (NICE, 2003)
- reasons for recommending a particular CVAD and the benefits related to their treatment (NICE, 2003)
- potential complications (Dougherty, 2006)
- care of the CVAD (NICE, 2003)
- information about the insertion procedure
- instructions for the preparation for the procedure and recovery period

As most patients are administered sedation as a pre-medication they should be advised:

- about discharge procedures and the need to have a responsible adult to assist them
- avoidance of driving and other dangerous activities
- avoidance of undertaking business or legal matters (Australian and New Zealand College of Anaesthetics [ANZCA], 2005)

(Refer to Section Three for more information on patient education)

4.2.2. Insertion of the CVAD

Many CVADs are now inserted in radiology departments by a radiologist. In some cancer settings, nurses educated and trained in the insertion of PICCs undertake this procedure. Conscious sedation is used in many CVAD insertion procedures. Conscious sedation is a drug-induced depression of consciousness during which patients can respond purposefully to verbal commands or tactile stimulation (ANZCA, 2005).

The management of the patient undergoing a procedure to insert a CVAD should include the following principles:

- educating the patient about the procedure and seeking their understanding of the reason for device insertion and the procedure
- gaining written consent for the procedure and the sedation (if sedation planned) (ANZCA 2005)
• preparing the patient for the procedure
  o assessment of:
    • relevant medical history
    • respiratory and cardiovascular status
    • medications
  o allergies
  o fasting status
  o appropriate pathology e.g.
    • full blood count
    • coagulation profile
  o administering:
    • prescribed blood products e.g.
      ▪ pre-procedural platelet transfusion to approximately 50,000/ml may reduce the risk of bleeding in the person with thrombocytopenia (Povoski 2005)
      ▪ pre-procedural vitamin K or fresh frozen plasma to correct clotting factor abnormalities to reduce the risk of bleeding during and after the procedure (Povoski 2005)
  o administering prescribed pre-medications
  o undertaking baseline observations
  o for patients receiving sedation it is recommended they fast according to the Australian and New Zealand College of Anaesthetists (ANZCA) (2000) Recommendations for the Perioperative Care of Patients Selected for Day Care Surgery unless otherwise specifically prescribed by the anaesthetist or where other institution guidelines apply.

A Cochrane review has found:

• washing preoperatively with 4% chlorhexidine offers no benefit over placebo or bar soap in preventing surgical site wound infection
• no difference in postoperative surgical site wound infection rate between patients who washed with 4% chlorhexidine compared with patients who did not wash preoperatively (Webster & Osborne 2005).

**Reducing the risk of infection**

A neutrophil count < 1,000/mm3 is a relative contraindication to placement of a CVAD, as the patient would have a higher incidence of a septic episode (Povoski, 2005).
A meta-analysis evaluating antibiotic prophylaxis before insertion of a CVAD suggests that if the risk of infection is high, such as for neutropenic patients or for patients commencing induction therapy for haematological malignancies, consideration should be given to administering antibiotics prior to the insertion of the device (van de Wetering & van Woensel, 2003). This review identified that this intervention was effective in preventing gram-positive catheter tunnel infections and if given only to the susceptible population described, will not imply a danger of developing a vancomycin resistance.

Antimicrobial prophylaxis should not routinely be given for all patients before insertion to prevent catheter colonisation or bloodstream infection (O’Grady et al. 2002).

To reduce the risk of infection during insertion:

- use optimum aseptic technique during catheter insertion (sterile gown, mask, gloves and large drapes) (O’Grady et al. 2002; NICE, 2003; RCN, 2003)
- prepare the insertion site using alcoholic chlorhexidine gluconate and allow it to dry before skin penetration (O’Grady et al. 2002; RCN, 2003)
- select subclavian insertion site in preference to the jugular or femoral sites for non-tunnelled catheters and consider a PICC if suitable for patient’s therapy (O’Grady et al. 2002; Pellowe et al. 2004).

To reduce the risk of air embolus:

- patients are placed in the Trendelenberg position with their feet positioned higher than their heads during insertion and removal (if able) (Povoski 2005; Dougherty, 2006). The risk of air embolism with a PICC is reduced due to its longer length and smaller diameter and also that the hub is usually lower than the level of the heart (Ryder 1993).
- the literature promotes asking conscious patients to perform the Valsalva manoeuvre to increase the intra-thoracic pressure to engorge the vessels in the upper body during insertion and removal (Dougherty, 2006).
- clamp the catheter at any time the catheter hub is open to the air (CNSA CVAD working party).

An overview of the insertion procedures

Non-tunnelled central catheters

- the patient is placed supine in the Trendelenberg position (if able) (Povoski 2005; Dougherty, 2006)
- a peel-away introducer sheath is inserted percutaneously into the vein
- a guidewire is advanced
- the catheter is advanced over the guidewire until it reaches the superior vena cava and then the guidewire is removed
• confirmation of the device position should be confirmed by image intensification
• each lumen should be flushed with saline to check for flow impedance (Povoski, 2005)
• each lumen should be aspirated to check blood return (Povoski, 2005)
• each lumen should be locked with the appropriate solution or connected to a prescribed infusion
• the catheter should be secured with sutures, tape or a securement device
• the exit site is covered with an occlusive dressing.

PICCs may be inserted by percutaneously inserting a peel-away introducer needle into the vein and then advancing the PICC with a stylet until it reaches the superior vena cava and then the stylet is removed.

**Tunnelled central catheters**

This surgical procedure is performed by a surgeon or an interventional radiologist using the Seldinger technique in most circumstances (Camp-Sorrell, 2004). In some situations a cut down insertion is undertaken.

• the patient is placed supine in the Trendelenberg position (if able) (Povoski, 2005; Dougherty, 2006)
• access is usually via the internal jugular or subclavian veins (Lyon, 2005)
• needle is inserted percutaneously into the vein (Lyon, 2005)
• a guidewire is advanced into the vein
• a pull-apart sheath introducer is threaded over the guidewire
• the guidewire is removed
• the catheter is advanced through the introducer until it reaches the superior vena cava and then the introducer is peeled apart and removed
• the tunnel is formed using a tunnelling trocar; the tunnel can be several centimetres in length and if the catheter has a tissue ingrowth (Dacron®) cuff, this should be positioned a short distance from the exit site
• most insertions use techniques with image guided insertion
• the placement of the catheter needs to be verified by radiological imaging
• each lumen should be flushed with saline to check for flow impedance (Povoski, 2005)
• each lumen should be aspirated to check blood return (Povoski, 2005)
• each lumen should be locked with the appropriate solution or connected to a prescribed infusion
• the catheter should be secured with sutures, tape or a securement device
• the exit site is covered with an occlusive dressing.
Implanted ports

Ideally an experienced nurse should recommend the location of the portal body to ensure the port is placed in a site that will enable ease of access for treatment (Hayden & Goodman, 2005).

Insertion of an implanted port is performed by a surgeon or an interventional radiologist often using image guided insertion (Lyon, 2005).

- access is usually via the internal or external jugular or subclavian veins or the cephalic, basilic veins for a peripheral port
- the catheter is placed using a cut down procedure or percutaneous method
- the one-piece device is measured and cut to length at the distal end; two-piece devices are measured and cut at the port body end then the port body is attached
- the port pocket is made and the port is generally positioned against a rib to provide stability during the access procedures
- suturing to the muscular fascia should be done in such a way so the port cannot migrate or flip over in the subcutaneous pocket. The suture line should not be directly over the port
- meticulous haemostasis of the subcutaneous pocket should be practiced as the patient may be at risk of bleeding
- the port is accessed to check for infusion and withdrawal patency.

**Documentation following the procedure**

All procedures should be documented stating the:

- type of CVAD
- product serial number
- manufacture date
- date of placement
- length of the catheter
- external length of PICC
- catheter tip placement
- presence of blood return
- lock performed or if an infusion was commenced
- condition of the patient.
- name of the person who inserted the device (CNSA CVAD working party).
Recommendations:

Written consent for the procedure and the sedation (if sedation planned) should be gained following patient education about the procedure (ANZCA, 2005).

The CVAD insertion technique and insertion site with the lowest risk for complications for the anticipated type and duration of therapy should be selected (O’Grady et al. 2002).

A CVAD with the minimum number of ports or lumens essential for the management of the patient should be selected to reduce the risk of complications (O’Grady et al. 2002).

Antimicrobial prophylaxis should not routinely be given before insertion or during use of a CVAD to prevent catheter colonisation or bloodstream infection (O’Grady et al. 2002).

Optimum aseptic technique during catheter insertion (sterile gown, mask, gloves and large drapes) should be implemented (O’Grady et al. 2002; NICE, 2003; RCN, 2003).

The insertion site should be prepared with 2% chlorhexidine gluconate in 70% alcohol and allowed to air dry before skin penetration (O’Grady et al. 2002; RCN, 2003).

Details of the procedure, the device, tip placement and the condition of the patient should be documented in the patient record, following the insertion (CNSA CVAD working party).

Research Gaps:

The use of PICCs and implanted ports for the reinfusion of PBPCs remains unresolved.
5. Caring for the person with a central venous access device: post-insertion

5.1. Immediate post-operative care

If the patient has been sedated:

- recovery should take place under appropriate supervision in a properly equipped and staffed area (ANZCA, 2005)
- the patient should be discharged/transferred into the care of a responsible adult to whom written instructions should be given, including advice about eating and drinking, pain relief, resumption of normal activities and well as making legally binding decisions (ANZCA, 2005).

Post-operative observations should include:

- level of consciousness (ANZCA, 2005)
- cardiorespiratory status (ANZCA, 2005)
- pain (ANZCA, 2005)
- CVAD site for swelling, bleeding or other complications (CNSA CVAD working party).

Patients being discharged home should fulfil the following criteria:

- stable vital signs for at least one hour
- correct orientation to time, place and relevant people
- adequate pain control
- minimal nausea, vomiting or dizziness
- minimal bleeding or wound drainage
- a responsible adult to take the patient home
- discharge should be authorised by an appropriate staff member after discharge criteria have been satisfied
- written and verbal instructions for all relevant aspects of post-anaesthetic and surgical care must be given to the patient and the accompanying adult (a contact place and telephone number for emergency medical care must be included)
- a telephone enquiry as to the patient’s wellbeing on the following day should be made whenever possible (ANZCA, 2005).

The anatomical placement of the catheter tip must be documented in the patient record and checked prior to the initiation of any therapy through the device (RNAO, 2005).
Following catheter insertion, a chest X-ray may be obtained to:

- verify catheter placement
- detect adverse events such as a pneumothorax
- retain as a record of placement (Povoski, 2005).

Catheters may change position when the patient moves. PICC lines can move two centimetres away from the head with arm movement; subclavian or jugular catheters can move two to three centimetres towards the head. The initial catheter tip position in the lower third of the superior vena cava may have a final position in the upper end of the superior vena cava (RNAO, 2005).

### 5.2. Hand hygiene

Observe proper hand hygiene procedures before and after any CVAD manipulations or procedures (O’Grady et al. 2002) as below:

- hands that are visibly soiled or contaminated should be washed with soap and water before using an alcohol-based antiseptic hand rub
- before and after any CVAD manipulation including drug administration, injection cap access or line change that does not break the closed system:
  - hand antisepsis can be achieved by washing hands with antimicrobial soap or by use of an alcohol-based antiseptic hand rub by generating friction on all surfaces of the hands for at least 15 seconds (ANZCHOG Nursing Group working party, 2005)
- before any CVAD manipulation including accessing an implanted port, injection cap changes that does break the closed system and before and after a wound dressing:
  - procedural hand antisepsis can be achieved by washing hands with antimicrobial soap or by use of an alcohol-based antiseptic hand rub (after washing hands with soap and water) by generating friction on all surfaces of the hands for 30–60 seconds (ANZCHOG Nursing Group working party, 2005).

The use of gloves does not negate the need for hand washing (O’Grady et al. 2002).

### 5.3. Accessing a CVAD

Prior to infusion of any solution the integrity of the system should be determined by obtaining a blood return, as this avoids the risk of extravasation by confirming that the CVAD is in the venous system (Dougherty, 2006).

It is recommended that the delivery of antibiotics via catheters with multiple lumens should be rotated so that each lumen is used for antibiotic administration (CNSA CVAD working party).
5.4. Skin antisepsis

There has been much discussion in the literature regarding the optimum cleansing solution for CVAD site care. Products include:

- isopropyl alcohol 70%
  - bacteriocidal effect occurs through denaturation of proteins (Camp-Sorrell, 2004)
  - excellent effectiveness against gram negative and gram positive organisms, and good effect against TB, fungi and virus (Camp-Sorrell, 2004)
  - concentrations between 70% and 92% are rapidly effective, but does not have any residual effect (Camp-Sorrell, 2004; Crosby & Mares, 2001)
  - required drying time of approximately 30 seconds (RNAO, 2005)

- chlorhexidine gluconate
  - broad spectrum of antimicrobial activity causes disruption of microbial cell membranes (Camp-Sorrell, 2004)
  - excellent activity against gram positive organisms, good activity against gram negative organisms and viruses, fair activity against fungi, poor activity against TB (Camp-Sorrell, 2004)
  - anti-infective effect after application last four to six hours with excellent residual activity (Camp-Sorrell, 2004)
  - antimicrobial action is not affected by organic matter such as blood or exudates (Camp-Sorrell, 2004)
  - can be used for pre- and post-insertion care (O’Grady et al. 2002)
  - required drying time of approximately two minutes (RNAO, 2005)

- povidone-iodine
  - complex action that consists of iodine and carrier causing oxidation and substitution of microbial content with free iodine (Camp-Sorrell, 2004; O’Grady et al. 2002).
  - excellent effectiveness against gram-positive organisms, good effectiveness against gram negative, TB, fungi and viruses
  - anti-infective effect last for two hours with minimal residual activity (Camp-Sorrell, 2004)
  - antimicrobial action is diminished by organic matter such as blood and exudates (Camp-Sorrell, 2004)
  - required drying time at least two minutes (O’Grady et al. 2002).
Two percent chlorhexidine gluconate significantly lowers catheter-related bloodstream infection rates when compared with 10% povidone-iodine and 70% isopropyl alcohol (RNAO, 2005; Camp-Sorrell, 2004; O’Grady et al. 2002), and may reduce risk of catheter-related blood stream infection up to 49% (Camp-Sorrell, 2004; Chaiyakunapruk et al. 2002).

Organic solvents such as acetone or ether should not be applied (O’Grady et al. 2002) as this may cause skin irritation or affect catheter integrity (RNAO, 2005).

Some cleansing solutions (10% povidone-iodine, chlorhexidine and alcohol) may be toxic if introduced to the central nervous system, i.e. via Ommaya reservoir or epidural catheter (Camp-Sorrell, 2004).

Excessive amounts of cleansing solutions should not be used (Camp-Sorrell, 2004).

All antiseptics should be allowed to air dry before needle insertion or application of dressing.

**Antimicrobial Ointments**

Antimicrobial ointments may promote antimicrobial resistance and fungal colonization, affect catheter integrity and should not be used at the catheter insertion site (RNAO, 2005; Camp-Sorrell 2004; O’Grady et al 2002). Any ointments used, should be checked against catheter and ointment manufacturers’ recommendations regarding compatibility of the products (O’Grady et al. 2002).

**Chlorhexidine-Impregnated Sponge Dressing**

A chlorhexidine-impregnated sponge (Biopatch™) placed over the catheter insertion site may reduce the risk for catheter colonization and catheter related bloodstream infection (Levy et al. 2005; O’Grady et al. 2002; Roberts & Cheung, 1998). The Biopatch™ dressing is usually covered with a transparent, semi-permeable dressing.

Another study demonstrated effectiveness of reduction of bacterial colonization of epidural catheter exit site (Mann et al. 2001).

The use of chlorhexidine-impregnated sponge dressings have reduced bacterial colonization on CVAD and epidural catheter sites, but there is limited evidence currently available to demonstrate reduction in CVAD infections.

**5.5. Skin and catheter cleansing**

Skin cleaning and antisepsis are essential for preventing infection related to central venous catheters. Organisms that may cause infections can be introduced either from the patient’s own skin, from the hands of health care workers or through catheter movement in and out of the insertion site (RNAO, 2005).
The skin must be clean of organic matter such as blood or dirt prior to the application of the antiseptic.

