CENTRAL VENOUS ACCESS DEVICES (CVAD)

PRACTICE GUIDELINE ©

KEY POINTS

Note: Medical staff who have completed an education and training program may insert a CVAD.

Accessing and clinical management of CVADs can only be performed by accredited Nursing staff and Medical staff who have undergone appropriate SCHN education.

- See specific guidelines for:
  - Peripheral Cannula and Central Venous Catheters in Neonates – GCNC - CHW
  - Haemodialysis and Plasma Exchange: Managing Catheter Access - CHW
  - Vascular Access Catheters: Insertion & Management of Temporary Vascaths - SCH
- Before committing to CVAD insertion, the clinician must balance the risks and advantages. Femoral catheters should be avoided due to the risk of infection.
- CVAD placement must be confirmed and documented before a CVAD is used.
- Although CVADs may be used for blood collection, venepuncture or finger prick blood sampling should be utilised wherever possible to minimise the frequency of CVAD access.
- Once CVAD is connected to an IV infusion set, the infusion set should be routinely changed no more frequently than 96 hours for patients not receiving blood products or fat emulsions.
- Disconnected IV infusion sets must be discarded and not (1) reconnected at a later time or (2) reconnected to the alternate lumen.
- Transparent semi-permeable polyurethene dressing or alternate dressing must be used for securement.
- **Preventing CVAD occlusion**: Flush with at least 10mL 0.9% sodium chloride using **pulsating technique** following the administration of medications, collection of blood samples or prior to connecting IV infusion sets.
- Heparinise saline lock using **positive pressure** technique. Performed by accredited nursing staff only, or by medical staff that has received appropriate education.
- Flush with a compatible solution before and between medication administrations to prevent precipitation and occlusion.
- All access points must be **vigorously cleaned** with 2% Chlorhexidine in 70% alcohol

Approved by:	SCHN Policy, Procedure and Guideline Committee	
Date Effective:	3rd July 2017	**Review Period**: 3 years
Team Leader:	CNS2 Vascular Access [CHW and SCH]	**Area/Dept**: Surgical & Anaesthetics Program

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swab for **minimum 15-30seconds** and allowed to dry before connection, disconnection and administering medications.

- **Periodic assessment** [minimum of two years] of nursing staff knowledge should take place to ensure competence is maintained.
- Parents require suitable education, training and assessment in maintaining the CVAD in the home environment prior to discharge.

CHANGE SUMMARY

The CVAD Manual has been endorsed by SCHN Vascular Access Governance Committee to be rolled out across SCHN. All facility specific documents pertaining to CVAD insertion and management have been rescinded.

As time will be required to implement some of the changes, the date effective where full implementation it is expected [and therefore compliance with this document] is 1st May 2017.

- Updated links throughout the document.
- Terminology: IVAD/TID – for simplicity, now referred to colloquially as “Port”. [NB: portacath is a brand-name and should not be used]
- Update information about the new neutral displacement Needless connectors.
- ALL extension sets and IV infusion sets need to be changed up to 96 hours (or as per special consideration for specific medications, parenteral nutrition and blood products).
- 3 ways taps are only to be used in ICU for vasoactive infusions, wards are to use extension pieces with split septum valves. [SN 002/15 and NSW MoH PD2011_060]
- Updated the section on removal of CVADs as per SN004/14.
- Standardised consumables, such as needleless connectors, across SCHN.
- Standardised agent for clearing thrombotic occlusions to alteplase.
- Heparinised saline concentration has been reviewed and confirmed to be 10Units/mL.
- CVAD training and assessment will be using the Cancer Institute CVAD Module.
- Standard aseptic technique education through HETI.
- Addition of section 3.8: Determining internal volume (deadspace) of a CVAD
- **May 2017:** minor review to address minor issues such as grammatical errors etc.
- **June 2017:** added a note in section 3.3 about vasoactive infusions and NADs; Section 4.4 updated with aqueous 0.1% Chlorhexidine Irrigation Solution for skin cleansing for patients under 3 months; p22, update information in dot point under Picture 5.

READ ACKNOWLEDGEMENT

Training/Assessment required by Registered Nurses for:

- Complete **CVAD Accreditation package** via the Cancer Institute online eLearning: https://education.eviq.org.au/courses/central-venous-access-devices
- Complete the **HETI online 'Aseptic Technique'** [HETI code: 40027445] and '**Invasive Device Protocols'** [HETI code: 42364545] training.
- Accreditation for clinical management.
- Advanced skill accreditation and procedures:
  - repair tunnelled CVCs
  - clearing thrombotic occlusions in CVADs
- Additional education and training is required for identified RNs responsible for sterilising an infected CVAD with antibiotic lock or ethanol lock and removal of non-tunnelled CVCs, uncuffed tunnelled CVCs [CHW only], Midlines and PICCs.

Training/Assessment required by Endorsed Enrolled Nurses for:

- Administration of medication via CVAD

Nursing staff returning from leave for up to 12 months or greater must re-do CVAD competency assessments with CNE/NE or CVAD accredited assessor.

Training/Assessment required by Medical staff for:

- Complete the HETI online 'Aseptic Technique' and 'Invasive Devices' training
- Insertion: Clinicians without prior paediatric experience of CVAD insertion must complete a training program consistent with NSW Ministry of Health Central Line Education and Training Framework. Untrained clinicians must be supervised by supervising Surgeon / Interventional Radiologist or Anaesthetic consultant when inserting a CVAD.
- JMOs accessing CVADs
- Registrars and Fellows who are clearing blocked tunnelled CVAD
- Registrars and Fellows sterilising tunnelled CVCs with ethanol or hydrochloric acid.

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Glossary

Standard Aseptic Technique	refers to the identification of 'key parts' of the CVAD and infusion set, not touching them either directly or indirectly. This is the single most important step in achieving asepsis.
Key parts	Refers to the parts of the CVAD that should never be touched, doing so will compromise the aseptic technique and increase the risk of infection. **Examples of Key parts include: Hubs of CVADs, needless connectors and extension sets, needle and syringe tips, and tips of IV infusion sets and dressings.**
Breaking the closed system	Refers to any instance when the integrity of the CVAD and IV infusion set is compromised or the CVC catheter hub is exposed.
Closed System	IV administration system with no mechanism for external entry after initial set-up & assembly.
CVAD	**C**entral **V**enous **A**ccess **D**evice. Overall term that refers to CVC (tunnelled and non-tunnelled) PICC and Port. CVAD is an intravascular device whose catheter tip is situated in the superior vena cava, inferior vena cava or right atrium.
CVC	**C**entral **V**enous **C**atheter: Has a skin entry point in the neck or trunk and whose catheter tip is situated in the superior/inferior vena cava or right atrium. These CVCs can either be classified as tunnelled, non-tunnelled or Cuffed or Uncuffed. Refer to page 7.
Hub	External end of the CVC
Intravenous (IV) Infusion Set	An intravenous infusion set refers to the use of a burette, infusion sets and extension tubing.
Port	**I**mplantable **V**enous **A**ccess **D**evice or **T**otally **I**mplantable **D**evice (IVAD) or Totally Implantable Device (TID), otherwise more commonly known as ports or portacath (type of CVAD). The term "Port" will be used for the remainder of document. Refer to page 7.
Midline	Medium length venous line for short term use. A Midline is a 5cm or 8cm long vascular catheter that is inserted peripherally into the basilic, cephalic or brachial vein using ultrasound guidance. The tip of the catheter lies in the axillary vein and does not extend beyond the axilla. Midlines can also be inserted into the long saphenous vein at the ankle, but this is less common.
PICC	**P**eripherally **I**nserted **C**entral **C**atheter. Has a skin entry point in the upper arm or lower leg and is advanced through to the central circulation.
Positive Pressure Technique	Refers to a technique that is required during heparinised saline locking procedures. While instilling the heparin the operator should clamp the CVAD off while instilling the last amount of fluid in the syringe. This creates a positive pressure within the CVAD and prevents backflow of blood into the catheter tip and subsequent thrombus formation.
Pulsating Action Technique	Pulsating action refers to flushing a CVAD using a pulsing (push-pause-push) motion following the administration of medications, collection of blood samples, and prior to connecting IV infusion sets. This creates turbulence in the catheter lumen assisting the prevention of fibrin sheath formation and drug precipitation.
rTPA / alteplase	**r**ecombinant **T**issue **P**lasminogen **A**ctivator or also known as alteplase
Standard Precautions	Apply to: blood and blood products (including dried blood), all body substances, secretions and excretions (excluding sweat) regardless of whether or not they contain visible blood, non-intact skin and mucous membranes including eyes. Are designed to reduce the risk of transmission of micro-organisms from both recognised and unrecognised sources of infection in health organisations. Involve the use of safe work practices and protective barriers including: hand hygiene, appropriate use of gloves, appropriate use of Personal Protective Equipment (PPE) (e.g. gowns & masks) and appropriate device handling.
Needleless connector device (NAD)	Luer activated needleless connector or needleless access device. These devices are also known as valves or bungs. NAD will be used for the remainder of the document.

1 Introduction to Central Venous Access Devices (CVADs)

1.1 What is a CVAD?

A Central Venous Access Device (CVAD) is an intravascular device whose catheter tip is situated in the superior vena cava, inferior vena cava or right atrium. Central veins within the thorax are utilised to insert CVADs as they are in direct continuity with the right atrium[1].

> **Note:** The catheter tip of a Midline is not situated in a central vein within the thorax; therefore it is not classified as a CVAD for the purposes of medication administration. However the clinical management of a Midline is the same as a CVAD.

The goals in the clinical management of CVAD are:

- maintenance of catheter patency,
- prevention of catheter and tunnel infection,
- avoidance of dislodgment or displacement of the catheter.

1.1.1 CVAD types[2]

1. **Peripherally inserted Central Venous Catheters (PICCs) for short term use**.

Peripherally inserted central catheters (PICCs) are inserted in the basilic, brachial or cephalic vein in the upper arm and advanced through to the central circulation. Some neonates have a PICC inserted into the long saphenous vein at the ankle. The exit site for PICCs is directly above the entry into the vein and they are not tunnelled through the subcutaneous tissue. PICCs can remain in place for weeks to months.

2. **Centrally inserted Central Venous Catheters (CVC):**
    i. **Tunnelled cuffed CVCs:** Tunnelled cuffed CVCs are for long-term treatment and can remain in place for months to years. CVCs are “tunnelled” subcutaneously from the vein insertion site to the catheter exit site. Tunnelled CVCs contain a dacron cuff that is situated under the skin close to the exit site. The cuff provides stability due to the fibrous adhesion that occurs around the cuff, also minimising infection as it forms a barrier to ascending pathogens from the exit site along the external catheter tunnel. Single, double or triple lumen cuffed central catheters (such as **Hickman or Broviac**) are examples of tunnelled CVCs.
    ii. **Tunnelled un-cuffed CVCs:** These CVCs are used for IV access for a shorter period (weeks to months) compared to tunnelled cuffed CVCs. They are generally used in children less 2 years old and have replaced PICCs in this age group. These CVCs are tunnelled just like the cuffed CVCs but do not have a cuff so can be more easily dislodged. They are either single or double lumen.
    iii. **Non-tunnelled CVCs for short term use and emergency situations**. Non-tunnelled CVCs are inserted percutaneously into the internal or external jugular vein, femoral vein and have an exit site directly above where they enter into the vein. They are used in Operating Theatres and ICU for therapy less than 3 weeks[1]. Vascaths are a short-term type of non-tunnelled CVC inserted for haemodialysis, haemofiltration and Peripheral Blood Stem Cell Collection (PBSCC) and are discussed in Section 4.6.

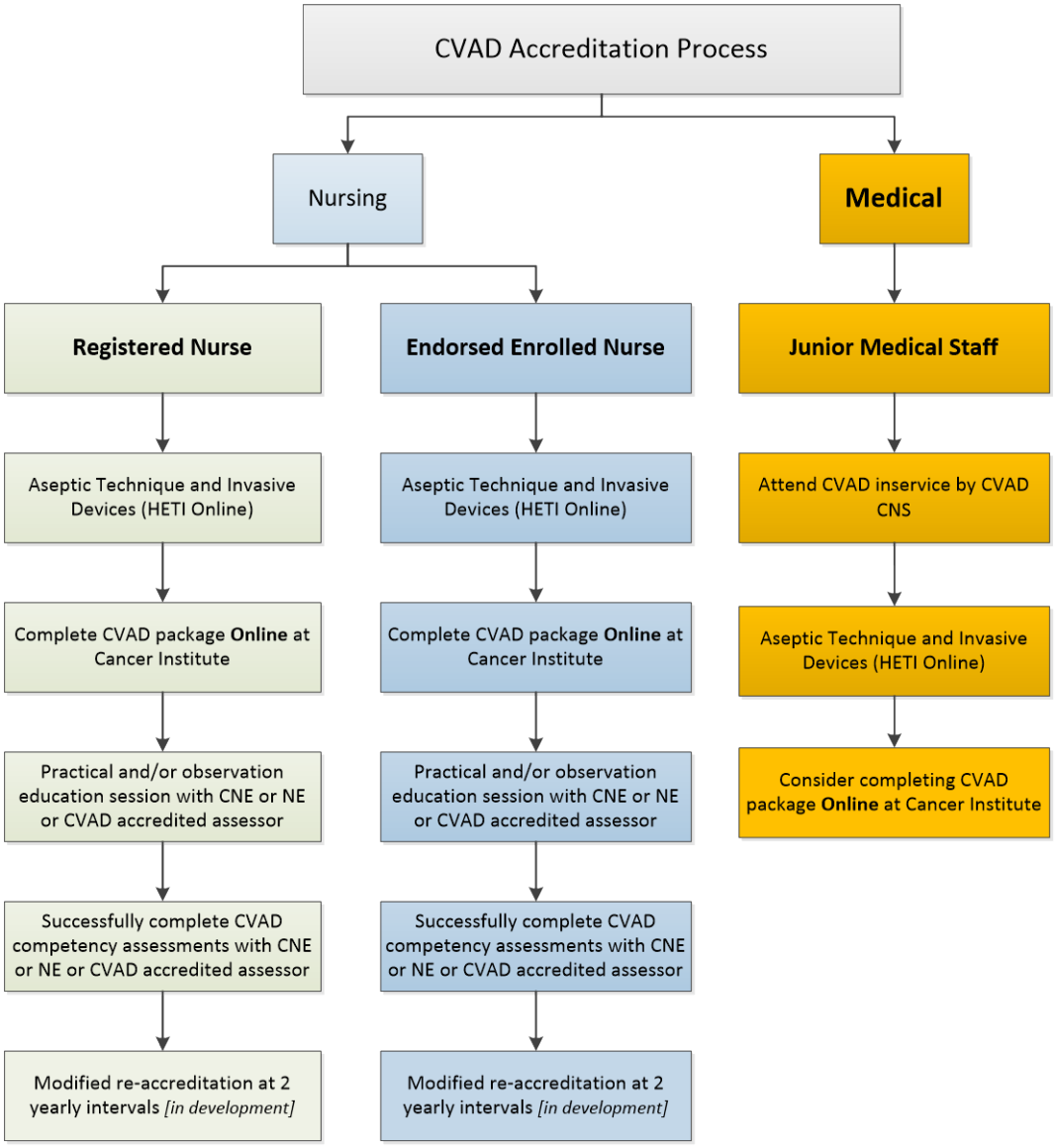
Note: Haemodialysis catheters are not discussed further in this document. Refer to:

- **CHW** Haemodialysis and Plasma Exchange: Managing Catheter Access or
- **SCH** Vascular Access Catheters: Insertion & Management of Temporary Vascaths.

3. **Ports** are long term CVADs that can remain in place for years. Ports are totally implantable and positioned in a subcutaneous pocket and are sutured into the tissues for stabilisation. Ports are made of plastic, stainless steel or titanium and have a chamber made of self-sealing silicone. The Port is accessed via the reservoir with a non-coring needle that is inserted through the skin and into the chamber[1]. Ports can remain in place until no longer needed or when a complication arises.

1.2 Staff Education and Training[3,4]

Note: Accessing and clinical management of CVADs can ONLY be performed by accredited RNs and Medical staff who have undergone appropriate SCHN education. See the Cancer Institute online eLearning and HETI Online for Aseptic Technique and Invasive Devices.



1.2.1 Registered Nurse Staff Advanced Skill Accreditation

Following CVAD accreditation, RNs may have the opportunity to obtain advanced skills in:

- Tunnelled CVC repair
- Clearing thrombotic occlusions in CVADs
- Sterilising an infected CVAD

- Advanced skill accreditation is not appropriate for all RNs managing CVADs. These skills are to be limited to clinical areas that manage CVADs on a daily basis and can maintain competency in advanced skills.
- Advanced skill accreditation is available in the following clinical areas: Oncology Services (including Wards where oncology patients are managed), Intensive Care Services, Renal Services, Haematology Service.
- NM, NUM, CNE or NE identify and support appropriate nursing staff to obtain CVAD advanced accreditation.
- Assessors for advanced CVAD skills include CNE/NE/CNCs in the identified clinical areas. CNE/NE/CNCs will gain advanced training in these procedures prior to assessing appropriate RNs.
- Complete additional education and training for specified skill.
- Successfully complete the CVAD competency assessments with CNE or NE utilising competency assessment tool.
- CNE or NE to complete CVAD Advanced Skill Accreditation paperwork and file a hard copy of accreditation within a designated area in the clinical unit.
- Accreditation to be recorded in HETI including assessors' details.

Additional

Additional education and training is required for identified RNs responsible for removal of non-tunnelled CVCs, uncuffed tunnelled CVCs [CHW only], and PICCs. All CVAD removals must be documented in the "CVAD Insertion Form" (hardcopy at **SCH**, or electronically at **CHW** using the PowerChart "CVAD Insertion Form").

1.2.2 Junior Medical Staff Education

Junior Medical Officer (JMO) orientation will include appropriate education on accessing and managing CVADs and the location of additional resources.

JMOs will be given the opportunity to attend practical CVAD education sessions each term. The practical sessions will be mandatory for Registrars doing terms in surgery, oncology, anaesthetics and ICU where the need to access CVADs is more likely to arise, and optional for other JMOs. An attendance record will be maintained in HETI.

1.3 Parent / Carer education and homecare

When a patient requires a long term CVAD, the parents and patient require education[3, 5] in managing the CVAD in the home environment. The following should occur with parents/ patients/ carers:

- Parents and patient should be shown the type of CVAD that is being inserted prior to insertion and be prepared for what to expect in the post-operative period after insertion including pain, bruising, bleeding and dressings.
- Demonstrations of CVAD cares, such as dressings.
- Must receive both verbal and written education including a copy of the Central Venous Catheter Dressing Homecare Guideline and/or Heparinised Saline Locking a Central Venous Catheter Homecare Guideline or Port Homecare Guideline and a copy of the appropriate CVAD factsheet.
- Education in the areas of:
    - Issues relating to infection and the importance of early recognition.
    - Risks of dislodgement and damage to the external portion of the tunnelled CVC and the procedure they should follow if these occur.
    - Risk of haemorrhage and embolism.
    - Any changes to their child's daily routine due to CVAD insertion or additional precautions required. For example, protect CVAD whilst child is playing, bathing or interacting with pets.
- Parents are encouraged to learn how to care for the CVAD at home including completing dressings and, in some instances parents may take on the responsibility of heparinised saline locking the CVAD. Parents need to be educated on maintaining aseptic technique during procedures prior to permitting parents to take on these responsibilities at home.
- Parents must be observed performing the procedure/s to assess competence prior to discharge including hand washing and preparation. Document the parent's education and assessment in the patient's medical record.
- Parents are required to troubleshoot adverse events in the home. Their competence in managing adverse events should be assessed prior to discharge. Refer to Homecare Guidelines for further information: Central Venous Catheter Dressings Homecare, Port Catheter Homecare or Heparinised Saline Locking a Central Venous Catheter Homecare.
- RNs should evaluate the parent's/carer's/patient's understanding of CVAD management by asking parents to explain their understanding of CVAD management in the home.
- Parents must know who to contact if they have any concerns.
- All CVAD education must be completed and documented in the patient's medical record prior to patient's discharge.

1.3.1 Bathing, Showering and Swimming with CVADs

CVCs, Midlines and PICCs[6]:

There are significant risks of serious infection[3] if the area underneath the CVC/Midline/PICC dressing and/or the exit site becomes wet. It is recommended not to submerge the catheter under water, therefore swimming is not advised. If a patient prefers to swim, consider inserting a Port as they can be safely submerged in water when the device is not accessed, without the risk of infection.

If patients/parents disagree with the above recommendation they need to discuss any issues they may have with their Consultant.

