

Insertion, Management and Removal of **Central Venous Access Devices**



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Insertion, Management and Removal of Central Venous Access Devices

Disclaimer – 21st of December 2020

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Insertion, Management and Removal of Central Venous Access Devices

Table of Contents

Introduction and CVAD Insertion	3
Definition of Terms	3
Types of CVADs	3
Information for patients and families/carers	6
Referral for CVAD insertion.....	7
Insertion	8
Complications associated with CVAD insertion	11
Maintenance of CVADs	12
Preparation for: port access, suture-less securement device and needleless connector changes	13
Guide to Tegaderm Advanced™ sizes	18
Preparation for medication administration, priming lines, flushes, changing IV bags and blood sampling	19
Summary of when changes are to be performed	22
Heparin locking and flushing.....	24
Heparin locking LB-TC-CICC.....	25
CVAD complications and management.....	26
CVAD complications and management.....	27
Initial Management of CVAD occlusion – attempt to flush the catheter	29
Alteplase dosing and administration	29
CVAD complications and management – alteplase administration for <i>partially</i> occluded catheters.....	30
CVAD complications and management – alteplase administration for <i>completely</i> occluded catheters.....	30
CVAD removal	37
Appendix one: Midline catheters.....	39
Appendix two: Choosing an appropriate device algorithm	42

Introduction and CVAD Insertion

Definition of Terms

Term or Acronym	Definition
PIVC	Peripheral Intravenous Cannula
CVAD	Central Venous Access Device
PICU	Paediatric Intensive Care Unit
NICU	Neonatal Intensive Care Unit
RA	Right Atrium
LDA	Lines Drains and Airway
EMR	Electronic Medical Record
Scrub the hub	Applying vigorous friction with a 2% chlorhexidine and 70% alcohol solution to the surface of a needleless connector or catheter hub. Scrubbing is to occur for a minimum of 15 seconds. The needleless connector is to completely air dry.

Types of CVADs

Device	Acronym	Other common names
Peripherally Inserted Central Catheter	PICC	
Centrally Inserted Central Catheter	CICC	CVC
Tunnelled CICC	T-CICC	Tunnelled CVC
Tunnelled Cuffed CICC	TC-CICC	Hickman™ Broviac™
Femorally Inserted Central Catheter	FICC	Femoral line, femoral CVC
Umbilical Venous Catheter	UVC	
Totally Implanted Venous Access Device	Port	Port-a-cath™ Infusaport™
Large Bore CICC or dialysis catheter	LB-CICC	Vascath™
Large Bore Cuffed CICC	LB-TC-CICC	Permcath™

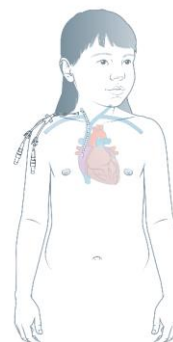
Centrally Inserted Central Catheter (CICC)

Description: Inserted into the subclavian vein, internal jugular vein, or external jugular vein. Most commonly used in acute and critical care settings. They are not to be used outside of the hospital setting

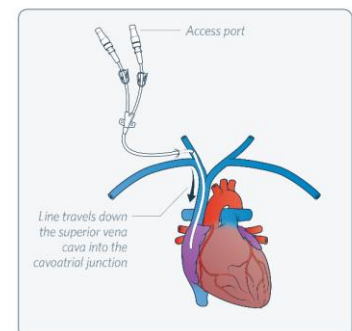
Usual duration: approximately two weeks.

Usually inserted by:

- PICU
- Interventional Radiology
- Department of Anaesthesia



Centrally Inserted Central Catheter (CICC)



Insertion, Management and Removal of Central Venous Access Devices

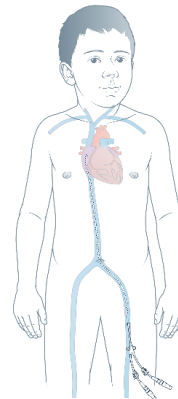
Femorally Inserted Central Catheter (FICC)

Description: Inserted into the internal femoral vein. Most commonly used in acute and critical care settings. They are not to be used outside of the hospital setting.

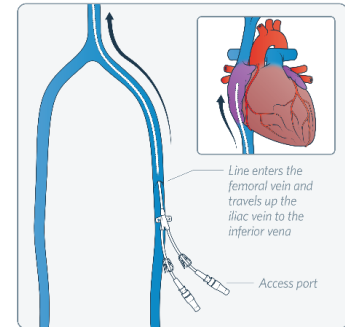
Usual duration: approximately two weeks

Usually inserted by:

- PICU
- Interventional Radiology
- Department of Anaesthesia



Femorally Inserted Central Catheter (FICC)



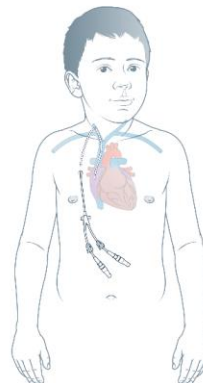
Tunnelled – Centrally Inserted Central Catheter (T-CICC)

Description: An alternative to a PICC for patients with small arm veins, usually less than 3 years of age or 15kg. The catheter is tunnelled beneath the skin to the vein entry point, usually the internal jugular vein.

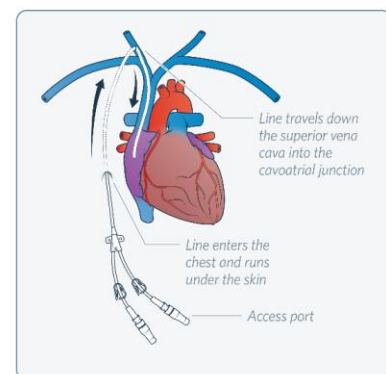
Occasionally direct RA catheters are placed during cardiac surgery for complex cardiac disease. The femoral vein may also be used.

Usual duration: approximately 2 – 12 weeks

Usually inserted by: Department of Anaesthesia



Tunnelled Centrally Inserted Central Catheter (T-CICC)



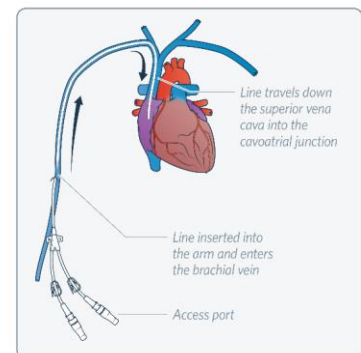
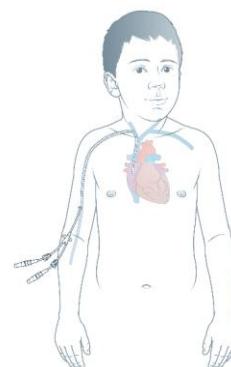
Peripherally Inserted Central Catheter (PICC)

Description: A long fine bore catheter inserted into a peripheral vein (usually the basilic or brachial vein in the mid upper arm), with the internal tip terminating in the lower SVC. May have multiple lumens. Intended for medium to long term use.

Usual duration: approximately 1-6 weeks

Usually inserted by:

- NICU and PICU teams
- Interventional Radiology
- Department of Anaesthesia



Insertion, Management and Removal of Central Venous Access Devices

Tunnelled Cuffed – Centrally Inserted Central Catheter (TC-CICC)

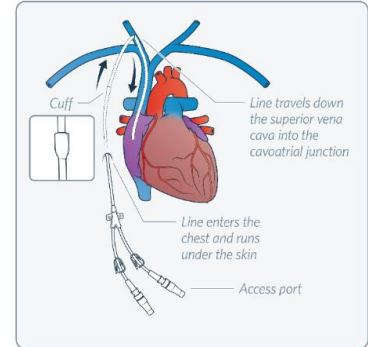
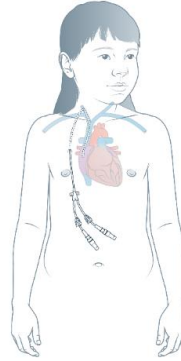
Description: In addition to being tunnelled there is a 'Dacron' cuff around the catheter which lies beneath the skin in the tunnelled section of the line. Subcutaneous tissue granulates around the cuff which serves two functions:

- Prevents dislodgment
- Provides a mechanical barrier from bacteria entering the subcutaneous tract.

Usual duration: months – years

Usually inserted by:

- Department of Paediatric Surgery
- Interventional Radiology
- Department of Anaesthesia

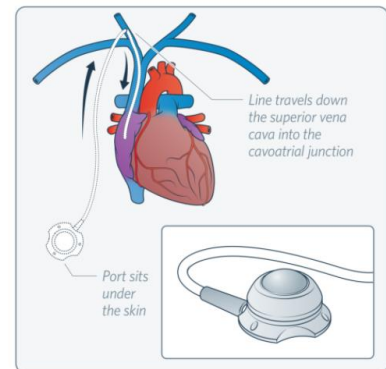
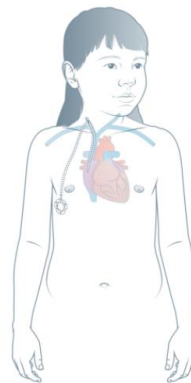


Port

Description: The self-sealing injection reservoir is surgically placed under the skin of the chest wall. The catheter is tunnelled beneath the skin to the vein entry point, usually the internal jugular vein. The port is accessed through the skin using a non-coring needle.

Usual duration: months – years

Usually inserted by: Department of Paediatric Surgery



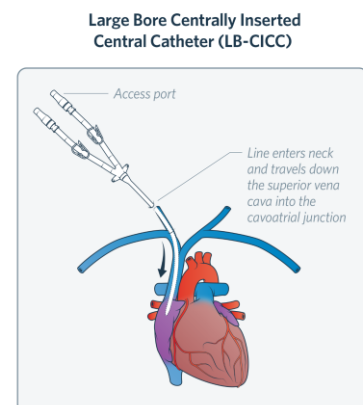
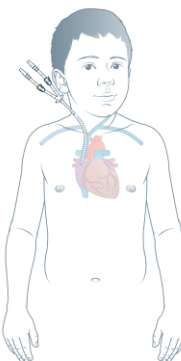
Large Bore Centrally Inserted Central Catheter (LB-CICC)

Description: A specialised CVAD with two large bore lumens – one to take blood and other to return it. Used for plasmapheresis, apheresis, plasma exchange or dialysis. Can also be inserted into the femoral vein.