Solutions to clean the skin of organic matter must be dry before chlorhexidine is applied. Liquid chlorhexidine should not come in contact with liquid 0.9% sodium chloride as a reaction between the saline and chlorhexidine can cause precipitates (Denton, 2001). If 0.9% sodium chloride is used prior to skin prepping with chlorhexidine, the 0.9% sodium chloride must be completely dry before using the chlorhexidine. Initial cleansing could be performed with sterile water.

The technique used traditionally to apply cleansing solutions to the skin has been to work in concentric circles out from the catheter exit point, taking care not to return to the clean area (Camp-Sorrell, 2004). The optimum technique when using a chlorhexidine solution is to apply it using gentle friction to maximise its effect (Hadaway, 2003). All skin that will be covered by the dressing should be cleaned.

The external length of the catheter should also be cleansed during the dressing procedure. This should be performed using 2% chlorhexidine and alcohol 70%, cleansing the catheter from the exit site towards the bifurcation, involving the catheter length to be covered by the dressing. While undertaking this procedure the nurse should ensure that the catheter is well secured (CNSA CVAD working party).

5.6. Injection access caps

All injection access caps used with central catheters must be of luer-lock design and provide needleless access to the catheter (CNSA CVAD working party).

Needleless connectors reduce the incidence of sharps injuries and resultant risk of transmission of blood-borne infections to health-care workers (Seymour et al. 2000). They also maintain the closed system for longer periods.

Using aseptic technique, minimising catheter hub manipulations and the number of entries into the CVAD can reduce complications (RNAO, 2005).

To prevent the entry of micro-organisms into the vascular system, access caps must be vigorously cleansed with either alcohol or an alcoholic solution of chlorhexidine gluconate before and after it has been used to access the system (MHRA, 2005; NICE, 2003; Maki & Mermel, 1998). The access cap must only be accessed with sterile devices (O’Grady et al. 2002).

The integrity of the access cap should be confirmed before and after each use. Access caps should be changed at least every week or earlier if compromised by presence of blood or lack of integrity (MHRA, 2005; Perucca, 2001). Any time an access cap is removed from the catheter, it should be discarded, and a new access cap should be attached (RCN, 2005).

There has been limited research to inform practice in the appropriate methods and solutions to clean the needleless access caps. It is possible for micro-organism
to gain entry though access caps, however the potential infection risk remains unclear (Seymour et al. 2000). A recently published study finds that disinfection of a heavily contaminated membranous septum of needleless luer-activated cap with 70% alcohol does not reliably prevent entry of microorganisms (Menyhay & Maki, 2006). A novel technology using an antiseptic access cap was found to be more effective and should be evaluated further in clinical trials (Menyhay & Maki, 2006).

5.7. Intravenous line management

The use of tape on tubing connections should be avoided because of possible microbial contamination (Camp-Sorrell, 2004).

Administration sets should not be disconnected (and reconnected at a later time) for the purpose of the patient showering or toileting as this may increase the risk of complications such as infection and catheter occlusion (CNSA CVAD working party).

For patients receiving intravenous medications only and not requiring additional IV fluid, it is recommended that catheter patency is maintained with the delivery of a medically ordered IV solution at an infusion rate of 10-20 ml/hour between the delivery of medications.

The type of solution administered can alter the frequency of administration set change. More frequent administration set change is required for fluids that enhance microbial growth (O’Grady et al. 2002).

5.7.1. Administration sets used for fluids

A recent Cochrane review concluded that there is no evidence that changing intravenous administration sets more often than every 96 hours reduces the incidence of blood stream infections (Gillies et al. 2005).

5.7.2. Administration sets used for blood products

A range of recommendations have been made regarding the frequency of administration set change when transfusing fresh or frozen blood products.

- The American Association of Blood Banks (AABB, 2000) states that intravenous lines should be changed after every unit of blood
- RNAO (2005) recommendations suggests every 4 hours or after every 2 units of packed cells
- The Centre for Disease Control guidelines (O’Grady et al. 2002) suggest every 12 hours
- The British Committee for Standards in Haematology (1999) suggest every 12 hours
• The Australian and New Zealand Society of Blood Transfusion/ RCNA (ANZSBT/ RCNA) “Guidelines for the Administration of Blood Components” suggest lines should be changed every 8 hours (ANZSBT/RCNA, 2004).

The CNSA CVAD working party recommends that administration sets used for the transfusion of fresh or frozen blood products should be changed every 8 hours as per the ANZSBT/RCNA guidelines.

5.7.3. Administration sets used for lipids

Administration sets that contain lipids should be changed every 24 hours (Gillies et al. 2005).

5.8. CVAD add-ons and equipment

Add-ons include all intravenous equipment additional to the catheter and the intravenous line. These include extension sets, burettes, stopcocks and filters. All add-ons must be of a Luer-lock design and should be changed when the intravenous line is changed or when the integrity of the add-on is compromised (Tropp et al. 2006).

Stopcocks and ‘piggyback’ systems used for injection of medication, administration of IV infusion and blood sample collection are potential entry ports for micro-organisms. Aseptic technique and vigorous cleaning of the device with alcohol or 2% Chlorhexidine in 70% alcohol should occur prior to access/connection (O’Grady et al. 2002).

5.9. CVAD dressings

The main issues regarding dressings for central lines are:

• which material should be used and
• how often the dressing should be changed.

Following insertion, the dressing should be changed within the first 24 hours (RCN, 2003).

Central catheters should be dressed with a sterile dressing and the dressing should be changed if the integrity of the dressing is compromised and at an interval determined by the product used (O’Grady et al. 2002).

Tunnelled catheters that have well healed exit sites and implanted ports that are well healed and not accessed do not require dressings (RNAO, 2005; O’Grady et al. 2002). (The patient should be educated to clean the exit site and catheter on a daily basis and observe for any problems).
5.9.1. Type of dressing

A meta-analysis did not detect statistically significant differences in the incidence of catheter-related blood stream infections or exit site infection when comparing sterile transparent polyurethane dressings and sterile gauze dressings (Gillies et al. 2003). The choice of dressing may be made according to the clinical situation including patient allergies and preference (Gillies et al. 2003; O’Grady et al. 2002).

Sterile gauze and tape

Sterile gauze dressings are appropriate immediately following catheter insertion when the site might be bloody or oozing or in the cases of patients who are allergic to particular dressing adhesives or are diaphoretic. Gauze dressings do not provide an occlusive barrier but do have absorbing action (Camp-Sorrell, 2004). Gauze dressings should be changed every 48 hours using an aseptic technique (RNAO, 2005) and consideration must be given to the fact that the insertion site cannot be visualised for assessment.

Sterile transparent semi-permeable dressings

Semi-permeable dressings allow moisture evaporation whilst acting as barrier to extrinsic liquid and micro-organisms (RNAO, 2005; Camp-Sorrell, 2004). Not all transparent dressings are suitable, since they may not be semi-permeable.

Transparent semi-permeable membrane (TSM) dressings should be changed using an aseptic technique every seven days or earlier if integrity of dressing is compromised (RNAO, 2005; Camp-Sorrell, 2004; O’Grady et al. 2002). Lower rates of phlebitis and infiltration have been reported with TSM dressing (Tripepi-Bova et al. 1997) and reduced frequency of dressing change and catheter site visibility have positive clinical logistic implications.

TSM dressings should be applied without stretching the skin, smoothed from the centre to the edge and the edges should not be sealed with tape (RNAO, 2005). Avoid touch contamination of the catheter insertion site when the dressing is replaced (O’Grady et al. 2002).

All catheter site dressings should be replaced when the dressing becomes damp, loosened, or soiled. Change dressings more frequently in diaphoretic patients.

If sterile gauze is placed under a transparent dressing it is considered a gauze dressing and 48-hourly dressing change is recommended (RNAO, 2005).

The TSM dressing should not be submerged under water but showering is permissible if the catheter and connecting device are covered with an impermeable cover. This reduces the likelihood of introducing organisms into the catheter (O’Grady et al. 2002).
5.10. Securement of a CVAD

Securing central venous catheters using appropriate methods allows assessment and monitoring of the site, and prevents dislodgement, migration and catheter damage (RNAO, 2005).

5.10.1. Sutures

Suturing is a common method used to secure the short-term central line catheter hub to the patient’s skin. Sutures are also used to secure the tunneled catheter by suturing to the skin and then tying the suture around the catheter. These remain in situ until adequate granulation occurs into the catheter cuff and tunnel to ensure stability of the device (Dougherty, 2006). In the event that sutures become loose or grow out, sterile surgical strips can be used as temporary securement. Resuturing may be necessary to secure the line (RNAO, 2005).

5.10.2. Surgical strips and tape

If securing the catheter with sterile surgical strips, the catheter exit site should be visible for assessment and not taped over (RNAO, 2005).

Some patients may not tolerate standard dressing products. Nursing staff need to consider the patient’s tolerance for various types of tapes to ensure maximum comfort (RNAO, 2005).

5.10.3. Securement devices

A variety of securement devices are commercially available for CVADs. Securement devices eliminate the need to suture the catheter hub. Some studies investigating the use of securement devices in PICC lines found lower infection rates, reduced catheter migration and longer dwell time (RNAO, 2005). Sterile TSM dressings applied over the securement device assist further in securing the catheter. Securement devices should be changed every seven days (RNAO, 2005).

Practice considerations

• Ensure the catheter is not dislodged during the change of the securement device and dressing
• The use of securement devices may not be feasible for some non-tunneled and tunneled CVADs
• Line tubing can be looped and secured with tape (RNAO, 2005). For PICC lines, the use of an elastic tubular bandage over the patient’s arm and catheter exit site may provide security and comfort. (Ensure the bandage does not interfere with circulation)
• If taping lines, reduce risk of discomfort and pressure injury by ensuring the clamps are not pressing into patient’s skin.
5.11 Flushing a CVAD

Flushing the CVAD maintains patency, prevents the mixing of incompatible medications or solutions, and reduces the build-up of intra- and extra-catheter material such as fibrin or blood (Camp-Sorrell, 2004).

There is limited evidence to inform the appropriate technique to flush CVAD lumens. The creation of a turbulent flow is purported to be beneficial in cleaning the catheter lumen/s of debris (RNAO, 2005). Turbulent flow is caused by using a “push-pause” technique, pressing the syringe plunger with a push/pause or stop/start motion.

CVADs should be flushed at established intervals if used intermittently.

The flushing of central venous catheters is recommended:

- before and after
  - medication administration
  - administration of blood and blood products
  - intermittent therapy
- after obtaining blood specimen
- when converting from intermittent therapy
- when the device is not in use
  (RNAO, 2005).

Brazier (2000) undertook a meta-analysis of flushing protocols for central catheters, which identified a wide range of practices. The interval times to flush unaccessed capped catheters ranged from every four hours to every 12 hours. The frequency is influenced by: the practice setting; the CVAD in use; therapy administered and further depends on institutional policy and guidelines. Tezak (2003) suggests that consistency in flushing practices promotes patency of the lumens. A standardised approach to flushing should be implemented as institutional protocol.

Sterile 0.9% sodium chloride solution is the commonly used flushing solution to flush CVADs after drug or blood administration (Camp-Sorrell, 2004). CVADs should be flushed with sterile 0.9% sodium chloride solution before and after the administration of potentially incompatible medications or fluids (Tropp et al. 2006). Check for compatibility of flushing solution with administered medications and choose other appropriate solutions as necessary.

Recommendations for flushing volumes range between 10-30mls of sterile 0.9% sodium chloride solution. It is recommended that the flush volume after medication administration, blood withdrawal or administration of blood and blood products is at least 20mls (Camp-Sorrell, 2004; RNAO, 2004).
It is recommended to access CVAD with no smaller than a 10ml syringe (RNAO, 2005; Camp-Sorrell, 2004). Smaller syringes exert higher output pressure and may cause catheter rupture. Most manufacturers recommend a minimum size of 10mls (Primhak, Gathercole & Reiter, 1998). Excessive force should never be used when flushing a CVAD.

5.12 Locking a CVAD

Locking prevents catheter occlusions by preventing blood flow back into the catheter when the CVAD device is not in use (Camp-Sorrell, 2004), and reducing blood clotting risk if blood backflow occurs (RNAO, 2005).

A locking volume of 3-10ml or at least twice the volume of the catheter lumen, plus priming volume of all add-on devices is recommended (RNAO, 2005).

**Positive pressure lock technique**

The correct technique requires maintaining pressure on the syringe plunger whilst clamping the CVAD line and before removing the syringe from the CVAD injection access cap (RNAO, 2005). This prevents blood flow back into the catheter and subsequent thrombus formation and catheter occlusion (RNAO, 2005). Education regarding correct positive pressure technique is essential, and incorrect technique can lead to thrombus formation (RNAO, 2005).

The positive pressure lock technique should not be used when using a positive fluid displacement device (RNAO, 2005).

5.12.1 Locking a CVAD

The issues of appropriate solution, the appropriate technique and the frequency of locking to reduce CVAD occlusion remain unresolved. A systemic review and meta analysis of randomised controlled studies evaluating the effect of heparin on catheter patency and prevention of complications associated with the use of peripheral venous and arterial catheters, concluded that heparin at doses of 10 IU/ml for intermittent flushing is no more beneficial than flushing with 0.9% sodium chloride alone (Pellowe et al. 2004).

The type of catheter in use is the main criteria for differing locking regimens. However, manufacturers of CVADs may recommend heparin saline locking regimens to maintain catheter patency (Pellowe et al. 2004).

**Valved CVAD’s**

The use of a 0.9% sodium chloride lock to maintain patency for valved CVADs is supported by the literature (RNAO, 2005). Locking each seven days or after each use is recommended (Camp-Sorrell, 2004).
Open-ended catheters

Open-ended CVADs, without positive pressure caps, have a risk of blood reflux and subsequent clotting (RNAO, 2005; Camp-Sorrell, 2004). Heparin sodium inhibits the conversion from prothrombin to thrombin and fibrinogen to fibrin, therefore coagulation is inhibited and fibrin build up is decreased (RNAO, 2005). To reduce the risk of clot formation and fibrin build up, locking open-ended catheters with heparinised-saline has been recommended.

Implanted ports not in use

There is limited evidence to guide the optimal time period between flush and locks for dormant implanted ports. Routine flushing for dormant ports is recommended to maintain patency of these devices (RCN 2005; Camp-Sorrell, 2004) with a flushing interval of four to six weekly (Camp-Sorrell, 2004).

Recent research suggests that less frequent access may be feasible to maintain port viability, with average interval of accession among patients of up to 63 days without any difficulty (Kuo et al. 2005). Kuo et al. (2005) performed a retrospective review of all patients who had undergone implanted port insertion from 1988-1993 and 1997-2002 with a total number of 73 patients included into the study. Considerable variation in maintenance was noted with individual median accession times varying between 28 to 262 days and an overall median of 42 days. Average interval of accession among patients without blood return on access was 79 days versus 63 days without any difficulty. This suggests that less frequent access may be feasible to maintain port viability, however further research is required.

The concentration of heparinised-saline locking solution ranges from 10-10000 IU/ml (Tropp et al. 2004; RNAO, 2005). A common concentration used is 50 IU Heparin in 5 ml 0.9% sodium chloride (CNSA CVAD working party). Sterile 0.9% sodium chloride is recommended for implanted ports with valved tips (Camp-Sorrell, 2004).

Concentration of heparin saline solution

Heparin should be used only when necessary, and in the lowest concentration and volume possible (RNAO, 2005).

Heparin, even in low doses has been associated with a number of serious complications. This may include iatrogenic haemorrhage, heparin induced thrombocytopenia, drug interactions and inaccurate blood results (Passannante & Macik, 1998).

An over-riding principle for the use of heparin in flushing/locking solutions should be “heparinise the catheter not the patient” (RNAO, 2005).

There is limited evidence in the literature regarding the removal of the heparin lock solution. There are suggestions that if the CVAD is being locked with
concentrations of heparin greater than 1000 IU or if the device is being accessed frequently there may be a risk of administering a therapeutic dose of the drug, causing anticoagulation. In such cases, consider withdrawing the heparin lock to prevent anti-coagulating the patient (Camp-Sorrell, 2004).