Therefore:

- **Bathing** is permitted however, the CVAD and IV infusion set connections MUST NOT be submerged in water[3]. No direct water should flow onto the CVAD site.
- **Showering** is permitted however no direct flow of water should flow onto the CVC/Midline/PICC site. The CVC/Midline/PICC exit site should be covered with an occlusive dressing and cleaned with 2% chlorhexidine gluconate in 70% alcohol swab immediately following the shower.
- **Swimming:** Not recommended with CVC, Midline or PICC.

If the area underneath the CVAD dressing and/or the CVAD exit site becomes wet/moist, the dressing must be changed as soon as practicable. Refer to Section 4.4 “Dressings for CVC, Midline and PICC”.

Ports:

- If the Port is not accessed, patients are able to shower, bathe and swim.
- For inpatients with an accessed Port, care must to be taken to ensure no part of the dressing or IV infusion set is submerged in water. In the accidental event of submersion, the dressing needs to be changed and the site re-assessed.

2 CVAD Insertion and Placement Confirmation

Refer to NSW Ministry of Health Policy Directive (PD2011_060) "CVAD Insertion and Post-Insertion Care"[7] for more information.

2.1 Requesting Insertion

- CVADs may only be inserted by medical staff who have been trained in the insertion of CVADs or being supervised by a trained clinician.
- These include surgeons, anaesthetists, interventional radiologists, neonatologists, ED physicians and intensive care medical staff.
- The booking team should follow the venous access decision pathway to help decide what line is appropriate for the patient.
- There are numerous factors that determine this. Some of these include the length of time the CVAD may be needed, the reason for insertion (e.g. IV fluids, antibiotics or TPN) and the age of the patient.
- Refer to the relevant **Venous Access Decision Pathway**:
  - At CHW: Venous Access Decision Pathway - CHW
  - At SCH: Venous Access Decision Pathway - SCH

Requesting CVAD insertion

- The appropriate proceduralist should be contacted to discuss the type of line, the urgency of the line and any other relevant patient factors. If the patient requires an anaesthetic line, the type of line should be discussed with duty anaesthetist or on-call anaesthetic registrar.

  The **risks and advantages must be balanced** by the clinician before committing to CVAD insertion.

- Prior to insertion, consent must be obtained by the proceduralist (surgeon or interventional radiologist) or the requesting team (anaesthetic lines). Any further information regarding anaesthetic lines can be supplied by the anaesthetist inserting the line on the day of the procedure. Refer to the policy "Consent to Medical Treatment: Patient Information" for further details.
- Refer to the relevant **CVAD Request Pathway**:
  - At CHW: CVAD Request Pathway - CHW
  - At SCH: CVAD Request Pathway - SCH

  Note: CVAD Insertion Record must be completed as mandated by NSW Ministry of Health [PD2011_060].

  At SCH: staff should complete the form in hardcopy [SMR090.200];
  At CHW: staff should complete an electronic "CVAD Insertion Form" via PowerChart.

- Parents or guardians **must** be provided with the relevant factsheet as part of the informed consent process.
  - Surgical CVAD factsheet - in progress
  - PICC factsheet
  - Midline factsheet – in progress
  - Non-Tunnelled CVC factsheet – in progress
  - Uncuffed tunnelled CVCs factsheet – in progress

2.2 General Principles in relation to Insertion[3,4,7]

2.2.1 Aseptic technique

- All CVADs and Midlines must be placed using an aseptic technique.
- The proceduralist must perform a full 2 minute hand-wash with 2% chlorhexidine gluconate or povidone iodine handwash.
- The proceduralist must wear sterile gloves and gown, and a cap and mask
- 2% chlorhexidine gluconate in 70% alcohol is recommended over povidone-iodine solution for insertion-site skin disinfection. Povidone-iodine may be used if diathermy is to be used or if the patient or proceduralist is allergic to chlorhexidine-gluconate.
- The patient must be fully covered with an appropriately sized drape. A small sterile field is inadequate and may lead to contamination of the guide wire or catheter.

- Antibiotic prophylaxis is only required for **haemodialysis** patients but is not necessary for all other CVAD insertions
- After placement a primed needleless connector is to be placed at the end of all CVADs and Midlines except those lines where vasoactive drugs are being infused through the line.
- A primed needleless access device [NAD] needs to be attached to the ports of the gripper/huber needle extension set before use.
- All CVCs should be heparinised saline locked if not in use or fluids should be connected and started immediately. This is to prevent line occlusion.
- Ports may be left accessed using a non-coring gripper or huber needle and connected to fluids for immediate use or heparinised saline locked if not in use.
- It is good practice to run 'to keep vein open' [TKVO] fluids through the Midline, PICCs and un-cuffed tunnelled CVC while the patient is in hospital.
- A semi-permeable dressing is to be used for securing all CVADs post insertion.
- A CVAD insertion record MUST be completed by clinicians inserting the CVAD[7].
  At SCH: staff should complete the form in hardcopy [SMR090.200];
  At CHW: staff should complete an electronic "CVAD Insertion Form" via PowerChart; no separate operation note is written.

2.2.2 Non-Tunnelled CVC Insertion Considerations

- The most commonly used veins for non-tunnelled CVAD insertion are the internal jugular, femoral and subclavian veins.
- In an intensive care setting, femoral vein access has not been shown to have a higher infection rate compared to other sites. This may not be true in a ward setting.
- Ultrasound is a useful tool to aid insertion and should be available if required.
- All non-tunnelled CVADs are inserted using a full surgical scrub. On the occasion where these catheters are inserted outside theatres (e.g. ICU), the same aseptic technique should be adopted.
- A Seldinger technique is used for insertion[7]. The vein is accessed using a needle or cannula and a wire is then fed up into the vein. The line is then inserted over the wire. Before dilation of the vessel, venous placement must be confirmed, either by ultrasound confirmation of the placement of the wire or by transducing a narrow gauge cannula placed in the vessel.
- Once placed and the tip location confirmed (see section 2.3), the line should be secured with a Statlock catheter fixation device (or suturing if more appropriate) and covered with Semi Permeable dressing (e.g. IV 3000).

2.2.3 PICC Insertion Consideration After Placement

- The most commonly used veins for PICC insertion are the basilic, brachial and cephalic veins in the upper arm. The long saphenous vein at the ankle is also commonly used in neonates.
- Vein selection is dependent on both the proceduralist and patient factors. Ultrasound is commonly used to select the appropriate vein and should be available if required.
- A Seldinger technique is used for insertion[7].
- The line should not fill greater than 1/3 of the vessel lumen with the tourniquet down. This will help prevent vein thrombosis.
  - 3mm vessel diameter → 3F PICC is the appropriate size
  - 4mm vessel diameter → 4F PICC is the appropriate size
- PICCs should ideally be cut to size to avoid large amounts of catheter outside the patient. This needs to be clearly documented on the CVAD insertion form.
- The line should be fixed at the insertion site using a Grip-Lok securement device (nasal gastric securement device) if a length of catheter is left outside the patient. The line should also be secured at the fixation wing on the catheter using a StatLock or Grip-Lok catheter stabilisation device (or sutures).
- It is good practice to have PICCs attached to TKVO when patient is in hospital to prevent occlusion.

2.2.4 Tunnelled Surgical CVAD/Port Insertion Considerations

- Three veins are typically used by surgeons
  - Internal jugular vein
  - External jugular vein
  - Subclavian veins
- Alternative veins may need to be considered if these are not suitable.
- Two techniques are used for insertion
  - The first is a percutaneous technique, in which ultrasound is used to locate the relevant vein, access is obtained via a Seldinger technique[7] and the line is tunnelled from an appropriate site.
  - The second option is an open approach in which an incision is made over the vein and the relevant vein is directly exposed with a venotomy.
- After placement a primed NAD must be placed on each lumen and heparinised saline locked if not in use or fluids should be connected and started immediately. Primed NAD need to be attached to the gripper needle extension set before use.
- A semi permeable dressing is to be used for securing the CVAD post insertion.
- **At CHW:** Operative documentation is placed directly into Powerchart. No separate operation note is written.

2.2.5 Tunnelled un-cuffed CVC Insertion Considerations

- These CVCs are inserted by interventional radiologists or anaesthetists.
- The internal jugular vein is most commonly accessed.
- A percutaneous technique is used and the line is tunnelled out onto the chest wall.
- The line used does not have a cuff and is secured with a Statlock or Grip-lok catheter fixation device and semi-permeable dressing (e.g. IV 3000 dressing).
- It is good practice to have tunnelled un-cuffed CVC attached to TKVO when patient is in hospital to prevent occlusion.

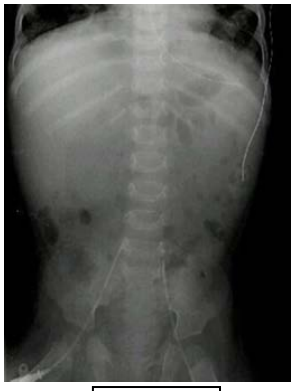
2.2.6 Midline Insertion Considerations

- Midlines should ideally be inserted whilst the patient is awake or under sedation as it is a shorter and simpler procedure.
- In young patients or patients having additional procedures, a general anaesthetic may be needed.
- A strict aseptic technique applies.
- The basilica and brachial veins in the upper arm are the veins of choice.
- Ultrasound must be used to select the vein.
- The line should be inserted into the mid upper arm so the tip of the line does not extend beyond the axilla.
- The catheter should not fill more than 1/3 of the vein diameter with the tourniquet down and the vein should ideally be at least 4mm in diameter.

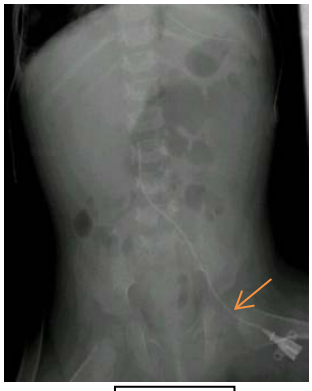
- The line must be fixed with a StatLock or Grip-Lok stabilisation device and covered with semi permeable dressing (e.g. an IV 3000 dressing).
- After placement, all Midlines must have a NAD placed on each lumen and heparinised saline locked if not in use or fluids should be connected to the line and started immediately to prevent line occlusion.
- It is good practice to have Midlines attached to TKVO when patient is in hospital to prevent occlusion.
- Radiological confirmation of tip position is NOT required as the tip of the catheter does not extend beyond the axilla.
- Midlines should be labelled with a sticker denoting it as a venous line.
- The CVAD insertion form needs to be completed [CHW: in Powerchart, SCH: hardcopy].

2.3 Confirmation of CVAD placement

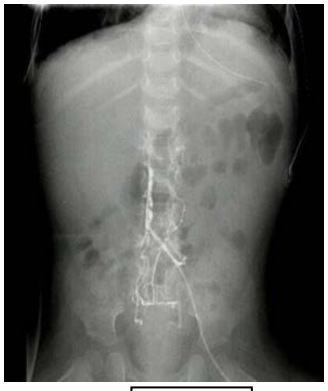
- **Do not use the CVAD until the position of its tip is known**.
- In the theatre environment, a non-tunnelled CVAD may be placed and used by the anaesthetist before the line is X-rayed. This is up to the discretion of the anaesthetist.
- **Radiological confirmation of the position of the tip must be performed**. This may be done during the procedure using image intensifier (II), or in the interventional suite, or afterwards with conventional X-ray.
- It is unnecessary to re-X-ray a line on the ward if this has already been done and is documented as being safe to use on the CVAD insertion form.
- The CVAD tip should sit in the low SVC or at the SVC-RA junction. The tip should be WITHIN 2 vertebral body heights below carina.
- Avoid placing the tip in the right atrium or in the high SVC. Exceptions to this are with certain cardiac patients, certain neonates and with haemodialysis catheters, where the tip may lie in the right atrium.
- Femoral placed lines should have their tips located in the IVC, either above the renal vessels (i.e. tip placement T9-T11 and below the diaphragm) or below the renal vessels (i.e. below L2). All femoral lines need to be X-rayed to confirm placement. Lines that are difficult to insert may need to have contrast injected down them to exclude lumbar plexus placement. (Picture 3)



Picture 1

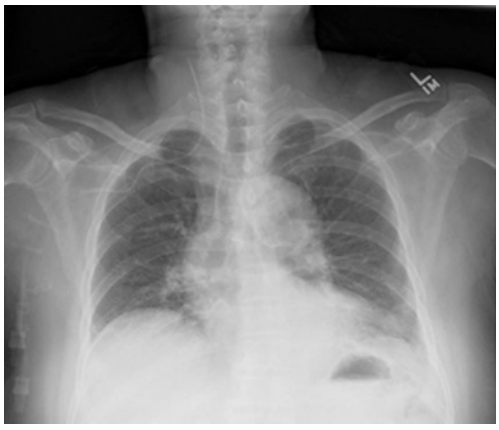


Picture 2



Picture 3

- The pictures above are abdominal X-rays of femoral lines. Picture 1 shows a right sided catheter which has only just entered the IVC, the tip lying to the right of the vertebral column. The left sided catheter lies to the left of the vertebral column and is therefore presumed to have entered the lumbar plexus. It was replaced over the wire by the catheter in Picture 2. This appears to have crossed the Midline at L4 level and to have entered the IVC. However, there is a subtle “hump” in the curvature of the line suggesting it is not in fact in the iliac vein. Injection of contrast shows that it is in the lumbar plexus (Picture 3). It was therefore removed.
- A common complication of PICCs is malposition. Simply as a result of arm movement, PICCs can move more proximally from their ideal position and migrate to other intravascular areas such as the subclavian or internal jugular veins. Non-centrally placed line tips have higher complication rates. A serious complication is perforation of the vessel wall by erosion of the PICC tip through the wall.
- An **IIMS report** must be lodged where an incident has occurred for any malpositioned CVAD tip.



Picture 4: PICC that has flicked out of SVC into right IJ

- **Midlines:** The tip of a midline does not extend beyond the axilla therefore radiological confirmation of the tip position is not required before use.

3 General Management of CVADs

Note: Nursing Quick Reference Guide is available.

3.1 Postoperative Nursing Management & Observation (24hrs post insertion) [7]

Do not use the line until the position of its tip is known.

- Registered nurses must be aware of potential complications related to CVC insertion. These include:
  - Bleeding
  - Infection
  - Dislodgement/ Tip migration
  - Thrombosis
  - Haematoma formation
  - Arterial injury
  - Nerve injury
  - Pneumothorax
- Temperature, Pulse, Respirations (TPR), Blood Pressure (BP) and surgical site check and pain assessment to be completed on return to ward. **Document in patient's medical record**.
- Observations required:
  - Hourly TPR for first 4 hours upon return to ward.
  - Then 4 hourly TPR if an in-patient, unless otherwise indicated by patient's condition. There is no clinical indication to continuously monitor a patient post CVAD insertion unless indicated by the patient's underlying medical condition.
- There are usually 2 surgical incisions for *tunnelled* cuffed and un-cuffed CVCs; at the vein entry site (usually the neck) and at the exit site (usually in the chest). For Ports, there are two surgical incisions at the entry site and a second where the chamber is placed. All entry and exit sites must be checked for:
  - Bleeding (swelling, ooze early after insertion)
  - Infection (heat, redness, swelling, pain); usually 1 – 7 days post insertion.
  - CVC dislodgement (exposed cuffs, increased length of catheter exposed) – call for immediate medical assistance.
- CVADs should have hourly site checks recorded for the first 24 hours post insertion.
- Dressings applied during insertion of a CVC ideally should be left intact for a minimum of 5 – 7 days, unless heavily soiled or lifting off.

Note: If there are any changes in the patient's condition postoperatively that relates to the above points, contact the surgical team/duty anaesthetist responsible for insertion and document in the patient's medical record.

- Prior to discharge, ensure parents have a copy of the appropriate CVAD factsheet and that parent education has been completed and documented in the patient's medical record (refer to Parent Education and Homecare section). Also ensure that parents are aware of the need to inspect the entry site and exit site regularly (at least 3 times/day).

3.2 Daily Nursing Management

- Document observations for both the exit site and integrity of the CVAD each shift for:
  - Infection (heat, redness, swelling, pain)
  - Inflammation/Swelling
  - Dislodgement (exposed cuffs, measurement of external PICC, Midline and uncuffed CVC, observing for increased or decreased length of catheter exposed, or increase of the circumference of the limb above or below PICC/Midline insertion site)
  - Splitting or cracking of CVC
  - Dressings and securement devicesLeaking and discharge
  - Patency of CVAD (if accessed)

  Note: Any indication of the above points, contact relevant medical officer or CVAD accredited senior nursing staff or the Vascular Access CNS2 immediately.

- While the CVAD is connected to infusion therapy, hourly site checks are required and documented on the patient's flow chart, fluid balance chart or the CCIS (in PICU).
  - **At SCH**: document in the form MR.20 PICC CVAD Checking Procedure.
  - **At CHW**: document in eMM "Interactive View & I&O" checklist.
- When a CVAD is not in use, during each shift a CVAD site check and documentation of the CVAD condition is entered into the patient's medical record or CVAD care checklist in "Interactive View & I&O" (CHW).
- Ensure infusion sets are secured to avoid accidental removal of the CVAD if pulled. Tunnelled cuffed CVCs should contain a loop that is secured to the skin with semi-permeable dressing. If accessed, Ports should be similarly dressed and extension tubing securely dressed with semi permeable dressing to the skin. Alternate securement devices are available, refer to section 4.4.
- The patency of the patient's CVAD should always be documented in the patient's medical record on each admission, including difficulty flushing or aspirating blood. If patency is difficult or if changes to patency are detected, notify the medical team or CVAD accredited senior nursing staff or Vascular Access CNS2. (Section 6)
- Any movement of the CVAD tip beyond the right mid-atrium can cause cardiac arrhythmia (refer to Complications Table for further information). If an irregular pulse is felt on palpation consider an ECG to check for cardiac arrhythmias and contact medical team immediately.

3.3 Needleless Access Device (NAD)

- A needleless access device [NAD] is a device that provides a safe alternative to accessing a patient's CVAD when using a needle. NADs are used for various procedures (such as administration of fluids, medications, blood products, blood sampling) to reduce the risk of injury involving contaminated sharps, air emboli, and reduction of the risk of contamination[3, 4, 7-10]
- Practice of clamping NAD is dependent on the connectors properties, e.g. neutral connectors require a positive pressure clamping technique.
- All lumens on CVADs require a NAD to be securely attached to the hub at all times.

> **Note:** NADs are NOT to be placed between the hub of the CVAD and any vasoactive infusion or central venous pressure monitoring sets.

- **Continuous Infusions:** NADs are to be changed when the administration set is changed (e.g. up to 96hours) or sooner if there is residual blood or debris within the NAD or the NAD becomes contaminated.
- **Intermittent Infusions:** NADs are to be changed every 7 days or sooner if there is residual blood or debris within the NAD or the NAD becomes contaminated.
  - **EG:** If a patient only has IV fluids/medications up to 96 hours and does not need to remain connected to TKVO then the NAD can remain insitu and the IV infusion sets may be removed; the CVAD is heparinised saline locked. The NAD then needs to be changed 7 days from the time it was first connected.
  - **NB**: If the patient is being discharged home and the CVAD is not going to be accessed for 7 days, then a new NAD can be connected when heparinised saline locking the CVAD. The parents are to be given the next NAD change date.
- Change date must be documented in the patient's notes or if at CHW, in the CVAD care checklist in "Interactive View & I&O".
- Change of NAD should be timed to occur together with line change or heparinised saline locking when possible.
- NADs need to be primed with 0.9% sodium chloride (or heparinised saline when heparinised saline locking) before connection to a CVAD.
- The hub of the NAD must be cleaned for a minimum of 15-30 seconds of vigorous scrubbing with 2% chlorhexidine gluconate in 70% alcohol (large) swab while also holding the hub of the CVAD with 2% chlorhexidine gluconate in 70% alcohol (large) swab and allowed to dry before accessing.
- The hub of the CVAD must be cleaned for a minimum of 15-30 seconds of vigorous scrubbing with 2% chlorhexidine gluconate in 70% alcohol (large) swab before attaching a new NAD to the hub of the CVAD.
- NADs may be left insitu for blood/blood culture collection if not visibly soiled or contaminated.
- Patients presenting from home or other hospital facilities need to have a new NAD connected before performing any procedures. Follow the procedure for changing a NAD.

3.4 Intravenous (IV) Infusion Sets [3, 4, 7,11]

Disconnected IV infusion sets MUST be discarded and NOT reconnected (1) at a later time or (2) to an alternate lumen of the CVC.

- **All extension piece with a split septum valve or 3 ways taps (in ICU only) with luer activated valves should be placed between the CVC hub and the IV infusion set as the portal for blood collection and administering medications whilst acting to maintain the closed system**.