Usual duration: less than one week

Usually inserted by:

- PICU
- Interventional Radiology
- Department of Anaesthesia



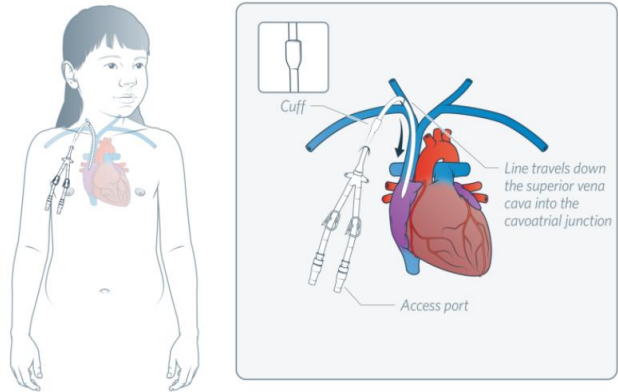
Insertion, Management and Removal of Central Venous Access Devices

Large Bore Cuffed CICC (LB-TC-CICC)

Description: In addition to having a large bore, this specialised CVAD also has a 'Dacron' cuff. Used for long term plasmapheresis, apheresis, plasma exchange or dialysis.

Usual duration: months to years

Usually inserted by: Department of Urology



Information for patients and families/carers

Refer to the [Kids Health Info website](#) for information on different types of CVADs and midlines.

- [Tunnelled Cuffed – Centrally Inserted Central Catheter](#) (commonly referred to as a Hickman™/Broviac™)
- [Tunnelled – Centrally Inserted Central Catheter](#)
- [Peripherally Inserted Central Catheter](#)
- [Port](#)
- [Midline](#)

Insertion, Management and Removal of Central Venous Access Devices

Referral for CVAD insertion

Surgical Venous Access

Outpatient referral

1. Review the indication and refer to appendix two to select the appropriate device.
2. Ensure the parents, guardian +/- patient and treating consultant are aware of the request.
3. Place 'Referral to Outpatient Paediatric Surgery – Line Insertion' order in the EMR, ensuring all fields are accurately completed.
4. The referral will be triaged to an appropriate surgical consultant to be actioned.

Contact the Department of Paediatric Surgery on extension **55081** if there are any concerns.

Inpatient referral

1. Review the indication and refer to appendix one to select the appropriate device.
2. Ensure the parents/guardian +/- patient and treating consultant are aware of the request.
3. Place 'Surgical Line Insertion Inpatient Referral' order in the EMR, ensuring all the fields are accurately completed.
4. Contact the surgical registrar on extension 52193.

The surgical team will review the patient, document the consult in the notes and arrange theatre access as appropriate.

Anaesthetic Vascular Access Service (AVAS)

1. Review indication and refer to appendix two to select the appropriate device.
2. Ensure the parents, guardian +/- patient and treating consultant are aware of request.
3. Discuss with the in-charge anaesthetist in person or call extension 52000.
4. Search for 'AVAS' in the orders tab in the EMR and select 'Anaesthesia Vascular Access Service Inpatient Referral'.
5. Complete all details, providing as much information as possible.

Once the request has been discussed with the in-charge anaesthetist and the AVAS referral has been completed, the patient will be reviewed and the anaesthetist will arrange theatre access if appropriate.

Interventional Radiology

1. Review indication and refer to appendix two to select the appropriate device.
2. Ensure the parents / guardian +/- patient and treating consultant are aware of request.
3. Discuss request with the Duty Interventional Radiologist (IR) to determine if the line insertion is appropriate for Medical Imaging; awake teenager for PICC line or complex patient requiring IR skills for insertion. Call the duty radiologist on extension 52544 or 9345 7621 to find the IR doctor on duty.
4. Place order in the EMR for 'PICC line in Radiology' or 'Central Venous catheter Insertion in radiology'.
5. Complete all details, providing as much information as possible, especially referring doctor's contact details.

The completed request will allow booking of the patient – MID will arrange anaesthesia for patient requiring GA.

Insertion, Management and Removal of Central Venous Access Devices

Insertion

Consent

Consent is required for CVAD insertion, except if this would delay lifesaving interventions. The child/ young person and their parent/guardian is to have an explanation the risks and benefits associated with CVAD insertion. The person inserting the CVAD is to be the person gaining consent and ensure the risks have been understood by the patient/guardian.

Who may insert the device?

- Paediatric CVADs, especially in children under two years of age can be difficult to insert. Predictors of difficulty include; <2yo, weight <15kg, previous difficult lines and a history of multiple CVAD insertions.
- Every CVAD has subtle differences in insertion technique, the product information is to be read and understood prior to use.
- If additional wires are being used, the inserter is to be aware of complications specific to these extra wires and their characteristics.
- Knowledge of venous anatomy and competency with the use of ultrasound are prerequisites for most insertions.
- It is the responsibility of the manager of the inserting practitioner to decide if the inserter has the necessary experience to insert a CVAD.

Insertion technique

- Insertion technique will depend on the patient's age/size, type of CVAD, site of insertion and the need for sedation or general anaesthesia.
- Specific line insertion techniques are outside the scope of this document.
- Critical aseptic technique and maximal barrier precautions must be maintained Refer to [Aseptic Technique Procedure](#)
- Hand Hygiene is to be undertaken before & after palpating catheter insertion, disinfectant of probe.
- Use maximal barrier precautions, including a 60 seconds hand scrub with alcohol or disinfectant preparation, the use of a cap, mask, sterile gown, and sterile gloves for the operator and those assisting in the procedure for the insertion of CVADs or guide wire exchange.
- For the patient, applying maximal barrier precautions means covering the patient from head to toe with a sterile drape, with a small opening for the site of insertion.
- Where possible, staff are to be kept to a minimum in the room where the procedure is being undertaken and staff present in the room should wear a cap and mask.

Skin Antisepsis

- For most of the paediatric population, 2% chlorhexidine and 70% alcohol, in a single use applicator is the optimal skin antisepsis for CVAD insertion.
- There may be circumstances whereby the use of this product is contraindicated.
- For additional information on skin antisepsis, refer to the [Surgical and Skin Antisepsis Procedure](#)

Insertion, Management and Removal of Central Venous Access Devices

Confirming tip position

Practitioners are to ensure that all guide wire(s) used are removed and that number of wires used and discarded is documented.

X-ray is to be performed prior to use. A transducer or blood gas can also be used to assist in the determination of position.

CICCs inserted peri operatively or in an urgent situation may be used prior to imaging provided the majority of the following criteria are met:

- Uncomplicated insertion with no concerns re line placement
- Ultrasound was used
- Transduced pressure wave confirms placement in venous system
- Free aspiration of blood from all lumens of CVAD
- No pulsatile blood flow observed

Post CVAD insertion, the tip position is to be confirmed using the appropriate imaging, this may be with an image intensifier or CXR.

NOTE: If there is any doubt about CVAD position, an x-ray is to be done prior to use.

If CVAD re-positioning is required the patient may require a second anaesthetic or sedation. It is highly recommended that the x-ray be performed whilst the patient is still anaesthetised.

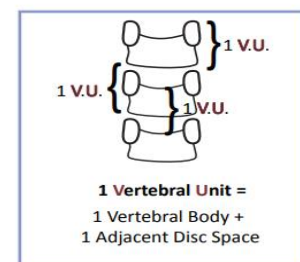
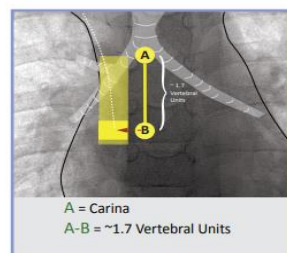
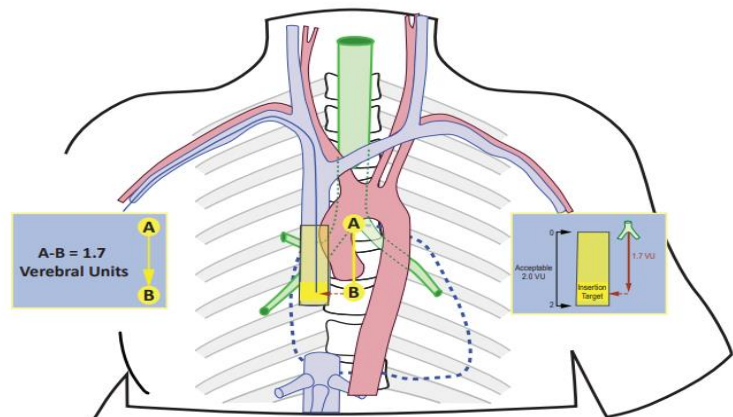
Documentation

The insertion of all CVADs is to be documented including; date, time, inserter, assistant, indication for CVAD, brand/ type of catheter, site of insertion, depth of catheter placement and confirmation of catheter site on CXR. A procedure note, LDA and implant record must be entered into the EMR.

Confirming tip position continued – upper venous system

Tip position for upper venous system CVADs

- The optimal tip position is in the lower SVC/cavo-atrial junction. The ideal tip position is approximately 1.5 vertebral bodies below the carina
- A tip left in any other position is more likely to result in complications
- The end of the catheter should lie parallel to SVC wall; tips positioned high in the SVC abutting the wall can cause erosion, perforation and predispose to thrombosis
- If positioned too high the catheter can flick out of the SVC and upwards into the neck with patient arm movement
- Tips positioned too low can enter the heart which may risk perforation and arrhythmias



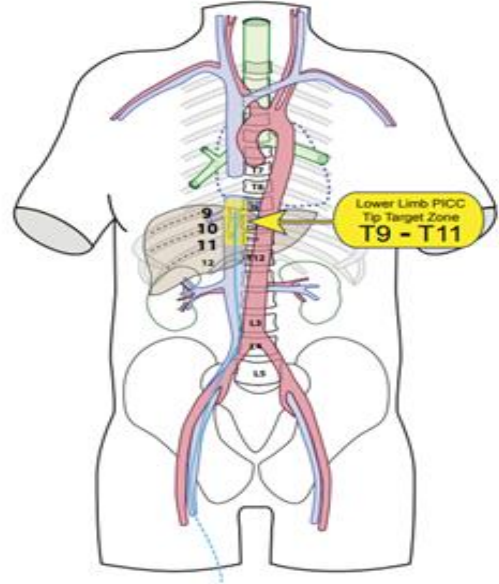
Insertion, Management and Removal of Central Venous Access Devices

Confirming tip position continued – lower venous system

Tip position for lower venous system CVADs

- PICC / UVC: position at / just above the level of the diaphragm - L5 is the lower border of the IVC – position PICCs above this
- FICC/LB-CICC: position in the lower IVC
- Avoid L1 level – the renal veins are at this level
- A good catheter position is parallel to the long axis of the vertebral column and above L5.