**Multiple lumen CVADs**

Patients with CVADs discharged from health care facilities should have all dormant lumens flushed and locked prior to discharge. Documentation of catheter patency should be part of discharge documentation and referral (CNSA CVAD working party).

**5.13 Drawing blood from a CVAD**

Blood may be aspirated from a CVAD for laboratory testing except in the following situations:

- when inotropes are being infused as this infusion should not be ceased (an alternative method of blood sampling should be used) (Camp-Sorrell, 2004).
- some drugs such as aminoglycosides and cyclosporine adhere to the catheter wall and cause inaccurate drug level readings (Camp-Sorrell, 2004).

Where there is a choice, blood should be collected from a dormant lumen or collected from lines which are not infusing medications or other therapies, such as electrolytes or parenteral nutrition (CNSA CVAD working party).

Blood for coagulation studies (e.g. APTT, INR) can be taken from CVADs. Document on laboratory form that the source of blood collected is from a CVAD, as values may be falsely prolonged as traces of heparin may cause false results (Camp-Sorrell, 2004).

Blood results that appear to be inaccurate should be repeated using a sample drawn from a peripheral vein (Camp-Sorrell, 2004).

Blood withdrawn for CVAD blood cultures should include the lock solution in the specimen if drawn from a dormant lumen (Everts & Harding, 2004).

**5.13.1 Methods for blood withdrawal**

CVADs are designed to permit withdrawal of blood for specimens. To maximise accuracy of laboratory tests, specific methods of withdrawal are used to reduce the likelihood of blood being diluted by, or mixed with clinical solutions such as heparinized saline. Several methods of blood withdrawal are described in the literature; these include discard, re-infusion or push-pull (RNAO, 2005). Methods need to be assessed regarding potential complications and choice depends on clinical setting, patient group and local protocols and guidelines.

The exception to using these methods is when the blood being collected is for culture and sensitivity testing. For these tests, the blood that is dwelling in the catheter lumens at the time of collection, even if mixed with other solutions, is the blood that
is required and should not be discarded (Everts & Harding, 2004). Particular care should also be taken during the blood collection procedure to avoid contamination of the specimens or containers (CNSA CVAD working party).

**discard method**

A specific amount of blood is removed via syringe or vacutainer system. Another sterile syringe or vacutainer is used to obtain the blood sample. This process is followed by a flush with 0.9% sodium chloride solution. A potential problem using the discard method is potential risk for nosocomical blood loss (RNAO, 2005). This method is commonly used in the adult population, who have a CVAD (Camp-Sorrell, 2004).

**re-infusion method**

A specific amount of blood is removed into a syringe and capped with a sterile cap. The blood specimen is obtained via syringe or vacutainer. The ‘discard’ from the first syringe is re-infused. This process is followed by a flush with 0.9% sodium choride solution. The re-infusion method may allow clot formation and introduction into the vascular system (RNAO, 2005). This method is used more often in the neonatal and paediatric population as it minimizes blood loss (Camp-Sorrell, 2004).

**push-pull method**

The CVAD is flushed with 5mL 0.9% sodium chloride solution in a 10 ml syringe. Without removing the syringe, 6mls of blood are aspirated, then pushed back into the CVAD. This process is repeated three times. The syringe in removed and another sterile syringe or a Vacutainer is used to obtain the blood sample. This process is followed by a flush with 0.9% sodium chloride solution. There may be difficulties obtaining enough blood for three push-pull sequences, and there may be a risk of haemolysis with the agitation of blood (RNAO, 2005).

**discard volume method**

Recommendations regarding the volume of blood that should be discarded to ensure test results are accurate are variable. Suggested discard volumes vary between 3-10 ml, with 5-6ml being the most frequently used volumes (Camp-Sorrell, 2004). At least, two times the internal catheter volume is recommended for coagulation tests (RNAO, 2005). Odum and Drenk (2004) recommends that a discard volume corresponding to at least six times the dead space of the catheter is sufficient after initial saline flushing to obtain samples for haematological analysis, coagulation tests and serum measurements. Flushing after blood sampling has not been specified in the literature (RNAO, 2005). Appropriate flushing volumes have been recommended to be at least 20mls of a compatible fluid (RNAO, 2005; Camp-Sorrell, 2004).

5.14.1 Accessing implanted ports

An implanted port must be accessed using specially designed non-coring needles. The design prevents “coring” of the septum and the offset bevelled end allows the tip of the needle to be flush with the bottom of the port without impeding the flow of solution (Tropp et al. 2006).

If the non-coring needle is to remain in place it should be covered with a sterile transparent semi-permeable dressing and this dressing should be changed each seven days or if the dressing is compromised (Tropp et al. 2006).

There is limited evidence to inform practitioners regarding the length of time the non-coring needle can remain in place. A small number of studies have examined the length of time the non-coring needle can remain in place. Karamanoglu et al. (2003) report that in a study of 60 patients requiring protracted chemotherapy regimens needles remained in place for an average of 28 days with no adverse effects. An earlier Australian study reports a dwell time of up to 21 days for non-coring port needles for patients receiving protracted venous infusions with no adverse events (Cox et al.1997). It is recommended that the non-coring needle should be changed at least every seven days (Tropp et al. 2006).

Both the Oncology Nurses Society (Camp-Sorrell, 2004) and Intravenous Nursing Society (Tropp et al. 2006) guidelines suggest a sterile technique should be used when accessing an implanted port, but the RNAO (2005) guidelines suggest that if the needle is of the variety that has a handle with which the needle is held, then non-sterile gloves may be utilised. CNSA recommend the use of a sterile technique to access all implanted ports (CNSA CVAD working party).

5.14.2 De-accessing implanted ports

When de-accessing the implanted port, it is important to combat the slight negative pressure caused by the removal of the needle. This can be achieved by clamping the tubing attached to the needle whilst still flushing the line (Camp-Sorrell, 2004). The Oncology Nurses Society (Camp-Sorrell, 2004) suggest that in the absence of clamps to aid the creation of positive pressure in the catheter that continuing to flush whilst withdrawing either the syringe from the injection cap or the needle from the port will create the same effect. This may increase risk of needlestick injury, as the operator uses one hand to press the syringe plunger and the other to remove the needle, making it difficult to maintain port stability. Another technique suggested is to have the patient holding and stabilising the port during de-access (NSW Health, PD 2005-088).

It is recommended to use port access devices that have clamps attached (CNSA CVAD working party).
5.15. Removal of a CVAD

The removal of a CVAD should only be performed by an appropriately educated and trained health care practitioner (RCN, 2005). Patients having their CVAD removed should have the procedure explained to them.

Prior to device removal, the patient’s coagulation profile should be reviewed by a medical practitioner and be deemed adequate to ensure the risk of bleeding is minimised (Dougherty, 2006).

If the device is being removed due to suspected or confirmed infection, the tip may be cut off using a sterile procedure and sent for culturing (Dougherty, 2006).

On removal of the CVAD, the health care practitioner should check the catheter’s integrity and length to ensure removal of the entire device (Dougherty, 2006).

Following removal, digital pressure should be exerted over two sites, the vein insertion area and the exit wound, until haemostasis is achieved (CNSA CVAD working party). Then a sterile occlusive dressing should be applied for at least 72 hours (RCN, 2005). Air embolism has been shown to occur up to 72 hours following device removal (RCN, 2005).

Following removal, nurses should monitor the site and implement interventions as required (RCN, 2005).

Following device removal, documentation in the patient record should include:

- type of device removed
- date and time of removal
- integrity of the device when removed
- whether tip was sent for culture
- status of the site
- details of dressing applied and ongoing care required
- patient’s status following removal
- detail what patient education was provided (CNSA CVAD working party).

The procedures for removal depend on the device in place.

**Central venous lines**

Patients should be positioned in the Trendelenburg position with head lower than their feet so that the potential for air entry is reduced (Dougherty, 2006). When the device is being removed the patient should perform the Valsalva manoeuvre. Once the dressing has been removed, remove the sutures and apply gentle traction on the catheter to allow removal.
PICCs

The patient should be positioned comfortably, and once the dressing has been removed, ask the patient to perform the Valsalva manoeuvre and apply gentle traction on the catheter to remove. Venous spasm may occur and cause the removal of the PICC to be difficult and uncomfortable to the patient. Firm constant traction may overcome mild venous spasm but care must be taken not to damage the catheter. If problems are experienced, apply a warm compress to the patient’s arm and try again after a short time. If continued difficulty: administer a warmed saline infusion and try again after 30 minutes (Dougherty, 2006). If ongoing problems inform a medical practitioner as a surgical cutdown may be required to remove the device.

Tunnelled catheters

There are two main methods for the removal of tunnelled catheters: traction and surgical incision (Dougherty, 2006).

Traction

This method applies constant traction to the catheter, gently pulling to ease the catheter out of the tunnel (Dougherty, 2006). This can be uncomfortable for the patient. There are risks with this procedure including catheter breakage and that the cuff may be left in the subcutaneous tunnel.

Surgical incision

This minor surgical procedure, undertaken by a medical practitioner, requires an incision over the site of the cuff and blunt dissection to prise away the tissue away from the cuff. The catheter may be cut and then removed in two sections. Pressure is applied over the incision site and once bleeding has stopped two to three skin sutures are placed. A transparent occlusive dressing should be applied for at least 72 hours with both of these procedures (Dougherty, 2006).

5.16 Technological advances with CVADs

It is recommended when changing technology, that catheter-related blood stream infection rates are monitored, approved policies are in place and comprehensive, detailed education and clinical skills training supports the change in practice (Health Devices Alerts, 2006).

5.16.1 Positive fluid displacement devices

These devices are needle-free positive fluid displacement injection caps, which are attached to the hub end of the lumen, that cause fluid displacement into the catheter following the disconnection of the syringe after flushing (Dougherty, 2006). A small amount of fluid is redirected into the internal catheter tip when the syringe is removed, thus preventing blood flow back into the catheter (RNAO, 2005). Blood aspiration can be performed through positive fluid displacement caps (Rummel, Donnelly, & Fortenbaugh, 2001). Catheters using these caps should not be clamped
until after disconnection of the flush syringe (RNAO, 2005; Hadaway, 2006). Early studies are reporting a decrease in catheter occlusion with use of this type of valve (Jacobs et al. 2004; RCN, 2005).

There is currently considerable debate regarding whether the use of positive fluid displacement caps is associated with increased risk of infection. A prospective, controlled trial examining the impact of a positive fluid displacement device in 153 children with 312 lumens found that there were fewer complete occlusions in CVADs capped with the device and that there was no significant difference in partial occlusions, phlebitis or catheter related bloodstream infections between the two groups (Jacobs et al. 2004). However, one large facility reported a sustained increase in catheter-related bloodstream infection after change from a mechanical valve to a positive fluid displacement device, and decrease of blood stream infection has been demonstrated after discontinuing use of the device (Margakis et al. 2006).

### 5.16.2 Vascular access devices with valve technology

There are two types of catheters that have specifically designed valves to prevent blood flow into the catheter lumen. This includes the Groshong® catheter or Pressure Activated Safety Valve (PASV®) PICC. For infusion, minimal pressure opens these valves to deliver infusate. For blood sampling, aspiration pressure opens the valves. Positive pressure on the syringe plunger is required when disconnecting the syringe, in addition, positive pressure caps can be used (RNAO, 2005).

### 5.16.3 ‘Safety’ non-coring port access needles

Newly developed safety non-coring port access needles have been designed to protect the user from a needle stick injury on withdrawal of the needle from the implanted port. Trials of these needles in the clinical setting continue.

**Recommendations:**

Proper hand hygiene procedures, before, during and after any CVAD manipulations or procedures, must be implemented to reduce the risk of infection (O’Grady et al. 2002).

Impeccable maintenance practices should be implemented to reduce the risk of CVAD-related complications (CNSA CVAD working party).

**Verification of catheter tip placement**

The anatomical placement of the catheter tip must be documented in the patient record and checked prior to the initiation of any therapy through the device (RNAO, 2005).

Following catheter insertion, radiological examination (e.g. chest X-ray) should be obtained to: verify catheter placement; detect adverse events and retain as a record of placement (Povoski, 2005).
Prior to infusion of any solution, the integrity of the system should be determined by obtaining a blood return, as this confirms that the CVAD is in the venous system (Dougherty, 2006).

**Accessing and de-accessing CVADs**

CVADs should be accessed using a sterile technique (Tropp et al. 2006; Camp-Sorrell, 2004).

An implanted port must be accessed using a specially designed non-coring needle (Tropp et al. 2006).

If the non-coring needle is to remain in place, it should be covered with a sterile transparent semi-permeable dressing, which should be changed at least every seven days (Tropp et al. 2006).

**Solutions**

2% chlorhexidine gluconate and 70% alcohol solution should be used for CVAD site and catheter care and allowed to air dry before the application of the dressing (RNAO, 2004).

Organic solvents such as acetone or ether should not be applied (O’Grady et al. 2002).

Antimicrobial ointments should not be used at the catheter insertion site (RNAO, 2005; Camp-Sorrell, 2004; O’Grady et al. 2002).

**Injection access caps, administration sets and add-on changes**

All administration lines, extension sets and access caps used with CVADs should be sterile, luer-lock design (Tropp et al. 2006).

Needleless access to the catheter and safety non-coring port access needles should be implemented to protect health care practitioners from injury (CNSA CVAD working party).

The injection access cap should be changed for a sterile cap each seven days or earlier if compromised by presence of blood or if the integrity of the cap is compromised (MHRA, 2005; RCN, 2005; Perucca, 2001).

Positive fluid displacement injection caps may be used on CVADs to reduce the risk of occlusion (Rummel, Donnelly & Fortenbaugh, 2001).

Administration sets should not be disconnected and reconnected at a later time for the purpose of the patient showering or toileting as this may increase the risk of complications such as infection and catheter occlusion (CNSA CVAD working party).

The type of solution administered can alter the frequency of administration set change. More frequent administration set change is required for fluids that enhance microbial growth (O’Grady et al. 2002).
Intravenous administration sets being used for:

- continuous infusions should be changed every 96 hours (Gillies et al. 2005)
- transfusion of blood and fresh or frozen blood products should be changed every eight hours or on completion of administration, whichever occurs first (ANZSBT, 2004).
- infusion of lipids and parenteral nutrition containing lipids should be changed every 24 hours (Gillies et al. 2005; RNAO, 2005)
- parenteral nutrition containing only amino acids and dextrose should be changed every 72 hours (O’Grady et al, 2002)
- fractionated products (IvIG, clotting factors, albumin) should be changed on completion of infusion (RNAO, 2005)
- propofol infusion tubing should be replaced every six or 12 hours, depending on manufacturers’ recommendation (O’Grady et al. 2002).

DRESSINGS

Tunnelled catheters that have well healed exit sites and implanted port sites that are well healed and not accessed do not require dressings (RNAO, 2005; O’Grady et al, 2002).

CVADs should be dressed with a sterile dressing, using an aseptic technique (RNAO, 2005; O’Grady et al. 2002).

The dressing should be changed if the integrity of the dressing is compromised and at an interval appropriate for the dressing product used (RNAO, 2005; O’Grady et al. 2002).

The choice of dressing may be made according to the clinical situation, including patient allergies and preference (Gillies et al. 2003; O’Grady et al. 2002).

- Gauze dressings should be changed every 48 hours or earlier if integrity of dressing is compromised (RNAO, 2005)
- Transparent semi-permeable dressings should be changed every seven days or earlier if integrity of dressing is compromised (Camp-Sorrell, 2004; RNAO, 2005; O’Grady et al. 2002).

Instruct the patient to cover the exit site and the external catheter and connecting device with a waterproof cover when showering to reduce the risk of introducing organisms into the catheter or exit site (Camp-Sorrell, 2004; O’Grady et al. 2002).
**Flushing**

Flushing of CVADs with 10-30mls of 0.9% sterile sodium chloride solution using a “push-pause” positive pressure technique is recommended:

- before and after
  - administration of medication
  - administration of blood and blood products
  - intermittent therapy
- after obtaining blood specimen/s
- when converting from intermittent therapy
- for device maintenance when not in use (RNAO, 2005).

The minimum size syringe used to access or flush CVADs should be 10ml (RNAO, 2005; Camp-Sorrell, 2004).