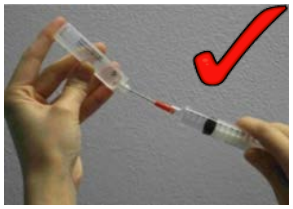
Note: Once CVAD is connected to an IV infusion set via a NAD, it is referred to as a ***closed system***. This system remains closed for procedures that can be performed through an extension piece with a split septum valve or a NAD, such as flushing, withdrawing blood and administering medications.

- The closed system should only be broken for procedures such as changing IV infusion sets, changing NADs, disconnecting IV infusion sets or heparinised saline locking.
- If IV infusion sets become contaminated or the integrity of the closed system is compromised, change the IV infusion set immediately.
- The set up and priming of IV infusion sets should be performed in close proximity to the patient (i.e. IV infusion sets are to be primed in the same location as the patient) and close to time of connection to CVAD.
- **Intravenous fluid bags must be changed every 24 hours**.
- **All extension sets and IV infusion sets need to be changed up to 96hrs** (or as per special considerations for specific medications, parenteral nutrition and blood products).
- NAD's need to be changed when the administration set is changed (e.g. 96hours), for **continuous infusions** or sooner if there is residual blood or debris within the NAD or the NAD becomes contaminated.
- **Intermittent Infusions:** NADs are to be changed every 7 days or sooner if there is residual blood or debris within the NAD or the NAD becomes contaminated.
- Before accessing the CVAD, wash hands for 60 seconds using 2% chlorhexidine gluconate hand wash and dry hands. Alternatively, using an alcohol based chlorhexidine handrub for 30 seconds (until hands are dry) will achieve adequate hand antisepsis as long as the hands are not visibly soiled or contaminated with organic materials.
- IV infusion sets should be set up, connected and disconnected, using aseptic technique to ensure the sterility of the internal catheter is maintained.
- The date and time of IV infusion set changes must be documented in the patient's care plan and on the IV infusion set using a 'line change due' sticker.
- When in TKVO mode, CVAD IV infusion sets should infuse through an infusion pump at a minimum volume dependant on the pump type (e.g.10mL/hour in the Baxter volumetric pump) to prevent an occlusion of the CVAD. Please note that this minimum amount may vary according to patient age and condition as well as infusion pump device used.
- CVADs are not to be routinely heparinised saline locked to enable patients to walk around, shower or at the sole request of the parents.

3.5 Administration of medications [4, 5, 11]

- If patients require frequent medications, the CVAD should remain connected to an IV infusion set [closed system] to decrease the potential risk of infections.
- Policy and guidelines related to the administration of specific medications must also be followed in conjunction with the CVAD guidelines to prevent medication precipitation.
- When accessing the closed system to administer medications via a valve or burette, the point of access must be vigorously cleaned with 2% chlorhexidine gluconate in 70% alcohol swabs for minimum of 15-30 seconds using friction and allowed to dry before proceeding.
- Vigorous friction while cleaning catheter hub or NAD prior to CVC access is pivotal in reducing catheter related infections.
- Hands that are visibly soiled require washing with 2% chlorhexidine gluconate in 70% alcohol hand-wash, otherwise 0.5% chlorhexidine gluconate in 70% alcohol hand-rub can be used when administering medications via a burette or valve.
- A blunt drawing up needle is to be used to draw up any medication from an ampoule into syringes. Syringe tips are not to be connected straight onto ampoules. See Picture 5

Picture 5



- If a patient has a CVAD insitu and develops a fever without any obvious signs of infection or a CVAD infection is confirmed, **each IV antibiotic dose should be administered through alternate lumens of the CVC**. All lumens of the CVC are to be connected to IV infusion sets.

  In cases where continuous infusions of chemotherapy or inotropes are in progress, alternating each dose of antibiotic may not be possible.

  Similarly, in cases where parenteral nutrition (PN) is in progress consider stopping PN for administration of antibiotic or if necessary, discuss compatibility of antibiotics with Pharmacy.

  Note: If a patient is receiving a vasoactive infusion, the lumen MUST NOT be interrupted. Discuss with an Intensivist the best way to alternate lumens for antibiotic therapy.

- The name of the lumen (e.g. white or red, brown or blue) the IV antibiotic is administered through is to be documented in the patient's medical record.
- CVCs should not be heparinised saline locked more than once a day.
- Multi-dose vials must not be used[12].
- **Note:** When attaching a sideline or pushing medications, all principles of CVAD management **MUST** be maintained.

3.6 Blood Collection from a CVC

Note: The risk of infection and CVC occlusion increases each time a CVC is accessed[3, 5]. Venepuncture or finger prick sampling should be utilised wherever possible.

Small diameter PICCs have an increased likelihood of clot formation. PICCs should only be used for blood collection in extreme circumstances under the direction of a Consultant.

- CVADs should be accessed as infrequently as practical to reduce the risk of contamination.
- Where CVADs are being accessed for blood sampling, blood collections should be timed to occur together when possible (e.g. only once daily).
- All blood sampling should be taken without breaking the closed system (e.g. via an extension piece with a split septum valve or via a 3-way tap [in ICU ONLY] with a NAD attached).
- If blood cultures are required, blood should be collected from all lumens. Ensure blood cultures are labelled with specific lumens (e.g. blue, white etc). NAD may be left insitu for blood culture collection if not visibly soiled or contaminated.

  Note: If a patient is receiving a vasoactive infusion, the lumen **MUST NOT** be interrupted. Discuss with an Intensivist the best way to collect blood in this situation.
- If CVAD infection is suspected, it is recommended, where possible, peripheral blood cultures should be collected at the same time that CVAD blood cultures are collected. This is to determine if the patient has a true CVAD infection or a systemic bacteraemia. If CVAD culture becomes positive prior to the peripheral sample this information can assist in diagnosing a CVAD infection[13].

  Exception: Oncology/Haematology and BMT patients with CVC presenting to ED with fever; for these patients only collect blood cultures from the CVC lumen/s.
- Discard blood is not to be re-infused into the patient due to the potential for clot formation on its introduction to the vascular system. Discard blood re-infusion may be required in extreme circumstances; however this should be discussed with medical staff and documented.

3.7 Saline Flushing and Heparinised Saline Locking a CVAD [4,14-16]

3.7.1 Flushing following administration of medications, collection of blood samples or prior to connecting IV Infusion Sets

- The technique recommended to remove any substances that could cause occlusion is **pulsating action**.
  - **Pulsating action** refers to flushing a CVAD using a pulsing (push – pause – push) motion following the administration of medications, collection of blood samples or prior to connecting IV infusion sets. This creates turbulence in the catheter lumen assisting with the prevention of fibrin sheath formation, internal lumen thrombosis and drug precipitation.
- Routine flushing of the CVAD should occur after:
  - Medication administration
  - Blood collection
- The minimum volume for a pulsate flush is 10mL of 0.9% sodium chloride; certain viscous medications may require a higher volume. Please note that the minimum amount may vary according to patient age and condition and this should be discussed with patient's medical team.
- Prefilled 10mL 0.9% sodium chloride syringe (Posiflush) may be utilised for flushing through CVAD as long as the sterility of the internal fluid pathway is maintained.

3.7.2 Heparinised saline Locking CVAD

- Heparinised saline lock (Hep-lock) refers to the instillation of heparinised saline into the CVAD when the lumens are not being used. Heparinised saline is used to reduce the risk of thrombosis formation in maintaining the CVC lumen patency. The technique recommended is **positive pressure lock action**.
  - 'Positive pressure lock' prevents the backflow of blood into the lumen.
- A NAD **must** be used when heparinise saline locking CVADs. Red caps or any other caps are not to be used as they do not have any internal mechanisms to ensure a positive pressure lock or prevent back flow of blood into the lumen.
- To create Positive Pressure within the CVC/Midline/PICC lumen while flushing the catheter, maintain constant pressure on the syringe plunger whilst clamping the lumen of the CVAD during the last 1 mL of the heparinised saline instillation. This prevents backflow of blood into the catheter tip and subsequent thrombus formation.
- To create positive pressure lock within the Port, the non-coring needle should be removed while maintaining constant pressure on the syringe plunger during the last 1mL of the heparinised saline instillation. In order to create a positive pressure lock in a Port you may require assistance from a second nurse or parent to either flush the Port or remove the non-coring needle.

- **Tunnelled-cuffed CVC:** each lumen requires weekly locking with 3mL of 10units/mL of heparinised saline after flushing with 10mL of 0.9% sodium chloride when not in use for up to 7 days.
- **Uncuffed tunnelled CVC/PICC/Midline:** each lumen requires weekly locking with 1.5mL of 10units/mL of heparinised saline after flushing with 10mL of 0.9% sodium chloride when not in use for up to 7 days.
- **Port:** require **monthly** locking with 4mL of heparinised saline 10 Units/mL, after flushing with 10mL of 0.9% sodium chloride when not in use for up to 4 weeks.
- Only 10mL luer lock syringes are to be used when heparinise saline locking.
- Heparinised saline locks must be charted in the patients PRN medication chart.
- Document heparinised saline lock in patient's medical record.
- It is recommended that heparinised saline locks are aspirated and discarded when accessing CVADs and not flushed into the patient. PICC and Midline do not require heparinised saline to be aspirated refer to section 4.3.4 for more information.
- CVCs should not be heparinised saline locked more than once a day to minimise manipulation. Alternatively, the line must be positive pressure locked with 0.9% sodium chloride.
- Set up as per section 4.3.3 [for CVC, Midline or PICC] or section 5.3.1 [for Ports].

Note: When clamping cuffed Silastic catheters, this should be done over the guard on the lumen stating 'CLAMP HERE' with a non-crushing clamp

Note: Once heparinised saline locked, clamps on the CVAD should not be moved as this will remove the positive pressure lock that has been created.

Type	Concentration (heparinised saline)	Use	Volume required
Cuffed tunnelled CVC	10units/mL	CVC not in use up to 7 days	3mL per lumen
Uncuffed tunnelled CVC	10units/mL	CVC not in use up to 7 days	1.5mL per lumen
PICC	10units/mL	CVC not in use up to 7 days	1.5mL per lumen
Midline	10units/mL	CVC not in use up to 7 days	1.5mL per lumen
Non-tunnelled CVC (jugular or femoral)	10units/mL	CVC not in use up to 7 days	1mL per lumen
Port	10units/mL	Port not in use up to 1 month	4mL

Regardless of the solution utilised the most important aspect is the technique in relation to flushing and heparinised saline locking CVADs. A pulsating action should always be used to flush CVADs to create a turbulent flow within the catheter. Positive pressure technique is used when heparinised saline locking CVADs to prevent the backflow of blood into the internal tip of the device and the formation of clots.

3.8 Determining internal volume (deadspace) of a CVAD

- Occasionally it is necessary to administer medications just into the catheter lumen and not systemically into the patient (e.g. alteplase, hydrochloric acid or ethanol). Prior to administration of these types of medications it is necessary to calculate the catheter dead space.
- Many CVADs in children will be trimmed at time of placement, so the internal volume of the lumen is different between patients depending on the length of catheter that has been trimmed.
- Review the Operation Report to determine if the length of the catheter has been documented or how much of the catheter has been cut.
- The dead Space needs to be calculated directly from the hub of the CVAD, in Port this would be from the hub of the gripper needle.
- All aspects of the aseptic technique must be followed.
- Each lumen needs to be measured to determine the deadspace, as the deadspace volumes will most likely differ between lumens.
- If unable to draw back and the tip of the catheter is in the correct location use the product information identifying the priming capacity of these devices as a guide. If the dead space is to be calculated using the volume on the manufacturer's chart, the clinician must consider that the catheter was most likely cut at time of placement therefore this dead space will most likely allow for a proportion of the pharmacologic agent to enter the patient's bloodstream. This should be discussed with the patient's medical team, preferably the Fellow or Consultant.

Equipment:

- A dressing trolley
- Containment field to maintain Aseptic technique during procedure. (Sterile plastic sheet or green plastic tray).
- Large 70% alcohol wipe or antiseptic wipe
- 4 x 10mL luer lock syringes
- 3 x 0.9% sodium chloride (10mL ampoules) or Sodium Chloride 0.9% prefilled syringe. (1 x 0.9% sodium chloride must be a 10mL ampoule).
- 3 x 2% chlorhexidine gluconate in 70% alcohol (large) swabs.
- 1 x blunt needle for drawing up 2mL from 0.9% sodium chloride ampoule.
- Non-sterile gloves and other PPE

Procedure:

1. Set up as per general set up for accessing a CVC or accessing a Port.
2. Attach blunt drawing up needle to 10mL luer lock syringe and draw up exactly 2mL of 0.9% sodium chloride, ensuring all air bubbles are removed. Remove blunt needle from the syringe and discard. Place the tip of the syringe within the aseptic field.
3. Ensure CVC lumen is clamped.
4. Perform a 60 second clinical hand wash & dry with clean paper towels. Alternatively use an alcohol-based chlorhexidine hand-rub for 30 seconds (until hands are dry).
5. Don non-sterile gloves.
6. Hold the hub of the CVAD with 2% chlorhexidine gluconate in 70% alcohol swab and remove the NAD.
7. Hold the hub of the CVAD in a downward position, with the second 2% chlorhexidine gluconate in 70% alcohol swab vigorously clean the hub of the CVAD for a minimum of 15-30 seconds and allow to completely dry.
8. If the CVAD has been locked with heparinised saline then remove the heparinised saline by taking a 5 mL discard in a 10mL luer lock syringe.
9. Attach a 10mL per-filled 0.9% sodium chloride syringe and flush the lumen using a pulsating technique.
10. Clamp CVAD and remove syringe.
11. Attach the 10mL luer lock syringe with 2mL of 0.9% sodium chloride to the CVAD hub. Inject slowly to the 1mL mark of the syringe. Then SLOWLY aspirate the 0.9% sodium chloride from the lumen until you see the first “flush” of blood in the syringe. This volume, minus 1mL, is the dead space of the line.
12. Clamp the lumen and remove syringe.
13. If unsure about the volume measured repeat steps 9-12 again, to ensure accuracy of the dead space volume.
14. Attach second 10mL per-filled 0.9% sodium chloride syringe and flush the lumen using a pulsating technique.
15. Clamp CVAD and remove syringe.
16. Clean the Hub of the CVAD with 2% chlorhexidine gluconate in 70% alcohol (large) swabs and allow to dry completely.
17. Re-heparinised saline lock the lumen with appropriate locking solution or connect IV fluids or continue with the required procedure.
18. This process needs to be repeated for all other lumens, as the dead-space volumes will most likely differ between lumens.

4 Clinical Management: CVC, PICC and MIDLINE

Note: Only Accredited Nurses and Medical staff who have undergone appropriate education are to access and manage CVCs PICCs and Midline. Refer to Section 1.2

4.1 General Principles

- All procedures related to the long term management of CVADs should be performed:
  - in close proximity to the patient i.e. IV infusion sets are to be primed as close to the patient as possible (i.e. in the same location) and/or practical, *and*
  - close to time of connection of CVAD.
- Using aseptic technique (refer to Section 4.3 and should be read in conjunction with the SCHN Aseptic Technique policy), vigorously clean the required access points with 2% chlorhexidine gluconate in 70% alcohol swab for minimum 15-30 seconds and allow to dry before connection, disconnection and administering medications[2].
- Vigorous friction while cleaning CVAD hub or NAD hub prior to CVAD access is pivotal in reducing catheter related infections.
- To decrease the patient's risk of an extravasation injury, CVADs (except PICCs and Midlines) should be bled to confirm position prior to the commencement of IV treatment.

  Note: 10mL luer lock syringes are to be used with all CVADs as smaller syringes can exert force and cause ruptures within the CVAD membrane[2, 17].

  *(**Exception:** 1mL blood gas syringe. **Rationale:** Patency of the CVAD needs to be determined first and then the action is aspirating/pulling out rather than pushing in , so there is minimal chance of catheter rupture from excessive pressure.)*

  Note: Sodium Chloride 0.9% pre-filled syringes come in volumes smaller then 10mL, but the syringe bore is still a 10mL size so these are acceptable for use on CVAD's
- Jewellery, false nails or nail polish must not be worn when performing CVADs procedures[12].

4.2 Midlines - Additional General Principles

- Midlines are considered as peripheral cannulas for the purposes of medication administration.
- When administrating medication via a Midline, dilute to concentrations suitable for administration in a peripheral cannula or a peripheral vein.
- TPN **cannot** be administered via a Midline. Contact pharmacist if unsure of recommended dilution of any drug that is to be administered via a Midline.
- Blood is not to be collected from Midlines until the day of planned discharge and line removal.
- Midlines can be capped off once daily using 1.5mL of heparinised Saline (50 units/5mL). When re-accessing Midlines after capping drawing back is not necessary.

- It is good practice to keep the Midline attached to TKVO fluids when the patient is on the ward to prevent line occlusion.
- If blood appears in the Midline once it is capped off, the line needs to be flushed with 10mL of 0.9% sodium chloride and re-locked with heparinised saline.
- If the patient is leaving the ward for a gate pass, advise to return to ward if they see blood in the line and flush line as above.
- In all other respects Midlines should be managed on the ward as per the guidelines for PICC's outlined below.

Flucloxacillian and Vancomycin are not to be infused through a Midline.

4.3 Standard Aseptic Technique [3, 5]

The below section should be read in conjunction with the SCHN Aseptic Technique Policy.

4.3.1 Definition

Asepsis: "***The aim of the aseptic technique is to prevent the transmission of micro-organisms to wounds or susceptible sites, to reduce the risk of infection***." [18]

No-touch technique refers to the identification of the 'key parts' of the CVC and IV infusion set, not touching them either directly or indirectly. This is the single most important step in achieving asepsis.

Key parts refers to the parts of the CVC that if contaminated with micro-organisms increase the risk of infection. These parts of the CVC include anything that comes into direct contact with the liquid infusion. (e.g. syringe tips, connection pieces on the IV infusion sets, tops of ampoules etc)

Standard Aseptic Technique is achieved by using sterile equipment and ensuring that the sterile component of the product does not come into contact with a non-sterile surface.[19]

Aseptic technique includes hand-washing with 2% chlorhexidine gluconate. Hand-washing should be performed *prior to*:

- setting up for the procedure and
- application of non-sterile gloves[20] for accessing and de-accessing, heparinsed saline locking, blood collection, IV infusion set changes and performing dressings.

This is to protect the practitioner/patient from cross-contamination as per standard precautions. Aseptic technique with hand-washing[5] has been shown to be as safe and effective[3] as sterile technique for PICC, Midline and CVC management.

Standard Aseptic Technique does not require gloves for procedures such as fluid bag changes and administration of medications via the burette or valves on the extension pieces.

> **Important:** Aseptic technique must be utilised for all procedures in the management of CVCs, Midlines and PICCs.

4.3.2 Changing Needleless Access Device (NAD) procedure

Equipment

- A dressing trolley.
- Containment field to maintain Aseptic technique during procedure. [Sterile plastic sheet or green plastic tray].
- Large 70% alcohol wipe or Antiseptic wipe
- 1x 0.9% sodium chloride (10mL ampoules) or Sodium Chloride 0.9% prefilled.
- 2 x 2% chlorhexidine gluconate in 70% alcohol (large) swabs.
- 1x Blunt needle for drawing up 0.9% sodium chloride (omit if using Sodium Chloride 0.9% prefilled syringe).
- Non-sterile gloves and other Personal Protective Equipment (PPE).
- 1x Needleless access device

Procedure

1. Clean trolley with large 70% alcohol wipe or antiseptic wipe.
2. Perform a 60 second hand-wash with 2% chlorhexidine gluconate. Dry hands with clean paper towels. Alternatively, using an alcohol-based hand-rub for 30 seconds (until hands are dry) will achieve proper hand antisepsis, as long as hands are not visibly soiled or contaminated with organic materials.
3. Ensure trolley is dry. Open sterile plastic sheet in centre of trolley surface.
4. The sterile sheet acts as an **aseptic field**. All sterile items are to be added to the field. **Note:** the sterile sheet has a 2.5 cm border that is not sterile.
5. Open equipment using aseptic non-touch technique onto aseptic field.
6. Attach blunt drawing up needle to 1x 10mL luer lock syringe and draw up 10mL 0.9% sodium chloride flush. Remove blunt needle from syringe and discard. Prime the needless connector with 0.9% sodium chloride flush or sodium chloride 0.9% prefilled syringes and place the tip of the NAD within the aseptic field with the syringe attached. **NOTE:** If accessing the CVAD, depending on the CVAD type either an empty syringe or syringe with 0.9% sodium chloride could be left attached.
7. Open 2% chlorhexidine gluconate in 70% alcohol swabs and leave in packaging. Place packaging on edge of sterile plastic sheet.
8. Ensure CVAD lumen is clamped.
9. Perform a 60 second clinical hand wash and dry with clean paper towels. Alternatively using an alcohol-based chlorhexidine hand-rub for 30 seconds (until hands are dry).
10. Don non-sterile gloves.
11. Hold the hub of the CVAD with 2% chlorhexidine gluconate in 70% alcohol swabs and remove the NAD.
12. Hold the hub in a downward position and wrap the second 2% chlorhexidine gluconate in 70% alcohol swabs around the outside of the hub, this is to ensure that no fluid is placed into the open hub of the CVAD. Vigorously clean the hub of the CVAD for minimum 15-30 seconds and allow to completely dry.

