Guideline for the Insertion, Management, Replacement and Removal of Central Venous Catheters in Adults and Children

Guideline Detail

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1. Background

This guideline sets out broad principles of safe practice in the management of Central Vascular Access Devices (CVADs) across Leeds Teaching Hospitals Trust.
It is not intended as a comprehensive guide to the technical aspects of surgical, radiological or anaesthetic practice for the insertion of such devices. The principles contained within this guideline will be supported by local policies, guidelines and standard operating procedures required by the clinical needs of particular patient populations, for example those of neonates where there is a specific standard operating procedure for the insertion and maintenance of peripherally inserted central catheters:
http://nww.lhp.leedsth.nhs.uk/common/guidelines/detail.aspx?ID=917

1.1 Aim

To minimise the risk of CVAD-related complications by ensuring that:

- Intravenous access is accomplished by using the optimal venous access device for that patient.
- Insertions are performed by competent personnel with minimal delay using the optimal technique via the safest route.
- CVADs are managed by competent personnel according to best practice and removed as soon as indicated.
- Complications are recognised and managed as soon as they arise.

1.2 Objectives

- Provide cost effective, safe, timely intravenous therapy for patients.
- Reduction in Catheter Related Bloodstream Infections (CRBSI).
- Reduce treatment delays and complications.

1.3 Key Changes from previous guideline

The guideline revision was undertaken in the light of the publication of the revised ‘EPIC3: National evidence-based guidelines for preventing health-care associated infections in NHS Hospitals (Loveday et al 2014).
Key changes include:

- The guideline is for the management of Central Venous Access Devices (CVAD) only; it will become part of a new Trust-wide initiative in the management of Intravenous Access Devices, the ‘Blood Vessel Health and Preservation Programme’ (Hallam et al 2016).
- Review of the guidance on antimicrobial catheters (section 2.5.2)
- Additional guidance on the use of ‘maximal sterile barrier precautions (section 4.2)
- Modification of the recommendation favouring the use of sutureless catheter securement devices over sutures (section 5.6).
- New recommendation to consider the use of daily cleansing with chlorhexidine in adult patients as part of an agreed strategy to reduce CRBSI (section 6.2).
- Updated recommendation on changing of administration sets for IV solutions that do not contain blood products or lipid emulsions (e.g. TPN) to every 96 hours in line with EPIC3

1.4 Abbreviations used in this document

- ANTT - Aseptic Non-Touch Technique
- CRBSI – Catheter Related Bloodstream Infection
- CHG - Chlorhexidine Gluconate
- CVAD - Central Venous Access Device
- CVP - Central Venous Pressure
- HDU - High Dependency Unit
- ICU - Intensive Care unit
- IV - Intravenous
- IVAD – Intravenous Access Device
- KVO - Keep Vein Open
- PICC - Peripherally Inserted Central Catheter
- PPE - Personal Protective Equipment
- TPN – Total Parenteral Nutrition
- VHP – Vessel Health Programme

2. Considerations prior to CVAD Insertion

2.1 General Principles

Please check the patients allergy status, as they may be allergic to Chlorhexidine, and alternative solution will be required.

Be aware; Chlorhexidine is considered an environmental allergen

Vascular access is common practice in healthcare, and plays a significant role in the care and management of many of our patients (Hallam et al 2016). A decision making framework should be used to guide practitioners in making decisions as to whether a patient requires a peripheral access device, a 'Mid-line' catheter (where the tip is positioned near the axilla), or a CVAD (***Appendix 1: Example of decision making framework***).

Once a decision has been made that a CVAD is required, careful selection of an appropriate device should be made, taking into consideration the size of the patient, the intended route of insertion and predicted use for the device.

2-D imaging ultrasound guidance should be the preferred method when inserting of central venous catheter into the internal jugular vein in adults and children in 'elective situations', and should also be considered in emergency situations (Bodenham et al 2016). Anyone using 2D ultrasound imaging should be trained and competent to do so.

The importance of strict adherence to hand hygiene and the use of an aseptic technique are fundamental to the prevention of catheter related infection.

2.2 Competent personnel

All health care workers caring for patients with CVADs should be trained and assessed as competent in using, and consistently adhering to practices for the

safe management of these devices, and for the prevention of catheter related blood stream infections (EPIC 3 IVAD1).

Operators should only undertake CVAD insertion using a technique or route in which they are recognised to be competent, and that is suitable for the type of catheter being used. Operators who are not competent in the employed technique may insert CVADs but this must be under the direct supervision and control of a competent individual. The responsibility for insertion and troubleshooting of the CVAD will remain with the competent individual at all times.