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Insertion, Management and Removal of Central Venous Access Devices

Complications associated with CVAD insertion

Complication	Risks & Actions
Bleeding, haematoma at insertion site	<ul style="list-style-type: none"> • Apply pressure to vein insertion site until bleeding stops • If bleeding continues or is excessive, notify medical team. Consider investigating coagulopathy.
Difficulty inserting catheter	<ul style="list-style-type: none"> • Use ultrasound to pre-scan predicted difficult patients (age <2yo, <15kg, previous multiple or difficult CVADs – cystic fibrosis, home TPN or oncology patients). • Have a clinician skilled with ultrasound guided venous access be present/ do these predicted difficult lines. • Ensure a patent vein with diameter > 3x catheter diameter present. • Seek assistance if >3 attempts (2 for neonates) or more than 10 minutes attempting to access a vein.
Malposition	<ul style="list-style-type: none"> • Verify placement using X-ray, transducer waveform and/or blood gas.
Temporary nerve damage/pain	<ul style="list-style-type: none"> • Using ultrasound guided insertion reduces nerve injury.
Dysrhythmias	<ul style="list-style-type: none"> • May occur if catheter and/or wire enter heart. • Withdraw catheter within SVC/IVC and observe. • Verify position with x-ray/ ultrasound.
Arterial puncture	<ul style="list-style-type: none"> • Verify placement with x-ray, transducer waveform and/or blood gas. • If arterial, remove small bore catheters and apply pressure to insertion site. Large bore catheters may require surgical consult prior to removal.
Damage to blood vessels, heart or lungs	<ul style="list-style-type: none"> • Use ultrasound guidance for insertion. • If sudden haemodynamic instability or respiratory compromise, request urgent x-ray. • MET if urgent medical help required.
Air Embolism	<ul style="list-style-type: none"> • Always ensure needle and catheter is flushed, not open to air and is patent. • Patient head down for neck lines.
Reaction to contrast	<ul style="list-style-type: none"> • Contrast can cause reactions and, rarely, anaphylaxis.

Insertion, Management and Removal of Central Venous Access Devices

Maintenance of CVADs

Review

- All inpatients with a CVAD in situ are to be reviewed daily by the multidisciplinary team.
- For outpatients with a CVAD in situ, the device is to be reviewed at out-patient appointments.
- This includes; site assessment, review of how long the device has been in situ, the necessity for central venous access and consideration of alternative methods of treatment.
- CVADs no longer required are to be removed without delay. The longer a CVAD remains in situ the greater the risk of CVAD related complications.

Educational framework

Prior to accessing a CVAD independently, staff are required to have completed:

- The Vascular Access Essentials Bundle, including assessment of surgical and standard aseptic technique (both are available on Learning Hero).
- The Aseptic Technique e-learning Package (available on Learning Hero).
- Nursing staff are required to have also completed all relevant sections of the Nursing Competency Framework book.

For additional information on Aseptic Technique, refer to the Aseptic Technique Procedure.

Assessment

In addition to the daily multidisciplinary review, the CVAD is to be assessed every shift by the bedside nurse. This assessment is guided by the fields outlined in the LDA tab in the EMR. All CVAD related complications and interventions are to be recorded in the LDA.

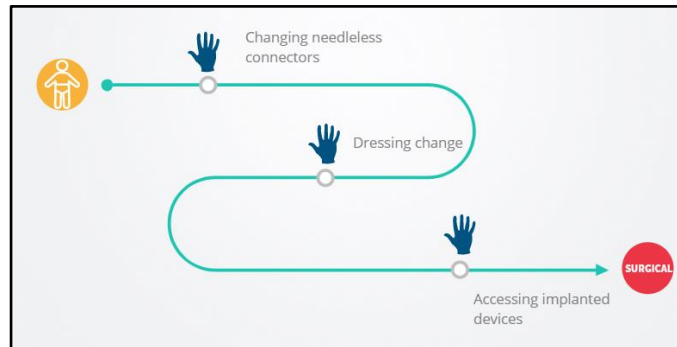
Key messages for performing dressing changes and site assessment:

- **Ensure the old dressing is removed gently. Trauma to the skin is associated with an increased risk of skin injury. Use a 'low and slow' technique. Consider using an adhesive remover wipe, such as Convacare adhesive remover wipes™.**
- **Ensure the skin preparation is completely dry before applying any dressing component. The adhesives in the dressing interact with wet skin preparation, potentially leading to skin complications.**
- **Secure the CVAD and add on devices (e.g. three way taps and giving sets) away from potential sources of contamination such as nappies. For single lumen TC-CICCs, ensure a significant portion of the catheter is secured underneath the dressing to help prevent accidental dislodgement.**
- **Consider support from Child Life Therapy or Comfort First before commencing the dressing change.**

Insertion, Management and Removal of Central Venous Access Devices

Preparation for: port access, suture-less securement device and needleless connector changes

These procedures require a surgical aseptic field as key sites are exposed. Assess the need for additional support to ensure key sites remain protected at all times. Take into consideration the patient's age, developmental level and family participation.



Dressing changes

CVAD dressing provides a barrier to the external environment. In addition to dressing the CVAD, adequate securement reduces the risk of catheter migration.

- At the time of insertion, the exit site may be secured with sutures, tissue adhesive and in some cases both. Tissue adhesive has haemostatic and bacteriostatic properties. Both of which reduce bleeding and provide a barrier to microbes entering the blood stream via the CVAD.
- Depending on the patient's weight, a Biopatch™ may also be used at the exit site. A Biopatch™ is a chlorhexidine impregnated disk which reduces the bio burden of skin flora at the exit site. A Biopatch™ is not to be used over infected wounds, directly over burns or on patients with a known sensitivity to chlorhexidine. **It is not to be used on infants less than 1000 grams.**
- In addition to securing the exit site, a suture-less securement device may be used to anchor the hub of the CVAD to the patient's skin. Suture-less securement devices vary depending on the type of CVAD in situ.
- The standard dressing used to cover the CVAD is Tegaderm Advanced™. If the patient has a known allergy to components in Tegaderm™ dressings, use IV3000™.
- The Biopatch™, suture-less securement device and dressing are to be changed every seven days or sooner if any component becomes soiled, wet or loosened. If any component is submerged in contaminants such as bath water or nappies, they are to be changed.
- For neonatal dressing changes, refer to Dressing change for neonatal PICCs
https://www.rch.org.au/neonatal_rch/intranet_resources/CVAD_line_management_in_NICU/

Equipment

- Dressing pack
- A pair of sterile and non-sterile gloves
- Sterile dressing, the standard dressing is Tegaderm Advanced™
- Suture-less securement device
- Biopatch™
- 2% chlorhexidine and 70% alcohol skin preparation
- Cavilon™ barrier swab stick (not to be used on infants <1 month of age)

Insertion, Management and Removal of Central Venous Access Devices

Technique

- Collect required equipment.
- Ensure surface has been cleaned with Tuffie 5™ wipe before setting up a surgical aseptic field.
- Perform hand hygiene and using a non-touch technique open equipment onto the field.
- Perform hand hygiene and don non-sterile gloves.
- Gently remove the old dressing including the Biopatch™ and suture less securement device if in situ. Statlocks™ are to be removed with a 2% chlorhexidine and 70% alcohol skin preparation pad to assist with ease of removal. Ensure a 'low and slow' technique is used to minimise trauma and prevent skin breakdown.
- Assess the insertion site and surrounding skin, take precautions to prevent dislodgement.
- Site assessment is to include identifying signs and symptoms of infection which include; erythema, purulence, tenderness, haemoserous ooze or any other abnormalities. Altered skin integrity includes; erythema, sheering or cuts in the skin, irritation, discomfort or any other abnormalities. Findings from the site and skin assessment may alter management from this point. Consider taking a clinical image and seeking advice from a senior member of staff.
- Remove gloves and repeat hand hygiene.
- Don sterile gloves.
- Ensure the gauze and 2% chlorhexidine and 70% alcohol skin preparation solution has been wrung out (i.e. still damp but not soaking wet).
- Securing the exit/insertion site with a piece of gauze soaked in 2% chlorhexidine and 70% alcohol solution, gently scrub the line moving away from the patient and allow to air dry.
- Clean skin with 2% chlorhexidine and 70% alcohol solution from the centre to the outer area in a circular motion, approximately 5-10cm. Repeat this three times and allow to completely air dry. Do not fan the area to speed up the drying process.
- Apply the Biopatch™ with the blue side facing upwards with the slit aligned with the catheter tubing.
- Apply Cavity™, 2cm away from the exit site (not to be used on infants <1 month of age).
- For PICCs and T-CICCs, replace the suture-less securement device (Statlock™). Before placing the CVAD into the plastic retainer, ensure you are familiar with how the paper backing is removed. Place the bifurcation of the CVAD into the Statlock™ and then clip the wings closed. Remove the paper backing and place on the skin.
- Apply the dressing, ensuring it covers the Biopatch™, an appropriate portion of the catheter and surrounding skin.
- For double lumen TC-CICCs, the suture less securement device is to be applied close to or over the top of the primary dressing.
- Dispose of equipment and rubbish.
- Perform hand hygiene.
- Document procedure in the EMR

Accessing a port

Preparation

Consider feeling for where the port reservoir is located prior to starting the procedure, some ports may be situated deep in the adipose tissue. A longer port needle may be required depending on how deep the port is. Apply topical anesthetic cream such as AnGel™ 40 minutes before the procedure. Consider support from Child Life Therapy or Comfort First before commencing the port access.

Insertion, Management and Removal of Central Venous Access Devices

Equipment

- Dressing pack
- A pair of sterile and non-sterile gloves
- Sterile dressing, the standard dressing is Tegaderm Advanced™
- Port needle with appropriate extension set
- Ampoule of 0.9% sodium chloride
- X2 10mL syringes
- Drawing up needle
- 2% chlorhexidine and 70% alcohol skin preparation

Technique

- Collect required equipment.
- Ensure surface has been cleaned with a Tuffie 5™ wipe before setting up a surgical aseptic field.
- Perform hand hygiene.
- If required, ask the patient to/assistant to expose the port site and remove the topical anesthetic.
- Perform hand hygiene and using a non-touch technique open equipment onto the field.
- Perform hand hygiene and don sterile gloves.
- Draw up two syringes of 0.9% sodium chloride, with approximately 5mLs in each.
- Ensure the port needle and extension set are attached tightly.
- Prime the port needle and extension set with 0.9% sodium chloride and keep it connected, then set aside.
- Clean the skin with the skin with 2% chlorhexidine and 70% alcohol-soaked gauze preparation in a circular motion from the centre to the outer area, approximately 5-10cm away from the port reservoir. Repeat three times and allow to air dry. Ensure the gauze and 2% chlorhexidine and 70% alcohol skin preparation solution has been wrung out (i.e. still damp but not soaking wet). Do not fan the area to speed up the drying process.
- Using the non-dominant hand, feel for the edges of the port and hold between the thumb and index finger.
- Press the needle through the skin using gentle but steady pressure until the needle touches the base of the port.
- Attempt to aspirate blood using the connected 0.9% sodium chloride filled syringe, if blood is unable to be aspirated, gently flush the port. Once blood return is achieved, flush the port with the second syringe of 0.9% sodium chloride.
- Apply a sterile dressing and secure lines to reduce pull on the needle.
- Dispose of equipment and rubbish
- Perform hand hygiene
- Document procedure in the EMR.