**Locking the CVAD**

There is limited evidence to inform the appropriate solution and the frequency of flushing and locking.

Heparin should be used only when necessary, and in the lowest concentration and volume possible (RNAO, 2005).

The use of 0.9% sterile sodium chloride solution for locking is effective in maintaining the patency of valved CVADs (RNAO, 2005).

A common concentration for locking implanted ports is 50IU Heparin in 5 ml 0.9% sterile sodium chloride solution (CNSA CVAD Working Party).

Routine flushing and locking is recommended for dormant ports (RCN, 2005; Camp-Sorrell, 2004) with a flushing interval of four to six weekly (Camp-Sorrell, 2004).

**Securing the CVAD**

All CVADs should be secured using a method appropriate for the device to enable assessment and monitoring of the site, and prevent dislodgement, migration and catheter damage (RNAO, 2005).

**Removal of a CVAD**

The removal of a CVAD should only be performed by an appropriately educated and trained health care practitioner (RCN, 2005).

If the device is being removed due to suspected or confirmed infection, it is recommended the tip be cut off using a sterile procedure and sent for culturing (Dougherty, 2006).
On removal of the CVAD, the health care practitioner should check the catheter’s integrity to ensure removal of the entire device (Dougherty, 2006).

**NEW TECHNOLOGY**

When changing technology, it is recommended that: catheter-related bloodstream infection rates are monitored; approved policies are in place; and comprehensive, detailed education and clinical skills training supports the change in practice (Health Devices Alerts, 2006).

**RESEARCH GAPS:**

The effectiveness of various cleansing solutions and methods for reducing CVAD complications

The most effective time intervals and solutions for locking CVADs to maintain catheter patency.

The optimal dwell time for non-coring port needles for people receiving protracted venous infusions via an implanted port.

The safety of using administration sets intermittently for patients who require regular intravenous medications and not intravenous fluids.
6. Complications related to central venous access devices and their management

The invasive nature of CVADs and longer dwell times are associated with a comparatively high rate of complications in the cancer patient population (Rosenthal, 2004). These complications can cause serious ramifications for the patient.

Nurses have an important role in the prevention, early detection and management of complications related to CVADs (Dougherty, 2006).

All information relating to CVAD events, including the cause, action taken and outcomes should be documented in the patient’s record (CNSA CVAD working party).

Information relating to CVAD events including incidence, degree, cause and corrective action should be collected and readily retrievable so that trends and possible causative factors can be identified, rectified and reported widely (CNSA CVAD working party).

This section provides an overview of each complication and the factors involved in causing them. Refer to Appendix 5 for information on signs, symptoms and risk factors of complications associated with CVADS.

6.1 Infection

Infections are classified as:

- early infections, which occur within three weeks of insertion and are usually associated with contamination with skin flora during insertion
- late infections, which occur greater than three weeks after insertion (Ray, 1999).

Infections can be:

- localised CVAD infections at the CVAD exit site; along the cutaneously tunnelled tract or at the skin pocket containing an implanted port (Rosenthal, 2004).
- systemic CVAD infections which are also known as bacteraemias or catheter-related blood stream infections (CR-BSIs) (Rosenthal, 2004; O’Grady et al. 2002). Catheter-related blood stream infections are where catheter cultures and blood cultures are positive for the same pathogen (O’Grady et al. 2002).

Many CVAD infections are undiagnosed or only recognised when septicaemia has ensued (Dougherty, 2006).
6.1.1. Routes of contamination

Catheter-related blood stream infections may occur when:

- skin flora contaminates the CVAD on insertion (O’Grady et al. 2002; Penne, 2002)
- organisms enter the body via the CVAD exit site and migrate along the external surface of the catheter to the tip (O’Grady et al. 2002)
- organisms migrate along the internal surface of the catheter and then enter the bloodstream, introduced via:
  - the CVAD hubs during lumen manipulations (Camp-Sorrell, 2004; Penne, 2002)
  - contaminated infusate or any other components of the infusion set (Camp-Sorrell, 2004; Penne, 2002)
- haematogenous seeding occurs from a remote site such as the urinary tract (Hebden, 2002).

Incidence of infection can increase as a result of thrombosis formation and build up of biofilm (Mehall et al. 2002; Donlan, 2001).

6.1.2. Preventing and managing CVAD related infections

Reducing the risk of infection

Consider the administration of prophylactic antibiotics before the insertion of tunnelled catheters for ‘at risk’ patients e.g. neutropenic patients or patients commencing induction therapy for haematological malignancies (van de Wetering & van Woensel, 2003).

Use optimum aseptic technique during catheter insertion (sterile gown, mask, gloves and large drapes) (O’Grady et al. 2002; NICE, 2003; RCN, 2003).

Prepare the insertion site using 2% chlorhexidine gluconate in 70% alcohol and allow it to dry before skin penetration (O’Grady et al. 2002; RCN, 2003).

Select subclavian insertion site in preference to the jugular or femoral sites for non-tunnelled catheters and consider a PICC if suitable for the patient’s therapy (O’Grady et al. 2002; Pellowe et al. 2004).

Educate health care staff in appropriate infection-control measures to prevent CVAD related infections (O’Grady et al. 2002).

Educate the patient and family caregiver to undertake regular surveillance and report any concerns about the device or their health (CNSA CVAD working party).

Observe proper hand hygiene procedures before, during and after any CVAD manipulations or procedures (O’Grady et al. 2002). The use of gloves does not negate the need for hand washing (O’Grady et al. 2002).
Implement regular and consistent maintenance procedures using strict aseptic techniques (Penne, 2002; Tezak, 2003; Camp-Sorrell, 2004).

Limit the number of CVAD manipulations where possible (Rosenthal, 2004; O’Grady et al. 2002).

Ensure appropriate nursing staff levels in high acuity patient areas to minimize the incidence of CVAD related infections (O’Grady et al. 2002).

**MANAGEMENT**

Implement, at minimum, daily site assessment, using inspection and light palpation of the exit site (through the dressing), tunnel or port pocket (Camp-Sorrell, 2004). If tenderness/pain, swelling or exudate is present the dressing should be removed to enable closer inspection (CNSA CVAD working party).

Document the assessment of exit site or implanted port site daily (Camp-Sorrell, 2004).

Assess the patient’s temperature regularly (CNSA CVAD working party).

Document signs and symptoms of suspected infection and report to a medical officer to enable further investigation and implementation of appropriate treatment (CNSA CVAD working party).

The course of action for suspected infection depends on:

- **patient factors**
  - for patients with normal immune function catheter salvage may be possible
  - systemic infections in immunocompromised patients can be life threatening and protecting the patient from a progressive infection must be the primary goal (Dougherty, 2006)
- the type of organism involved (O’Grady et al. 2002; Ray, 1999)
- the need for the CVAD (Ray, 1999)
- type of infection (O’Grady et al. 2002; Ray, 1999)

**Local infection:**

- culture exit site drainage, apply dressing and commence antibiotics as per medical order (Camp-Sorrell, 2004)
- do not use topical anti-microbial ointment at the exit site as this promotes fungal infections and antimicrobial resistance (O’Grady et al. 2002)
- review dressing procedures on care plan as frequency of dressing may need to be increased to keep the site clean of exudate and enable regular assessment (CNSA CVAD working party).
Systemic Infection:

- obtain blood cultures from all lumens of the CVAD and peripheral blood cultures (Camp-Sorrell, 2004; Mermel et al. 2001)
- administer intravenous antibiotics as per medical order; administer the antibiotics via all lumens during the course of treatment (Camp-Sorrell, 2004)
- if thrombus-related infection, consider the use of anti-thrombolytic to lyse clot and prevent recurrent infection (Camp-Sorrell, 2004)

Catheter removal is usually necessary when there is:

- persistent tunnel infection over a number of weeks
- fungal infection
- continued infection despite antibiotic therapy
- confirmed catheter-related blood stream infections (Camp-Sorrell, 2004; O’Grady et al. 2002)
- risk of progressive infection in a patient who is neutropenic (Dougherty, 2006).

Send catheter tip for culture on removal if erythema or exudate at the exit site or clinical signs of sepsis (O’Grady et al. 2002).

The use of the antibiotic lock technique in patients with long-term CVADs who have had history of multiple catheter-related blood stream infections can show benefits (Hachem & Raad, 2002; O’Grady et al. 2002).

The value of scheduled replacement of non-tunnelled CVADs to reduce incidence of infection remains controversial (Camp-Sorrell, 2004; O’Grady et al. 2002).

There is some evidence to suggest that the insertion of catheters coated with anti-microbial agents reduces the risk of catheter-related blood stream infections (RCN, 2003; O’Grady et al. 2002).

The use of chlorhexidine impregnated sponge dressings remains unresolved (Camp-Sorrell, 2004; O’Grady et al. 2002).

**6.2. CVAD occlusion**

Loss of catheter function due to occlusion is a common complication with CVADs. There are two main types of occlusion.

1. Persistent withdrawal occlusion is when the catheter will flush but there is an inability to withdraw blood. This decreases the function of the catheter, but also reduces the ability to check the patency of the catheter (Mayo, 2001).
2. Total occlusion is where the practitioner cannot infuse fluids into the catheter or withdraw blood (Mayo, 2001).

Resistance when flushing a CVAD may be the first signs of an impending CVAD occlusion.

6.2.1. Causes

The causes of device occlusion may be divided into two categories: non-thrombotic or thrombotic (McKnight, 2004).

Non-thrombotic occlusions

- Mechanical obstructions may be caused by:
  - External factors such as:
    - kinked or clamped IV tubing
    - a clamped CVAD lumen
    - tight sutures around CVAD insertion site (Dougherty, 2006; Grant, 2002).
  - Internal factors such as:
    - CVAD tip malposition (Camp-Sorrell, 2004)
    - catheter abutment against a valve or vessel wall (Camp-Sorrell, 2004)
    - by compression of the catheter itself by the clavicle and the first rib, known as pinch-off syndrome (Dougherty, 2006; Camp-Sorrell, 2004; Grant, 2002)
    - damage or malposition of catheter or needle (Camp-Sorrell, 2004).
  - Chemical occlusions may be caused by precipitates or lipid deposits from infusions of incompatible solutions (Dougherty, 2006; Hamilton, 2006; Steiger, 2006). Case reports of irreversible catheter occlusion secondary to simultaneous 5-FU and calcium folinic acid have been reported (Fackler-Schwalbe et al. 2004; Bruch & Esser, 2003).

Thrombotic occlusions

Thrombotic occlusions may occur due to:

- a fibrin sheath or tail forming on the catheter tip acting as a one-way valve permitting infusion, but not withdrawal of blood.
- a mural thrombus when the fibrin from the catheter surface binds with fibrin from a vessel wall injury and forms a venous thrombus
- fibrin deposits and/or sludge accumulation within a portal reservoir
- an intraluminal blood clot (Camp-Sorrell, 2004; Gorski, 2003; Mayo 2001).
6.2.2. Clinical practices to prevent and manage CVAD occlusions

Prevention

Effective flushing is the key to prevention of occlusion (Dougherty, 2006; Hamilton, 2006; Tezak, 2003). That is flushing:

- with the correct solution, volume and technique
- at the correct frequency for the device in use
- between drugs
- following blood withdrawal and transfusion of blood products.

Fluids should be infused using a pump and a ‘to keep vein open’ rate should be the least rate of administration to prevent backflow at any time the CVAD is connected (Dougherty, 2006).

Positive pressure injection caps enable fluid displacement and assist in the prevention of occlusions (Dougherty, 2006).

Mechanical occlusion can be limited by:

- avoiding tight sutures
- unclamping catheters prior to infusing
- preventing kinks in the catheter and administration sets
- implementing procedures so that only trained personnel insert port needles
- regularly checking the port needle position (CNSA CVAD working party).

Chemical occlusion can be limited by:

- avoiding mixing drugs/infusions
- flushing the tubing and lumen as recommended (CNSA CVAD working party).

The documentation of line patency on each access, including the observation of blood return and any resistance experienced is a key aspect of prevention (CNSA CVAD working party).

Management

Early detection is important because the longer the catheter remains occluded the lower the success rate for clearance (RNAO, 2004).

Assessment includes:

- external occlusion: clamps, needle correctly positioned, kinking in the line
- catheter function and history of function: ability to withdraw and infuse
• changes in catheter’s function related to patients posture and positioning suggests pinch-off syndrome

• physical assessment: signs of oedema, redness, venous distension (Dougherty, 2006)

• pinch-off syndrome, thrombosis and fibrin sheaths involves medical review and the use of medical imaging (chest X-ray, vascular ultrasound and dye studies) (Tropp et al. 2006; Camp-Sorrell, 2004).

If unable to withdraw blood, using a 10 ml syringe, gentle flushing and aspiration with 0.9% sodium chloride solution may clear the line and blood flashback may be returned (Dougherty, 2006). If this method is unsuccessful, then the instillation of a thrombolytic agent, such as a tissue plasminogen activator (tPA), has been found to be safe and effective in restoring patency (Dougherty, 2006; Camp-Sorrell, 2004; McKnight, 2004).

There is limited evidence to guide practice relating to the safe delivery of medication through a CVAD with no blood return. Extravasation can occur in CVADs due to backtracking along the catheter tunnel due to a fibrin sheath or a catheter tip malposition. In many clinical settings, medications are given through a CVAD that has a withdrawal occlusion, once assessment shows that a free flowing 0.9% sodium chloride solution has been safely administered. However, the administration of vesicants through a CVAD that has no blood return should be prohibited until it can be verified that an extravasation will not occur (CNSA CVAD working party). This would require a medical review and dye studies.

If complete thrombotic occlusion is suspected, instillation of a thrombolytic agent is indicated (Dougherty, 2006; Camp-Sorrell, 2004; McKnight, 2004).

**Practice Consideration**

A key factor is to instil the thrombolytic agent using a technique that does not increase pressure within the lumen (Dougherty, 2006).

When difficulty injecting into the device, a three-way tap can be attached to the end of the occluded CVAD lumen. Two syringes, one empty and one containing the thrombolytic agent are attached to the tap. A gentle rocking action between the two syringes creates negative pressure in the empty syringe. The three-way tap to the empty syringe is turned off, which will then permit the thrombolytic agent to enter the occluded lumen (Dougherty, 2006; Hamilton, 2006).

If the cause is drug precipitate or lipid deposition the following methods may be initiated on a medical order.

• For lipid deposition occlusions - instill 70% alcohol equal to the internal volume of the catheter; wait for one hour and withdraw (Steiger, 2006; RNAO, 2004)

• For mineral precipitate occlusions - instill 0.1-N hydrochloric acid equal to the internal volume of the catheter; wait for 20 minutes and withdraw (Steiger 2006; RNAO, 2004)
For medication related occlusions - instill 1.0 mEq/ml sodium bicarbonate equal to the internal volume of the catheter; wait for 20 minutes and withdraw (RNAO, 2004)

6.3. CVAD-related thrombosis

The major thrombotic complication of CVADs is deep vein thrombosis (DVT). The resultant thrombi are of four types:

1. fibrin sleeve thrombosis - a sheath that wraps around the catheter
2. mural thrombi - a clot that attaches to the vein wall
3. veno-occlusive thrombi - a clot that completely occludes the vein
4. intraluminal thrombosis - a thrombus within the CVAD lumen/s.

Sequelae may include post-phlebitic syndrome of the upper extremities, pulmonary embolism, infection (Kuter, 2004; Knutstad et al. 2003) and drug infiltration/extravasation due to fibrin sheath thrombosis (Knutstad et al. 2003).

6.3.1. Causes

The pathogenesis of CVAD-related venous thrombosis is multifocal and may include:

- endothelial injury upon CVAD insertion, leading to the accumulation of platelets at the site
- irritation of the vessel wall intima by the catheter tip
- alterations in laminar flow within the vessel caused by the presence of the catheter itself.