13. Attach the primed NAD with the required syringe attached to the hub of the CVAD and continue with the required procedure [i.e.: withdraw blood for a discard for CVC or, flush the Midline/PICC with 0.9% sodium chloride or attach primed IV fluids]

> **Note:** If during this step the hub of the NAD has become contaminated then the hub needs to be cleaned vigorously with 2% chlorhexidine gluconate in 70% alcohol swabs for minimum of 15-30 seconds and allowed to completely dry before continuing with the required procedure.

4.3.3 General Set up for accessing a CVC, Midline or PICC

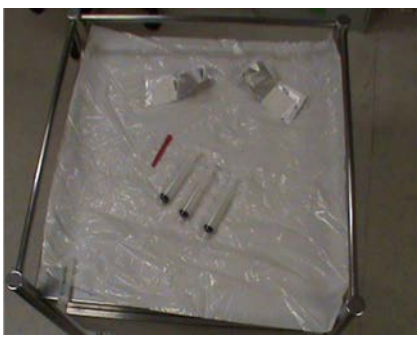
- Standard precautions apply (refer to Glossary)

Equipment:

- A dressing trolley.
- Containment field to maintain Aseptic technique during procedure. [Sterile plastic sheet or green plastic tray].
- Large 70% alcohol wipe or Antiseptic wipe.
- 2x 10mL luer lock syringes.
- 1x 0.9% sodium chloride (10mL ampoules) or Sodium Chloride 0.9% prefilled.
- 3 x 2% chlorhexidine gluconate in 70% alcohol (large) swabs.
- 1x Blunt needle for drawing up 0.9% sodium chloride (omit if using Sodium Chloride 0.9% prefilled syringe).
- Non-sterile gloves and other Personal Protective Equipment (PPE).
- Prescribed IV fluids and IV infusion set.
- Extension piece with built in valve (or 3 way tap in ICU only).
- NAD if indicated. If changing the NAD then follow the steps required to change a NAD first before proceeding with the procedure.

Procedure (A) using sterile plastic sheet

1. Clean trolley with large 70% alcohol wipe or antiseptic wipe.
2. Perform a 60 second hand-wash with 2% chlorhexidine gluconate. Dry hands with clean paper towels. Alternatively, using an alcohol-based hand-rub for 30 seconds (until hands are dry) will achieve proper hand antisepsis, as long as hands are not visibly soiled or contaminated with organic materials.
3. Ensure trolley is dry. Open sterile plastic sheet in centre of trolley surface.
4. The sterile sheet acts as an **aseptic field**. All sterile items are to be added to the field. **Note:** the sterile sheet has a 2.5 cm border that is not sterile.
5. Open equipment using aseptic non-touch technique onto aseptic field.



Picture 6

6. Attach blunt drawing up needle to 1x 10mL luer lock syringe and draw up 10mL 0.9% sodium chloride flush. Remove blunt needle from syringe and discard. Place the tip of the syringe within the aseptic field or remove cap from Sodium Chloride 0.9% prefilled syringes (e.g. Posiflush) syringe and place with tip in the sterile field.
7. Open 2% chlorhexidine gluconate in 70% alcohol swabs and leave in packaging. Place packaging on edge of sterile plastic sheet.
8. Ensure CVC lumen is clamped (if collecting blood from double or triple lumen CVC ensure all lumens are clamped).
9. Perform a 60 second clinical hand wash & dry with clean paper towels. Alternatively using an alcohol-based chlorhexidine hand-rub for 30 seconds (until hands are dry).
10. Don non-sterile gloves.
11. Follow the required procedure- see 4.3.4 (accessing a PICC or Midline) or 4.3.5 (accessing a CVC for blood collection when not in used) or 4.3.6 (accessing a CVC for blood collection when in use).

Procedure (B) using containment with a green plastic tray

The only difference when using this form of containment is that sterile items are opened and placed into the plastic tray in their original packaging to protect key parts. The green plastic tray must be cleaned with a large 70% alcohol wipe immediately prior to use for CVAD management.

4.3.4 Accessing a PICC or Midline

Note: Small diameter of Midline/PICC have an increased likelihood of clot formation. Midline/PICCs should only be used for blood collection in extreme circumstances under the direction of the Medical Team or Anaesthetist.

Equipment

- As per General Set up for accessing a CVC, Midline or PICC.

Procedure

1. Set up as per General Set up for accessing a CVC, Midline or PICC.

   Note: At all stages of this procedure the hub and valve of the Midline/PICC should **only be handled** with the 2% chlorhexidine gluconate in 70% alcohol swab[5].
2. If changing the NAD then follow the steps required to change a needless connector first before proceeding with the procedure. .
3. Hold the hub of the Midline/PICC with 2% chlorhexidine gluconate in 70% alcohol swab and with the second swab vigorously clean the hub of the NAD for a minimum of 15-30 seconds with 2% chlorhexidine gluconate in 70% alcohol swab and allow to complete dry.
4. Attach 0.9% Sodium chloride in a 10mL luer lock syringe or 10mL Sodium Chloride 0.9% prefilled syringe to the hub of NAD and flush using a pulsating action.

   Note: If Midline/PICC is heparin saline locked, heparinising the patient is minimal due to small volume
5. Clamp lumen, remove syringe.

6. Attach a primed IV infusion set including extension piece with valve (or 3 way tap in ICU) to the hub of the NAD.
7. Complete process for 2nd lumen if required.

4.3.5 Accessing a CVC for blood collection when not in use (non-accessed CVC)

Note: There is a risk of delivering a septic shower to patients when CVCs are accessed. This is due to the colonisation of microbes within the lumens of the CVC that are flushed into the circulation when the lumens are accessed. Signs and symptoms of septic showers include rigors, fever and hypotension. (Refer to Complications Table) Aspirate and discard the heparinised saline lock: DO NOT flush it into the patient[2].

Note: SCH does not routinely access CVCs when not in use for blood collection purposes. All blood samples are collected via venepuncture.

Equipment

- As per General Set up for accessing a CVC, Midline or PICC; additional equipment required for taking blood includes: extra 10mL leur lock syringes, appropriate blood tubes/ blood culture bottles and additional 2% chlorhexidine gluconate in 70% alcohol swabs.

Procedure

1. Set up as per General Set up for accessing a CVC, Midline or PICC.

   Note: At all stages of this procedure the hub of the CVC should **only be handled** with the 2% chlorhexidine gluconate in 70% alcohol swab[5].
2. Ensure CVC lumen is clamped.
3. If changing the NAD then follow the steps required to change a NAD first before proceeding with the procedure.
4. Hold the hub of the CVC with 2% chlorhexidine gluconate in 70% alcohol swab and with the second 2% chlorhexidine gluconate in 70% alcohol swab vigorously clean the hub of the NAD for a minimum of 15-30 seconds and allow to complete dry before attaching the empty 10mL luer lock syringe.
5. Unclamp lumen and withdraw 5mL blood for discard. Clamp lumen, remove syringe.

   Note: Smaller discard volumes may be withdrawn for neonates and small infants. In this situation, at least double the internal volume of the lumen must be discarded. Discard blood may be used for blood cultures. If blood cultures are to be collected and the patient has a multiple lumen CVC, then blood cultures need to be collected from all lumens. Ensure all blood cultures are labelled with specific lumen (e.g. white, red etc).

   Aspirate and discard the heparinised saline lock: DO NOT flush it into the patient[2].
6. Attach second 10mL luer lock syringe, unclamp lumen and withdraw required amount of blood.

Note: If resistance is encountered when attempting to obtain blood return from the CVC, reposition the patient, ask them to cough, take a deep breath or raise their arms over their head.

If unable to aspirate blood, using a 10mL luer lock syringe gently flush with no more than 5mL 0.9% sodium chloride. This may clear the internal lumen restoring blood aspiration. If unsuccessful, abandon procedure and refer to the restoring patency algorithm in Section 6 or contact the medical team or CVAD accredited senior nursing staff or the Vascular Access CNS2 immediately.

7. Clamp lumen, remove syringe and slowly agitate blood in syringe for 10 seconds to prevent clotting. Place on trolley.
8. Attach a 10mL 0.9% sodium chloride syringe (luer lock or prefilled syringe) to the lumen and flush using a pulsating technique. **Pulsating action** refers to flushing a CVC using a pulsing (push – pause – push) motion following the administration of medications, collection of blood samples or prior to connecting IV infusion sets. This creates turbulence in the catheter lumen assisting the prevention of fibrin sheath formation.
9. Clamp lumen, remove syringe.

Note: If there is blood still present in the NAD, then it needs to be flushed again with 0.9% sodium chloride or the NAD changed if blood is unable to be flushed through.

10. Vigorously clean the hub of the NAD for a minimum of 15-30 seconds with the third 2% chlorhexidine gluconate in 70% alcohol swab and allow to completely dry before attaching IV infusion.
11. Attach a primed IV infusion set including extension piece with valve (or 3 way tap in ICU) to the hub of the NAD.
12. Agitate syringe before adding blood to specimen tubes as required.
13. When adding blood to blood culture bottles, if there is insufficient blood for both aerobic and anaerobic bottles, aerobic culture should be collected first as this will detect the majority of bacteraimic episodes.
14. Complete process for 2nd lumen if required.

4.3.6 Accessing a CVC for blood collection when in use (accessed CVC)

Note: For inpatients, blood should be collected from the lumen already accessed via a valve on the extension piece using Aseptic technique. To decrease the breaking of the closed system, an extension piece with a built in valve (or 3 way tap in ICU) should be placed between the CVC hub and the IV infusion set.

If collecting blood for a drug level (e.g. Cyclosporin) confirm whether it is feasible to collect the sample from a CVC lumen which the drug has been administered through.

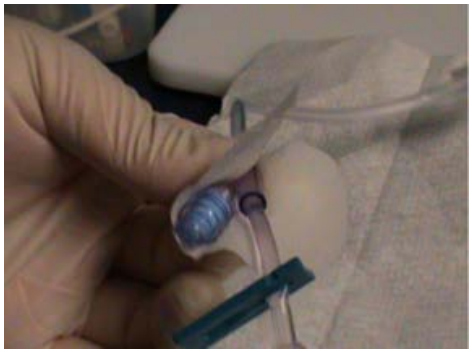
If blood cultures are to be collected and the patient has a multiple lumen CVC, all lumens require blood cultures to be collected. Ensure all blood cultures are labelled with specific lumen (e.g. white, blue etc).

Equipment

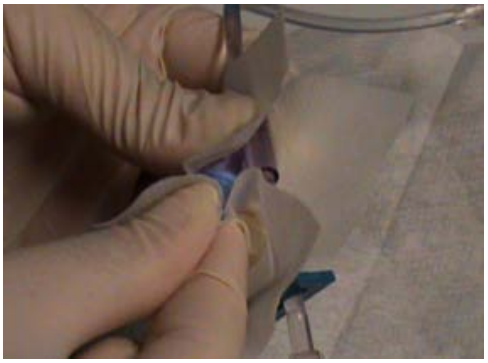
- As per General Set up for accessing a CVC, Midline or PICC, *plus*:
  - Appropriate blood tubes
  - Blood culture bottles (if required)
  - 2% chlorhexidine gluconate in 70% alcohol [large swabs]
  - 10mL luer lock syringes

Procedure

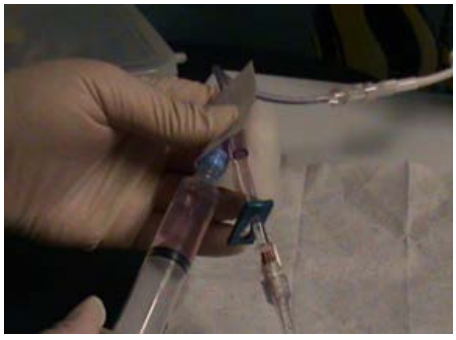
1. Procedure as per General Set up for accessing a CVC, Midline or PICC.
2. Ensure all lumens have been clamped before commencing procedure Rationale see above. (At this point, ensure fluids are stopped by clamping lumen/s. This allows time for the fluid to dissipate from the area allowing for accurate Pathology results.)
3. Close the blue slider clamp of the extension line. Clamp distal to the valve (Picture 7)
4. Holding below the valve with a 2% chlorhexidine gluconate in 70% alcohol swab, then wrap the second 2% chlorhexidine gluconate in 70% alcohol swab around the valve on the extension piece and vigorously clean for a minimum of 15-30 seconds and allow to dry completely dry before attaching the empty 10mL luer lock syringe. (Picture 8)
5. Attach a 10mL luer lock syringe to the valve on the extension piece, unclamp the lumen (or in ICU open valve), withdraw 5mL of blood, re-clamp lumen, remove syringe and place on trolley if blood cultures are required or discard (Pictures 9 and 10).



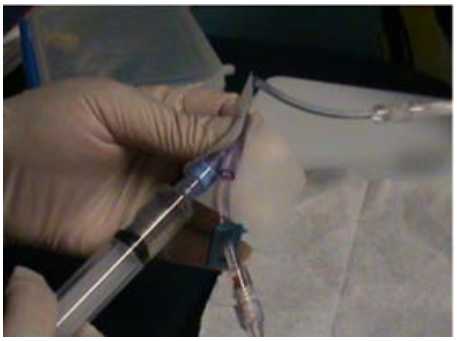
Picture 7



Picture 8



Picture 9



Picture 10

6. Attach a second 10mL luer lock syringe to the valve.

7. Unclamp the lumen (or in ICU open 3-way tap to the valve) and withdraw required amount of blood for pathology collection.

> **Note:** If resistance is encountered when attempting to obtain blood return from tunnelled CVC reposition patient, ask them to cough, deep breath or raise arms over head.
>
> If unable to aspirate blood, using a 10mL luer lock syringe gently flush with no more than 5mL 0.9% sodium chloride. This may clear the internal lumen restoring blood aspiration. If unsuccessful, abandon procedure and refer to the restoring patency algorithm in Section 6 or contact CVAD accredited senior nursing staff or the Vascular Access CNS2 immediately.

8. Clamp lumen, remove syringe and slowly agitate blood in syringe for 10 seconds to prevent clotting. Place on trolley.
9. Clean the valve with a new 2% chlorhexidine gluconate in 70% alcohol swab and allow to dry.
10. Attach 10mL luer lock syringe with 10mL of 0.9% sodium chloride or 10mL 0.9% Sodium Chloride prefilled syringe to valve, unclamp the lumen and flush using pulsating action. **Ensure that blood has cleared the IV infusion set and valve (or 3 way tap in ICU); if still present, flush again with 0.9% sodium chloride using pulsating action**.
11. Repeat procedure for each available lumen.
12. Unclamp CVC, IV infusion sets and extension set clamp and recommence IV therapy at required rate
13. Agitate syringe before adding blood to specimen tubes as required.
14. When adding blood to blood culture bottles, clean the top of the bottle with 70% alcohol swabs and allow to dry. If there is insufficient blood is available for both aerobic and anaerobic bottles, aerobic culture will detect the majority of bacteraemic episodes.

> **Note:** If a child is receiving an inotropic infusion through a lumen, the lumen **MUST NOT** be interrupted. Discuss with an Intensivist the best way to collect blood.

4.4 Dressings for CVC, Midline and PICC [3-5, 7, 21]

- Dressings that are applied at the time of catheter insertion should be left intact for at least 5 – 7 days if at all possible unless soiled, lifting or skin irritation.
- Cleaning procedure for CVC/Midline/PICC sites is the same regardless of what type of dressing is used, or whether a dressing is required or not.
- Patients under three months of age should use aqueous 0.1% Chlorhexidine Irrigation Solution for skin cleansing. For non-skin areas such as needless devices, use 2% chlorhexidine gluconate in 70% alcohol.
- The exit site should be cleaned with 2% chlorhexidine gluconate in 70% alcohol swab stick. Betadine 70% should not be used, unless required due to patient skin sensitivity, as it is less effective antiseptic than chlorhexidine.

Note: Chlorhexidine should not come into contact with 0.9% sodium chloride as a precipitation will occur leading to the inactivation of the chlorhexidine. If using 0.9% sodium chloride to clean the skin ensure it is dry prior to applying the chlorhexidine.

- Saline should not be used for skin antisepsis unless there are no other options for skin antisepsis. Saline should only be used to remove debris from the site and allowed to adequately dry before application of chlorhexidine to ensure deactivation of the chlorhexidine does not occur.
- Non-sterile gloves should be worn when performing a CVAD dressing. Note: If difficulty is experienced when applying adhesive dressing, non-sterile glove may be removed as long as the principles of aseptic technique are maintained and the sterile components of the dressing are not contaminated by touching.
- A transparent semipermeable dressing or dry dressing may be used to cover the tunnelled CVC exit site. (e.g. IV3000)
- The external portion of the tunnelled cuffed CVC should contain a loop or 'S' shape underneath the transparent dressing to assist in preventing the catheter from being accidentally pulled out. (See Picture 14)
- All CVADs must ALWAYS be covered with a sterile transparent semi permeable dressing.

Transparent Semi Permeable Dressing

- Dressings that are applied at the time of catheter insertion should be left intact for at least 5 – 7 days if at all possible unless heavily soiled, lifting or skin irritation.
- If dressing does need to be changed post operatively sooner than 5 days then extra caution should be taken to prevent the dislodgement of the CVAD. A sterile transparent semi permeable dressing can be used to cover the catheter exit site.
- Dressings must be changed at least every 7 days or sooner if visibly wet or soiled or become loose.
- All dressing changes must be dated on the dressing and documented in the patient's medical record and CVAD care plan.

Dry Dressing

- For tunnelled CVCs a sterile dry dressings can be used as an alternative to sterile transparent dressings temporarily if:
  - CVAD site is infected.
  - Area around the CVAD exit site is irritated or broken down.
  - The patient is receiving cytotoxic drugs that are excreted in sweat and can cause skin irritations (e.g. Thiotepa).
- If gauze dressing used, it must be changed at least daily and after showering.
- 2% chlorhexidine gluconate in 70% alcohol should be used to clean the skin in non-infected or irritated sites.
- In infected catheter exit sites, consult with CVAD accredited senior nursing staff or the Vascular Access CNS2 or medical team in regard to cleaning solution.

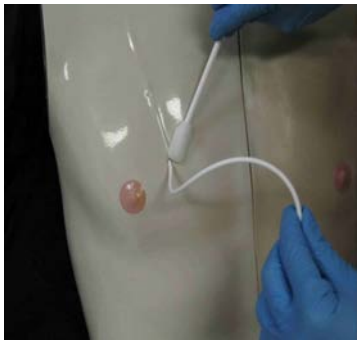
4.4.1 Procedure for Tunnelled cuffed CVC Dressing

Equipment

- Trolley.
- Large 70% alcohol wipe.
- Transparent dressing or dry dressing.
- 1 x 2% chlorhexidine gluconate in 70% alcohol swab sticks (consider using 2 swab sticks if exit site is visibly soiled).
- 2 x 2% chlorhexidine gluconate in 70% alcohol swab (large).
- Non-sterile gloves.
- If exit site is visibly soiled, 0.9% sodium chloride can be used to clean the skin, however it must be allowed to dry as it will cause a precipitate if it comes into contact with chlorhexidine.