Needleless connector changes

Needleless connectors (MicroClave Clear™) are to be changed every seven days unless visibly contaminated. If the needleless connector is submerged in contaminants such as bath water or nappies, they are to be changed. Assess the needleless connector and catheter before commencing the procedure, there may be certain circumstances when additional cleaning is required.

Equipment

- Dressing pack
- Sterile gauze
- Sterile gloves

Insertion, Management and Removal of Central Venous Access Devices




- Syringes 10mL leurlock
- Drawing up needle(s)
- Ampoule(s) of 0.9% sodium chloride
- Needleless connector(s)
- 2% chlorhexidine and 70% alcohol solution

Technique

- Collect equipment.
- Ensure surface has been cleaned with a Tuffie 5™ wipe before setting up a surgical aseptic field.
- Perform hand hygiene and using a non-touch technique open equipment onto the field.
- Perform hand hygiene.
- Don sterile gloves.
- Draw up saline flush without touching key parts, prime needleless connector(s), set aside.
- Hold the end of the catheter with a piece of 2% chlorhexidine and 70% alcohol-soaked gauze.
- Remove the old needleless connector with a piece of 2% chlorhexidine and 70% alcohol-soaked gauze.
- With the hub of the catheter exposed and facing downwards, clean the end of the CVAD vigorously for at least 15 seconds, allow to air dry.
- Connect the new needleless connector. ** Repeat process if there is more than one lumen. If the patient has a double lumen CVAD, keep the syringe connected to the new needleless connector and place it on the drape. Once the needleless connector is changed on the second lumen, flush both lines*.*
- Unclamp the catheter, check for patency by aspirating for flashback and then flush the CVAD with a new 0.9% sodium chloride flush.
- Lock and clamp the CVAD or recommence new infusions.
- Dispose of equipment and rubbish
- Perform hand hygiene.
- Document procedure in the EMR.

Insertion, Management and Removal of Central Venous Access Devices

Dressing and securement products





Device	Dressings and securement:	Picture:
PICC	*Biopatch™, Statlock™ and Tegaderm Advanced™	
CICC and FICC	*Biopatch™, suture (+- tissue adhesive), Tegaderm Advanced™	
T-CICC	*Biopatch™, suture or Statlock™ and Tegaderm Advanced™	
TC-CICC	*Biopatch™, Statlock™ (only for double lumens) and Tegaderm Advanced™	

*Please refer to the instructions under 'dressing changes' which outline when a Biopatch™ is indicated for use

Insertion, Management and Removal of Central Venous Access Devices

Guide to Tegaderm Advanced™ sizes

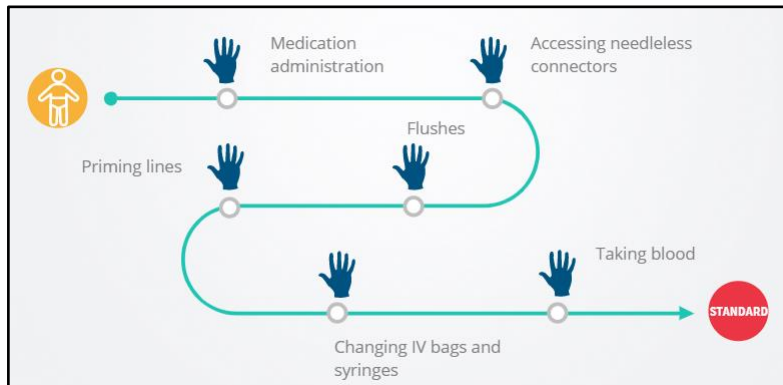
This is a guide only, please use clinical discretion when considering the appropriate dressing

Device	CICC and FICC <i>Neonates and infants <10kg</i>	CICC and FICC Infants >10kg	PICC, TC-CICC, double lumen TC- CICC for children four years of age and under, T-CICC, LB-CICC	Double lumen TC- CICC and ports
Product number	1682	1683	1685	1688
Dimensions	5cm x 5.7cm	6.5cm x 7cm	8.5cm x 11.5cm	10cm x 12cm
Picture				

Insertion, Management and Removal of Central Venous Access Devices

Preparation for medication administration, priming lines, flushes, changing IV bags and blood sampling

These procedures require a standard aseptic field as key parts are exposed. Assess the need for additional support to ensure key parts remain protected at all times. Determine the need for an assistant by taking into consideration the patient's age, developmental level and family participation. After performing a risk assessment, there may be some circumstances whereby a standard aseptic procedure may exceed a 20-minute duration. If this is foreseeable risk, a surgical aseptic technique would be more suitable.



Medication administration

Medication administration requires an aseptic non touch technique where there is a needleless connector in-situ.

Equipment

- Clean tray
- Medications as prescribed
- 2% chlorhexidine and 70% alcohol solution or swabs
- Syringes (10 ml leurock)
- Drawing up needles and red caps
- Sterile 0.9% sodium chloride/heparin flush

Technique

- Collect required equipment.
- Perform hand hygiene.
- Prepare equipment and work area.
- Don non sterile gloves if wearing for personal protection.
- Prepare medications using drawing up needles taking care to protect key parts.
- Expose CVAD and needleless connector.
- Assess insertion site and check position.
- Perform hand hygiene.
- Scrub access point vigorously with 2% chlorhexidine and 70% alcohol swab for 15 seconds and allow for it to completely air dry.
- Administer medications.
- Flush the line with the appropriate flushing solution and volume to clear the CVAD.
- Perform hand hygiene.
- Document procedure in the EMR.

Insertion, Management and Removal of Central Venous Access Devices

Accessing a needleless connector

Administration sets that have been disconnected (either accidentally or planned) are no longer sterile and are to be discarded and replaced.

Prior to accessing a CVAD, the point of access must be scrubbed vigorously with friction using 2% chlorhexidine and 70% alcohol solution for at least 15 seconds then allowed to air dry completely.

Priming lines/infusion set changes

CVAD lines are replaced at least every 7 days using an aseptic non touch technique. If the needleless connector requires changing at the same time, this exposes a key site and sterile gloves and an aseptic field is required. Refer to 'changing needleless connector'.

Fluid bags and syringes with nil additives are changed at least every 7 days.

Fluid bags and infusions with additives are changed every 24 hours.

If using fresh blood or fresh blood products replace line(s) at the end of the infusion or 24 hourly.

If lipid emulsion is being infused change lipid syringe/bag and line every 24 hours.

Equipment


- Clean tray/dressing pack
- Fluid bag(s)/ Syringe(s)
- Additives/medications (if prescribed)
- 2% chlorhexidine and 70% alcohol solution
- Syringes and drawing up needles
- Giving sets
- Lines/tubing
- Burettes (if required)
- Taps or two/three or four way extension (if required)
- Non sterile gloves/Sterile gloves

Technique

- Collect required equipment.
- Perform hand hygiene.
- Prepare equipment and work area.
- Remove bags or syringes from packaging.
- Check fluids/additives with RN.
- Make up bags or syringes according to prescription and without touching key parts.
- Label all fluids/infusions.
- Perform hand hygiene and don non-sterile/sterile gloves as required.
- Without touching key parts, add the required connections and prime the lines.
- Scrub the needleless connector (connected to the patient side) with a 2% chlorhexidine and 70% alcohol swab for least 15 seconds and allow to air dry.
- Disconnect cap from lines/giving set and connect without touching key parts.
- Dispose of equipment and rubbish.
- Document procedure the in EMR.

Insertion, Management and Removal of Central Venous Access Devices

Setting up administration sets and add on devices

External devices (TC-CICC, T-CICC, PICC and CICC)	Ports
Ensure there is a two-way extension or blood tap connected to the needleless connector for blood sampling and fluid/drug administration.	Ensure there is a two-way extension connected the access needle to allow for blood sampling and fluid/drug administration.
<div data-bbox="177 645 520 1059" style="border: 1px solid black; padding: 5px;"> <p>Order of connections:</p> <ul style="list-style-type: none"> - Needleless connector (on the end of the catheter) - Blood tap - Needleless connector (on the end of the blood tap) - Giving set </div>	

De-accessing a port

Preparation

- Using a pulsatile flushing technique, flush and lock the port with the appropriate lock solution.
- Prepare the patient for the procedure, ensuring they are in a comfortable position.

Equipment

- Non-sterile gloves
- Band-aid™

Technique

- Perform hand hygiene.
- Don non-sterile gloves.
- Remove the old dressing using a 'low and slow' technique.
- Using the non-dominant hand, hold the base of the port reservoir with a firm grip.
- Using the dominant hand, remove the needle in one swift movement.
- Apply a Band-aid™ (if required).
- Perform hand hygiene.
- Dispose of equipment and rubbish.
- Document procedure in the EMR.

Insertion, Management and Removal of Central Venous Access Devices

Summary of when changes are to be performed

Task	Minimum frequency of changes	Aseptic technique method (based on risk assessment)
Fluid bag/syringe with additive	Every 24 hours	Standard aseptic technique
Giving set with lipid or blood products	Every 24 hours	Standard aseptic technique
Giving set with inline filter	Every 96 hours	Standard aseptic technique
Fluid bag/syringe with no additive	Every seven days	Standard aseptic technique
Giving set with no additive	Every seven days	Standard aseptic technique
CVAD dressing	Every seven days	Surgical aseptic technique
Port needle	Every seven days	Surgical aseptic technique
Needleless connectors extension sets or three-way taps	Every seven days	Surgical aseptic technique
NOTE: all components are to be changed earlier if the integrity of the dressing is compromised or if there is any visible debris in any of the add on devices or needleless connectors		

Insertion, Management and Removal of Central Venous Access Devices

Blood sampling

Blood sampling requires an aseptic non-touch technique where there is a needleless connector (MicroClave Clear™) in-situ. All CVADs >3Fr can be bled back for blood sampling if required.

For CVADs with more than one lumen, use the largest lumen possible for blood sampling. If there is difficulty aspirating blood from the CVAD refer to the 'CVAD complications and management' section of this procedure.