6.3.2. Clinical practices to prevent and manage CVAD-related thrombosis

Prevention

The risk of CVAD-related thrombus can be reduced by:

- correct placement of catheter and impeccable maintenance practices (Hamilton, 2006; Kuter, 2004; Knutstad et al. 2003; Mayo, 2001)
- educating patients about the signs and symptoms of thrombosis so they can report problems early (Mayo, 2001)
- monitoring patients with higher risks
- administration of oral low dose warfarin has been shown to decrease the rate of CVAD-related thrombosis but overall benefit has not been well established (Camp-Sorrell, 2004; Kuter, 2004; Knutstad et al. 2003).
**Management**

Treatment includes:

- reporting signs of venous thrombus to medical officer
- administration of subcutaneous heparin or oral warfarin therapy as ordered to prevent propagation of the clot and obstruction of the collateral vessel (post-phlebitic syndrome) (Knutstad et al. 2003; Kuter, 2004)
- removal the CVAD as ordered (Hamilton, 2006; Knutstad et al. 2003)
- elevation of limb if affected.

### 6.4. Air embolism

Air embolism occurs when intrathoracic pressure is less than atmospheric pressure, allowing air to enter the patient’s venous circulation through the open end of the catheter (Camp-Sorrell, 2004). The bolus of air travels to the right ventricle impeding the blood outflow in the pulmonary artery. Cardiac output, venous return, and coronary artery flow are decreased. Vascular collapse, arrhythmias, hypoxemia, hypercapnia, neurological deficits and death may ensue. The degree of harm caused is directly related to the gauge of the CVAD insitu, the volume of air infused, the rate of air entry and the patient’s position at the time of the event (Rosenthal, 2006; Brown, 2005; Andrews, 2002; Masoorli, 1999).

#### 6.4.1. Causes and risk factors

Air entry into the circulation can be due to:

- fracture or detachment of catheter connections e.g. during infusion tubing/access cap change
- failure to occlude the needle hub and/or catheter during insertion or removal
- dysfunction of self-sealing valves in plastic introducer sheaths
- presence of a persistent catheter tract following the removal of a central venous catheter
- deep inspiration during insertion or removal, which increases the magnitude of negative pressure within the thorax (Camp-Sorrell, 2004).

#### 6.4.2. Clinical practices to prevent and manage air embolus

Prevention and early detection are critical to minimizing the degree of iatrogenic injury sustained.

**Prevention**

The risk of air embolism can be limited by:

- inserting the smallest gauge CVAD possible
• placing the patient supine or in Trendelenburg position when inserting/removing a CVAD
• using luer-lock intravenous tubing and syringes
• using intravenous pumps with in-line air detection
• clamping lumens prior to dis/reconnecting access caps, intravenous tubing
• ensuring all clamps are present on CVAD lumens
• clamping the catheter proximal to any breaks or leaks detected
• instructing the patient to perform a Valsalva manoeuvre during CVAD removal
• applying gentle digital pressure at exit site and vein entry site until haemostasis is achieved
• dressing exit site with an air impermeable dressing following CVAD removal (leave in situ for 24-48 hours)
• providing patient education re: catheter displacement; dislodgment; accidental laceration or fracture
• timely assessment and intervention

**Management**

Air embolism is a medical emergency.

Treatment includes:

• aspirating any remaining air from the CVAD lumens
• if catheter is removed, ensuring occlusive dressing is applied to site
• placing patient on left side in Trendelenberg position (moves the emboli away from pulmonic valve)
• seeking urgent medical assistance
• applying 100% oxygen (air emboli are composed of room air - 79% nitrogen. Oxygen aids nitrogen in embolus to dissolve into the blood)
• closely monitoring the patient’s status – follow institutional medical emergency procedures

### 6.5. Infiltration and extravasation

Infiltration is defined as the inadvertent administration of non-vesicant solutions or medications into tissues surrounding the catheter (Tropp et al. 2006). Extravasation is defined as the inadvertent administration of vesicant solutions or medications into tissues surrounding the catheter (Tropp et al. 2006). Extravasation can lead to tissue necrosis, pain, infection, loss of mobility of the extremity and surgical procedures (D’Andrea, 2004; Schulmeister & Camp-Sorrell, 2000). Fatality following extravasation has been reported (Buchanan et al. 2005).
6.5.1. Causes
Causes of infiltration or extravasation include:

- catheter tip malposition/migration
- incorrect port access
- port needle dislodgement
- internal catheter damage
- fibrin sheath formation
- faulty equipment
- human error
- system problems
  (Dougherty, 2006)

6.5.2. Clinical practices to prevent CVAD infiltration and extravasation
To limit the likelihood of extravasation ensure:

- the patient is educated to report any burning or pain on drug infusion (Sauerland et al. 2006)
- educated and clinically competent nurses access implanted ports (CNSA CVAD working party)
- the correct needle length for the implanted port (Sauerland et al. 2006)
- correct placement and stabilization of port needle (Dougherty, 2006; Sauerland et al. 2006)
- educated and clinically competent nurses administer irritant and vesicant drugs (Sauerland et al. 2006)
- the patency of the catheter by checking for blood return and free flowing infusion before and during administration of drugs (Dougherty, 2006; Sauerland et al. 2006; Buchanan et al. 2005)
- frequent observation of the catheter/needle insertion site (CNSA CVAD working party)
- if in doubt, radiographic confirmation of catheter placement and patency should occur prior to drug administration (Camp-Sorrell, 2004; Buchanan et al. 2005).

6.5.3. Clinical practices to manage CVAD infiltration and extravasation
Extravasation should be considered as an emergency and action should be immediate (Hamilton, 2006). Treatment for extravasation remains controversial as there is limited evidence informing the management of extravasation, with little published about extravasation from a CVAD.

Currently, the management of extravasation remains largely based on anecdotes of interventions deemed effective in small studies or single cases (Kretzschmar et
al. 2003). The following strategies are suggested to assist in minimising the damage caused by the extravasation of irritants and vesicants.

- Stopping the administration of the drug (Weinstein, 2001)
- Manual extraction of the extravasate (Wickham et al. 2006)
- Using antidotes
  - Thiosulfate has been reported to be effective for the extravasation of cisplatin (Polovich, White & Kelleher, 2005)
  - There is some support for the use of hyaluronidase for the management of vinca-alkaloid or taxane extravasations (Wickham et al. 2006)
  - Topical steroids probably have no value in the management of extravasation
- Injection of large amounts of sterile 0.9% sodium chloride solution into the extravasation site to dilute the drug and promote local oedema to activate reabsorption into the blood stream (Wickham et al. 2006)
- Medical intervention
  An urgent medical review should be obtained (CNSA CVAD working party). Referral to a plastic surgeon to remove the tissue containing the drug may assist in minimising damage (Dougherty, 2006). Requirement for surgery will be determined by the location of the extravasation, the drug, and the amount of drug that has extravasated.
  - Application of hot/cold packs
    - Cold packs are proposed for the extravasation of doxorubicin as they cause vasoconstriction possibly reducing the amount of drug absorbed. Cold packs are controversial for the extravasation of oxaliplatin as there is some suggestion that they may cause neuropathy (Foo et al. 2003).
    - Hot packs are suggested for the management of the non-DNA binding drugs such as the vinca-alkaloids (Dougherty, 2006). Hot packs increase the local blood supply which may increase the absorption of the drug (Wickham et al. 2006).
- Documentation of extravasation
  Documentation in the patient record should include:
  - the site of the extravasation
  - the drug
  - an estimate of the amount of drug extravasated
  - the access device in use
  - all actions taken to minimise damage and to provide patient support
6.6. Cardiac tamponade

Injury to the myocardium can cause a pericardial effusion; an accumulation of blood or fluid within the pericardial space. If this effusion causes sufficient pressure to cause cardiac compression this is known as tamponade. This can lead to progressive limitation of ventricular diastolic filling, lowered stroke volume, reduced cardiac output and patient death (McCance & Huether, 2002).

6.6.1. Causes

Immediate atrial or ventricular perforation can occur due to tissue puncture during CVAD insertion by a guidewire, dilator or by the catheter tip (Garden & Laussen, 2004).

Delayed perforation can occur hours to months later and may be due to:

- direct contact between the catheter tip and the vessel or heart wall causing erosion (Garden & Laussen, 2004; RCN, 2005);
- local irritation caused by hyperosmolar fluid such as parenteral nutrition (Garden & Laussen, 2004; Czepizak et al. 1995)

6.6.2. Clinical practices to prevent and manage cardiac tamponade

Prevention

The risk of developing a cardiac tamponade can be reduced by:

- inserting a CVAD with smallest possible gauge lumens for specific patient need (CNSA CVAD working party);
- confirming CVAD tip placement on insertion (Garden & Laussen, 2004; Shields, Hunsaker & Hunsaker, 2003);
- routine monitoring of long-term CVAD tip positions with chest X-ray is recommended (Garden & Laussen, 2004);
- using silicone and polyurethane CVADs in patients requiring long-term vascular access (Garden & Laussen, 2004).
Management
Cardiac tamponade is a medical emergency.
If cardiac tamponade is suspected:
• seek urgent medical review
• apply oxygen as medically prescribed
• assess the patient’s vital signs
• prepare patient for possible surgical procedure:
  o urgent trans-oesophageal echocardiogram
  o guided pericardiocentesis or surgery (Garden & Laussen, 2004).

6.7. Dysrhythmias
CVAD induced arrhythmias can present as atrial or ventricular premature beats
or ventricular tachycardia or fibrillation which are resistant to drug suppression
(Czepizak et al. 1995).

6.7.1. Causes
Dysrhythmias can be caused by malposition or over insertion of the CVAD in
the atrium whereby the catheter tip irritates the atria or ventricles resulting in
cardiac arrhythmias (Dougherty, 2006; Czepizak et al. 1995).

6.7.2. Clinical practices to prevent and manage cardiac dysrhythmias
Prevention
The risk of developing cardiac arrhythmias can be reduced by:
• positioning the CVAD guided by ECG
• confirming CVAD tip placement on insertion
• measuring and documenting external length of CVAD on insertion and
  routinely when suture-free securing devices are used (CNSA CVAD
  working party).

Management
Cardiac arrhythmias can be assessed and managed by:
• performing an ECG
• reporting any cardiac rhythm disturbances to a medical officer
• withdrawing the CVAD from the right atrium or ventricular chambers
  (Czepizak et al. 1995).
6.8. CVAD tip migration

CVAD tips can spontaneously migrate at anytime during an indwelling period. This is more common in long-term devices. Migration is usually into the internal jugular vein.

It should never be assumed that the CVAD tip will not move after initial insertion. Any deviation of the CVAD tip from the lower SVC can lead to the development of:

- catheter dysfunction
- catheter fracture/migration
- venous thrombosis
- venous perforation
- cardiac tamponade

(Hadaway, 1998; RNAO, 2005).

The correct position must be confirmed radiographically and documented in the patient’s notes prior to accessing the device (RNAO, 2005).

Optimal timeframes for routine tip confirmation have not been established. At a minimum, tip position should be checked radiographically if there are changes in CVAD function, if signs and symptoms of complications are evident or the catheter has been replaced over a guidewire. This may include x-ray confirmation, dye studies, ultrasound or doppler ultrasound and fluoroscopy (RNAO, 2005).

6.8.1. Causes

The causes of CVAD tip migration can include:

- normal anatomical forces/bodily movements that increase intrathoracic pressure i.e. breathing, coughing, sneezing, vomiting or strenuous upper extremity movements such as golf or weight lifting (Camp-Sorrell, 2004; Hadaway, 1998)
- forceful flushing (Camp-Sorrell, 2004).

6.8.2. Clinical practices to prevent and manage CVAD tip migration

Prevention

CVAD tip migration can be limited by:

- adequately securing the external portion of CVAD
- instructing patients with long-term CVADs insitu of the types of activities that may cause migration of the catheter (such as heavy lifting) and recommend avoiding these activities.
**Management**

The assessment and management of CVAD tip migration includes:

- documenting the length of the external portion of CVAD post-insertion
- observing the CVAD exit site and the length of the external segment of the catheter routinely for signs of catheter migration
- asking the patient to report any discomfort they may experience related to the catheter (CNSA CVAD working party)
- asking the patient to report if they experience sensations or hear noises on flushing the CVAD (CNSA CVAD working party)
- reporting signs and symptoms of CVAD dysfunction to enable full investigation (Hadaway, 1998)
- flushing and locking a CVAD suspected of migrating and not using until correct tip position can be confirmed (Hadaway, 1998)
- confirming catheter tip placement by radiology (Camp-Sorrell, 2004)
- salvaging/repositioning malpositioned CVADs can be undertaken, often by an interventional radiologist (Hadaway, 1998)
- removing malpositioned CVAD as requested by medical officer (Hadaway, 1998).

**6.9. Catheter damage**

Catheters can be damaged at several points along the catheter line both internally and externally.

- **At the catheter hub**
  Applying a cap before the cleansing solution has dried will effectively ‘glue on’ the cap which can result in cracking of the hub of the lumen (Dougherty, 2006; Hamilton, 2006).

- **Near the catheter hub or below the bifurcation.**
  Use the correct clamps or smooth blade forceps to reduce the risk of damage to the catheter (Dougherty, 2006).

- **Above the catheter bifurcation**
  Damage to external catheter sections can be repaired, however this should be considered as a temporary measure until the catheter can be replaced (Dougherty, 2006). Repair increases the risk of infection, haemorrhage and air embolis (Hamilton, 2006).

- **The catheter internally**
  CVADs have the potential to fracture and if fragments are not detected and
removed there is a risk of mortality, due to injury/perforation of the atria, ventricles, and myocardium, pericardial effusion, cardiac tamponade, cardiac arrhythmias and pulmonary embolism (Garden & Laussen, 2004; Knutstad et al. 2004).

6.9.1. Causes of Catheter Fragmentation
CVAD fragmentation can occur during insertion, removal, or whilst the CVAD is insitu. The causes of catheter fracture and subsequent embolism include:

- catheter shearing from instruments during insertion (Dougherty, 2006)
- applying excessive pressure on the CVAD when flushing or clearing an occlusion (Dougherty, 2006)
- manufacturing defect (Dougherty, 2006)
- repeated mechanical stress upon the CVAD such as occurs in pinch-off syndrome (Dougherty, 2006; Garden & Laussen, 2004; Knutstad et al. 2004; Mirza, Vanek & Kupensky, 2004)
- separation of the catheter from the port body (Dougherty, 2006)
- using excessive force is used against traction e.g. on removal (Dougherty, 2006)
- incorrect insertion of needle, when accessing an implanted port, subsequently piercing the catheter.

6.9.2. Clinical Practices to Prevent and Manage Damage to CVADs
**Prevention**
CVAD damage can be limited by:

- adhering to manufacturers specifications for safe pressure (Dougherty, 2006)
- assessing CVADs with signs of pinch-off syndrome (Dougherty, 2006)
- removing CVADs that are damaged due to pinch-off syndrome (Mirza, Vanek & Kapensky, 2004)
- using a 10ml or greater syringe size on CVAD lumens (Dougherty 2006; Andris & Krzywda, 1999; Hadaway, 1998)
- not using excessive force when attempting to flush, unblock or inject into a CVAD (Dougherty, 2006; Hamilton, 2006; Andris & Krzywda, 1999; Hadaway, 1998).
- using the negative pressure and three-way tap technique to instil thrombolytic agents (Dougherty, 2006)
- avoiding the use of sharp instruments near CVADs (Dougherty, 2006; Andris & Krzywda, 1999; Hadaway, 1998)
- educating patients and the family caregiver never to use sharp instruments near their CVAD (CNSA CVAD working party)
- educating patients to protect their external devices at all times e.g. sexual, leisure and sporting activities (CNSA CVAD working party).
Management

For external fracture:

- educating the patient regarding immediate actions to undertake (CNSA CVAD working party)
- immediately clamping the portion of CVAD remaining outside the skin, proximal to the damage (Dougherty, 2006)
- ensuring the CVAD does not migrate into the vein (CNSA CVAD working party)
- maintaining a firm grasp on the CVAD during a repair (CNSA CVAD working party)
- if repair is not possible, the CVAD should be removed (Dougherty, 2006).

For internal fracture

- contacting a medical officer
- placing the patient on the left side in Trendelenburg position
- applying oxygen
- ensuring a chest x-ray is performed urgently to confirm catheter fragmentation and location
- if a PICC breaks during removal, immediately tourniquet the arm and monitor vital signs and pulses in the tourniquet arm (Andris & Krzywda, 1999; Hadaway, 1998).