It is recommended that an expert operator should insert CVADs into high risk patients, such as those who have had previous complications with a CVAD; patients with significant coagulopathy, patients with Long Term Conditions who may require life-long venous access (e.g. long term TPN patients), infants, children and the elderly.

2.3 Indications

Indications for placing a CVAD are outlined in the decision making tool at Appendix 1 and include:

- The need for IV access when peripheral venous access is poor
- The need for IV access of acutely ill patients in the critical care setting
- The need for medium or long term IV access
- Repeated collection of blood specimens in the absence of good peripheral veins
- Parenteral Nutrition - including total parenteral nutrition (TPN)
- Administration of vesicants
- Administration of preparations with extremes of pH or high osmolality
- Administration of vasoactive drugs
- Monitoring of central venous pressure
- Certain cardiac procedures
- Haemodialysis.

2.4 Choice of CVAD

One of the key factors in deciding what type of CVAD to use is the anticipated duration of therapy, as outlined in the decision making tool at Appendix 1.

- **Non-tunnelled short term CVAD**

  When short term use is anticipated (*7-10 days*) a non-tunnelled CVAD, a PICC or a Mid-line catheter should be used.

- **Peripherally Inserted Central Catheter (PICC)**

  Consider use of a PICC for patients in whom medium term (*10 days and up to 6 months*) intermittent access is required (EPIC3 2014).

- **Tunnelled CVAD *(e.g. 'Hickman'™ or 'Broviac'™)***

  A tunnelled catheter should be used when continuous, or long term access (*months/years)* is required (EPIC3 2014).

- **Totally Implantable Venous Access Devices *(e.g. 'Port-A-Cath'™)***

  An implantable access device should be used if IV therapy will be long term, *(months/years)* particularly if the patient will be managed at home, or has difficulty in accepting or safely managing the external portion of a tunnelled device. An implantable device is suitable for intermittent access, but less suitable than a tunnelled device for continuous or lengthy periods of access.

2.4.1 Number of lumens

Use a catheter with the minimum number of ports or lumens essential for the management of the patients (EPIC3 2014). Additional lumens may increase the opportunity for microbial contamination of the system. The number of lumens should, however, be sufficient to achieve therapeutic goals, and avoid the mixing of non-compatible fluids and medications. This will avoid the requirement to insert another device.

When TPN or other lipid based solutions are to be used a designated single lumen catheter is preferred, but this is not always possible (EPIC3 2014). On a CVAD with multiple lumens a dedicated lumen should be allocated for TPN; where possible this should not be used for any other purpose.

A multiple lumen CVAD will be necessary for the management of most patients undergoing major surgery, transplantation, or who are critically ill.

2.4.2 Antimicrobial-impregnated catheters

Catheters impregnated with antimicrobials are not recommended for routine use. They should be considered for 'high risk' adult patients (such as those in critical care) whose CVAD is expected to stay in place for more than five days, and in clinical areas where catheter-related bloodstream infections remain high despite the implementation of a comprehensive strategy to reduce infection rates (EPIC3 2014). A recent trail showed evidence of a reduction in CRBSI when used in the Paediatric Intensive Care setting (Gilbert et al 2016). A decision to use an antimicrobial impregnated catheter should always be made in discussion with the Infection Prevention team, reviewing the CRBSI rates in the specific patient population, and the cost benefit of such an intervention; this may be in the context of a clinical trial.

2.4.3 Choice of insertion site

The insertion site of a CVAD can influence the subsequent risk of CRBSI because of variation in both the density of local skin flora and the risk of thrombophlebitis. In selecting an appropriate intravascular insertion site the risks of infection should be assessed against the risks of mechanical complications and patient comfort (EPIC3 2014; Parienti JJ 2015). The femoral site should be avoided if possible because of the risk of contamination and subsequent bacteraemia. The upper extremity should be used for non-tunnelled catheters unless medically contraindicated (EPIC3 2014 IVAD 12).

In children the femoral approach may sometimes be required, particularly in infants and smaller children and in complex cardiac cases. It should be avoided where possible in longer term CVADs.

There are a number of factors which should be taken into account when selecting the insertion site; these include:

- Age and size of the patient
- Patient preference
- Previous CVAD insertion (*or complications with CVAD insertion*)
- Previous surgery to chest or neck
- Previous radiotherapy to chest or neck
- Presence of a clotting disorder
- Presence of other significant co-morbidities

If patients have had previous CVADs, they may require an Ultrasound scan or an MRI venogram to assess the patency of veins for CVAD placement.