Refer to the Specimen Collection handbook to verify blood tubes and volume required. **Please refer to this procedure for patient identification procedures when blood sampling:**

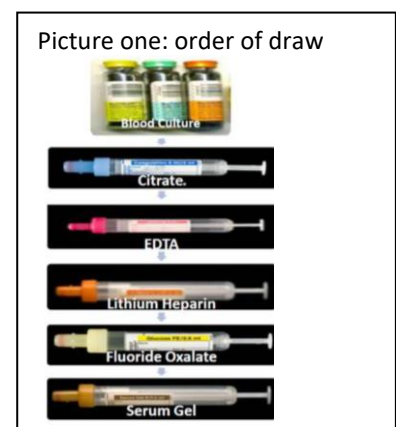
[https://www.rch.org.au/policy/policies/Specimen Identification and Labelling/](https://www.rch.org.au/policy/policies/Specimen%20Identification%20and%20Labelling/)

Equipment

- Clean tray
- Request slips, labels and blood tubes required.
- 2% chlorhexidine and alcohol preparation pads
- Sterile syringes
- 0.9% sodium chloride flush and heparin lock if required

Technique

- Collect required equipment.
- Perform hand hygiene.
- Prepare equipment and work area.
- Perform hand hygiene and don non-sterile gloves.
- Scrub the hub and allow to air dry.
- Clamp any lines not being accessed, unless there are vasoactive infusions running.
- Attach a 10mL luerlock syringe to the needleless connector and aspirate 5mL of blood. Discard the blood unless blood cultures are required.
- Attach another syringe for blood specimens.
- Fill collection tubes according to the 'Order of Draw' (picture one), with the required amount of blood. Make sure the tip of the syringe does not touch the blood tube. Ensure the tubes are not overfilled or under filled.
- Blood tubes are to be filled as soon as possible to prevent clotting.
- Label the tubes and sign the request form as per the 'Specimen Identification and Labelling' procedure.
- Flush the line with 5-10mL (2mL for neonates) 0.9% sodium chloride, using a pulsatile technique. Ensure all the blood components are flushed through the line.
- Lock the CVAD with heparin, if required.
- Dispose of equipment and rubbish.
- Perform hand hygiene.



Insertion, Management and Removal of Central Venous Access Devices

Heparin locking and flushing

Definitions

Flush: 0.9% sodium chloride solution which is administered after blood sampling, medication administration or before a heparin lock.

Lock: Locking solution which is administered at the end of a treatment period. This can be either saline or heparin, depending on the frequency of line access. Both flushing and locking CVADs is to be done using nothing smaller than a 10mL syringe.

Technique

- When flushing the CVAD with either 0.9% sodium chloride or heparin, a pulsatile technique is to be used. This creates a turbulent flow inside the catheter which assists with removing debris.
- Leave a small amount (0.5-0.1mL) of flush/lock solution in the syringe at the end of the flushing sequence, this prevents blood refluxing back into the lumen of the CVAD.
- Clamp the CVAD under positive pressure when the final lock is being administered.

If a CVAD is being accessed more frequently than six hourly, it is to be flushed and locked with 0.9% sodium chloride.

If a CVAD is being accessed between six and 24 hourly, at the end of each access the CVAD is to be flushed with 0.9% sodium chloride followed by a short-term heparin lock of 10 units of heparin/mL.

If a CVAD is being accessed less frequently than 24 hourly, at the end of each access the CVAD is to be flushed with 0.9% sodium chloride flush followed by a long-term heparin lock of 100 units of heparin/mL.

NOTE: A 0.9% sodium chloride flush should always be administered prior to the heparin lock

CVAD type	Minimum frequency of flushing and locking	Short term heparin lock. 10 units of heparin per mL	Long term heparin lock. 100 units of heparin per mL <10kg	Long term heparin lock. 100 units of heparin per mL >10kg
PICC	Every seven days	2mL	1mL	2mL
CICC	Every seven days	2mL	1mL	2mL
FICC	Every seven days	2mL	1mL	2mL
TC-CICC	Every seven days	2mL	1mL	2mL
T-CICC	Every seven days	2mL	1mL	2mL
LB-CICC	Every seven days	2mL	1mL	2mL
Port	Every four – six weeks	2mL	1mL	2mL

Please note: For patients with haemophilia it is appropriate for a heparin lock to be used at the time of CVAD insertion. However, 0.9% sodium chloride locks are generally used for CVAD maintenance.

Other flushing volumes

Flushing	Volume
Intermittent medication e.g. drug 'push'	2mL
After blood sampling	5-10mL
Syringe driver with minimum volume extension tubing	2mL
Standard infusion set with or without burette	20mL

Insertion, Management and Removal of Central Venous Access Devices

Heparin locking LB-TC-CICC

Large bore catheters are to be locked with 1000 units/mL of heparin to the total intraluminal volume of the catheter.

Example

If a patient had a 10Fr, 15cm catheter, the lock solution would be: 0.9mL of 1000 units/mL of heparin for the red lumen and 0.9mL of 1000 units/mL of heparin for the blue lumen.

The following table outlines the intraluminal volume for each size of LB-TC-CICCs used at RCH. The intraluminal volume is also displayed on the clamps of the catheter.

NOTE: Prior to prescribing the heparin locks, ensure the catheter was not trimmed at the time of insertion as this will alter the intraluminal volume. This information can be found in the insertion operation notes.

Catheter & Size	Code	Manufacturer	Red Lumen volume	Blue Lumen volume
8Fr 18cm Hemo-Cath	SL18P	MEDCOMP	0.8mL	0.8mL
10Fr 15cm Split Cath XL	ASPC15P-XL	MEDCOMP	0.9mL	0.9mL
10Fr 18cm Split Cath XL	ASPC18P-XL	MEDCOMP	1.0mL	1.0mL
10Fr 24cm Split Cath XL	ASPC24P-XL	MEDCOMP	1.1mL	1.1mL
12.5Fr 15cm Hemo-Cath	MC 101241	MEDCOMP	1.1mL	1.1mL
12.5Fr 18cm Hemo-Cath	MC 101242	MEDCOMP	1.2mL	1.2mL
12.5Fr 24cm Hemo-Cath	MC 101243	MEDCOMP	1.3mL	1.3mL
14Fr 24cm Split Cath III	ASPC 24-3E	MEDCOMP	1.6mL	1.7mL
14Fr 28cm Split Cath III	ASPC 28-3E	MEDCOMP	1.7mL	1.8mL

Prophylactic alteplase (LB-TC-CICC Permcath™)

- Patients receiving haemodialysis thrice weekly will receive alteplase locking solution following the midweek dialysis session. The lock will remain in place until the catheter is accessed again, prior to the following haemodialysis or plasmapheresis procedure.
- For those haemodialysis or plasmapheresis patients who receive twice weekly procedures, the alteplase lock should be instilled between the two treatments with the shortest inter-procedural timeframe.
- Patients being weaned from haemodialysis or plasmapheresis may retain their catheters until the need for the procedure can be determined. During this time, an alteplase lock is to be administered for a one-hour dwell prior to the heparin lock.

***Alteplase dosing for LB-TC-CICC only** (for all other CVADs, refer to the alteplase dosing section of this procedure) *

Weight:	Dose/concentration:	Volume:
<10kg	0.5mg of alteplase in 2mL <i>*note 0.5mg of the pre-prepared alteplase is to be decanted into 1.5mLs of 0.9% sodium chloride.</i>	The intraluminal volume of the LB-TC-CICC
>10kg	1.5mg in 1.5mL	The intraluminal volume of the LB-TC-CICC

Insertion, Management and Removal of Central Venous Access Devices

CVAD complications and management

Catheter occlusion is one of the most frequently reported complications associated with CVADs.

An occluded CVAD is characterised by the inability to easily infuse fluid or aspirate blood from the catheter. A CVAD can become partially or completely occluded and in some cases the occlusion will only occur when attempting to aspirate blood.

Additional signs and symptoms of a CVAD occlusion are resistance when flushing, sluggish flow, increased frequency of pump alarms or leaking at the insertion site. All types of occlusion should be investigated and treated as soon as possible.

Partial occlusion: A partially occluded CVAD is defined as difficulty flushing and/or aspirating from the catheter. One or both aspects are characterised by sluggish flow.

Withdrawal occlusion: An inability to withdraw blood but fluid can be administered.

Complete occlusion: A completely occluded CVAD is evident when the catheter is totally blocked to both flushing and aspiration.

The causes of CVAD occlusion can be due to; mechanical dysfunction, drug precipitate or a thrombotic blockage. Investigating the underlying cause is essential in the treatment and management of CVAD occlusions.

Mechanical dysfunction

Causes	Diagnosis and treatment
Kinks in catheter or add on devices such as the extension set or filters, tight sutures, closed clamp, a clogged needleless connector or dislodged port needle.	Assess the external portion of the CVAD and all add on devices for any kinks or blockages. Consider replacing the port needle and all add on devices (e.g. needleless connector or in-line filters).
Tip of catheter abutting vessel wall.	Reposition patient and ask them to cough.
Damaged or fractured CVAD.	Assess the entire CVAD for any swelling, bulging, fracture or leaking. If any of these complications are identified, contact the medical team. In most cases the device will require removal and/or replacement. With certain devices such as silicone TC-CICCs, the damaged portion of the catheter may be repaired. Additional imaging may be required such as a linogram, which will assess the internal integrity of the device.
Tip malposition, internal kinking or pinch off syndrome.	Inspect the external length of the CVAD and assess if the catheter has migrated. Consider a chest x-ray to ensure the tip of the catheter is in the correct position and to eliminate a mechanical obstruction.

Insertion, Management and Removal of Central Venous Access Devices

CVAD complications and management

Thrombotic blockage

Causes	Diagnosis and treatment
Intraluminal thrombus	An intraluminal thrombus is the most common cause of CVAD occlusion. It occurs when there is a build-up of fibrin on the intraluminal surface of the CVAD. This type of thrombus may present as a partial or complete occlusion. If mechanical dysfunction is not expected to be the underlying cause of occlusion, alteplase can be instilled to restore catheter patency.
Fibrin tail	A fibrin tail is the result of blood components built up at the tip of the CVAD. This type of thrombotic occlusion acts as a one-way valve which permits fluids to be infused but inhibits aspiration of blood. Administration of intraluminal alteplase may assist with lysis of the fibrin tail.
Fibrin sheath	A fibrin sheath may develop on the external surface of the CVAD and extend all the way down to the tip of the catheter creating a 'pocket'. If medication becomes trapped in the pocket, it may travel back up the external surface of the catheter causing tissue irritation and swelling. A linogram may assist with the diagnosis of this.
CVAD associated deep venous thrombosis	<p>Deep venous thrombosis most commonly occurs at the insertion site, where endothelial damage and flow interruption are at their greatest. Thus, they can be totally missed if contrast is put through the catheter as in a linogram. Less commonly, they occur when the catheter tip irritates the vessel wall resulting in the tip of the CVAD adhering to the vein.</p> <p>CVAD associated DVT can present with line dysfunction, but can also present with signs of venous obstruction including; swelling of the distal limb, pain, or increased superficial collaterals.</p> <p>CVAD associated DVT may be occlusive or only partially occlusive and can embolise to cause pulmonary embolus or paradoxical emboli.</p> <p>Depending on the site of insertion of the CVAD, diagnosis may be made by ultrasound, but will often require CT or MR venography to show the true extent of the DVT.</p>

Drug precipitate

Causes	Diagnosis and treatment
Incompatible medication mixing within the lumen of the CVAD resulting in precipitation and blockage.	Occlusion caused by precipitate may present similarly to other types of occlusion. Treatment may include the administration of hydrochloric acid.
<p>Hydrochloric acid dosing and considerations: Administration of hydrochloric acid is to be done in consultation with senior medical staff and pharmacy. 0.1M of HCl in 1.5mL to be instilled for 2-4 hours.</p>	