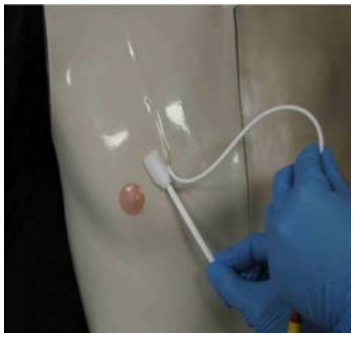
Procedure

1. Gather equipment.
2. Clean trolley with large 70% alcohol wipe or antiseptic wipe.
3. Perform 60 second hand wash with 2% chlorhexidine gluconate, dry with paper towels. Alternatively, using an alcohol-based chlorhexidine hand-rub, rub hands for 30 seconds (until hands are dry) will achieve adequate hand antisepsis, as long as hands are not visibly soiled or contaminated with organic materials.
4. Ensure trolley surface is dry. Open transparent or dry dressing: at CHW, use open pack as aseptic field; at SCH, use green tray as aseptic field.
5. Open 1 x 2% chlorhexidine gluconate in 70% alcohol swab sticks but do not remove from packaging: place onto aseptic field.
6. Open 2% chlorhexidine gluconate in 70% alcohol swab: place onto aseptic field.
7. Remove old dressing.
8. Perform 60 second hand-wash with 2% chlorhexidine gluconate. Alternatively, use an alcohol-based chlorhexidine hand-rub for 30 seconds (until hands are dry).
9. Don non-sterile gloves (standard precaution for dealing with potential body fluids).
10. Pick up a 2% chlorhexidine in 70% alcohol swab stick with dominant hand and hold CVC in other. With the swab stick clean around the CVC site in a vigourous scrubbing circular motion moving outwards from exit site ensuring whole area to be covered with dressing is cleaned. Alternatively, a cross hatch scrubbing motion can be used. Turn swab stick over (or repeat with a 2nd swab stick). Discard stick. If debris still visible, repeat with second stick. (Picture 11 – 13)

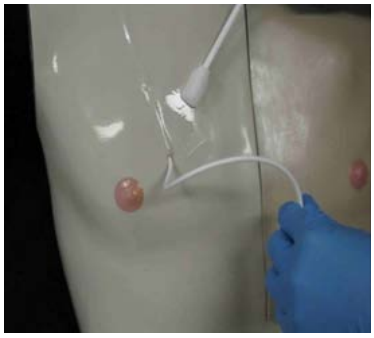


Picture 11

11. Pick up 2% chlorhexidine 70% alcohol swab with dominant hand and hold CVAD in other hand. With the swab, clean along the CVAD lumen starting from the exit site, moving outwards to the CVAD hub including the bifurcation. Discard swab.



Picture 12

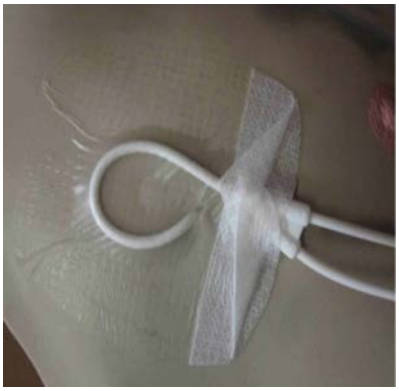


Picture 13

Note: Caution is required when cleaning the CVAD lumen, ensure CVAD is not pulled creating pain or discomfort to patient and the potential movement of the tip within the body.

12. If debris still visible, repeat with another swab.

Tunnelled cuffed CVC Transparent dressing procedure:



Picture 14

1. Allow to dry.

2. Loop the tunnelled CVC lumen around the exit site. The position of the loop may be changed if the skin is compromised; do not force the CVC to loop in the other direction.

3. Apply transparent dressing over the looped CVC ensuring bifurcation is covered and the exit site is in the centre of the dressing. Ensure the dressing is in contact with the skin around the exit site.

Tunnelled cuffed CVC dry dressing procedure

1. Loop the CVAD around the exit site.

2. Use three adhesive wound closure strips (e.g. Steri-strips) wrapped around the lumen and crossed in a butterfly style to secure the CVAD.

3. Place a dry dressing over the exit site and secure with Steri-strips.

4. If skin around CVAD exit site is compromised, consider applying hydrocolloid dressing to the skin so that the tape securing the CVC can be attached to this rather than to the skin.

5. Cut hole in hydrocolloid dressing to place around the CVAD site.

4.4.2 Procedure for Non-tunnelled CVC, Tunnelled uncuffed CVC, Midline and PICC Dressing

- The transparent semi permeable dressing of these lines must be changed at least every 7 days or sooner if visibly wet or soiled or become loose.
- The catheter securement device should be changed if lifting from the skin, if it is not providing adequate securement of the catheter, if it is significantly soiled or if the skin is showing signs of redness/irritation from the device. If the device appears soiled but is still providing adequate securement, then clinical judgement should be used as to whether an exchange of the device is necessary. This is to lessen the chance of catheter dislodgement during the exchange procedure.

Equipment

- As per procedure for Tunnelled cuffed CVC Dressing, plus: Securement Device and sterile gloves (only if the securement device needs changing).
- **Note:** If the securement device needs changing then it is recommended to be a 2 person procedure. This is to ensure that the catheter does not move when the securement device is changed.

Procedure

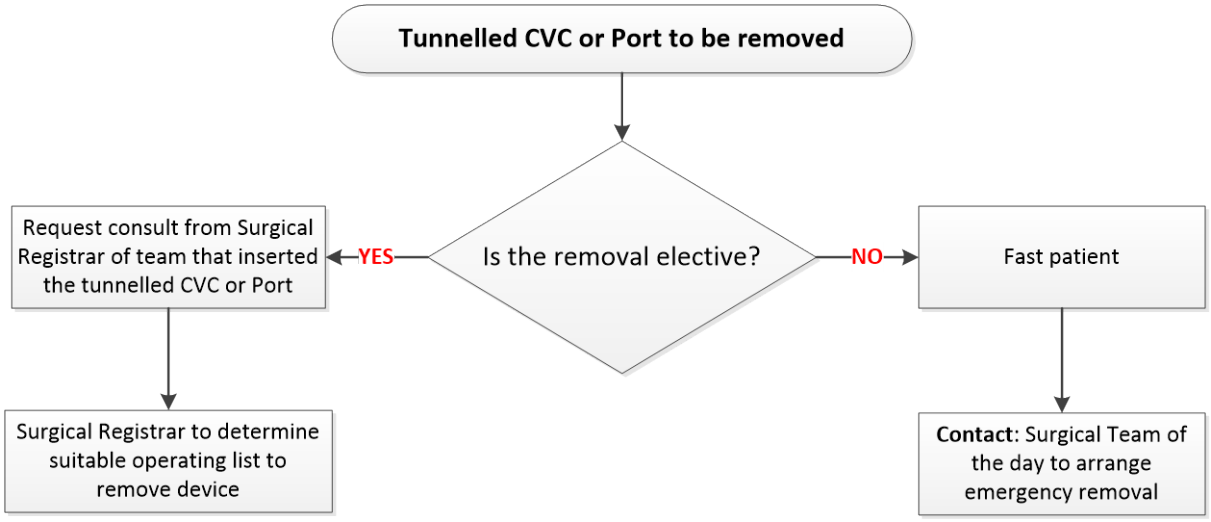
- **Note:** If a weekly dressing change is being attended without needing to change the securement device then follow the below procedure excluding points 5, 10, 11, and 14.
- **Note:** Document the **external length** of catheter from exit site to hub, prior to dressing exchange procedure.

As per procedure for tunnelled cuffed CVC Dressing, **points 1, 2 and 3**

4. Ensure trolley surface is dry. Open transparent dressing: use open pack as aseptic field.
5. Open Securement device but do not remove from packaging: place onto aseptic field.
6. Open 1 x 2% chlorhexidine gluconate in 70% alcohol swab stick but do not remove from packaging: place onto aseptic field.
7. Remove old dressing, from site by pulling edges away from each other. Leave the securement device insitu for now.
8. Perform 60 second hand-wash with 2% chlorhexidine gluconate. Alternatively, using an alcohol-based chlorhexidine hand-rub for 30 seconds (until hands are dry).
9. Don non-sterile gloves (standard precaution for dealing with potential body fluids).
10. Assistant to also perform hand hygiene and then don sterile gloves.
11. Assistant is to provide manual catheter securement at the insertion site, while the proceduralist removes the securement device (as per manufacturer's instructions).
12. The insertion site, surrounding skin and catheter is to be cleaned with the 2% chlorhexidine gluconate in 70% alcohol swab stick.
13. Allow to dry.
14. Apply new securement device as per manufacturer's instructions, while assistant provides manual catheter securement at the insertion site.

15. Apply transparent dressing over the PICC or Midline ensuring the securement device is covered and the insertion site is in the centre of the dressing. Ensure the dressing is in contact with the skin around the insertion site.
16. Document the external length of catheter from the insertion site to hub. If the external length of catheter has changed during the dressing change procedure, contact Anaesthetics and do not restart IV therapy until advised.

4.4.3 Flowchart of tunnelled cuffed CVC or Port Removal Process



4.5 Removal of CVAD[7]

- All CVADs should be assessed by both the medical and nursing teams on a daily basis to determine ongoing need. If the catheter is no longer considered necessary it should be removed.
- Removal of a non-tunnelled CVC/un-cuffed tunnelled CVCs /Midline/PICC is a competency based assessment and should only be performed by accredited RN's.
- Responsibility for routine removal of non-tunnelled CVC/un-cuffed tunnelled CVCs /Midline/PICCs rests with the clinical team managing the patient. If more than one consultant is involved in the patient's care, there should be discussion amongst the involved teams prior to the removal of the catheter to ensure that all teams agree with the removal. Removal orders must be documented by the medical team in the progress notes prior to removal.
- Routine removal of a non-tunnelled CVC/uncuffed tunnelled CVC [CHW only] /Midline/PICC at completion of therapy is not an indication for culture of the tip of the catheter. Tip culture should only be performed if there is a specific indication such as unexplained fever, significant erythema or exudate at the insertion site of the peripheral catheter tip.
- Non-tunnelled CVCs and Midlines should not be trimmed.
- Uncuffed tunnelled CVCs are always trimmed.

- PICC's are usually trimmed at insertion. This is dependent on the anaethetists preference and the type of PICC inserted. If a PICC has been trimmed this should be documented in the CVAD insertion form in Powerchart. When removed, the catheter tip must be inspected to ensure it is intact or if the PICC has been trimmed the length should be checked with the length documented in the Powerchart insertion form. All catheters removed should be checked for integrity particularly the small 2.7 Fr catheters as a segment may fragment off and be left behind in the vein.

  Note: Cardiac Surgeons may cut the tip because it can be in the way during surgery. If the cardiac surgeon cuts the catheter then this must be documented in the patient's medical record and insertion checklist to ensure that staff removing the catheter are aware.
- In the event of a non-tunnelled or uncuffed tunnelled CVC/Midline/PICC becomes kinked, blocked or develops a leak around the insertion site, the catheter should not be removed until reviewed by an Anaesthetist (or Intensivist or Neonatologist) or Vascular Access CNS2. In many situations it is possible to restore the patency. Re-wiring a non-tunnelled CVC may be considered in children in whom options for venous access are limited.
- Removal of the catheter **must** be documented in the CVAD "Removal Form". At SCH, the form is in hardcopy, and at CHW the PowerChart CVAD removal Form is to be completed.
- The 2 major complications associated with the removal of a CVAD are air embolism and bleeding. Other complications include haematoma, infection, dislodged thrombus and breakage of the catheter tip.
- Signs and symptoms of an air embolism include cyanosis, hypotension, increased venous pressures, and rapid loss of consciousness. This is a medical emergency. Position patient head down on left side, apply 100% oxygen, follow emergency protocols. Commence Basic Life Support as needed.

4.5.1 Procedure for removal of non-Tunnelled CVC, un-cuffed tunnelled CVC, Midline and PICC

Note: Procedure performed by a Medical Officer or Registered Nurse who has been deemed competent through the accreditation process.

Equipment

- Sterile Field
- Stitch cutter (for removal of CVAD, if it has been secured with stitches)
- Sterile gauze square
- Occlusive dressing
- Personal Protective Equipment (PPE)
- Sterile scissors and specimen jar if catheter tip requires culture
- 2% chlorhexidine in 70% alcohol swab stick
- Non-sterile gloves

Procedure

1. Attend baseline observations prior to commencing procedure.
2. Apply PPE as necessary.
3. Turn off all infusions and clamp all lumens of the catheter.
4. **Position patient supine with head slightly down** (if tolerated).

   Note: This is to increase the pressure in the large veins to above atmospheric pressure, which reduces the risk of air aspirating into the venous circulation.
5. Loosen dressing and lift securement device.
6. Remove sutures if necessary.
7. Clean any bloody debris and insertion site with 2% chlorhexidine in 70% alcohol swab stick and allow to dry.
8. Hold a gauze square over the insertion site with your non-dominant hand or if uncuffed tunnelled CVC press on the base of the neck at the insertion site and on the exit site.
9. If the patient is able, ask them to take a deep breath and hold their breath. Then with your dominant hand, gently remove the catheter using a slow steady motion. If they are unable to hold their breath, then remove the catheter in the same manner at the beginning of expiration.

   Note: Breath holding lessens the risk of air entering the exit tract and causing an air embolism.
10. Grasp the catheter not the hub, until completely removed.

    If resistance is encountered, do not continue with removal, apply clear dressing and call medical team. Stay with the patient until reviewed by medical team.
11. Remove dressing with catheter and place onto the sterile field taking care not to contaminate the tip of the catheter if a tip culture required.
12. Once removed remind the patient to breath normally.
13. Continue to hold pressure using the sterile gauze over insertion site and apply pressure to stop bleeding. If uncuffed tunnelled CVC, maintain pressure at both sites for a minimum of 5 minutes post removal until bleeding stops at exit site on the chest.
14. Apply occlusive dressing. The site must be sealed with an occlusive dressing which remains insitu for at least 24 hours to reduce the risk of late air embolism.
15. Observe for the signs of complications and maintain supine bed rest (if possible) or semi-fowlers if supine is not tolerated, for a minimum of 30minutes.
16. Attend at least one set of observations during this 30minute period, as well as immediately prior to moving the patient back to the upright position.
17. Inspect the tip of the catheter to ensure it is intact. If catheter appears to be cut at the distal end, measure the catheter length and compare this to the CVAD insertion record. This will confirm if the catheter has been removed intact. If these values do not correlate and there is a possibility of part of the catheter remaining internally in the patient call for an urgent medical review.

    Send tip to Microbiology if indicated. Cut approximately 2-3cm from the end of the catheter with sterile scissors and using sterile forceps place tip of catheter in the sterile specimen jar. Ensure Pathology request has been completed by medical team.

18. Document removal in the CVAD insertion/removal record on Powerchart and in the patient's progress notes. Noting the presence of an intact tip.
19. Advice the patient to keep dressing dry and intact for first 24hours post removal, the dressing can be removed 5-7 days post removal. If parents have any concerns at home post removal then parents can be advised to present to their closest emergency department or GP.

Note: Patient must be observed for a minimum of 1 hour post removal before being discharged home or in the care of the parent.

4.6 Vascaths for Stem Cell Harvesting

At SCH: Refer to Vascular Access Catheters: Insertion and Management of Temporary Vascaths – SCH Practice Guideline.

At CHW:

- **The clinical management of a vascaths is the same as a CVAD with the following additional principles:**
  - Haemodialysis CVAD or Vascaths / Gamcaths are inserted into oncology patients to enable the collection of Peripheral Blood Stem Cells (PBSC).
  - These catheters do not have a cuffed and are inserted under GA by anaesthetists in operating theatres and remain in place for the duration of the PBSC collection procedure (s) for a maximum of 5 days.
  - These catheters are only for PBSC harvesting/ therapeutic apheresis procedures and must not be used for any other purpose unless authorised by the BMT/Apheresis Clinical Nurse Consultant/ Collection facility Medical Director.
  - The catheters can be locked with heparin. Due to the large bore size of these catheters, a higher concentration of heparin is required. The type of lock used is at the discretion of the consultant and will be dependent on the individual child's circumstances. All the vascaths have the volume of the lumen documented on the catheter. This documentation will be on the extensions or clamps. The lock volume used should be the exact volume documented on the catheter. The vascaths are to be locked using positive pressure lock.
  - **Heparinise saline lock for vascaths: 50units per mL.**
  - Patients need to remain hospitalised while the femoral line is in place, with no weight bearing or where possible not sitting at an angle greater than 45 degrees.
  - Blood can be collected from the Vascath by CVC accredited Registered nurses.
  - Due to the short duration a Haemodialysis CVC is required for Stem Cell Harvesting, the exit site dressing is left intact until removal of the CVC where possible.
  - The Vascath will be removed when it is no longer required for PBSC harvesting.

- Prior to removing the CVC, the patient's platelet count must be checked and be greater than 50 000 x 10^9. Peripheral coagulation studies need to be attended and corrected if required prior to removal of the Vascath.
- The Vascath can be removed by CVC accredited Registered nurse following confirmation of completion of PBSC collection by the Apheresis nurse and confirmation of coagulation results by oncology registrar.

Procedure for removal:

The removal of a Vascath procedure is the same as removal of non-tunnelled CVC with the following additional principals:

1. Remove the occlusive dressing.
2. Remove the stitch(s) and apply firm pressure to the exit site for at least 10-15 mins.
3. Apply pressure dressing to the exit site.
4. Pressure dressing can be removed the next day if there are no problems with bleeding.
5. Advise the patient not to shower / bathe for the first 24 hours following removal.

5 Clinical Management: PORTS

Note: Only Accredited RNs and Medical staff who have undergone appropriate education are to access and manage Ports. Refer to Section 1.2

5.1 General Principles

- Surgical aseptic technique with the use of sterile gloves is used for accessing Ports.
- Non-coring needles are to be used when accessing Ports as traditional needles would core the silicone chamber of the Port resulting in blood leakage and contact with air.
- Non-coring needles must be changed weekly from the date of access.
- The bevelled tip of the non-coring needle allows the tip of the needle to sit flush with the back of the Port without impeding the flow of the solution infusing.
- Due to the possibility of damaging the chamber of the Port or creating a hole in the base of the chamber, non-coring needles should not to be manipulated sideways or rotated once *insitu*.
- Topical anaesthetic can be applied to the skin over the portal chamber prior to access. However, in the event that the patient presents/develops a fever or the non-coring needle is accidentally removed, do not wait for topical anaesthetics to take effect to access the Port.
- The dressing should be changed if it becomes loose or visibly soiled.
- The non-coring needle must be well secured to prevent accidental dislodgement and levering at the insertion site.

Minimum syringe size to be used with Port is 10mL. This is to reduce the possibility of an over pressurisation effect (this may cause catheter rupture when pressures are in excess of 40psi).[2]

- If Ports are to be used immediately post-operatively, a non-coring needle is used to access the Port whilst the patient is anaesthetised and position is to be checked by aspiration and backflow of blood. It is then either heparinised saline locked or connected to IV fluids.
- The extension set must have primed NAD's attached before connecting to the Port.
- Once a Port is accessed, the extension line of the non-coring needle takes on the role as a CVC. All clinical management of Ports will follow that of a tunnelled CVC, including the application of a NAD.

5.2 Blood Collection

- Ports are designed to be utilised for the collection of blood specimens if needed.
- Ports should only be accessed for the sole purpose of blood collection when:
  - there is no other form of IV access,
  - blood cultures are required for suspected Port infection
- If a patient has previously had a Port that was blocked, it may not be advisable to use the new Port for blood sampling. This must be documented in the patient's notes.
- Blood collection via a Port is to be attended using the same procedure as via a tunnelled CVC. See Section 4.3.5 [when not in use] and Section 4.3.6 [when in use]

Note: If a child has a double chamber Port, both chambers require blood cultures collected.

5.3 Accessing Ports – Sterile technique [3,5]

- Sterile technique with the use of sterile gloves is used for accessing Ports.

  Rationale: direct contact between the operator and the needle and the introduction of a foreign body into the patient.

- Topical anaesthetic or "Coolsense" can be applied to the skin over the portal chamber prior to access, allow sufficient time for effect. Refer to Topical Anaesthesia - Lignocaine, Prilocaine 5% Cream (EMLA) Nurse Initiated Medication.

- In the event that the patient presents to the Emergency Department with a fever or the non-coring needle is accidentally removed, do not wait for topical anaesthetics to take effect to access the Port. However a "coolsense" device can be used if readily available.

- Topical anaesthetic cream is to be removed with a dry wipe first followed by a wet wipe to ensure all cream is removed to prevent possible contamination when accessing.

- The skin over the chamber must be cleaned with 2% chlorhexidine gluconate in 70% alcohol swab stick and allowed to dry prior to access.

- When accessed, Ports should be covered with a sterile transparent semi-permeable dressing. The dressing should be changed every 7 days when the non-coring needle is changed or if the area underneath the dressing becomes moist.

- If patient's skin is sensitive to transparent dressing:

  - Use dry (gauze) dressings and must be changed every 48 hours or sooner if soiled or lifting or silicone foam dressing can also be used and must be changed every 5-7 days.

- The IV infusion set attached to the accessed Port must be well anchored to the patient to prevent accidental dislodgement and the non-coring needle levering at the insertion site.

5.3.1 Accessing a Port

Note: There is a risk of delivering a septic shower when the patients' Port is accessed. This is due to the colonisation of microbes within the internal catheter or chamber of the Port that are flushed into the circulation when the Port is accessed.

Signs of septic showers include- fever, rigors and hypotension. (Refer to Complications Table.)

Aspirate and discard the heparinised saline lock; DO NOT flush it into the patient[2].

Prior to collecting equipment and commencing the procedure, palpate the Port to locate the position and discuss angle location with patient.

Prime IV infusion sets using aseptic technique ensuring the sterility of the key parts are maintained. If a Port will be used for blood collection, place valve on the 'Y' site of the non-coring needle extension set to maintain a closed system.