Treatment usually involves interventional radiological removal of the fragment via femoral puncture and snaring of the CVAD segment (Dougherty, 2006; Andris & Krzywda, 1999; Hadaway, 1998). If percutaneous retrieval is unsuccessful open surgery has been necessary (Kapadia et al. 2005).

Recommendations:

Many CVAD-related complications can be limited by:

- inserting the smallest gauge CVAD with the least number of lumens possible for the patient’s treatment (O’Grady et al. 2002)
- verifying catheter tip placement in the lower third of the superior vena cava on insertion and routinely over the placement period
- regular and consistent maintenance procedures using strict aseptic techniques (Camp-Sorrell, 2004; Tezak, 2003; Penne, 2002).

The patient and family caregiver should be educated to:

- undertake regular surveillance of their CVAD
- undertake immediate emergency action to minimise risks if a CVAD complication is detected
• report any concerns about the device or their health (CNSA CVAD working party).

All patient concerns about their CVAD should be investigated (CNSA CVAD working party).

Information relating to a CVAD event, including the cause, action taken and outcomes should be documented in the patient’s record (CNSA CVAD working party).

Information relating to CVAD events including incidence, degree, cause, corrective action and outcome should be collected and readily retrievable so that trends and possible causative factors can be identified, rectified and reported (CNSA CVAD working party).

**CVAD-related infections**

The patient and the family caregiver should be educated to report symptoms of infection, redness, swelling, pain/discomfort or any exudate at the exit or implanted port site (CNSA CVAD working party).

Health care staff should be educated in appropriate infection-control measures to prevent CVAD-related infections (O’Grady et al. 2002).

Appropriate nursing staff levels should be allocated in high acuity patient areas to minimize the incidence of CVAD-related infections (O’Grady et al. 2002).

The number of CVAD manipulations should be limited (Rosenthal, 2004; O’Grady et al. 2002).

**Maintenance procedures should include:**

• At minimum, daily site assessment, using inspection and light palpation of the exit site (through the dressing), tunnel or port pocket (Camp-Sorrell, 2004). If tenderness/pain, swelling or exudate the dressing should be taken down, using aseptic technique to enable closer inspection (CNSA CVAD working party)

• Documentation of the assessment of exit site or implanted port site daily (Camp-Sorrell, 2004)

• Regular assessment of patient’s temperature (CNSA CVAD working party)

• Signs and symptoms of suspected infection should be documented and reported to a medical officer to enable further investigation and implementation of appropriate treatment (CNSA CVAD working party).

**Suspected infection should be investigated by:**

• exit site swabs if there are signs of localised infection (Camp-Sorrell, 2004).

• blood cultures from all lumens of the CVAD and peripheral blood cultures if there is suspected catheter infection (Camp-Sorrell, 2004; Mermel et al. 2001).
Multiple-lumen catheters should have each lumen used for the administration of the antibiotic during the course of the treatment (Camp-Sorrell, 2004).

Removal of the CVAD should only be done when there is: persistent tunnel infection over a number of weeks; fungal infection; continued infection despite antibiotic therapy; confirmed CVAD sepsis (Camp-Sorrell, 2004; O’Grady et al. 2002) or if there is a risk of progressive infection in a patient who is immunocompromised (Dougherty, 2006).

**CVAD occlusions**

Line patency on each access, including the observation of blood return and any resistance experienced, should be documented to assist early detection and management (CNSA CVAD working party).

Flushing procedures should be established to reduce the risk of occlusion including: flushing between drugs; flushing with the correct solution, volume and technique and flushing at the correct frequency for the device in use (Dougherty, 2006; Hamilton, 2006; Tezak, 2003).

Fluids should be infused using a pump and a ‘to keep vein open’ rate should be the least rate of administration to prevent blood backflow into the lumens at any time the CVAD is connected (Dougherty, 2006).

**CVAD-related thrombosis**

The risk of CVAD-related thrombus can be reduced by:

- correct placement of catheter and impeccable maintenance practices (Hamilton, 2006; Kuter, 2004; Knutstad et al. 2003; Mayo, 2001)
- educating patients about the signs and symptoms of thrombosis (i.e. redness, swelling, heat, pain/discomfort in any area along the catheter tract) so they can report problems early (Mayo, 2001)
- monitoring patients with higher risks.

**Infiltration and extravasation**

The patient should be educated to report any burning or pain on drug infusion (Sauerland et al. 2006).

Before and during administration of drugs, the patency of the CVAD should be assured by checking for blood return and a free flowing infusion (Dougherty, 2006; Sauerland et al. 2006; Buchanan et al. 2005).

Only educated and clinically competent RNs should administer irritant and vesicant drugs (Sauerland et al. 2006).

Each institution should have a policy for the management of drug extravasation (CNSA CVAD working party).
An extravasation should be documented in the patient record, including: the site of the extravasation; the drug; an estimate of the amount of drug extravasated; the access device in use; all actions taken to minimise damage and to provide patient support; and the outcomes for the patient (CNSA CVAD working party).

An extravasation should be reported as an adverse incident, with the possible cause reported, examined and all actions and patient outcomes reported (CNSA CVAD working party).

**CVAD-related cardiac complications**

Following catheter insertion, radiological verification must be obtained to verify catheter tip placement (Povoski, 2005)

Tip position should be checked radiographically if there are changes in CVAD function, if signs and symptoms of complications are evident or if the catheter has been replaced over a guidewire (RNAO, 2005).

Measure and document the external length of the CVAD on insertion and routinely when suture free devices are in use (CNSA CVAD working party).

There may be some benefit from routine radiological examination of tip location for patients with long term devices (CNSA CVAD working party).

**Catheter damage**

Educate patients and the family caregivers:

- never to use sharp instruments near their CVAD
- to protect their external devices at all times e.g. during sexual, leisure and sporting activities (CNSA CVAD working party).

CVADs with signs and symptoms of pinch-off syndrome should be assessed for damage (Dougherty, 2006).

CVADs that are damaged due to pinch-off syndrome should be removed (Mirza, Vanek & Kapensky, 2004).

Use a 10ml or greater syringe size on all CVAD lumens (Dougherty 2006; Andris & Krzywda, 1999; Hadaway, 1998).

Do not use excessive force when attempting to flush, unblock or inject into a CVAD (Dougherty, 2006; Hamilton, 2006; Andris & Krzywda, 1999; Hadaway, 1998).
For an external fracture of the catheter:

- educate the patient regarding immediate actions to undertake (CNSA CVAD working party)
  - immediately clamping the portion of CVAD remaining outside the skin between the site of damage and the chest wall (Dougherty, 2006)
  - ensure the CVAD does not migrate into the vein (CNSA CVAD working party)
  - immediately contacting the health care facility (CNSA CVAD working party)

For an internal fracture of the catheter:

- contact a medical officer
- place the patient on the left side in Trendelenburg position
- apply oxygen
- ensure a chest x-ray is performed urgently to confirm catheter fragmentation and location
- if a PICC breaks during removal, immediately tourniquet the arm and monitor vital signs and pulses in the tourniquet arm (Andris & Krzywda, 1999; Hadaway, 1998).

**Research Gaps:**

Safety of medication administration in CVADs with no blood return.

The role of routine radiological screening to identify CVAD tip malposition, pinch-off syndrome and fibrin sheath formation.
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## Appendix 1: List of acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>AABB</td>
<td>American Association of Blood Banks</td>
</tr>
<tr>
<td>ANF</td>
<td>Australian Nursing Federation</td>
</tr>
<tr>
<td>ANMC</td>
<td>Australian Nursing and Midwifery Council</td>
</tr>
<tr>
<td>ANZCA</td>
<td>Australian and New Zealand College of Anaesthetics</td>
</tr>
<tr>
<td>ANZCHOG</td>
<td>Australian and New Zealand Children’s Oncology Group</td>
</tr>
<tr>
<td>ANZSBT</td>
<td>Australian and New Zealand Society of Blood Transfusion</td>
</tr>
<tr>
<td>APTT</td>
<td>activated partial thromboplastin time</td>
</tr>
<tr>
<td>CINAHL</td>
<td>Cumulative Index to Nursing &amp; Allied Health Literature</td>
</tr>
<tr>
<td>CNSA</td>
<td>Cancer Nurses Society of Australia</td>
</tr>
<tr>
<td>CR-BSI</td>
<td>catheter-related blood stream infection</td>
</tr>
<tr>
<td>CVAD</td>
<td>central venous access device</td>
</tr>
<tr>
<td>DVT</td>
<td>deep vein thrombosis</td>
</tr>
<tr>
<td>ECG</td>
<td>electrocardiogram</td>
</tr>
<tr>
<td>INR</td>
<td>international normalised ratio</td>
</tr>
<tr>
<td>Acronym</td>
<td>Definition</td>
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<tr>
<td>IU/ml</td>
<td>international units per millilitre</td>
</tr>
<tr>
<td>IV</td>
<td>intravenous</td>
</tr>
<tr>
<td>MHRA</td>
<td>Medicines and Healthcare Products Regulatory Agency</td>
</tr>
<tr>
<td>NICE</td>
<td>National Institute for Clinical Excellence</td>
</tr>
<tr>
<td>PASV</td>
<td>pressure activated safety valve</td>
</tr>
<tr>
<td>PBPC</td>
<td>peripheral blood progenitor cells</td>
</tr>
<tr>
<td>PICC</td>
<td>peripherally inserted central catheter</td>
</tr>
<tr>
<td>RCNA</td>
<td>Royal College of Nursing, Australia</td>
</tr>
<tr>
<td>RN</td>
<td>Registered Nurse</td>
</tr>
<tr>
<td>RNAO</td>
<td>Registered Nurses’ Association of Ontario</td>
</tr>
<tr>
<td>SVC</td>
<td>superior vena cava</td>
</tr>
<tr>
<td>TB</td>
<td>tubercle bacillus, tuberculosis</td>
</tr>
<tr>
<td>TSM</td>
<td>transparent semi-permeable membrane</td>
</tr>
</tbody>
</table>
## Appendix 2: Glossary of terms

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>accessing CVADs</td>
<td>gaining entry into the central catheter or implanted port</td>
</tr>
<tr>
<td>air embolus</td>
<td>quantity of air that circulates in the bloodstream until it becomes lodged</td>
</tr>
<tr>
<td>algorithm</td>
<td>step-by-step procedure to gain a solution to a problem</td>
</tr>
<tr>
<td>antibiotic prophylaxis</td>
<td>antibiotics administered, prior to the advent of an infection, to prevent an infection from occurring</td>
</tr>
<tr>
<td>anti-microbial</td>
<td>against microbes</td>
</tr>
<tr>
<td>apheresis procedure</td>
<td>a procedure in which blood is processed through a machine to remove a component such as progenitor blood stem cells, platelets or plasma, and the rest is returned to the person</td>
</tr>
<tr>
<td>arrhythmias/dysrhythmias</td>
<td>deviation from the normal pattern of the heartbeat</td>
</tr>
<tr>
<td>aseptic technique</td>
<td>freedom from infection or septic material, sterile</td>
</tr>
<tr>
<td>‘at risk’ patient</td>
<td>any patient whose co-morbidities would put them at a greater risk of developing complications</td>
</tr>
<tr>
<td>axillary node dissection</td>
<td>removal of lymph nodes from the axilla (armpit)</td>
</tr>
<tr>
<td>bacteraemias</td>
<td>bacteria present in the bloodstream</td>
</tr>
<tr>
<td>basilic, median cubital or cephalic veins</td>
<td>superficial veins in the arm – often chosen for blood testing or gaining peripheral access for infusion of fluids or medications</td>
</tr>
<tr>
<td>bifurcation</td>
<td>the joining of two or more lumens to become one</td>
</tr>
<tr>
<td>biofilm</td>
<td>a coating of protein cells and other organic material which lines either or both the internal and external surfaces of a central line, and is a high potential risk for bacterial growth and subsequent infection</td>
</tr>
</tbody>
</table>
blood reflux: blood flowing back into the lumen of the CVAD

cardiac tamponade: pericardial effusion causing pressure resulting in cardiac compression - can lead to progressive limitation of ventricular diastolic filling, lowered stroke volume, reduced cardiac output and patient death

carina: structure shaped like a ridge – in the trachea it projects out from the lowest tracheal cartilage

catheter shearing: fracturing of a catheter, usually by force or with a sharp instrument

catheter tip migration: the catheter tip is found in a vessel other than the superior vena cava, e.g. external jugular vein

catheter-related bloodstream infections: where catheter cultures and blood cultures are positive for the same pathogen

cell separation: apheresis procedure

central haemodynamic monitoring: monitoring the physical aspects of the blood circulation - cardiac function and peripheral vascular physiological characteristics

central venous access device: small, flexible plastic tube inserted into the large vein a entering the heart, through which access to the blood stream can be made. The insertion site may be peripheral, but the proximal end is always central

Cochrane review: a systematic review by The Cochrane Collaboration - an international not-for-profit and independent organization, dedicated to making up-to-date, accurate information about the effects of healthcare readily available worldwide

collateral vessel: branch of a blood vessel used as an accessory to the blood vessel from which it arises

competence: may be broadly defined as the possession and development of sufficient skills, appropriate attitudes and experience for successful performance of specific activities - activities required by a profession or occupation to the level expected in the workplace.

competent: properly qualified, i.e. having the knowledge and skill necessary
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>conscious sedation</td>
<td>drug induced depression of consciousness during which patients can respond purposefully to verbal commands or tactile stimulation</td>
</tr>
<tr>
<td>contaminated infusate</td>
<td>infusion fluid that has harmful product added, e.g. bacteria</td>
</tr>
<tr>
<td>contamination</td>
<td>something added to make the product unusable or harmful</td>
</tr>
<tr>
<td>cutaneously</td>
<td>of the skin</td>
</tr>
<tr>
<td>cut down procedure</td>
<td>dissection of a vein for insertion of a cannula or needle for the administration of intravenous fluids or medication</td>
</tr>
<tr>
<td>CVAD fragmentation</td>
<td>a central line that has been broken into pieces or fragmented</td>
</tr>
<tr>
<td>de-accessing CVAD</td>
<td>removing intravenous access from the CVAD i.e. removing the needle from the implanted port or the infusion from the external CVAD with plans to flush and lock the device</td>
</tr>
<tr>
<td>deep vein thrombosis (DVT)</td>
<td>a clot formed in one of the deep veins – may be life-threatening</td>
</tr>
<tr>
<td>diaphoretic</td>
<td>sweating</td>
</tr>
<tr>
<td>digital pressure</td>
<td>pressure applied with a finger</td>
</tr>
<tr>
<td>drug precipitate</td>
<td>formation of a solid in a solution occurring when incompatible drugs are mixed – generally happens when the infusion line has not been flushed properly after the injection of one of the drugs</td>
</tr>
<tr>
<td>dysrythmias</td>
<td>defective rhythm</td>
</tr>
<tr>
<td>endothelial injury</td>
<td>this generally pertains to the endothelial lining of the heart which may be damaged when inserting central venous access devices</td>
</tr>
<tr>
<td>erythema</td>
<td>a name applied to redness of the skin produced by congestion of the capillaries</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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</tr>
<tr>
<td>exudate</td>
<td>material, such as fluid, cells or cellular debris, which has escaped from blood vessels and has been deposited in tissues or on tissue surfaces, usually as a result of inflammation</td>
</tr>
<tr>
<td>extravasation</td>
<td>accidental administration of vesicant solutions or medications into tissues surrounding the catheter</td>
</tr>
<tr>
<td>fibrin sheath</td>
<td>clot that forms around the end of the central line and grows to encase the lower portion of the line</td>
</tr>
<tr>
<td>French</td>
<td>is a measure that indicates the outside diameter of the catheter measured in millimeters multiplied by three</td>
</tr>
<tr>
<td>gram-positive catheter</td>
<td>a complication of tunnelled catheters, where gram-positive bacteria develop an infection</td>
</tr>
<tr>
<td>tunnel infections</td>
<td></td>
</tr>
<tr>
<td>granulation</td>
<td>healing of a wound</td>
</tr>
<tr>
<td>gauge</td>
<td>is a measure that indicates size of the lumen, smaller number indicates larger size lumen</td>
</tr>
<tr>
<td>guided pericardiocentesis</td>
<td>procedure where fluid is aspirated from the pericardium (the sac enveloping the heart) - generally done under ultrasound guidance</td>
</tr>
<tr>
<td>guidelines</td>
<td>document that aims to streamline particular processes according to a set routine – usually not mandatory</td>
</tr>
<tr>
<td>H2-receptor antagonist</td>
<td>drug used to decrease acid production in the stomach to treat dyspepsia</td>
</tr>
<tr>
<td>haemodialysis</td>
<td>procedure to filter waste products from the blood when the kidneys are malfunctioning</td>
</tr>
<tr>
<td>haemostasis</td>
<td>the arrest of bleeding, either by the physiological properties of vasoconstriction and coagulation or by surgical means</td>
</tr>
<tr>
<td>haematogenous seeding</td>
<td>seeding that is transported in the blood circulation</td>
</tr>
<tr>
<td>haemothorax</td>
<td>accumulation of blood and fluid in the pleural cavity around the lungs</td>
</tr>
<tr>
<td>heparin induced</td>
<td>clots developing throughout the body as a reaction to heparin therapy thought to be caused by the production within the body of antibodies to its own platelets</td>
</tr>
</tbody>
</table>
heparin lock: heparin solution used to lock the CVAD when not in use to prevent occlusions by preventing blood flow back into the catheter, and reduces blood clotting risk if blood backflow occurs.