Insertion, Management and Removal of Central Venous Access Devices

Summary of investigations to consider based on the clinical circumstances:

Clinical presentation:	Suggested intervention(s):
CVAD no longer flushing or drawing back normally - Most probably due to an intraluminal clot, fibrin sheath or a malpositioned catheter tip	- Administer alteplase - If unsuccessful, CXR then linogram
Multiple doses of alteplase have been administered within a three-month period	- Linogram - CT or MR venogram
Pain with administration of medication or fluids - Most probably due to a fracture, internal disconnection or migrated line	- CXR then linogram
Line functioning but there is inflammation around the port or along the subcutaneous tract of the line - Probably an infection but the CVAD may have fractured or disconnected	- Ultrasound +/- CXR
Clinical signs of SVC obstruction +/- line functioning - Important to investigate early as percutaneous intervention is much easier while the SVC is still patent versus completely occluded	- Linogram - CT or MR venogram

Insertion, Management and Removal of Central Venous Access Devices

Initial Management of CVAD occlusion – attempt to flush the catheter

Step one:

Using a standard aseptic technique for all steps:
 Draw up two ten mL syringes, each with 5mLs of 0.9% sodium chloride
 Attempt to gently flush 3mLs into the CVAD



Step two:

With the 0.9% sodium chloride syringe still attached, attempt to withdraw blood from the CVAD.
 If patency is restored, flush the CVAD with the second 0.9% sodium chloride syringe, using a pulsatile flushing technique.
 If patency is not restored, refer to the procedure to determine other causes of occlusion and management.
 *This technique can also be attempted without the needleless connector attached, however a surgical aseptic technique is to be used.



Alteplase dosing and administration

Once mechanical dysfunction has been ruled out as the likely cause of CVAD occlusion, alteplase can be administered to restore catheter patency. If the patients' coagulation profile is known to be deranged, the Haematology team are to be contacted for advice regarding administration of alteplase.

Weight:	Dose:
<10kg	<p>Concentration: 0.5mg (0.5mLs) of defrosted alteplase solution is to be added to 1.5mLs of 0.9% sodium chloride.</p> <p>Dose/volume: 1mL of this solution (0.25mg in 1mL) is to be instilled.</p> <p>Alteplase should not be administered into more than two lumens at once (i.e. the total dose given is not to exceed 0.5mg in 2mL of 0.9% sodium chloride)</p>
>10kg	<p>Concentration: 1.5mg of defrosted alteplase solution in 1.5mLs.</p> <p>Dose/volume: 1.5mg in 1.5mL</p> <p>Alteplase should not be administered into more than two lumens at once (i.e. the total dose given is not to exceed 3mg in 3mL of alteplase)</p>

Alteplase dwell time

The initial dose of alteplase is to dwell between two to four hours.

If catheter patency is not restored, and additional dose of alteplase can be administered immediately after attempting to remove the first dose. Consider a longer dwell time for subsequent doses of alteplase. It can be left to dwell for up to 72 hours.

Insertion, Management and Removal of Central Venous Access Devices

CVAD complications and management – alteplase administration for *partially* occluded catheters

Administration – using a standard aseptic technique

- Gently administer alteplase into the catheter and leave to dwell.
- Clamp the device (unless it is a Bioflo™ catheter which has an internal valve)

Removal

- Draw up two 10ml syringes with 5mLs of 0.9% sodium chloride.
- Attach the first syringe with 5mLs of 0.9% of sodium chloride and attempt to aspirate the alteplase and 2mL of blood out of the CVAD.
- If blood is aspirated, flush the CVAD using the second flush.
- If blood is unable to be aspirated, gently flush the CVAD with 2mLs of 0.9% sodium chloride and then attempt to aspirate blood again. The alteplase may be flushed into the bloodstream as the half-life of the drug is very short.
- If patency is restored, flush the CVAD.

Other considerations

- If patency is not restored, investigate for other causes of occlusion. Consider a second dose of alteplase. Document in the EMR.
- If a patient requires multiple doses of alteplase within a six-month period, further investigation is required.

CVAD complications and management – alteplase administration for *completely* occluded catheters

Step one:

Use a surgical aseptic technique for all steps:
 Prepare the patient and surgical aseptic field.
 Prime the three-way tap.
 Attach an empty 10ml syringe to the end of the three-way tap.
 Attach the alteplase to the side of the three-way tap.
 Turn the tap off to the patient and set the tap aside.



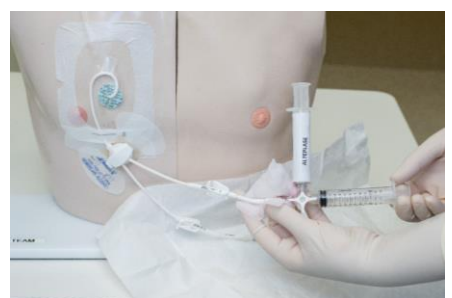
Step two:

Clean the old needleless connector and remove it.
 With a new piece of chlorhexidine-soaked gauze cleanse the hub of the CVAD for 15 seconds and let air dry.



Step three:

Attach the three way tap to the end of the CVAD.
 With the tap closed to the alteplase side, pull to the 3-5mL mark of the empty syringe. This will create negative pressure inside the CVAD.



Insertion, Management and Removal of Central Venous Access Devices

Step four:

Keeping the empty syringe pulled back turn the tap open to the alteplase side of the three-way tap.

Clamp the CVAD (unless it is a Bioflo™ catheter which has an internal valve)



Step five:

Reattach a new primed needleless connector and allow the alteplase to dwell.



Removal: *using a standard aseptic technique*

Draw up two 10ml syringes with 5mLs of 0.9% sodium chloride. Attach the first syringe with 5mLs of 0.9% of sodium chloride and attempt to aspirate the alteplase and 2mL of blood out of the CVAD.

If blood is aspirated, flush the CVAD using the second syringe.

If blood is unable to be aspirated, gently flush the CVAD with 2mLs of 0.9% sodium chloride and then attempt to aspirate blood again. If patency is restored, flush the CVAD

If patency is not restored, investigate for other causes of occlusion. Consider a second dose of alteplase.



Key messages for preventing CVAD occlusion:

- Ensure all CVAD lumens are flushed and locked with the appropriate solution.
- When locking CVADs use a pulsatile technique, leaving a small volume (0.5-0.1mL) in the syringe.
- Assess CVAD patency and escalate management with any signs of occlusion.

Insertion, Management and Removal of Central Venous Access Devices

Repair of damaged CVADs

External fractures of or damage to CVADs (TC-CICCs) lines can be repaired using designated catheter repair kits. Only staff who are trained and competent in fracture repair should perform catheter repair.

Repair of a CVAD line requires that there is at least 5cm of undamaged catheter remaining between the damaged area and the insertion site. Repair of multi-lumen requires device requires at least 2.5cm of undamaged catheter remaining between the damaged area and the junction of the lumens.

The catheter is to be clamped immediately between fracture and patient with an integral line clamp, a non-traumatic green plastic clamp or a metal clamp covered in gauze and must remain clamped for the duration of repair.

Equipment:

- Dressing pack
- Sterile drapes
- 2% chlorhexidine and 70% alcohol
- Catheter repair kit
- Scalpel or sterile scissors
- Sterile gloves
- Syringes and drawing up needle
- Sterile sodium chloride
- Needleless connector
- Sterile gauze
- Tongue depressor to make a splint
- Blunt green clamps

Technique

- Collect required equipment.
- Using a pair of blunt green clamps, clamp above the affected part of the catheter.
- Prepare equipment and aseptic field, perform hand hygiene and don sterile gloves.
- Remove plunger from syringe and insert medical adhesive into the syringe barrel.
- Replace plunger and attach blunt needle.
- Clean the fractured segment with 2% chlorhexidine and 70% alcohol solution.
- Clean catheter attached to patient vigorously with 2% chlorhexidine and 70% alcohol soaked gauze for at least 15 seconds and allow to air dry.
- Cut the patient side of the catheter immediately adjacent to damaged area at 90 degrees (ensure remaining length of catheter does not slide under the skin).
- Insert the stent attached to the replacement catheter segment into existing catheter lumen until the end of the replacement catheter tubing is 3mm from the cut end of patient catheter.
- Dry the space between catheter ends.
- Fill the 3mm space with adhesive and push the catheter ends together.
- Apply adhesive around the spliced joint to cover around 2.5cm.
- Slide the splice sleeve down and centre it over the joint.
- Inject adhesive underneath each end of the splice sleeve.
- Roll the splice sleeve between fingers to distribute adhesive and extrude excess.
- Wipe away excess adhesive.
- Fasten splint to repaired section of catheter with tape. The repair will not achieve full mechanical strength for 48 hours but may be used if necessary, in 4 hours.
- Attach syringe of normal sodium chloride, unclamp and aspirate air from repaired section. GENTLY fill the catheter with lock and re-clamp. If the catheter is unable to be aspirated or flushed, refer to the 'occluded CVAD' section of this procedure.

Insertion, Management and Removal of Central Venous Access Devices

Post insertion related complications

Event or complication	Risks and management
Accidental disconnection	<p>Risk venous air embolism, blood loss and exposure of key site.</p> <p><i>Treatment</i></p> <ul style="list-style-type: none"> • Resuscitate and call a MET if cardio respiratory compromise. • Immediately clamp catheter between the leak (and damaged area) and the patient with the integral line clamp, atraumatic green plastic clamp or metal clamp covered in gauze. • Using surgical aseptic technique, scrub patient side of line with 2% chlorhexidine and 70% alcohol solution. • Withdraw air and check for blood return. • Flush with sterile 0.9% sodium chloride and clamp line. • Using a standard aseptic technique prime new lines and continue infusion. • Document. • Notify medical team.
Accidental removal	<ul style="list-style-type: none"> • Apply pressure to insertion site until bleeding stops. • Cover the exit site with a sterile occlusive dressing (e.g. Tegaderm™) • Notify medical team. • Make arrangements for replacement of CVAD if required.
Air embolus	<p>Can occur due to</p> <ul style="list-style-type: none"> • An uncapped / unclamped line lumen. • Accidental air injection. • Vein exit site exposed during removal. <p><i>Prevention</i></p> <ul style="list-style-type: none"> • Do not allow air to enter the catheter. • Ensure all lines are primed before attaching to the patient. • Follow correct CVAD removal procedure. • Ensure clamps are closed on lines. <p>Symptoms: patient becomes acutely short of breath and distressed, cyanosis, tachycardia, decreased conscious state.</p> <p><i>Treatment</i></p> <ul style="list-style-type: none"> • Call a MET. • Lie patient left side down with a head down position. • Check the line for any obvious holes / disconnections. • Clamp / cover exposed catheter end as per 'accidental disconnection'.