Equipment

- Trolley and large 70% alcohol wipe.
- Sterile dressing pack.
- Sterile gauze.
- 3 x 10mL Luer lock syringes (more if blood collection is required).
- 2 x 0.9% sodium chloride (10mL ampoules).
- Non-coring needle with extension set.
- 2 x NAD
- 1 x 2% chlorhexidine gluconate in 70% alcohol swab sticks.
- 2 x 2% chlorhexidine gluconate in 70% alcohol swab.
- Blunt needles for drawing up 0.9% sodium chloride.
- Sterile gloves and other personal protective equipment (PPE).
- Primed IV infusion sets (use aseptic technique to prime the IV infusion set prior to commencing this procedure) if required.
- Semi-permeable transparent dressing, if required.
- Blood tubes, blood culture bottles and 70% alcohol wipe (if required).

Procedure

1. Clean trolley surface with large 70% alcohol wipe and allow to dry.
2. Perform 60 second hand wash with 2% chlorhexidine gluconate. Dry with clean paper towel. Alternatively, using an alcohol-based chlorhexidine hand-rub for 30 seconds (until hands are dry) to achieve adequate hand antisepsis, as long as hands are not visibly soiled or contaminated with organic materials.
3. Open dressing pack onto clean dry trolley surface. Note: the sterile dressing pack has a 2.5cm border that is considered not sterile.
4. Open all equipment and place onto dressing pack that acts as a sterile field.
5. Ensure the IV infusion set is primed prior to start of procedure using aseptic technique, if required.
6. Perform 2 minute hand wash with 2% chlorhexidine gluconate. Dry hands with paper towel.
7. Don sterile gloves.
8. Attach blunt needle to 10mL luer lock syringe and draw up 0.9% sodium chloride flush.
9. Attach 2x NADs to the gripper needle access points and prime both access points with 0.9% sodium chloride, clamp and remove syringe. Attach empty 10mL luer lock syringe (in preparation for aspirating heparinised saline lock).
10. Attach blunt needle to another 10mL luer lock syringe and draw up 10mL 0.9% sodium chloride flush and place the tip of the syringe in the middle of the aseptic field.
11. With 2% chlorhexidine in 70% alcohol swab stick clean around the Port site in a circular motion moving outwards from the Port site ensuring whole area to be covered with dressing is cleaned. Turn swab stick over and repeat for second side. Discard stick. If debris still visible, repeat with a second stick. Allow to dry.

12. Identify the Port membrane under the skin by palpation with non-dominant hand.

13. Stabilise the Port membrane securely between thumb and index finger with non-dominant hand.

14. Insert primed non-coring needle at 90 degree angle into the centre of the Port membrane, avoiding any old access sites or scar tissue. You will feel the needle hit the back of the Port once through the silicone chamber.

> **Note:** Once the needle is inserted the end of the non-coring needle extension line should **only be handled** with the 2% chlorhexidine gluconate in 70% alcohol swab.

15. Using a 2% chlorhexidine in 70% alcohol swab to hold valve, draw back on syringe to aspirate blood return ensuring the correct positioning of needle (unless contraindicated and documented by the Clinical Team managing the patient).

16. Aspirate and discard the heparinised saline lock: DO NOT flush it into the patient.

> **Note:** If unable to aspirate blood, using a 10mL luer lock syringe gently flush with no more than 5mL 0.9% sodium chloride. This may clear the internal lumen restoring blood aspiration. If unsuccessful, abandon procedure and refer to the restoring patency algorithm in Section 6 or contact CVAD accredited senior nursing staff or the Vascular Access CNS2 immediately.
>
> A chest x-ray may be required to determine the state of the device prior to any further investigation or assessment.

5.3.2 Accessing a Port when blood collection is NOT required

- If accessing and *IV therapy is required within a 24hr period*, then the non-coring needle and extension piece are to be left insitu and device locked with heparinised saline (10Units/mL).
  - Equipment as per 5.3.1 (above) with additional blunt needle, luer lock syringe and heparin saline (10 Units/mL).
  - Ensure lumen is flushed with 0.9% sodium chloride and clamped (as previous procedure) and remove luer lock syringe.
  - Attach the syringe with 4 mL of heparinised saline (10 Units/mL).
  - Unclamp and heparinise saline lock the Port with positive pressure as per section Preventing Port Occlusion leaving Port needle secured *insitu* with semi-permeable transparent dressing.
- If accessing *and requiring immediate IV therapy*:
  - Equipment as per 5.3.1 (above) with a primed IV infusion set.
  - Using a 2% chlorhexidine in 70% alcohol swab to hold valve, draw back on syringe to aspirate blood return ensuring the correct positioning of needle (unless contraindicated and documented by the Clinical Team managing the patient).
  - Aspirate heparinised saline lock, clamp extension tubing, remove syringe and discard.
  - Attach 10mL luer lock syringe with 0.9% sodium chloride and flush Port using pulsating action.
  - Attach primed IV infusion set.

5.3.3 Accessing a Port when blood collection is required

- Refer to Section 4.3.5 [when not in use] and Section 4.3.6 [when in use]

5.4 De-accessing a Port

Equipment:

- Trolley and large alcohol 70% wipe.
- Sterile plastic sheet or green plastic tray.
- 2x 10mL Luer lock syringes.
- 1x 0.9% sodium chloride (10mL ampoules).
- 2% chlorhexidine gluconate in 70% alcohol swabs.
- Heparinise saline lock as per Section 3.7 (Heparinised saline locking CVADs).
- Non-sterile gloves and other personal protective equipment (PPE).
- Sharps container.
- 2x Blunt drawing up needles.
- Gauze.
- Band-Aid

Procedure

Note: Assistance may be required from a second nurse or parent to maintain pressure on the syringe plunger as you remove the non-coring needle: otherwise the procedure may be performed by a single operator.

Note: At SCH, when using a green plastic tray, sterile items are opened and placed into the tray in their original packaging to protect key parts.

1. Clean trolley with large 70% alcohol wipe.
2. Perform 60 second hand wash with 2% chlorhexidine gluconate. Dry with clean paper towel. Alternatively, using an alcohol-based chlorhexidine hand-rub, rub hands for 30 seconds (until hands are dry) to achieve proper hand antisepsis, as long as hands are not visibly soiled or contaminated with organic materials.
3. Ensure trolley is dry. Open sterile plastic sheet and place in centre of trolley surface.
4. The sterile plastic sheet acts as an aseptic field.

Note: all sterile items are to be added to the field leaving a 2.5cm border that is not sterile.

5. Open equipment using aseptic non-touch technique onto the sterile plastic sheet.
6. Attach blunt needle to 10mL Luer lock syringe and draw up 0.9% sodium chloride flush and place on the edge of the sheet with the tip in the aseptic field. Alternatively a pre-filled 0.9% sodium chloride 10mL syringe may be used.
7. Repeat to draw up for heparinise saline lock.
8. Open 2% chlorhexidine gluconate in 70% alcohol swabs and leave in packaging, placing packaging on the edge of the plastic sheet.

9. Clamp non-coring needle extension piece.

10. Lift the edges of the transparent dressing to allow access to non-coring needle.

11. Perform a 60 second hand wash with 2% chlorhexidine gluconate or using an alcohol-based chlorhexidine hand-rub for 30 seconds (until hands are dry).

12. Don non-sterile gloves.

> **Note:** At all stages of this procedure the end of the non-coring needle extension line should **only be handled** with the 2% chlorhexidine gluconate in 70% alcohol swab.

13. Using aseptic non-touch technique:

- **i.** Disconnect IV infusion set from non-coring needle extension line and discard.
- **ii.** Attach 10mL luer lock syringe with 0.9% sodium chloride to the NAD on the extension piece, unclamp non-coring needle extension piece and flush the Port using pulsating action.
- **iii.** Clamp extension piece.
- **iv.** Attach 10mL luer lock syringe with previously drawn up heparinised saline lock. Instil 3mL of Heparinise saline lock and stop.
- **v.** In order to create a **positive pressure lock** in a Port constant pressure must be maintained on the syringe plunger as the non-coring needle is removed from the patient. This prevents backflow of blood into the catheter tip and subsequent thrombus formation. (At this point assistance from another nurse/parent may be required).
- **vi.** Stabilise the Port membrane between thumb and forefinger with non-dominant hand.
- **vii.** Take hold of the non-coring needle with dominant hand.
- **viii.** Secure Port with one hand; instil the final 1mL of the heparinised saline whilst removing the non-coring needle. (Using an assistant if needed)
- **ix.** Dispose of extension set into sharps container.
- **x.** Use a dry piece of gauze to place pressure over the entry site to control any bleeding.

> The technique of injecting as the needle is being pulled out from the Port, is to prevent blood moving back into the catheter lumen to occupy the space left behind by the withdrawn needle.

14. Place Band-Aid if required.

15. Document procedure in the patient's medical record.

6 Complications

There are many potential complications with the use of a CVAD. These complications can be potentially life threatening.

6.1 Complications that require an IIMS Report

- Confirmed CVAD infection noting the treatment used to clear the infection: antibiotic lock therapy, ethanol or HCl. This is the responsibility of Medical Staff. See 'How to enter CVAD infection incident into IIMS' sheet.
- All non-infection related complications include inability to remove device, faulty equipment, repairing tunnelled CVC, precipitation of medications in IV infusion sets, accidental removal of any CVC, malpositioned CVADs, blocked CVAD, etc.

Refer to section 6.9 Other possible CVAD Complications table for additional complications. See 'How to enter CVAD non-infection incident into IIMS' sheet.

6.2 Infections associated with CVAD[3,5]

Infection is the most common life threatening complication of CVADs. Limiting the frequency of access to the device to essential procedures only, is vital in attempting to decrease the risk of infection. Other possible complications are listed in the table Section 6.9.

- CVAD infections can occur due to contamination by:
  - Skin flora on insertion
  - Skin bacteria migration down the catheter
  - Bacteria transfer through the hub during manipulation
  - Transient bacteraemia from translocated organisms from other parts of the body (e.g. mouth, gastrointestinal tract or skin)
- The types of CVAD-related infections are:
  - Colonisation of the CVAD
  - Exit-site infection
  - Pocket infection (Port) / Tunnel infection (CVC)

Catheter removal is recommended for catheter related blood stream infection (CRBSI) due to *S. aureus* and Candida species, as well as treatment with systemic antibiotics. Catheter retention with ethanol or hydrochloric acid locks is NOT recommended for these organisms, unless there are unusual extenuating circumstances (e.g., no alternative catheter insertion site).

Note: Antibiotic locks are not to be used routinely to prevent infections (i.e. for prophylaxis), but can be utilised to sterilise confirmed CVAD infections[21] in conjunction with systemic antibiotic therapy. Refer to Section 6.3.2 for more details or contact Infectious Diseases.

6.2.1 Catheter Related Blood Stream Infections (CRBSI)

If a patient has a CVAD insitu and develops a fever without any obvious signs of infection, a CRBSI **must be considered** and remain as the key source of infection until proven otherwise. If confirmed infection, complete an IIMS report (responsibility of Medical Staff).

CRBSI occurs due to bacterial colonisation of the CVAD. Refer to the below section for CRBSI definition. If a CRBSI is considered, perform the following:

1. Take peripheral blood cultures (colonisation of catheter vs. sepsis)
2. Take blood cultures from CVAD (all lumens). Label blood cultures with each lumen.
3. Start IV antibiotics. Each IV antibiotic dose should be administered through alternate lumens of the CVC; therefore all lumens of the CVC are connected to IV infusion sets. In cases where continuous infusions of chemotherapy or inotropes are in progress, alternating each dose of antibiotic may not be possible. Similarly, in cases where PN is in progress consider stopping PN for a period of time or discuss compatibility of antibiotics with Pharmacy.
4. Notify consultant. Discuss CVAD removal.
5. If in doubt treat as infected CVAD for 48-72 hours until blood culture results are available.

6.2.2 Definition of Catheter Related Blood Stream Infections (CRBSI)

<table>
<tr><th colspan="2">NSW Health definition of central line associated blood stream infection for adults and paediatrics[22]</th></tr>
<tr><td colspan="2">The bloodstream event must meet one of the following three criteria (criteria 1 and 2 may be used for patients of any age, including patients < 1 year of age):</td></tr>
<tr><td>Criterion 1:
Patient has a recognised pathogen cultured from one or more blood cultures and organism cultured from blood is not related to an infection at another site. (See Notes 1 and 2 below.)</td><td rowspan="2">Criterion 3:
Patient < 1 year of age has at least one of the following signs or symptoms:
■ fever (>38ºC, rectal);
■ hypothermia (<37ºC, rectal);
■ apnea;
■ or bradycardia and displays:
■ signs and symptoms of infection and positive laboratory results are not related to an infection at another site and common skin contaminant is cultured from two or more blood cultures drawn on separate occasions. (See Notes 3, 4 and 5 below)</td></tr>
<tr><td>Criterion 2:
Patient has at least one of the following signs or symptoms:
■ fever (>38ºC); ■ chills; ■ or hypotension; and displays:
■ signs and symptoms of infection and positive laboratory results are not related to an infection at another site and common skin contaminant is cultured from two or more blood cultures drawn on separate occasions. (See Notes 3 and 4 below.)</td></tr>
<tr><td colspan="2">Notes:
1 In criterion 1, the phrase “one or more blood cultures” means that at least one bottle from a blood draw is reported by the laboratory as having grown organisms (i.e., is a positive blood culture).
2 In criterion 1, the term “recognised pathogen” does not include organisms considered common skin contaminants (see criteria 2 and 3 for a list of common skin contaminants). A few of the recognised pathogens are S. aureus, Enterococcus spp., E. coli, Pseudomonas spp., Klebsiella spp., Candida spp., etc.
3 In criteria 2 and 3, the phrase “two or more blood cultures drawn on separate occasions” means 1) that blood from at least two blood draws were collected within two days of each other (e.g., blood draws on Monday and Tuesday or Monday and Wednesday would be acceptable for blood cultures drawn on separate occasions, but blood draws on Monday and Thursday would be too far apart in time to meet this criterion), and 2) that at least one bottle from each blood draw is reported by the laboratory as having grown the same common skin contaminant organism (i.e., is a positive blood culture). (See Note 4 for determining sameness of organisms.)
Examples of common skin contaminants include diphtheroids [Corynebacterium spp.], Bacillus [not B. anthracis] spp., Propionibacterium spp., coagulase-negative staphylococci [including S. epidermidis], viridans group streptococci, Aerococcus spp., Micrococcus spp.
4 There are several issues to consider when determining sameness of organisms. Refer to Table 3 (page 6-7) in the NSW Heath Healthcare Associated Infection: Clinical Indicator Manual for more information:
http://www.cec.health.nsw.gov.au/__data/assets/pdf_file/0009/258372/hai-manual.pdf
5 For patients < 1 year of age, the following temperature equivalents for fever and hypothermia may be used: Fever: 38°C tympanic/temporal artery = 37°C oral = 36°C axillary Hypothermia: 37°C tympanic/temporal artery = 36°C oral = 35°C axillary.</td></tr>
</table>

6.3 Eradicating biofilm in an infected CVAD

Recommendations:

Current recommendations published by the Infectious Diseases Society of America (IDSA)[23] support firstly the removal of the CVAD (*A-II) to treat an infected CVAD.

When removal of the CVAD is not desirable the use of (in order of hierarchy) should be considered:

1. Treat with antibiotic lock (*B-II)

2. Treat with ethanol lock (*C-III) (tunnelled CVC use only)

3. Treat with hydrochloric acid† (tunnelled CVC use only)

The procedures must NOT be used in combination. If any of the above procedures are used, it should be noted in IIMS with the 'infected CVAD' incident.

***Strength of Recommendation**

A-II	Good evidence (from > 1 properly randomised controlled trial) to support the recommendation.
B-II	Moderate evidence (from > 1 properly randomised controlled trial) to support the recommendation.
C-III	Poor evidence at this point in time (opinions of respected authorities based on clinical experience etc) to support the recommendation
† IDSA do not mention using hydrochloric acid to sterilise infected tunnelled CVCs. However, a study from CHW suggests that it is effective in clearing the CVC from infection[24, 25], though this is a retrospective uncontrolled study.	

6.3.1 Equipment list

[List to be used for any of the following lock procedures (antibiotic, ethanol or HCl)]

Note: at SCH, when using a green plastic tray sterile items are opened and placed into the plastic tray in their original packaging to protect key parts.

- Trolley and large alcohol 70% wipe or antiseptic wipes
- Sterile plastic sheet or green plastic tray.
- 3x 10mL luer lock syringes.
- 1 x NAD.
- 0.9% sodium chloride (10mL ampoules).
- 2 x 2% chlorhexidine gluconate in 70% alcohol swabs.
- Non-sterile gloves and other PPE.
- Sharps container.
- Blunt drawing up needle.
- Lock solution (either antibiotic, 70% ethanol or 2M HCl – refer to procedures below).

6.3.2 Use of Antibiotic locks to sterilise an infected CVAD

Notes:

1. Antibiotic locks may be used to sterilise an infected CVAD[23], however, antibiotic prophylaxis is NOT recommended to prevent CRBSIs[3].

2. Antibiotic lock therapy **MUST be discussed** with the Infectious Diseases (ID) team and follow local Antibiotic Stewardship policy.

Consultation with the ID team is essential, as effectiveness of treatment is assessed by clinical and microbiological criteria.

Antibiotic Lock Therapy Recommendations[23]

- Antibiotic locks are indicated for all patients with CRBSI involving long term catheters with no signs of exit site or tunnel infection if catheter salvage is the goal.
- This procedure must be used in conjunction with appropriate systemic antimicrobial therapy with both regimens administered for 7 -14 days.
- Dwell times must not exceed 24hours before reinstallation of antibiotic lock solution.
- Catheter removal is recommended for CRBSI due to *S. aureus* and Candida species unless there are extenuating circumstances (e.g. no alternative catheter insertion site).
- For patients with no clinical evidence of sepsis and multiple positive catheter-drawn blood cultures that grow coagulase negative staphylococci or gram negative bacilli and concurrent negative peripheral blood cultures, antibiotic lock therapy can be given without systemic therapy for 10 -14 days.

Important:

Heparin is NOT compatible with most antibiotics and should NOT routinely be added to the antibiotic locks. (If the addition of heparin 10 Units/mL is deemed necessary the Pharmacy Department may be contacted to discuss compatibility and stability).

Table: Final concentrations of antibiotic lock solutions used to treat CRBSI[23]

- To make up the solutions, refer to CVAD Antibiotic Lock Dilution Tables:

Vancomycin	2mg/mL
	2.5mg/mL
	5mg/mL
Vancomycin at 5mg/mL is more efficacious than at 1mg/mL in eradicating staphylococci embedded within biofilm.	
Ceftazidime	0.5mg/mL
Cefazolin	5mg/mL
Cefazolin is the preferred agent for treatment of methicillin-sensitive staphylococci and vancomycin is the preferred agent for treatment of methicillin-resistant staphylococci	
Gentamicin	1mg/mL
Ampicillin	10mg/mL
Ampicillin is the preferred agent for treatment of ampicillin sensitive *Enterococcus* species and vancomycin is the preferred agent for ampicillin-resistant enterococcus other than vancomycin resistant enterococci.	

*Ceftazidime & gentamicin can be used for treatment of gram negative micro-organisms.
*The use of ethanol lock can be considered for the treatment of a mixed gram negative and gram positive infection.

Antibiotic Lock Therapy Procedure

NOTE: If the deadspace of the CVC is not known, then this should be determined before proceeding with the procedure. Refer to Section 3.8 Determining internal volume (deadspace) of a CVAD.

Equipment: refer to section 6.3.1 Equipment list.

Note: The following procedure is performed by RNs accredited in antibiotic lock therapy instillation and Medical staff who have undergone appropriate education.

Antibiotic lock therapy **MUST be discussed** with the Infectious Diseases (ID) team and follow local Antibiotic Stewardship policy.

Consultation with the ID team is essential, as effectiveness of treatment is assessed by clinical and microbiological criteria.

The procedure needs to be performed through a valve. Each lumen of the CVAD should be treated sequentially to allow access, but not simultaneously.

For CVCs, the hub should be held with a chlorhexidine swab at all stages of this procedure[3,5].

1. Clean trolley with large 70% alcohol wipe or antiseptic wipes.
2. Perform 60 second hand-wash with 2% chlorhexidine gluconate. Dry hands with paper towel. Alternatively, using an alcohol-based chlorhexidine handrub for 30 seconds (until hands are dry) will achieve adequate hand antisepsis, as long as hands are not visibly soiled or contaminated with organic materials.
3. Ensure trolley is dry. Open sterile plastic sheet and place in centre of trolley surface
4. The sterile sheet acts as an aseptic field.