high acuity patient areas: areas in a health facility caring for acutely unwell patients.

hypercapnia: greater than normal amounts of carbon dioxide in the blood.

hyperosmolar solutions: high number of solutes in solution, expressed in osmoles.

hypoxemia: abnormal deficiency of oxygen in the arterial blood.

iatrogenic: caused by treatment or diagnostic procedures.

immunocompromised: immune response weakened by disease or immunosuppressive agent.

implanted port: this is an implanted access device which allows professional carers to draw blood and make intravenous (or intra-arterial) injections into a patient.

inadvertent administration: accident occurring whilst administering solutions or medications.

incompatible medications or solutions: not capable of being administered together as they interfere with each other.

infiltration: inadvertent administration of non-vesicant solutions or medications into tissues surrounding the catheter.

injection ports and access caps: “bungs” used to cap off devices such as IV cannulae or central venous access device.

integrity: state of being whole/complete.

inter-rater reliability: is the degree of agreement among raters. It gives a score of how much consensus there is in the ratings given by judges.

intrathoracic pressure: pressure into the thorax.
laminar flow | sometimes known as ‘streamline’ flow, occurs when fluid flows in parallel layers, with no disruption between the layers

large bore | large internal diameter

locking | specific technique to instil fluid into CVAD that prevents catheter occlusions by preventing blood flow back into the catheter when the CVAD device is not in use

luer lock design | when the needle and syringe are screwed together, rather than slipped

lumen manipulations | accessing the lumen; changing of injection caps or infusion lines on a lumen of a CVAD

lymphoedema | swelling of the subcutaneous tissues, due to fluid accumulation caused by obstruction of the lymphatic drainage

lyse a clot | decomposing a clot

magnetic resonance imaging (MRI) | medical imaging using magnetic fields

maintenance procedures | procedures such as flushing and exit sit cares to reduce the risk of complications

malposition | wrong or faulty placement

mechanical obstructions | obstructions caused by clamps, kinks, clots

meta-analysis | a quantitative method of combining the results of independent studies (usually drawn from the published literature) and synthesizing summaries and conclusions which may be used to evaluate therapeutic effectiveness or to plan new studies

multiple-lumen catheters | catheter with many lumens

mural thrombus | clot built along the wall of the vein

negative pressure | vacuum

neutropenia | leucopenia in which the decrease in white blood cells is chiefly in neutrophils

non-coring needle | needle designed in such a way that it does not take a core of the material as it is inserted
<table>
<thead>
<tr>
<th>Term</th>
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</thead>
<tbody>
<tr>
<td>non-tunnelled devices</td>
<td>the catheter emerges from the skin at the site of entry into the vein</td>
</tr>
<tr>
<td>nosocomical</td>
<td>resulting from being treated in a hospital</td>
</tr>
<tr>
<td>occlusion</td>
<td>the act of closure or state of being closed- a blockage in the catheter</td>
</tr>
<tr>
<td>occlusive dressing</td>
<td>a dressing that hermetically seals a wound</td>
</tr>
<tr>
<td>parenteral nutrition</td>
<td>nutrition given directly into the bloodstream</td>
</tr>
<tr>
<td>patency</td>
<td>open – unobstructed</td>
</tr>
<tr>
<td>percutaneous</td>
<td>performed through the skin</td>
</tr>
<tr>
<td>pericardial</td>
<td>membrane surrounding the heart</td>
</tr>
<tr>
<td>peripheral vasculature</td>
<td>veins and arteries in the arms and legs, skin</td>
</tr>
<tr>
<td>phlebitis</td>
<td>inflammation of a vein</td>
</tr>
<tr>
<td>pinch-off syndrome</td>
<td>compression of the catheter by the clavicle and the first rib</td>
</tr>
<tr>
<td>pneumothorax</td>
<td>a collapse of the lung due to an abrupt change in the intrapleural pressure within the chest cavity; symptoms include shortness of breath and severe, one-sided (affected side) chest pain on inhalation</td>
</tr>
<tr>
<td>polyurethane</td>
<td>plastic material used in manufacturing some CVADs</td>
</tr>
<tr>
<td>policy</td>
<td>a plan of action to guide decisions and actions</td>
</tr>
<tr>
<td>positive pressure lock technique</td>
<td>maintaining pressure on the syringe plunger whilst clamping the CVAD line and before removing the syringe from the CVAD cap - prevents blood flow back into the catheter and subsequent thrombus formation and catheter occlusion</td>
</tr>
<tr>
<td>procedure</td>
<td>a series of steps taken to accomplish an end</td>
</tr>
<tr>
<td>professional standards</td>
<td>guides for practicing in the profession – e.g. Code of Ethics for Nursing</td>
</tr>
</tbody>
</table>
progenitor blood cells: original cells in the bone marrow which replicate and mature to become blood cells such as haemoglobin, leucocytes and platelets; also called stem cells.

proximal: near.

pulmonic valve: the semilunar valve of the heart that lies between the right ventricle and the pulmonary artery and has three cusps.

radio-opaque: able to be seen on X-ray.

ramifications: consequences – result.

scope of practice: defines the procedures, actions, and processes that are permitted for the licensed individual. The scope of practice is limited to that which the individual has received education and clinical experience, and in which competency has been demonstrated.

securement devices: sutures or devices used to hold the CVAD in place.

Seldinger technique: a method of percutaneous insertion of a catheter into a blood vessel: a needle is used to puncture the structure and a guide wire is threaded through the needle; when the needle is withdrawn, a catheter is threaded over the wire; the wire is then withdrawn, leaving the catheter in place.

semi-permeable dressing: a dressing that enables moisture to evaporate through it.

silicone: a rubber that is fairly resistant to heat and is longer lasting.

subcutaneous pocket: pocket created under the skin in which to insert the implanted port.

staggered tip catheters: lumens exit sites are at differing sites along the catheter.

stylet: a stiff wire, inserted in catheters or other tubular instruments to maintain their shape and prevent clogging.

superior vena cava: the major venous channel draining the thorax and head which ends in the right atrium.

surgical cutdown: procedure where the tissues are surgically opened to enable access to underlying structures.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>systematic review</td>
<td>a literature review focused on a single question which tries to identify, appraise, select and synthesise all high quality research evidence relevant to that question</td>
</tr>
<tr>
<td>thrombocytopenia</td>
<td>a decrease in the number of platelets in the blood, resulting in the potential for increased bleeding and decreased ability for clotting</td>
</tr>
<tr>
<td>thrombolytic agent</td>
<td>medications that dissolve blood clots</td>
</tr>
<tr>
<td>thrombosis</td>
<td>the formation, development or presence of a thrombus</td>
</tr>
<tr>
<td>tissue necrosis</td>
<td>tissue death</td>
</tr>
<tr>
<td>tissue plasminogen activator (tPA)</td>
<td>used to dissolve clots</td>
</tr>
<tr>
<td>titanium</td>
<td>metallic alloy that is fairly unreactive, used in devices inserted into the human body</td>
</tr>
<tr>
<td>traction</td>
<td>a weight applied to pull on an object</td>
</tr>
<tr>
<td>transoesophageal echocardiogram (TOE)</td>
<td>specialised scope containing an echocardiography transducer inserted into the patient’s esophagus, to take ultrasound images of the heart</td>
</tr>
<tr>
<td>Trendelenburg position</td>
<td>a supine position on the operating table, which is inclined at varying angles so that the pelvis is higher than the head with the knees flexed and legs hanging over the end of the table</td>
</tr>
<tr>
<td>tunnelled catheter</td>
<td>a section of the catheter is positioned in a subcutaneous tunnel, providing a distance between the entry into the vein and the exit site on the skin; the tunnel acts as a barrier to invading microbes and to secure the catheter</td>
</tr>
<tr>
<td>tumour lysis syndrome</td>
<td>breakdown of tumour cells resulting in electrolyte imbalances which may lead to multi-organ failure and cardiac arrest if left untreated</td>
</tr>
<tr>
<td>turbulent flow</td>
<td>irregular motion of the layers within moving fluid; in CVAD flushing produced by pressing the syringe plunger with a push/pause motion</td>
</tr>
<tr>
<td>ultrasound</td>
<td>a type of imaging technique which uses high-frequency sound waves</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<tr>
<td>validated</td>
<td>able to be confirmed – especially with trials where the study is able to be repeated by other researchers to obtain the same results</td>
</tr>
<tr>
<td>Valsalva manoeuvre</td>
<td>a manoeuvre elicited by bearing down for the purpose of decreasing venous blood return to the right side of the heart</td>
</tr>
<tr>
<td>vascular access device</td>
<td>a device that accesses the peripheral or central vasculature</td>
</tr>
<tr>
<td>venepuncture</td>
<td>a technique where a needle is inserted into a vein to take blood specimens</td>
</tr>
<tr>
<td>venous spasm</td>
<td>cramping of muscles in vein walls causing pain, and sometimes shutdown of venous flow. Warmth may help relieve the spasms</td>
</tr>
<tr>
<td>vesicant</td>
<td>a drug which, if extravasated, is capable of causing tissue necrosis</td>
</tr>
<tr>
<td>viability</td>
<td>patent – able to be used</td>
</tr>
<tr>
<td>vital signs</td>
<td>observations such as pulse, respiration rate, temperature, blood pressure</td>
</tr>
</tbody>
</table>
### APPENDIX 3:
Cancer Nurses Society of Australia
Central Venous Access Device Competency Assessment Tool

**Theoretical aspects**

<table>
<thead>
<tr>
<th>Describes</th>
<th>Met</th>
<th>Not Met</th>
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</thead>
<tbody>
<tr>
<td>• the venous access devices used in oncology/haematology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• the rationale for use of these devices</td>
<td></td>
<td></td>
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<tr>
<td>• the general anatomy related to CVADs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• the assessment criteria for selection of devices</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• complications of CVADs and signs and symptoms of these complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• strategies to manage complications related to CVADs</td>
<td></td>
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</tbody>
</table>

**Demonstrates**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>• patient education: pre- and post-CVAD insertion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• decision making when complications evident</td>
<td></td>
<td></td>
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<tr>
<td>• Identifies quality improvement processes</td>
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</tbody>
</table>

**Care Of The External Catheter**

<table>
<thead>
<tr>
<th>Accessing the Device</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Prepares the patient – explanation and positioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Reviews any patient concerns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Performs hand wash</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Prepares appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Performs assessment of the external device or location of the implanted port</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Performs hand wash</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Maintains strict aseptic technique</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cleanses injection cap appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Clamps catheter for access (unless device has a valved tip)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Accesses catheter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Assesses patency with flush or by commencing intravenous fluids as prescribed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Secures device appropriately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Documents procedure, outcomes for patient and device</td>
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</tbody>
</table>

**Injection cap change**

<table>
<thead>
<tr>
<th></th>
<th>Met</th>
<th>Not Met</th>
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<tbody>
<tr>
<td>• Prepares the patient – explanation and positioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Performs hand wash</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Prepares appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Washes hands</td>
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</tbody>
</table>
- Dons sterile gloves
- Cleanses injection cap and around base
- Considers processes to reduce exposure to air – clamps catheter or asks patient to perform valsalva manoeuvre
- Removes injection cap and discards
- Applies sterile injection cap
- Demonstrates knowledge of appropriate time intervals for injection cap changes
- Documents procedure, outcomes for patient and device

### Exit site care

<table>
<thead>
<tr>
<th>Met</th>
<th>Not Met</th>
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</tbody>
</table>

- Prepares the patient – explanation and positioning
- Reviews any patient concerns
- Performs hand wash
- Prepares appropriate equipment
- Performs hand wash
- Dons clean gloves
- Removes old dressing without touching exit site
- Removes gloves and discards
- Dons sterile gloves
- Cleans exit site
- Cleans catheter length
- Assesses exit site for signs of infection and takes appropriate action
- Assesses catheter for signs of damage and takes appropriate action
- Applies dressing
- Documents procedure, status of the exit site, actions taken, and outcomes for patient

### Locking catheters

<table>
<thead>
<tr>
<th>Met</th>
<th>Not Met</th>
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<tbody>
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</tbody>
</table>

- Prepares the patient – explanation and positioning
- Prepares appropriate solution for flushing and locking catheter
- Follows procedure for accessing catheter
- Flushes catheter using appropriate technique
- Documents procedure, outcomes for patient and device

### Documentation and patient education

<table>
<thead>
<tr>
<th>Met</th>
<th>Not Met</th>
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</table>

**Documents:**
- all procedures undertaken
- any changes in patient status or concerns
- actions implemented

Informs appropriate personnel if complications identified or suspected

**Educates patient and family about:**
- CVAD care and assessment
- When to report concerns to healthcare professionals

### Accessing implantable devices

<table>
<thead>
<tr>
<th>Met</th>
<th>Not Met</th>
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</tbody>
</table>

- Prepares the patient – explanation and positioning
- Reviews any patient concerns
- Performs hand wash
- Assesses the location and stability of the implanted port
- Assesses the site for complications
- Performs hand wash
- Prepares appropriate equipment
- Performs hand wash and dons sterile gloves
- Cleanses the area over the port body using a circular outward moving motion
- Secures the port body and pushes the non-coring needle into the port septum until it reaches the port base.
- Assesses patency of the port by flushing with sterile 0.9% sodium chloride solution and checking for blood return
- Applies dressing as per facility policy
- Attaches infusion or injection cap as required for treatment
- Changes non-coring needle, add-ons and dressing each 7 days (if continuous infusion)
- Documents procedure and any changes in patient status or concerns

### Accessing implantable devices

<table>
<thead>
<tr>
<th>Met</th>
<th>Not Met</th>
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</table>

- Prepares the patient – explanation and positioning
- Performs hand wash
- Prepares appropriate equipment
- Follows procedure for accessing catheter
- Flushes and locks lumen/s using appropriate technique
- Dons clean gloves
- Removes dressing and assesses site – discards gloves and dressing
- Performs hand wash and dons sterile gloves
- Stabilises the port with one hand, grasps non-coring needle hub with the dominant hand
- Pulls needle from port while firmly stabilising the portal body (Uses a technique that protects from needle stick injury)
- Applies pressure at site and applies a dressing as required
- Discards all waste appropriately
- Documents procedure and any changes in patient status or concerns

### Drawing blood from CVADs (using discard method)

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<th>Met</th>
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</table>

- Identify patient against name on pathology request
- Prepares the patient – explanation and positioning
- Follows procedure for accessing the CVAD
- Removes 5ml of blood and discards
- Clamps catheter at appropriate times
- Withdraws blood volume required
- Flushes catheter with 10 – 20 ml 0.9% sodium chloride solution
- Assesses catheter for patency
- ‘Locks’ lumen or re-establishes intravenous fluids as ordered
- Correctly labels pathology tubes after blood collection
- Documents concerns related to blood withdrawal or flushing
### Removal of non-tunnelled CVAD