Insertion, Management and Removal of Central Venous Access Devices

Event or complication	Risks and management
Tip malposition / migration	<p>Migration in: Catheter length outside the body gets shorter, tip discovered in an unacceptable low position on CXR or ECHO. Symptoms: Rarely tachycardia and palpitations due to migration into the right ventricle. <i>Treatment</i></p> <ul style="list-style-type: none"> • Assess and document. • Notify medical team. • Catheter will need to be pulled back to an acceptable position with a sterile technique, resecured, repeat CXR taken. • Tunnelled cuffed and implanted ports need to be pulled back under a general anaesthetic in the operating theatre. <p>Migration out: Catheter length outside the body gets longer, cuff protrudes from exit site, tip discovered in an unacceptable high position on CXR. Risk of extravasation and loss of therapeutic drug effect. Symptoms: Neck pain, rushing sound in ear when flushing, extravasation. <i>Treatment</i></p> <ul style="list-style-type: none"> • Stop infusions and clamp. • Secure catheter. • Place firm pressure on any bleeding areas. • Notify medical team. • Document.
Cardiac tamponade	<p>Cause: may occur within several hours of insertion due to accidental perforation of pericardium by insertion needle or catheter tip. Blood accumulates in the pericardial space around the heart and impairs cardiac function. Can be catastrophic and fatal. Rare, more common in neonates. Symptoms: cardiovascular instability and collapse <i>Treatment: Medical emergency.</i></p> <ul style="list-style-type: none"> • Call a MET. • Organize an urgent ECHO.
Catheter damage or fracture – internal	<p>CVAD catheter breaks inside the patient and the broken end cannot be retrieved. Medical emergency as haemorrhage can occur the catheter may split and embolism of the internal portion can occur into the heart or lungs <i>Treatment:</i></p> <ul style="list-style-type: none"> • Call a MET. • Organize urgent emergency theatre. • Any damaged line that requires removal should be sent to Biomedical and onto the manufacturer.
Catheter damage or fracture – external	<p>CVAD catheter is damaged or broken outside the patient’s body. Medical emergency as high risk of haemorrhage or venous air embolus <i>Treatment:</i></p> <ul style="list-style-type: none"> • Immediately clamp catheter between fracture and patient with integral line clamp, non-traumatic green plastic clamp or metal clamp covered in gauze. • Place occlusive dressing over fracture site. • Notify Medical team. • TC-CICCs can be repaired with the appropriate repair kit by trained staff. Management of fractured line. • Most lines will need removal and replacement. • Any damaged line that requires removal should be sent to Biomedical and onto the manufacturer.

Insertion, Management and Removal of Central Venous Access Devices

Event or complication	Risks and management
Difficult to remove	<ul style="list-style-type: none"> • Reposition patient and reattempt removal. • Ensure all sutures removed. • If CVAD remains difficult to remove, stop. • Notify medical team.
Extravasation	<p>Accidental administration of drugs into the extra vascular tissue instead of into the vein. Tissue damage and necrosis can be extensive with some drugs (e.g. vesicant chemotherapy) and should be treated as a medical emergency.</p> <p>Symptoms: pain, redness, swelling, visible leaking of drug via the skin tunnel</p> <p><i>Treatment:</i></p> <ul style="list-style-type: none"> • Stop infusion. • Assess insertion site and document. • Notify medical team. • Document. <p>• http://www.rch.org.au/rchcpg/hospital_clinical_guideline_index/Extravasation_Injury_Management/</p>
Leaking of fluid out of exit site	<ul style="list-style-type: none"> • Consider 'Extravasation'. • Assess and document. • Notify medical team.
Infection: Local	<p>Symptoms: redness, swelling, discharge, ooze, pain or tenderness at site. Neutropenic patients may not develop symptoms of redness or discharge.</p> <p><i>Treatment:</i></p> <ul style="list-style-type: none"> • May be treated with antibiotics and CVAD may be able to remain <i>in situ</i>. • Swab site and smear a glass slide for microscopy prior to placing swab into charcoal medium and transporting to the Bacteriology Laboratory. <p>Note: Local site infections in an implanted port or above the cuff of tunnelled cuffed CVAD are difficult to treat and line removal is often required.</p>
Infection: Systemic	<p>Symptoms: Pyrexia, hypotension, tachycardia, shock.</p> <p><i>Treatment:</i></p> <ul style="list-style-type: none"> • If patient febrile (Temp > 38°C), take blood cultures. Sample from all lumens and clearly label each on the bottles. <p>Note: Do NOT sample from lines with vasoactive infusions running.</p> <ul style="list-style-type: none"> • Antibiotics should be started immediately, see sepsis CPG <p>• https://www.rch.org.au/clinicalguide/guideline_index/SEPSIS_assessment_and_management/</p> <ul style="list-style-type: none"> • Do not remove CVADs on the basis of fever alone. Use clinical judgment regarding removal of the CVAD. Consider evidence of infection elsewhere, non-infectious cause of fever, difficult line replacement.
Phlebitis	<p>Irritation of the intima of the vein, may occur within 72 hours of insertion</p> <p>Symptoms: pain, erythema, warmth, a venous cord may be palpable</p> <p><i>Treatment:</i></p> <ul style="list-style-type: none"> • Often can be treated with warmth and analgesia. • Do not remove CVAD.

Insertion, Management and Removal of Central Venous Access Devices

Event or complication	Risks and management
Pneumothorax	<p>Presence of air in the pleural space between the lungs and the chest wall. Can occur during CVAD insertion when the needle used to access the vein inadvertently punctures the lung. This risk is reduced by using ultrasound.</p> <p>Symptoms: shortness of breath, reduced oxygen saturation, tachycardia, hypotension. It may also be discovered incidentally on a CXR.</p> <p><i>Treatment:</i></p> <ul style="list-style-type: none"> • Call a MET if cardio respiratory compromise present. • Urgent chest decompression with a needle or a chest tube may be required. Small pneumothorax may resolve spontaneously
Thrombosis (DVT)	<p>Thrombosis occurs when a clot develops within the vein around the catheter and extends into central veins. More common if the catheter takes up > 1/3 of the vein diameter, the tip of the catheter is malpositioned high in the SVC or in patients with sepsis or cancer</p> <p>Symptoms: May be asymptomatic or cause swelling, pain, tingling or numbness of arm, neck, face or legs. Surface vein collateral blood vessel formation may occur.</p> <p>It usually will not affect the patency of the catheter.</p> <p>Thrombosis can be confirmed by ultrasound.</p> <p><i>Treatment:</i></p> <ul style="list-style-type: none"> • Urgent referral to Haematology. • DO NOT remove CVAD without consulting haematology – removal if patient is not anticoagulated may cause clot embolism. • It may be possible/ preferable to treat a thrombosis using anticoagulants without removing the catheter if the CVAD is functional and required. Reinsertion risks thrombus at a second site.

Insertion, Management and Removal of Central Venous Access Devices

CVAD removal

CVADs are to be removed without delay once the multi-disciplinary team decides they are no longer required for patient care.

Location of CVAD removal

PICCs and midlines may be removed either in hospital or with Wallaby by an RCH nurse. CICC, TC-CICCs, T-CICCs, LB-CICC, LB-TC-CICC, FICCs and ports are to be removed in hospital.

Removal methods

Implanted devices (ports) and non-Bard™ brand TC-CICCs are to be removed in theatre under general anaesthesia, as surgical dissection and suturing is required.

Umbilical catheters – RCH Neonatal Intranet resources

https://www.rch.org.au/neonatal_rch/intranet_resources/Umbilical_venous_catheterisation_of_the_newborn/

CICC, T-CICC, PICC, TC-CICCs (*for TC-CICCs, the traction removal technique can only be used if the brand on the catheter is Bard™) are to be removed (pulled) using a traction technique.

Preparation for traction removal

- For removal of a CVAD, prepare the child and family; consider comfort first techniques and analgesia as required. Anaesthesia or sedation is rarely needed for T-CICC or CICC CVAD removal.
- The removal of a CVAD can be performed by 1 or 2 personnel. Determine the need for an assistant considering patient age, developmental level and family participation.
- Ensure all bloods required are taken prior to removal, including coagulation studies if necessary.
- Where possible, co-ordinate CVAD removal with other planned procedures requiring anaesthesia or sedation.

Equipment

- Dressing pack
- 2% chlorhexidine and 70% alcohol solution
- Non sterile gloves
- Sterile gloves
- Stitch cutter
- Gauze- Sterile transparent semi permeable dressing (e.g. Tegaderm™)
- Convacare™ adhesive remover wipes may be required to remove tissue adhesive from the exit site

Technique - Using a surgical aseptic technique.

- Collect required equipment
- Perform hand hygiene
- Prepare equipment and aseptic field
- Expose CVAD site and clamp all lines
- Don non sterile gloves
- Remove dressing and dispose
- Perform hand hygiene
- Don sterile gloves
- Clean insertion site using 2% chlorhexidine and 70% alcohol soaked gauze in a circular motion extending outwards.
- Remove any securing sutures or suture-less securement devices.
- If the patient is able to comply, ask them to take a deep breath and hold it. Remove catheter. For patients who can't hold their breath, if possible, remove on expiration.

Insertion, Management and Removal of Central Venous Access Devices

- Using gauze, place firm pressure over site(s), gently using steady pressure pull the CVAD out.
 - o For non-tunnelled CVADs, place firm pressure over insertion site with gauze until bleeding stops.
 - o For tunnelled CVADs, place pressure over vein insertion site – until bleeding stops.
- As catheter is about to exit, increase pressure on insertion site. If resistance is high at any point, stop and notify medical staff.
- Hold gauze over site until bleeding stops.
- Cover insertion site with a sterile transparent semi-permeable membrane dressing.
- For removal of LB-T-CICC; use gauze, sterile transparent semi-permeable membrane and then reinforce with pressure dressing.
- Following removal of LB-T-CICC, the patient must rest in bed for 4 hours.
- Dispose of equipment safely, perform hand hygiene, and record in EMR.

Further information for traction removal of TC-CICC only

Tunnelled cuffed CVADs may be removed by a nurse in the Children's Cancer Centre who is trained and competent in the removal of cuffed lines.

There may be some circumstances (e.g. sepsis) where surgical dissection may be the preferred option for cuffed CVAD removal, this decision is at the discretion of the treating medical team.

Consent

Prior to the removal of a cuffed CVAD, the procedure should be explained to the patient and/or their carer and verbal consent is to be obtained. Consent is to be done by the treating clinician and documented in the medical record. A line removal order is also to be completed.

On the day of CVAD removal, the nurse is to ensure this process has been followed.

Risks include:

- Infection associated with a retained cuff
- Migration of the cuff.
- An inability to remove the catheter.
- All other potential complications can be found in the **CVAD Adverse Events and Complications** section of this procedure.