   Note: all sterile items are to be added to the aseptic field leaving a 2.5cm border that is not sterile.
5. Open equipment using aseptic technique onto the sterile sheet/green tray.
6. Perform 60 second hand-wash with 2% chlorhexidine gluconate. Dry hands with paper towel. Alternatively, using an alcohol-based chlorhexidine handrub for 30 seconds (until hands are dry).
7. Prepare antibiotic solution. Refer to Antibiotic Lock Dilution Tables.
8. Draw up appropriate volume of antibiotic solution into a 10mL luer lock syringe (appropriate volume is the internal volume of the lumen + 0.1mL NAD internal volume).
9. Draw up 10mL of 0.9% sodium chloride into a 10mL luer lock syringe and attach is to NAD and prime the NAD and leave connected.
10. Ensure the CVC lumen is clamped.
11. Hold the hub of the CVC with 2% chlorhexidine gluconate in 70% alcohol swab and remove the NAD and vigorously clean around the hub of the CVC or Port extension piece with the second 2% chlorhexidine gluconate in 70% alcohol swab. Allow to dry.
12. Attach empty luer lock syringe, unclamp lumen and withdraw 5mL blood for discard. Clamp lumen, remove syringe.
13. Clean around the hub of the CVC or Port extension piece with 2% chlorhexidine gluconate in 70% alcohol swab. Allow to dry.
14. Attach the 10mL luer lock syringe with 0.9% sodium chloride with primed NAD attached to the hub of the CVC and flush using a pulsating technique and clamp lumen and

remove syringe from the NAD. If the NAD becomes contaminated then clean vigorously a new 2% chlorhexidine gluconate in 70% alcohol swab and allow to dry.

15. Connect syringe containing antibiotic solution to NAD and instil recommended volume (in accordance with catheter size + NAD deadspace) with positive pressure technique and remove syringe. Leave in situ for no greater than 24 hours. (Consult with ID team)
16. Clearly label that the CVAD lumen has an antibiotic lock in situ. Document the antibiotic lock procedure in patient's medical record, including which lumen is currently locked with the antibiotic solution.
17. Following the recommended dwell time, unclamp CVC or Port extension piece and aspirate the antibiotic solution and discard.

The Antibiotic lock is NOT to be flushed into the patient's circulation.

18. Flush CVAD with 0.9% sodium chloride using a pulsating action.
19. Repeat this process for 7 - 14 days such that each lumen has the antibiotic lock instilled for the recommended dwell time of 7 – 14 days. (Consult with ID team)

6.3.3 Use of Ethanol to eradicate biofilm in an infected tunnelled CVC

Note: Only RNs and Medical staff accredited in ethanol instillation may perform this procedure. Procedure to be noted in **IIMS** with the 'infected CVAD' incident.

Ethanol locks are reported to be a safe and well tolerated technique used to treat CVC infection in children who have persistently positive blood cultures[26, 27]. The following are principles outlined in the literature and are developed from current practices undertaken in children[28-30].

Recommendation

- This procedure must be used in conjunction with appropriate intravenous antibiotics.

Contraindications

- PICC
- Un-cuffed tunnelled CVC
- Midline
- Polyurethane catheters/Port
- Allergy to ethanol
- Evidence of a tunnel or exit site infection
- Evidence of a metastatic infection
- Under 2 years of age
- Liver impairment
- Avoid in poor metabolisers

Adverse Events

- Dizziness, headaches, nausea, tiredness, light headedness and alcohol intoxication.
- **Not to be used in patients who are sedated**.

Ethanol Lock Procedure

NOTE: If the deadspace of the CVC is not known, then this should be determined before proceeding with the procedure. Refer to section 3.8 Determining internal volume (deadspace) of a CVC.

Equipment: refer to section 6.3.1 Equipment list **plus** 1x NAD.

Each lumen of the tunnelled CVC should be treated sequentially to allow access, but not simultaneously. **At all stages of this procedure the CVC hub should be held with a chlorhexidine swab**[3, 5].

Instil ethanol into the lumen only (i.e. not via valve): valves serve as caps in this procedure.

1. Clean trolley with large 70% alcohol wipe or antiseptic wipes.
2. Perform 60 second hand-wash with 2% chlorhexidine gluconate. Dry hands with paper towel. Alternatively, using an alcohol-based chlorhexidine handrub for 30 seconds (until hands are dry) will achieve adequate hand antisepsis, as long as hands are not visibly soiled or contaminated with organic materials.
3. Ensure trolley is dry. Open sterile plastic sheet and place in centre of trolley surface.
4. The sterile plastic sheet acts as an aseptic field.

   Note: all sterile items are to be added to the aseptic field leaving a 2.5cm border that is not sterile.
5. Open equipment using aseptic non-touch technique onto the sterile sheet.
6. Perform 60 second hand-wash with 2% chlorhexidine gluconate. Dry hands with paper towel. Alternatively, using an alcohol-based chlorhexidine handrub for 30 seconds (until hands are dry).
7. Don non-sterile gloves.
8. Draw up 1.4mL of 100% ethanol and add 0.6mL 0.9% sodium chloride to make a 70% ethanol concentration.
9. Draw up 3mL of 0.9% sodium chloride into a 10mL luer lock syringe.
10. Draw up appropriate volume of 70% ethanol into a 10mL luer lock syringe (appropriate volume is the internal volume of the lumen).
11. Hold the hub of the CVC with 2% chlorhexidine gluconate in 70% alcohol swab and remove the NAD and vigorously clean around the hub of the CVC or Port extension piece with the second 2% chlorhexidine gluconate in 70% alcohol swab. Allow to dry.
12. Attach empty luer lock syringe, unclamp lumen and withdraw 5mL blood for discard. Clamp lumen, remove syringe.
13. Attach the 10mL luer lock syringe with 0.9% sodium chloride to the hub of the CVC and flush using a pulsating technique and clamp lumen and remove syringe.
14. Clean around the hub of the CVC or Port extension piece with 2% chlorhexidine gluconate in 70% alcohol swab. Allow to dry.
15. Connect syringe containing ethanol and instil recommended volume (in accordance with catheter size), clamp lumen, remove syringe and attach primed NAD and leave in situ for 4 hours.
16. After 4 hours remove NAD following the principals of CVAD access, attach empty syringe, unclamp lumen and aspirate ethanol and discard.

Ethanol is NOT to be flushed into the patient's circulation.
17. Flush tunnelled CVC with 10mL of 0.9% sodium chloride using a pulsating action.
18. Clean the hub of the CVC with 2% Chlorhexidine gluconate in 70% alcohol swab and allow to dry.
19. Attach new primed NAD

20. Repeat this process for 5 days such that each lumen has 70% ethanol instilled for 4 hours for 5 days.

Limit the amount of overflow into the bloodstream.

6.3.4 Use of Hydrochloric Acid (HCl) to sterilise an Infected tunnelled CVC

Note: Only trained Medical staff may perform this procedure.

The following protocol is based on expert opinion and refers to the long standing and current practice **at CHW**: it is not routine practice at SCH. (Also refer to the recommendations above)

Procedure to be noted in **IIMS** with the 'infected CVAD' incident.

Recommendation

- This procedure must be used in conjunction with systemic IV antibiotics.

Precautions

- Be aware that this is a very acidic drug and will precipitate with many drugs. Ensure the lumen/s of the tunnelled CVC are cleared with 0.9% sodium chloride before use.
- This is 2M HCl solution (not 0.1M), so depending on the patient's age/weight and underlying conditions some seemingly small volumes may result in acidosis.

Potential Complication

Febrile reaction: is not uncommon; presumably reflecting denatured proteins entering the circulation. The patient's blood can be cultured if febrile post-HCI treatment, and it should still be cultured 24hours after the procedure regardless.

Procedure for acidification

NOTE: If the deadspace of the CVC is not known, then this should be determined before proceeding with the procedure. Refer to section 3.8 Determining internal volume (deadspace) of a CVC.

Equipment: refer to section 6.3.1 Equipment list **plus** 1x NAD.

Instil HCl into the lumen only.

At all stages of this procedure the CVC hub should be held with a chlorhexidine swab[3, 5]. The hub of the NAD must be vigorously cleaned with 2% chlorhexidine gluconate in 70% alcohol swab before each access.

1. Change the NAD on both lumens as per section 4.3.2 and the deadspace of the lumen can then be determined through this NAD attached.
2. Clean trolley with large 70% alcohol wipe or antiseptic wipes.
3. Perform 60 second hand-wash with 2% chlorhexidine gluconate. Dry hands with paper towel. Alternatively, using an alcohol-based chlorhexidine handrub for 30 seconds (until hands are dry) will achieve adequate hand antisepsis, as long as hands are not visibly soiled or contaminated with organic materials.

4. Ensure trolley is dry. Open sterile plastic sheet and place in centre of trolley surface.
5. The sterile plastic sheet acts as an aseptic field.

   Note: all sterile items are to be added to the aseptic field leaving a 2.5cm border that is not sterile.
6. Open equipment using aseptic non-touch technique onto the sterile sheet/green tray.
7. Perform 60 second hand-wash with 2% chlorhexidine gluconate. Dry hands with paper towel. Alternatively, using an alcohol-based chlorhexidine handrub for 30 seconds until hands are dry.
8. Don non-sterile gloves.
9. Attach blunt needle to 10mL luer lock syringe and draw up 10mL of 0.9% sodium chloride or use 10mL prefilled luer lock 0.9% sodium chloride and attach NAD and prime.
10. Hold the hub of the CVC with 2% chlorhexidine gluconate in 70% alcohol swab and remove the NAD and vigorously clean around the hub of the CVC or Port extension piece with the second 2% chlorhexidine gluconate in 70% alcohol swab. Allow to dry.
11. Attach empty luer lock syringe, unclamp lumen and withdraw 5mL blood for discard. Clamp lumen, remove syringe.
12. Attach the 10mL luer lock syringe with 0.9% sodium chloride to the hub of the CVC and flush using a pulsating technique and clamp lumen and remove syringe.
13. Clean around the hub of the CVC or Port extension piece with 2% chlorhexidine gluconate in 70% alcohol swab. Allow to dry.
14. Slowly inject HCI (2M) into each lumen of the tunnelled CVC. The volume to be injected is the dead-space volume + 0.5mL. Clamp lumen and remove syringe and attach a valve. Clamp CVC and leave for 10 minutes.
15. Ensure the lumen is clamped, remove NAD following the principals of CVAD access and using a 10mL luer lock syringe aspirate as much of the HCI as possible back out of the catheter.

    HCl is NOT to be flushed into the patient's circulation under any circumstances.
16. Attach the 10mL of 0.9% sodium chloride or 10mL prefilled luer lock 0.9% sodium chloride with NAD to the hub of the CVC and flush using pulsating action and positive pressure lock the lumen.
17. Leave 20 minutes, and then repeat steps 1 to 13.
18. Repeat again, so that HCI is left in the tunnelled CVC lumen(s) a total of 3 times.
19. The tunnelled CVC can be used immediately.

NOTE: At the final 10mL of 0.9% sodium chloride flush after the third round. The NAD must be changed to a new primed NAD.

Re-culture blood from the tunnelled CVC 24 hours post HCl instillation

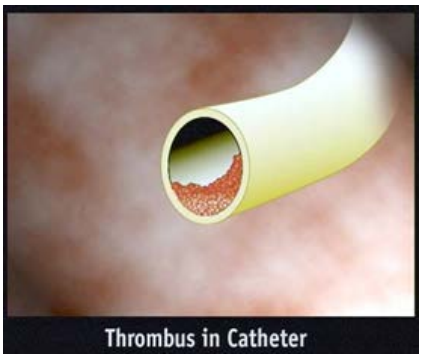
Note: If further positive cultures, the tunnelled CVC should be removed.

6.4 Occluded CVAD[31]

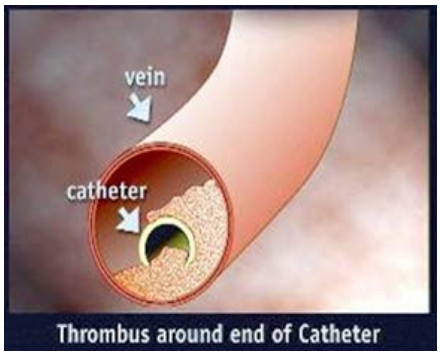
Definitions[13]

- Withdrawal Occlusion – ability to flush but not aspirate
- Total/Complete Occlusion – inability to flush or aspirate
- Partial Occlusion – resistance to flushing or sluggish blood return on aspiration

- CVADs are at risk of occluding due to:
  - **Fibrin deposits and blood clots**. Deposits of fibrin and blood components within and around the tip of the CVAD can impede or disrupt flow causing either partial, withdrawal or total occlusion (see Pictures 15 and 16)[32]

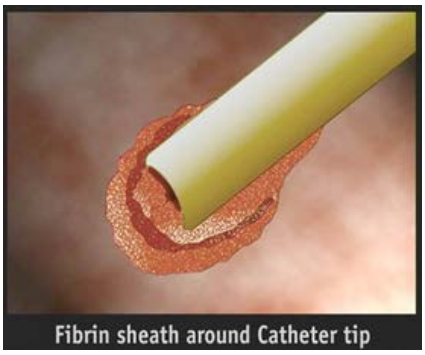


Picture 15

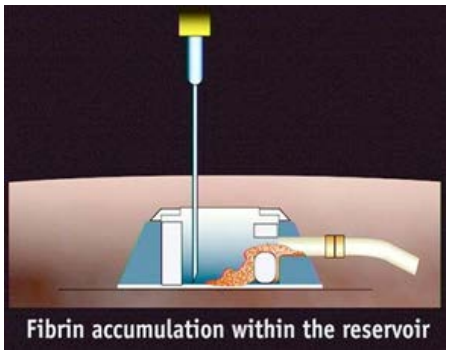


Picture 16

  - **Fibrin sheath**. Insoluble proteins (thrombi or fibrin tails) extending from the catheter tip. An extension of this fibrin sheath can block withdrawal of blood through the catheter but fluids may still be able to infuse through because the fibrin tails is pushed away with pressure from flushing. (see Picture 17)[32]



Picture 17



Picture 18

  - **Chemical occlusions.** Build-up of precipitate from medications, blood products and/or fat emulsions within the CVAD can impede or disrupt flow causing partial, withdrawal or total occlusion.

6.4.1 Other Potential Causes of Occlusion

Cause of occlusion	Signs of Symptoms	Intervention
Mechanical Occlusion		
1. External Secondary to clamps, sutures, occluded needles	• Complete occlusion	• Check for kinking or twisting of the CVAD and IV giving set • Ensure that all clamps are opened • Check that all connections are tight • Check that sutures at the catheter exit site are not too tight, and squeezing the catheter • If a Port is in situ ensure correct positioning of needle. Re-accessing with a new needle ***must*** be completed prior to any additional intervention[33,34]. Application of local anasthesia and waiting for its effect is not recommended.
2. Internal The following actions could potentially encourage movement of the catheter tip away from the vein wall:	• Complete occlusion related to postural changes	• Change position of patient and/or neck • Raise the patient's arms over their head on the ipsilateral side • Have the patient take a deep breath, cough, laugh or cry • X-ray to confirm correct catheter tip position and exclude catheter fracture, migration or Catheter Pinch of Syndrome[34]
3. Suspected Catheter Pinch off Syndrome Catheter Pinch off Syndrome occurs when catheter tubing is compressed between the clavicle and first rib. Although rare, this complication should be ruled out	• Complete occlusion related to postural changes • Points on the external catheter may "balloon out" during flushing	• Deep breathing, reposition or raising the arm on the ipsilateral side may re-establish blood flow, but usually only temporarily[32]. • Confirmation of this problem can only be made by X-ray[32] • May require radiologic evidence
Other causes of Internal Occlusions- Non Mechanical		
Suspected intraluminal occlusion • Intraluminal Thrombus • Precipitate	Complete occlusion Complete occlusion temporally related to drug administration (see Picture 15 & 16) [32]	Trial of pharmacologic agent – dependent on whether non-Thrombotic or Thrombotic occlusion is suspected. See Occluded CVAD Pathway
Suspected fibrin sleeve	Infusion with ease, inability to aspirate blood (see Picture 17) [32]	• Trial with pharmacologic agent may be attempted • Additional diagnostic testing may be warranted • See Occluded CVAD Pathway
Catheter malposition	Pain on infusion, swelling, resistance to infusion, inability to aspirate blood	• Immediately contact medical officer • Additional diagnostic testing may be warranted. See Occluded CVAD Pathway
Occlusion Beyond Catheter Tip- Non Mechanical		
Venous Thrombosis	Facial or eye lid swelling, headache, dilated veins over chest wall, complete and sudden occlusion, pain	• **Fellow or Consultant must be notified** • Chest x-ray and Doppler ultrasound. • Venogram may be required • See Occluded CVAD Pathway

- **DO NOT USE UNDUE force to unblock a CVAD.**
- **DO NO USE smaller volume syringes (less than 10mL) as this will generate an undesirably high pressure.**
- **Blocked CVADs should always be dealt with as soon as possible and not left without treatment.**

6.4.2 Preventing CVAD Occlusions

- The risk of occlusion due to formation of a fibrin sheath or blood clot can be minimised by:
  - Care in avoiding reflux of blood up the lumen.
  - Ensuring an adequate flow rate of fluid through the IV infusion set (10mL/hr through a Baxter infusion pump). If pump does not deliver IV fluids with continuous pressure, IV fluids are to run at no less than 10mL/hour.
  - Using positive pressure locks when the CVADs are not in use. Positive pressure locks maintain the positive pressure within the internal space in the lumen of the CVAD and prevent the backflow of blood into the internal tip of the catheter, therefore preventing clots and thrombotic device occlusions[17].
  - Performing effective pulsatile flushing post medication administration and blood collection.
- The risk of occlusion due to the formation of **precipitation of medications** can be minimised by:
  - Flushing before and after the administration of medications.
  - Avoiding the administration of multiple drugs via the same lumen of the CVC/Midline/PICC unless medications and IV solutions are compatible. For medication and IV solution compatibility advice, call Pharmacy and/or refer to the Micromedex database (via CIAP).
  - IV Medications must never be added into the parenteral nutrition bag or burette and running IV medications via a sideline of the parenteral nutrition solution should be avoided. Consult with Pharmacy and the Parenteral Nutrition Practice Guideline for further information.
  - If precipitation of medication does occur in the IV infusion set and is stopped prior to reaching the patient, clamp the CVC, and change the IV infusion set and any extension pieces immediately. Report incident to medical team and pharmacy immediately. Complete **IIMS**.
  - If precipitation of drugs does occur within the IV infusion set and is infused into the patient, stop the infusion, aspirate the contents of the CVC, flush the catheter with 10mL 0.9% Sodium Chloride and contact the Medical team and pharmacy immediately. Complete **IIMS**.

Regardless of the solution utilised the most important aspect in relation to flushing and locking CVADs and maintaining patency of the CVAD is the techniques utilised. A pulsating action should always be used to flush CVADs to create a turbulent flow within the catheter and creating positive pressure when locking CVADs to prevent the backflow of blood into the internal tip of the device and the formation of clots[1].

- When in TKVO mode, IV infusion sets should infuse through an infusion pump at a minimum of 10mL/hour to prevent an occlusion of the CVAD. Please note that this minimum amount may vary according to patient age and condition as well as infusion pump device used.
- The patency of the patient's CVAD should be documented in the patient's medical record on each admission and the CVAD careplan whenever the CVAD is accessed.

- It is good practice to have TKVO fluids running via the Midline, PICC and un-cuffed tunnelled CVC while the patient is in hospital to prevent line occlusions.

6.4.3 Assessment of the CVAD occlusion

A thorough and complete assessment of the CVAD occlusion is critical for successful management of an occlusion. The following assessment should be completed before embarking on any course of treatment.

This assessment must be documented in the patient's continuation notes along with any intervention and outcome. This assessment must be communicated with the medical officer.

- Double check catheter function – infusion and blood aspiration
- Screen for external compression from clamps, sutures and kinked catheter tubing
- Assess if the occlusion is relieved after postural changes, have patient raise the ipsilateral arm (arm on same side as catheter insertion into vessel), shrug the shoulders forward, cry, cough or laugh (catheter tip resting against vessel wall, Catheter Pinch Off Syndrome).
- Secure a history of what was recently infused via the catheter, including blood products, medications and/or fat emulsions as well as blood aspirations (intraluminal thrombus or precipitate).
- Determine if catheter can be flushed but inability to aspirate blood (fibrin sleeve).
- Assess the patient for physical signs of oedema, redness, pain or dilated vessels (venous thrombosis or catheter malposition).

INSTILLATION OF A PHARMACOLOGICAL TREATMENT SHOULD NOT BE DELAYED.