<table>
<thead>
<tr>
<th>Step</th>
<th>Met</th>
<th>Not Met</th>
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</thead>
<tbody>
<tr>
<td>• Verify order for catheter removal</td>
<td></td>
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<tr>
<td>• Note length of catheter on insertion</td>
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<td></td>
</tr>
<tr>
<td>• Prepares the patient – explanation and positioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Performs hand wash</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Prepares appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Dons clean gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Removes dressing, assesses site and discards gloves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Performs hand wash and dons sterile gloves</td>
<td></td>
<td></td>
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<tr>
<td>• Cleanse exit site</td>
<td></td>
<td></td>
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<tr>
<td>• Remove catheter at the same angle of insertion, parallel to the skin, using a gentle tension. (When removing a PICC, grasp at the insertion site and withdraw about 5cm, release and grasp again at the insertion site – continue in short increments)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Send tip for culture if catheter removed due to infection</td>
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<td></td>
</tr>
<tr>
<td>• Apply constant firm pressure to exit site until bleeding stops</td>
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<td></td>
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<tr>
<td>• Apply air-tight dressing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Inspect device for appropriate length or defects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Advise patient and family to report: any discomfort, bleeding, swelling or discharge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Document procedures and any changes in patient status or concerns</td>
<td></td>
<td></td>
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<tr>
<td>• Informs appropriate personnel if complications identified or suspected</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Demonstrates knowledge of problems with removal and strategies to ameliorate e.g. venospasm, catheter fracture and thrombosis.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Management of occluded catheter using a fibrinolytic agent

<table>
<thead>
<tr>
<th>Step</th>
<th>Met</th>
<th>Not Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Prepares the patient – explanation and positioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Follows procedure for accessing the CVAD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Assesses CVAD function to identify ability to withdraw blood or infuse fluids (partial or complete occlusion)</td>
<td></td>
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</tr>
<tr>
<td>• Discounts mechanical causes for occlusion e.g. malpositioning of catheter against vessel wall, clamps closed, catheter kinked, port needle positioned incorrectly.</td>
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<tr>
<td>• Assesses possible causes for catheter occlusion e.g. formation of precipitate or interaction of incompatible solutions</td>
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<td></td>
</tr>
<tr>
<td>• Discusses occlusion with medical practitioner and verifies order for fibrinolytic agent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Demonstrates knowledge of adverse effects of fibrinolytic agent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Demonstrates decision-making regarding techniques for instilling fibrinolytic agent into occluded catheter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Gathers all appropriate equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Follows procedure for accessing the CVAD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Demonstrates technique for instilling fibrinolytic agent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Administers fibrinolytic agent in the appropriate volume into the occluded lumen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Assesses the patient for adverse effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Labels lumen to ensure other staff are aware that fibrinolytic agent is instilled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Removes the fibrinolytic agent after appropriate time interval</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Assess the patency of the lumen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Flushes lumen with 10 – 20 ml 0.9% sodium chloride solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Assesses patient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Documents procedure, outcomes for patient and device</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX 4:
Cancer Nurses Society of Australia
Algorithm for Selection of Central Venous Access Device

CONSIDER:
- the reason access is required
- the duration of therapy
- where the therapy is administered
- the therapy to be administered
- patient assessment
- patient preferences
- patient lifestyle
- patient’s level of support

Infusion of intermittent drug therapy eg. Chemotherapy
- Inpatient or outpatient setting
  - Are drugs/infusate appropriate for a peripheral line?
    - YES: Peripheral cannula
    - NO: PICC

Infusion of continuous treatment eg. Chemotherapy (days only)
- Outpatient setting (generally)
  - Are drugs/infusate appropriate for a peripheral line?
    - YES: PICC
    - NO: PICC

Access for collection of peripheral progenitor blood cell only, cell reinfusion or therapeutic apheresis
- Inpatient setting (generally)
  - Are drugs/infusate appropriate for a peripheral line?
    - YES: Peripheral cannula
    - NO: Non-tunnelled double-lumen catheter suitable for apheresis

Access in an emergency/urgent situation eg. Central venous pressure monitoring or if poor peripheral access
- Inpatient setting
  - Non-tunnelled multi-lumen central venous line
Algorithm for Selection of Central Venous Access Device (Part 2)

**CONSIDER:**
- the reason access is required
- the duration of therapy
- where the therapy is administered
- the therapy to be administered
- patient assessment
- patient preferences
- patient lifestyle
- patient’s level of support

**Intermittent chemotherapy treatment (weeks to months)**
- Treatment administered and completed in the outpatient ambulatory care setting

**Long term antibiotics via infusion pump (weeks)**
- Treatment may be delivered while the patient is at home

**Continuous infusion of treatment (weeks) e.g. Chemotherapy**
- Treatment generally delivered while the patient is at home

**Long term treatment (many months) that is unlikely to cause prolonged nadir**
- Part of the treatment may be delivered while the patient is at home

**Long term treatment (many months) that is likely to cause prolonged nadir**
- Part of the treatment may be delivered while the patient is at home

**Are drugs/infusate appropriate for a peripheral line?**

**YES**
- Adequate peripheral access

**NO**
- Peripheral cannula

**Tunneled multi-lumen catheter**
- PICC or Port
## APPENDIX 5:
Cancer Nurses Society of Australia
CVAD Complications: Signs, symptoms and risk factors

<table>
<thead>
<tr>
<th>Problem</th>
<th>Signs and Symptoms</th>
<th>Risk Factors</th>
<th>Common Organisms</th>
</tr>
</thead>
</table>
| **Local Infection** | • Redness, swelling and tenderness/pain at the insertion site, port pocket or the catheter tunnel  
• fever without and obvious source (O’Grady et al. 2002)  
• cellulitis or exudate (Dougherty, 2006)  
• signs and symptoms may be subtle in the immunocompromised patient (Camp-Sorrell, 2004) | Patient specific variables which may increase risk of infection:  
• Age (<1 and >60 years)  
• Immune status  
• Severity of the underlying illness  
• Other co-morbidities  
• Presence of other sites of infection. (Rosenthal, 2004; O’Grady et al. 2002) | The most commonly occurring organisms (Dougherty, 2006; O’Grady et al. 2002)  
• Coagulase-negative staphlococci  
• Staphlococci aureus (Methicillin resistant and sensitive)  
• Enterococcus species  
• Candida species  
• Klebsiella species  
• Enterobacter species |
| **Systemic Infection**  
(Bacteremia; catheter related blood stream infection / CR-BSI) | Low grade temperature  
- Fever, chills, rigors, tachycardia, hypotension, shortness of breath, tachypnoea, nausea/ vomiting, diaphoresis, and altered mental state (Rosenthal, 2004; Jones, 1998). | Other factors which may increase risk of infection:  
• The type of device – number of lumens and catheter material e.g. silicone is more likely to be contaminated with staphylococcus aureus (Dougherty, 2006)  
• The method of insertion – the need for emergency access may have compromised infection control practices (O’Grady et al. 2002)  
• The site of insertion (O’Grady et al. 2002)  
• The type of fluid being infused e.g. TPN (Chang et al. 2003) |
<table>
<thead>
<tr>
<th>Problem</th>
<th>Signs and Symptoms</th>
<th>Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>CVAD Occlusion</td>
<td>• Inability to aspirate blood</td>
<td>• Patients with certain malignancies that cause hypercoagulopathies (e.g. adenocarcinoma of the lung) (Kuter, 2004; Perdue, 2001)</td>
</tr>
<tr>
<td></td>
<td>• Resistance to flushing</td>
<td>• Practitioners who have had little or no education and clinical training in the use of CVADs (CNSA CVAD working group)</td>
</tr>
<tr>
<td></td>
<td>• Sluggish infusion</td>
<td>• Poor flushing technique (Dougherty, 2006)</td>
</tr>
<tr>
<td></td>
<td>• Inability to infuse/ or flush</td>
<td>• Insufficient flushing fluid used or frequency of flushing (Dougherty, 2006)</td>
</tr>
<tr>
<td></td>
<td>• Increasing alarm activation on infusional device</td>
<td>• Inadequate flow of fluids through the lumen or the fluids have been stopped or run dry (Dougherty, 2006)</td>
</tr>
<tr>
<td></td>
<td>• Swelling in chest wall during infusion</td>
<td>• Stopping the administration of fluids without flushing the catheter (Dougherty, 2006)</td>
</tr>
<tr>
<td></td>
<td>• Leakage at the catheter exit site</td>
<td>• Reflux of blood into the catheter due to coughing, heavy lifting, congestive heart failure (Dougherty, 2006)</td>
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<tr>
<td></td>
<td>• Pain or burning with infusion in the neck, shoulder or chest</td>
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<tr>
<td></td>
<td>• Development of milky looking fluid within IV tubing/ IV fluids</td>
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<td></td>
<td>• Presence of visible clots in IV tubing</td>
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<td></td>
<td>(Bagnall- Reeb, 1998; Gorski, 2003)</td>
<td></td>
</tr>
<tr>
<td>Venous Thrombosis</td>
<td>The patient may present with the following signs and symptoms:</td>
<td>Certain patients are at higher risk of developing a thrombosis:</td>
</tr>
<tr>
<td></td>
<td>• Swelling of the neck, face, arm, or supra- clavicular area</td>
<td>• Patients with certain types of malignancies e.g. Adenocarcinoma lung (Kuter, 2004; Perdue 2001)</td>
</tr>
<tr>
<td></td>
<td>• Chest, neck, jaw arm or leg pain</td>
<td>• Patients with hypercoagulopathies (Kuter, 2004; Perdue 2001)</td>
</tr>
<tr>
<td></td>
<td>• Headache</td>
<td>• Patients who are immobile (Perdue 2001)</td>
</tr>
<tr>
<td></td>
<td>• Numbness and erythema of the affected extremity</td>
<td>• Patients who have venous compression by the cancer (Perdue 2001)</td>
</tr>
<tr>
<td></td>
<td>• Claudication in limb, hand, foot</td>
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<tr>
<td></td>
<td>• Venous distension</td>
<td>Other factors include:</td>
</tr>
<tr>
<td></td>
<td>(Kuter, 2004; Smith, 1998)</td>
<td>• CVAD dwell time (Knutstad et al. 2003)</td>
</tr>
<tr>
<td></td>
<td>CVAD function may also be affected leading to (Kuter, 2004; Smith, 1998):</td>
<td>• CVAD composition i.e. polyurethane versus silicone (Kuter, 2004)</td>
</tr>
<tr>
<td></td>
<td>• Leakage from the CVAD exit site</td>
<td>• CVAD placement with tip in distal SVC or brachiocephalic veins (Kuter, 2004; Knutstad et al. 2003)</td>
</tr>
<tr>
<td></td>
<td>• Poor flow rates via infusional pump</td>
<td>• Higher number of catheter lumens (Kuter, 2004)</td>
</tr>
<tr>
<td></td>
<td>• Resistance upon flushing</td>
<td>• Infusion of sclerosing agents (Kuter, 2004)</td>
</tr>
<tr>
<td></td>
<td>• Inability to aspirate blood via lumen/s</td>
<td>• Infusion of hyperosmolar solutions i.e. TPN</td>
</tr>
<tr>
<td></td>
<td>• Complete occlusion</td>
<td>• Improper maintenance (Mayo, 2001)</td>
</tr>
<tr>
<td>Problem</td>
<td>Signs and Symptoms</td>
<td>Risk Factors</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Air Embolus</strong></td>
<td>The larger the embolus the more severe the signs and symptoms; which may include:</td>
<td>Risk factors include:</td>
</tr>
<tr>
<td></td>
<td>• Dyspnoea</td>
<td>• Larger sized CVAD lumen</td>
</tr>
<tr>
<td></td>
<td>• Chest pain</td>
<td>• Patient’s position during procedure (sitting upright causes lower intravascular pressure)</td>
</tr>
<tr>
<td></td>
<td>• Tachycardia</td>
<td>• Deep inspiration by the patient (coughing, laughing, sneezing, vomiting) causing lower</td>
</tr>
<tr>
<td></td>
<td>• Cyanosis</td>
<td>intravascular pressure during CVAD insertion/ removal, line change.</td>
</tr>
<tr>
<td></td>
<td>• Thready pulse</td>
<td>• Presence of a persistent catheter tract after CVAD removal.</td>
</tr>
<tr>
<td></td>
<td>• Hypotension</td>
<td>• Failure to use an occlusive dressing over the CVAD removal site.</td>
</tr>
<tr>
<td></td>
<td>• Nausea</td>
<td>(Rosenthal, 2006; Brown, 2005; Andrews, 2002; Masoorli, 1999)</td>
</tr>
<tr>
<td></td>
<td>• Syncope</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Confusion</td>
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<tr>
<td></td>
<td>• “Cog-wheel” murmur over pericardium</td>
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<tr>
<td></td>
<td>• Decreased level of consciousness</td>
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</tr>
<tr>
<td></td>
<td>• Seizures</td>
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<td>(Rosenthal, 2006; Andrews, 2002; Masoorli, 1999)</td>
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<td><strong>Infiltration / Extravasation</strong></td>
<td>• Pain, tenderness or burning at the insertion site, along the catheter tunnel, which may develop to erythema or oedema (Hamilton, 2006). Consider patient’s position - if the patient is lying down a dependent site may swell (Wickham et al. 2006).</td>
<td>• Development of fibrin sheath at tip and along external segment of the catheter (Knutstad et al. 2003)</td>
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<td>• Absence of free flow when administered by infusion (Dougherty, 2006; Hamilton, 2006)</td>
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<td>• Aspiration difficulties (Dougherty, 2006)</td>
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<td>• Resistance on the plunger if the drugs are given as a bolus (Dougherty, 2006)</td>
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<td>• Leakage at port needle (CNSA CVAD working group)</td>
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<td>• Necrosis may occur two weeks after the extravasation (Hamilton, 2006)</td>
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<td>Problem</td>
<td>Signs and Symptoms</td>
<td>Risk Factors</td>
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| **Cardiac Tamponade** | Early signs and symptoms include:  
- Dyspnoea  
- Tachycardia  
- Hypotension  
- Chest pain  
- Syncope  
- Fatigue  
- Respiratory distress  
                                          (Garden & Laussen, 2004)  
|                      | Late signs and symptoms include:  
- Distended neck veins  
- Shock  
- Anuria  
- Agitation and restlessness  
- Muffled heart sounds  
- Pulsus paradoxus  
- Respiratory failure  
                                          (Garden & Laussen, 2004)  
|                      | Risk factors include:  
- Patients health status  
- Patients on anticoagulant therapy  
                                          (RCN, 2005)  

| **Dysrhythmias**      | Abnormal cardiac rhythms  
- Shortness of breath  
- Anxiety  
- Chest discomfort  
                                          (Czepizak et al. 1995)  
|                      | Patients with hobbies or employment that requires strenuous upper extremity movements  
                                          (Camp-Sorrell, 2004; Hadaway, 1998)  

| **CVAD tip migration**| Partial occlusion  
- Sensation in the patient’s neck when the device is being flushed.  
Most CVAD tip malpositions/ migrations are diagnosed on CXR/ venograms preformed due to CVAD malfunction.  
- (Hadaway, 1998; Knutstad et al. 2003)  
<p>|</p>
<table>
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<tr>
<th>Problem</th>
<th>Signs and Symptoms</th>
<th>Risk Factors</th>
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</table>
| Catheter Fracture / Embolisation | • Dyspnoea (Andris & Krzywda, 1999; Hadaway, 1998)  
• Cough (Dougherty, 2006)  
• Light-headedness (Andris & Krzywda, 1999; Hadaway, 1998).  
• Tachypnoea (Andris & Krzywda, 1999; Hadaway, 1998)  
• Arrhythmias (Camp-Sorrell, 2004)  
• Hypotension (Andris & Krzywda, 1999; Hadaway, 1998).  
• Extra heart sound (Camp-Sorrell, 2004)  
• Chest pain (Dougherty, 2006)  
• Anxiety (Andris & Krzywda, 1999; Hadaway, 1998).  
• Extravasation (Camp-Sorrell, 2004)  
• Incomplete catheter on removal (Macklin & Chernecky, 2004) | Patients experiencing pinch-off syndrome  
(Dougherty, 2006; Hamilton, 2006; Camp-Sorrell, 2004) |
References for Appendix 5


Smith JP. (1998), Thrombotic complications in intravenous access. Journal of Intravenous Nursing