Blood parameters

Prior to removal of the cuffed CVAD, the patient must have a platelet count equal to or greater than 50.

Maximum number of attempts

The nurse performing the procedure may have a maximum of two attempts at removing the CVAD. If the CVAD is unable to be removed, another two attempts (maximum) may be performed by another trained and competent Children's Cancer Centre nurse.

Surgical referral

If the CVAD cannot be removed, the treating medical team is to make a referral to the Paediatric Surgical team for the CVAD to be removed using surgical dissection. The referral is to follow the standard elective booking request process or emergency theatre request. The booking will be triaged accordingly.

Complications

If there are any acute complications during removal of the CVAD, a MET is to be called.

If the cuff is retained and is visible at the exit site following removal of the CVAD, a medical review is necessary for removal.

If the cuff is otherwise retained under the skin it should be left *in situ*. If erythema or other signs of infection occurs at the exit site, urgent surgical review +/- drainage and removal is required.

Insertion, Management and Removal of Central Venous Access Devices

Appendix one: Midline catheters

<p>Description: A midline is a catheter that is inserted into the brachial or basilic or veins in the arm.</p> <p>A midline functions in the same way as peripheral intravenous cannula, as the tip of the device remains in the peripheral vasculature.</p> <p>Usual duration: approximately 1-2 weeks</p> <p>Usually inserted by:</p> <ul style="list-style-type: none"> - NICU and PICU teams - Department of Anaesthesia 	
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Indications for midline insertion

A midline may be the most appropriate device for patients who need short term vascular access, either in the hospital or in the home. Midlines differ from central venous access devices as the tip of the catheter resides in the peripheral vasculature. Therefore, only medication that is suitable to be given peripherally can be given through a midline.

If the child requires volumetric pump continuous therapy, then the ONLY suitable devices for discharge to HITH are T-CICC, TC-CICC, PICC or 8cm (or longer) 'Midline' catheter in the upper arm (inserted into a vein above cubital fossa).

Device type	Proposed duration of treatment		
	0-3 days	3-7 days	8-14 days
PIVC (peripheral intravenous cannula)	Most hand or foot PIVC fail after 0-3 days		
US guided forearm long PIVC (USGPVIC)	<ul style="list-style-type: none"> • Preferred to PIVC catheter for > 2 days of therapy • Forearm cephalic = the preferred vein • 4-5cm length catheters are less likely to extravasate or dislodge • Preferred to a midline for 0-7 days 		
Midline catheter	<ul style="list-style-type: none"> • Long (usually 6-10cm) USG catheter. The upper arm basilic vein = preferred vein • Requires >5-8cm of patent upper arm vein between cubital fossa and axilla • Often not suitable for small children • Extravasation may go unnoticed for longer in shorter plump upper arms • PICC usually preferred if home care required: lower failure rate • PICC preferred for CF tune ups requiring general anaesthesia • PICC preferred if patient <8 years old for > 7 days of therapy 		

Referral for midline insertion

Outside of the critical care areas, midlines are usually inserted by the Anaesthetic Vascular Access Service (AVAS).

Referral for midline insertion through AVAS

- Review indication and refer to the 'Choosing an Appropriate Device' algorithm (appendix two).
- Ensure the parents, guardian +/- patient and treating consultant are aware of request.
- Discuss with the in-charge anaesthetist in person or call 52000.
- Search for 'AVAS' in the orders tab in EPIC and select "Anaesthesia Vascular Access Service Inpatient Referral".

Insertion, Management and Removal of Central Venous Access Devices

- Complete all details, providing as much information as possible.
- Once the request has been discussed with the in-charge anaesthetist and the AVAS referral has been completed, the patient will be reviewed and the anaesthetist will arrange theatre access if appropriate.

Midline insertion

Midlines can be inserted outside the theatre environment, such as treatment rooms in the out-patient and in-patient areas. Midline insertion must be conducted by a trained operator using ultrasound guidance and a surgical aseptic technique.

Midline maintenance

Dressings are suture-less securement devices are to be changed every seven days unless clinically indicated.

Equipment

- Dressing pack
- A pair of sterile and non-sterile gloves
- Tegaderm Advanced™ dressing
- Grip-Lok™ suture-less securement device
- 2% chlorhexidine and 70% alcohol skin preparation
- Cavilon™ barrier swab stick (not to be used on infants <1 month of age)

Technique

- Collect required equipment.
- Perform hand hygiene and using a non-touch technique open equipment onto the field.
- Perform hand hygiene and don non-sterile gloves.
- Gently remove the old dressing and suture less securement device. Ensure a 'low and slow' technique is used to minimise trauma and prevent skin breakdown.
- Assess the insertion site and surrounding skin, take precautions to prevent dislodgement.
- Site assessment should include identifying signs and symptoms of infection which include; erythema, purulence, tenderness, haemoserous ooze or any other abnormalities. Altered skin integrity includes; erythema, sheering or cuts in the skin, irritation, discomfort or any other abnormalities. Findings from the site and skin assessment may alter management from this point.
- Remove gloves and repeat hand hygiene.
- Don sterile gloves.
- Ensure the gauze and 2% chlorhexidine and 70% alcohol skin prep solution has been wrung out (i.e. still damp but not soaking wet)
- Clean skin with 2% chlorhexidine and 70% alcohol solution from the centre to the outer area in a circular motion, approximately 5-10cm. Repeat this three times and allow to completely air dry. Do not fan the area to speed up the drying time.
- Securing the line with 2% chlorhexidine and 70% alcohol solution scrub the line moving away from the patient and allow to air dry.
- Apply Cavilon™, 2cm away from the exit site (not to be used on infants <1 month of age).
- Replace the suture-less securement device. Before placing the midline into the retainer, ensure you are familiar with how the paper backing is removed. Place the hub of the midline into the Grip-Lok™ and cover. Remove the paper backing and place on the skin.
- Apply the dressing, ensuring it covers an appropriate portion of the catheter and surrounding skin.
- Dispose of equipment and rubbish.
- Perform hand hygiene.
- Document procedure in the EMR.

Insertion, Management and Removal of Central Venous Access Devices

Intermittent locking

Midline catheters are to be flushed and locked with 0.9% normal saline if they are not connected to a continuous infusion.

Complications

Occlusion: characterised by sluggish flow or a complete inability to infuse fluid through the catheter.

Infiltration and extravasation: can occur when the tip of the catheter is no longer in the vein, resulting in the infusate leaking into the surrounding tissue.

Thrombophlebitis: can occur when there is inflammation to the lining of the vessel wall. It can present as erythema or tracking along the vein cord.

Dislodgment: can occur due to accidental tension or pulling on the catheter. This often results in the tip migrating out of the correct position.

Most complications that occur with midline catheters result in device replacement, or alternative therapy.



Appendix two: Choosing an appropriate device algorithm

Device type	Expected duration of infusion				
	0-3 days	3-7 days	8-14 days	15-90 days (or more)	>60-90 days
PIVC (peripheral intravenous cannula)	Most hand or foot PIVC fail after 0-3 days				
US guided forearm long PIVC (USGPVIC)	<ul style="list-style-type: none"> Preferred to PIVC catheter for > 2 days of therapy Forearm cephalic = the preferred vein 4-5cm length catheters are less likely to extravasate or dislodge Preferred to a midline for 0-7 days 				
Midline catheter	<ul style="list-style-type: none"> Long (usually 6-10cm) USG catheter. The upper arm basilic vein = preferred vein Requires >5-8cm of patent upper arm vein between cubital fossa and axilla Often not suitable for small children Extravasation may go unnoticed for longer in shorter plump upper arms PICC usually preferred if home care required: lower failure rate PICC preferred for CF tune ups requiring general anaesthesia PICC preferred if patient <8 years old for > 7 days of therapy 				
CICC/FICC	<ul style="list-style-type: none"> Preferred in critically ill patients or if haemodynamic monitoring is required Not for home care due to morbidity and mortality associated with dislodgement 				
PICC			PICC preferred to midline if: <ul style="list-style-type: none"> Insertion requires general anaesthesia Patient <8-10 years of age Frequent blood draws are required. Awake/conscious sedated PICCs: request via radiology 		
T-CICC			Use if: <ul style="list-style-type: none"> Arm veins are too small for a PICC (< 3 years of age) Use if a PICC will occupy 1/3 of upper arm vein (no tourniquet) 		
TC-CICC					Frequent use (> 1 x a week)
Port					Intermittent use (< 1 x a week)
If the child requires volumetric pump continuous therapy, then the ONLY suitable devices for discharge to HITH are T-CICC, TC-CICC, PICC or 8cm (or longer) 'Midline' catheter in the upper arm (inserted into a vein above cubical fossa).					



Choosing an appropriate device algorithm – further guidance

PIVC, USGPVC and midline catheters	Consider a CICC/FICC, PICC, T-CICC, TC-CICC or port if:
Are only indicated for peripherally compatible therapy	<ul style="list-style-type: none">• Drugs or infusions require central access• pH <5 or >9• Osmolarity >600 mOsm/L• Parenteral nutrition• Vesicant drugs• Any drug potentially associated with endothelial damage• Duration of IV access > 7-14 days• Multiple incompatible infusions• Repeated daily blood samples• Hospital in the home > 2 days



References

Australian Guidelines for the Prevention and Control of Infection in Healthcare, retrieved from:

<https://www.nhmrc.gov.au/about-us/publications/australian-guidelines-prevention-and-control-infection-healthcare-2019>

Upper Limb PICC Tip Target Position and Lower Limb PICC Tip Target Position retrieved from:

Chopra, V., Flanders, S. A., Saint, S., Woller, S. C., O'Grady, N. P., Safdar, N., ... & Bernstein, S. J. (2015). The Michigan Appropriateness Guide for Intravenous Catheters (MAGIC): results from a multispecialty panel using the RAND/UCLA appropriateness method. *Annals of internal medicine*, 163(6_Supplement), S1-S40.

<https://www.cincinnatichildrens.org/service/v/vascular-access/hcp>

Guidelines for the Prevention of Intravascular Catheter-Related Infections, 2011, retrieved from:

<https://www.cdc.gov/infectioncontrol/pdf/guidelines/bsi-guidelines-H.pdf>

Gorski, L. A. (2017). The 2016 infusion therapy standards of practice. *Home healthcare now*, 35(1), 10-18.

Hill, J., Broadhurst, D., Miller, K., Cook, C., Dumanski, J., & Friesen, N. (2013). Occlusion management guideline for central venous access devices (CVADs). *Vascular Access*, 7(Suppl 1), 1-36.

Ullman, A. J., Bernstein, S. J., Brown, E., Aiyagari, R., Doellman, D., Faustino, E. V. S., ... & Chopra, V. (2020). The Michigan Appropriateness Guide for Intravenous Catheters in Pediatrics: miniMAGIC. *Pediatrics*, 145(Supplement 3), S269-S284.