After completing the assessment of the occluded CVAD, consultation with the responsible Fellow or Consultant, CVAD accredited senior nursing staff or Vascular Access CNS2 must occur to determine the best course of action. If occluded catheter is to be managed out of hours, on call RMO should contact the Fellow or Consultant.

6.4.4 Flowchart: Occluded Tunnelled cuffed CVC or Port

See the SCHN Occluded CVAD Pathway

6.5 Clearing a Thrombotic Occlusion from a Tunnelled Cuffed CVC or Port[35,36]

- Alteplase or sometimes known as rTPA (recombinant Tissue Plasminogen Activator), is NOT to be used to attempt to unblock a CVAD blocked by a chemical precipitate.
- Prior to using alteplase ensure other factors for CVAD dysfunction have been considered. These include catheter malposition, mechanical failure, constriction by a suture, lipid deposit or drug precipitate within the catheter lumen. Alteplase is not appropriate in these situations.
- Low dose alteplase instilled into the lumen of a CVC is effective in clearing a thrombus occluded catheter provided the thrombus is of recent origin[37-39]. If the clot is older than a few days then alteplase is less likely to work.
- The use of alteplase is expected to benefit patients in whom replacement of a CVC would be problematic or undesirable. Risks of removing the catheter as well as risks of using alteplase need to be considered.
- A full blood count and coagulation profile must be performed prior to proposed treatment. If coagulation is abnormal, do not proceed.
- Alteplase may only be prescribed by Surgeons, Nephrologists, Radiologists, Oncologists, Intensivists and Haematologists.
- The doctor MUST PRESCRIBE the DOSE and indicate the INTERNAL VOLUME OF THE LUMEN (i.e. the final concentration) to be instilled. This information is required before the alteplase will be dispensed by Pharmacy.
- Staff who instil alteplase must be aware of dosage, side-effects, contraindications and the procedure for instillation.

  Note: Registered Nurses who have undergone additional education and training may instil alteplase. Always consult with the patient's consultant prior to flushing as it may result in pulmonary embolism.

Precautions

- Vigorous suction should NOT be applied or it may cause damage to vascular wall or collapse of soft wall catheters.
- Excessive pressure should be AVOIDED when instilling alteplase because it can cause rupture of the catheter or expulsion of the clot into the circulation.
- Avoid in patients with active bleeding.
- Avoid if surgery within 48hrs.
- Avoid if percutaneous biopsy of viscera or deep tissue in 48hrs.
- Avoid if puncture of non-compressible vessels in 48hrs.
- Avoid in thrombocytopenia.
- Avoid in patients with haemostatic defects e.g. hepatic, renal disease.
- Avoid in patients at high risk of embolic complications.
- Avoid if known infection in catheter (risk of local infection becoming systemic).
- Do NOT instil more than twice into a lumen (unlikely to work after 2 administrations).
- Ensure that you are able to aspirate blood from the CVAD prior to attempting this procedure. If unable to aspirate, DO NOT proceed with the procedure.

Adverse Effects

The most common adverse effects:

- Sepsis ("septic shower")
- Gastrointestinal bleed
- Venous thrombus

Alteplase dose[40]

Central Venous Catheters (CVC)			
Age	Weight	Dose	Volume
Neonates and infants less than 3months	-	**Max 0.25mg per lumen**	Use volume equal to the internal volume of the lumen
Greater than 3months	<10kg	**Max 0.5mg per lumen**	Use volume equal to the internal volume of the lumen
Greater than 3months	>10kg	**Max 2mg per lumen** 2mg in 2mL (1mg/mL)	Use volume equal to the internal volume of the lumen
Port			
> 3months	<10kg	**Max 0.5mg per instillation**	Use volume equal to the internal volume of the reservoir and catheter
> 3months	> 10kg	**Max 2mg per instillation**	Use volume equal to the internal volume of the reservoir and catheter

6.5.1 Alteplase Procedure for treatment of thrombosed tunnelled CVC

Equipment

- Trolley
- Large alcohol 70% wipe.
- Sterile plastic sheet.
- 10mL Luer lock syringes.
- Valve
- Non-sterile gloves.
- 2mg/2mL alteplase (obtained from Pharmacy)
- 0.9% sodium chloride
- 2% chlorhexidine gluconate in 70% alcohol swabs

Procedure

The doctor MUST PRESCRIBE the DOSE and indicate the INTERNAL VOLUME OF THE LUMEN (i.e. the final concentration) to be instilled. This information is required before alteplase will be dispensed.

Only one lumen of the CVC or Port is to be treated at one time[41].

1. Clean trolley with a large 70% alcohol wipe.
2. Perform 60 second hand wash with 2% chlorhexidine gluconate. Dry with clean paper towel. Alternatively, using an alcohol-based chlorhexidine handrub for 30 seconds (until hands are dry) will achieve proper hand antisepsis, as long as hands are not visibly soiled or contaminated with organic materials.
3. Ensure trolley is dry. Open sterile plastic sheet and place in centre of trolley surface.
4. The sterile sheet acts as an aseptic field.

   Note: all sterile items are to be added to the aseptic field leaving a 2.5cm border that is not sterile.
5. Open equipment using aseptic non-touch technique onto the aseptic field.
6. Perform 60 second hand wash with 2% chlorhexidine gluconate. Dry with clean paper towel. Alternatively, using an alcohol-based chlorhexidine handrub 30 seconds (until hands are dry) will achieve adequate hand antisepsis, as long as hands are not visibly soiled or contaminated with organic materials.
7. Don non-sterile gloves.
8. Dilute required dose (in milligrams) with 0.9% sodium chloride to make the required volume.
9. Ensure the final concentration is no less than 0.2mg/mL[40, 41].
10. Vigorously clean around the hub of the CVC with 2% chlorhexidine gluconate in 70% alcohol swab. Allow to dry.

    Note: The hub of the CVC should only be handled with the 2% chlorhexidine gluconate in 70% alcohol swab.

    At all stages of this procedure the CVC hub should be held with a chlorhexidine swab.
11. Instil required volume of alteplase into ONE lumen of the CVC or the Port. Place primed NAD on CVC hub.
12. Allow 2 hours dwell time (may be left for up to 4 hours if required)[40, 41].
13. Gently aspirate the alteplase and the contents of the CVC or Port. If alteplase cannot be aspirated the procedure should be abandoned.

    Alteplase is NOT to be flushed into the patient's circulation.
14. After aspiration, if patency restored (i.e. blood return obtained), then flush with 10mL 0.9% sodium chloride using a pulsating action.
15. After aspiration, if patency not restored, then repeat procedure from steps 1 – 13.
16. If after 2 instillations of alteplase in 24hours the catheter is still not patent then NO further attempt may be made using alteplase. (Seek Specialist advice)

Although the use of continuous low dose alteplase infusion (12hr) for clearing of thrombosed CVC lumens has been described, it is not standard practice in SCHN hospitals.

Document the alteplase procedure in patient's medical record at completion of procedure, including patency.

6.6 Accidental Removal of a CVAD

Note: Accidental removal of a CVAD represents a potentially serious incident from a patient safety perspective and requires reporting in **IIMS**.

- If an un-cuffed tunnelled and non-tunnelled CVC, PICC or Midline is accidentally removed and there is need for ongoing access, it is important to establish whether ongoing therapy can be provided with a peripheral cannula alone or whether there is a need to re-site the non-tunnelled un-cuffed tunnelled and non-tunnelled CVC, PICC or Midline. If this is the case for a child outside the ICU, the child should be fasted immediately and contact:
  - **At CHW** - the Duty Anaesthetist contacted by paging 6777
  - **At SCH** - the Duty Registrar via switch
- If a tunnelled cuffed and un-cuffed CVC is accidentally removed apply firm pressure to both the catheter entry site in the neck vein and the external exit site in the chest regardless of how long the tunnelled CVC has been insitu. Do not release pressure until reviewed by medical team. Severe bleeding can often be controlled by pressure and sitting the patient up to lower the venous pressure.
- Monitor vital signs and estimate blood loss if any.
- Contact clinical team immediately.
- Complete an IIMS report.
- Refer to Complications Table for further instructions.
- Accidental removal of a CVAD must be documented in the CVAD Removal Form (hardcopy at SCH or electronically via PowerChart at CHW).

6.7 Repairing Tunnelled cuffed CVC

This is a reportable incident in IIMS.

In the event that a tunnelled CVC splits, snaps or cracks a repair of the tunnelled CVC may be possible. Tunnelled CVC repairs are limited to damaged external portions of the CVC. There **must be at least 5cm** of undamaged lumen remaining external to the exit site.

Contact CVAD accredited senior nursing staff or the Vascular Access CNS2 for review.

Note: If the external portion of a tunnelled CVC splits, snaps or is cracked, **immediately** clamp the lumen proximal to the site of damage on the tunnelled CVC, this must remain clamped during the repair. Cover split with sterile gauze prior to repair.

Instruct the child and family not to remove the clamp.

If a patient presents to Emergency Department with a tunnelled CVC needing repair, the patient should be admitted until the repair is completed

- Repairing tunnelled CVCs is an **advanced nursing skill** and will be limited to areas that regularly care for tunnelled CVCs. Identified staff in Oncology and intensive care services at CHW and SCH; CNS Vascular Access [both sites] and the CNC Gastroenterology [SCH] are permitted to repair tunnelled CVCs.
- Surgical Registrars: The surgical team is responsible for repair of CVC if there is no other appropriately accredited staff.
- At SCH, ONLY in exceptional circumstances will Oncology staff repair CVC in other areas of the hospital. A surgical/medical consult must be obtained by the team caring for that child before the Oncology staff can repair the line.
- The repair of tunnelled CVC is a **surgical aseptic** procedure due to the increased risk of introducing micro-organisms into the lumens of the CVC while performing the repair.
- A tunnelled CVC repair kit for each type of catheter is required for this procedure. Ensure the kit is not expired. The kit:
  - Must be the same size as the tunnelled CVC inserted. This is due to the internal lumen size. The lumen size is located on the bifurcation of the CVC.
  - Must have a current expiration date.
  - Is available through CSSD: need to know which lumen needs the repair as they are different sizes. Do not use the wrong size repair kit as it will damage the CVC. A double lumen repair kit is also available if the repair needs to be above the bifurcation.
- The tunnelled CVC repair kit contains:
  - external catheter segment with splice sleeves and clamps
  - medical adhesive
  - injection caps (these can be discarded)
  - 18 gauge blunt needle
  - Syringe

Equipment

- Tunnelled CVC repair kit
- Trolley
- Large 70% alcohol wipe (e.g Isowipe)
- Dressing pack
- Sterile gloves
- Sterile scissors
- Sterile Clamp
- 2% chlorhexidine gluconate in 70% alcohol swabs (large)
- 2 x 10mL luer lock syringe
- 1x NAD
- Tape
- Tongue depressor or application sticks
- Heparinise saline lock

Procedure

1. Clean trolley with a large 70% alcohol wipe or antiseptic wipe
2. Perform 60 second hand wash with 2% chlorhexidine gluconate. Dry hands with paper towel.
3. Ensure trolley is dry, open dressing pack onto trolley.
4. Open all equipment and place onto dressing pack that acts as a sterile field.
5. Two minute handwash with 2% chlorhexidine gluconate. Dry hands with paper towel.
6. Don **sterile** gloves.
7. Draw up 0.9% sodium chloride flush and heparinise saline lock.
8. Remove plunger from syringe barrel and inject medical adhesive into syringe barrel, insert plunger and attach blunt needle and place back onto the sterile field.

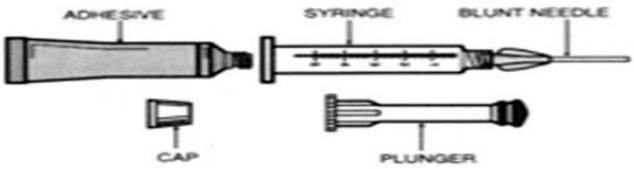


Figure 1

9. Prime the replacement lumen with 0.9% sodium chloride and clamp. Place back onto the sterile field.
10. Place sterile drape underneath external portion of the tunnelled CVC.
11. Vigorously clean the end of the tunnelled CVC that requires repair with 2% chlorhexidine in 70% alcohol swabs.
12. Wrap the lumen in sterile gauze above the intended cut and clamp the lumen, allowing enough remove so that the sleeve from the replacement catheter can fit.

> **Note:** at all stages of this procedure the hub of the CVC should only be handled with the 2% chlorhexidine gluconate in 70% alcohol swab.

13. Using sterile scissors cut the end of the damaged CVC (on the patient's side of the damaged catheter) at 90 degrees (to ensure that the damaged lumen has a straight edge and at least 5cm of catheter remains external to the patient)

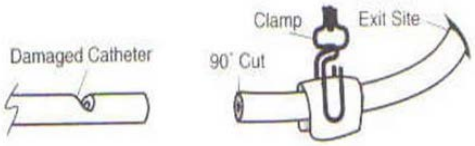


Figure 2

14. Insert the stent of the replacement catheter into the end of the remaining CVC until there is only 3mm between the replacement catheter and the cut end of the CVC.

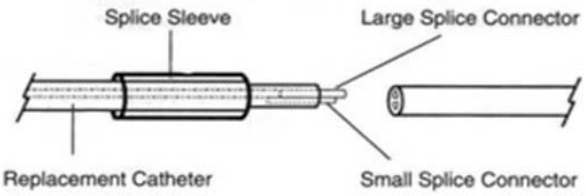


Figure 3

> Note: Do not remove the splice sleeve that is on the replacement stent.

15. Fill the 3mm space with adhesive and push the catheter ends together.
16. Move the splice sleeve onto the repaired section of tunnelled CVC, ensuring the 3mm space (catheter join) is in the centre of the splice sleeve.

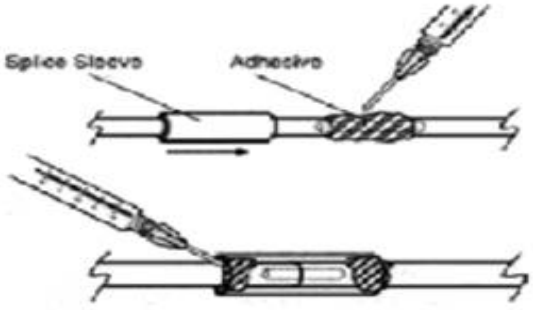


Figure 4
Pictures from Bard Access Systems 1997 product booklet

17. Inject the adhesive underneath the entire splice sleeve on both sides.
18. Wipe off any excess adhesive with a gauze swab.
19. Attach a 10mL luer lock syringe to the end of the new segment of tunnelled CVC.
20. Aspirate gently until the blood has reached the tip of the syringe. Ensure there is no leakage of fluid around the repair site. Clamp lumen and remove syringe.
21. Attach a 10mL luer lock syringe with 0.9% sodium chloride and GENTLY flush the lumen with 5mL and clamp lumen and remove syringe. Ensure there is no leakage of fluid around the repair site
22. Heparinise saline lock the CVC using positive pressure as per 'Heparinise Saline Locking a CVC' section above.
23. Splint repaired section of the CVC with the tongue depressor or application sticks. The splint must remain in place for 24 hours.
24. Do not use the repaired CVC for 24 hours.
25. Take a blood sample for a blood culture when next accessed.

6.8 Removal of Tunnelled cuffed CVC

- Ideally, all tunnelled CVCs should be removed under general anaesthesia in the operating theatre. As such, the same principles that govern insertion of the device apply to its removal.
- At the time of removal of the tunnelled cuffed CVC, care should be taken by the operating surgeon to ensure that the entire cuff has been removed and the tip of the catheter should be visually inspected to ensure that removal has been complete.
- Tips are only sent for microbiological culture if clinically indicated (i.e. unexplained fever, significant erythema or exudate at the insertion site of the peripheral catheter tip).

Removal of a tunnelled CVC must be documented in the CVAD Insertion Form. At SCH, the form is in hardcopy, and at CHW, staff should complete the PowerChart CVAD Insertion Form

6.9 Other Possible CVAD complications

Problem	Symptoms / Signs	Causes	Management
Bleeding	Insertion / Exit site bleeding Subcutaneous tunnel bleeding		Apply pressure dressing Notify surgical team Check coags and full blood count
Pneumothorax	Shortness of breath – shortly after insertion Decreased breath sounds Chest pain cyanosis	Subclavian or internal jugular insertion	Confirm with Chest X-Ray Insert intercostal drain **IIMS report – Medical team**
Septic showers	Fever Hypotension post access, Tachycardia, decrease in LOC, diaphoresis and rigors.	Accessing CVAD and flushing microbes into patient's circulation	• Blood cultures, commence IVABs • Consider stop using CVAD for administration of fluid and antibiotics. • Fluid resuscitation • Cardiovascular monitoring • PICU review as required • If loss of cardiac output – dial emergency number • Sepsis flowchart link to be added.
Air Embolism or thromboebolism	Shortness of breath Cyanosis Tachypnoea Hypotension Cardiovascular collapse	CVC being open and unclamped, without syringe attached. Air drawn in during inspiration. Thrombus attached to catheter.	• ***Urgent*** action - Clamp catheter • Dial the Emergency number • Apply oxygen • Place patient head down in the Trendelenburg position • Investigate • Consult cardiologist urgently **IIMS report – Medical Team**
Breaking or Splitting of the external component of CVC	Leakage of fluid or blood onto dressing and/or skin. Leakage of blood or fluid on external portion of CVC.	Accidental damage	• Clamp CVC with guarded clamps between exit site and site of leak. • Wrap the CVC in sterile gauze and notify surgical registrar or accredited nursing staff to repair lumen. • Identify the type and size of tunnelled CVC to notify repairer. This is found on the CVC bifurcation. • Collect blood culture only if indicated. **IIMS report - Nursing**
Exit Site Infection, tunnel infection, pocket infection	Fever Erythema swelling Pain Tracking Exudate	Bacterial invasion	• Swab for microbiology • Oral or IV antibiotics • Consider increasing frequency of dressings • Consider CVC removal if unable to control infection **IIMS Report – Medical team** Long-term salvage of infected CVC is unlikely due to bacterial persistence in the face of a foreign body. Short term

			suppression may sometimes be achieved, but ultimately CVC removal is usually necessary.
Problem	**Symptoms / Signs**	**Causes**	**Management**
Extravasation associated with a Port Extravasation with CVC	Local oedema. Redness. Localised burning or pain. Fluid leakage Swelling along tunnel or neck Localised pain on infusion	Dislodgment of needle in Port Blockage of catheter at the end or thrombosis of the vein where catheter is sited. Catheter rupture	• Stop infusion • Identify type of fluid infusing to obtain procedure for extravasation of drug • Ensure needle is correctly sited. • Withdraw residual drug • Consider resiting needle, do not wait for topical anaesthesia. • Notify medical officer. **IIMS Report - Nursing**
Superior Vena Cava Thrombosis	Shoulder or retrosternal pain. Facial or trunk oedema - prominent neck veins. Difficulty in aspirating or flushing CVAD.	Mechanical trauma to vein. Infection. High osmolality infusate. Proximal placement of CVC. Large catheter in small vein. Hypercoagulation states.	• Monitor vital signs • Possible fibrinolytic and heparin therapy • Possible catheter change • Consider radiological investigation (ultrasound / line-o-gram) **IIMS Report - Medical**
Cardiac Arrhythmia Decreased cardiac output	Pulse rate change or ECG rhythm change. Depending upon the rhythm, there may be hemodynamic instability and signs of shock.	Mal-positioned catheter tip within right atrium or ventricle. Arrhythmia most often occurs during insertion however can occur at any time if the CVC is located within the heart.	• Notify team who inserted CVC • ECG monitoring If there is an unstable arrhythmia, call **emergency number** and commence APLS algorithm prior to repositioning. Treat decreased cardiac output and arrhythmia. As above plus review medications ordered for patient. **IIMS report – Medical Team**
Cardiac Tamponade *Potentially fatal complication of CVC insertion*.	Tachycardia, diminished pulses, pulsus paradoxus, hypotension, pallor, cool extremities, clamminess and eventually altered level of consciousness. The neck veins may be distended and if measured the central venous pressure will be elevated. The heart sounds may be muffled. A CXR may show an enlarged cardiac shadow.	Occurs during insertion due to guide-wire or catheter perforation. Can be late complication due to erosion of CVC into pericardial space when it abuts a vessel or cardiac chamber wall (usually the right atrium).	Administration of fluid, which is a common emergency treatment for evolving tamponade, may exacerbate the problem if given by the offending CVC. If required, commence APLS algorithm and call emergency number. This is a **medical emergency** and the pericardial collection usually needs to be drained using ultrasound guidance. **IIMS report – Medical Team**
Pinch-off Syndrome	Inability to withdraw or infuse substances. This may improve with repositioning of the patient.	Compression of the catheter by the clavicle and the first rib	Chest x-ray to confirm position and exclude catheter tip migration. **IIMS report – Medical**

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