3 Preparation of the patient prior to CVAD insertion

3.1 MRSA Risk Assessment

When CVAD insertion is carried out as a planned procedure MRSA Risk assessment should be carried out. Screening should be carried out as indicated by the guideline for the relevant clinical area.
http://nww.lhp.leedsth.nhs.uk/common/guidelines/detail.aspx?ID=684#5
Decolonisation should be undertaken in any MRSA positive patient in line with previous history and trust and local guidelines; Mupirocin susceptibility result(s) should be checked prior to prescribing decolonisation.
Three negative screens should be received prior to elective CVAD insertion in a patient known to have been MRSA positive prior to decolonisation.
In an emergency situation when assurance of MRSA status cannot be obtained a risk assessment should be undertaken prior to insertion and a full programme of decolonisation completed.

3.2 Skin decolonisation for high risk groups

There are a number of high risk patient groups who should undergo decolonisation, irrespective of any MRSA screening results, to reduce the risk of infection with *Staphylococcus aureus*. The decision to introduce routine decolonisation into particular patient populations should be made through discussion between the clinical team and the microbiologist who supports that team. Patient groups who currently receive decolonisation include:

- Haemodialysis patients (adults and children)
- Paediatric Haematology and Oncology
- Adult Haematology and Oncology

3.3 Skin decolonisation prior to CVAD insertion

Decolonisation should follow the Trust guidance, with the daily use of Chlorhexidine skin wash **(or alternative if patient is allergic to Chlorhexidine, such as Octenisan)** and Mupirocin (Bactroban®) cream to the nostrils.

- In patients who are too unwell to have a bath or a shower with Chlorhexidine, Chlorhexidine impregnated wipes should be used.
- For infants under one year, Octenisan should be used instead of Chlorhexidine.

- Neomycin (Naseptin®) should be used if mupirocin contra-indicated (including if known resistance), unless also contra-indicated, when Prontoderm® should be used instead.

Decolonisation should be planned with the five day course completing on the day of surgery.
If CVADs are inserted in the acute situation, the decolonisation regime should commence as soon as the decision is taken to insert the device, and should be administered for a full five days.

4. Preparation of the environment

4.1 Location of insertion

The planned insertion of a CVAD will usually take place in an operating theatre, a designated procedure room, or a radiological treatment suite.

Where insertion occurs outside of these controlled environments, for example in critical care areas, the surroundings must be clean and clutter free. There should be sufficient space for the operator and their assistant to operate without risk of contamination. A dedicated metal trolley should be available with all the equipment required for insertion; it should be cleaned before use.

A recent review of the evidence (EPIC3 2014) suggested that the risk of infection depended largely on the magnitude of barrier protection used during insertion rather than the surrounding environment.

4.2 Maximal sterile barrier precautions during catheter insertion

Maximal sterile barrier precautions should be used for the insertion of CVADs (EPIC 3 IVAD13). The components are defined as:

- Sterile cap and mask *(person inserting the catheter)*
- Sterile gloves and gown *(person inserting the catheter)*
- Use of a full body sterile drape during insertion

4.3 Hand hygiene

The operator and their assistant(s) should decontaminate their hands using soap and water prior to undertaking the procedure.

4.4 Documentation

Any CVAD insertion should be a ‘witnessed’ procedure, and a CVAD Insertion Checklist, based on the ‘Matching Michigan’ Checklist should be completed (Bion et al 2013); where local CVAD insertion checklists are already in use (e.g. where they are included in the CVAD insertion packs) they should include the key elements of this checklist ***(Appendix 2: Insertion Checklist).***

5. Insertion of the CVAD

5.1 Skin decontamination

Decontaminate the skin at the insertion site with a single-use application of sterile 2% Chlorhexidine in 70% Isopropyl Alcohol solution (e.g. ChloraPrep™). It should be applied over the proposed entry site using

repeated strokes in a cross-hatching pattern for thirty seconds before moving outwards until an area significantly wider than that within which the insertion will take place has been covered. Allow the antiseptic to dry prior to catheter insertion.
Povidone-iodine in alcohol solution should be used for patients with a history of Chlorhexidine sensitivity.
Aqueous Chlorhexidine Gluconate, (**or a water based Iodine solution**) **should be used in patients with a history of sensitivity to topical alcohol**.

5.2 Insertion problems

CVADs should only be inserted by clinicians who are competent to do so. Clinicians who are not competent may insert CVADs but this must be under the direct supervision and control of a competent individual. Referral to an expert senior colleague prior to attempting insertion should be considered in all situations / patients where difficult cannulation can be predicted e.g. small infants and neonates, previous difficult cannulation or complications, morbid obesity, significant co-morbidity or the need for life-long access. Before beginning the procedure the operator must ensure they are aware of how to get senior help should the need arise.

5.3 If asepsis is breached

The insertion of a CVAD should always be a witnessed procedure; it is the duty of all LTHT employees involved in the procedure to immediately report breaches of asepsis to the practitioner inserting the CVAD.

If asepsis is breached during insertion of a CVAD then it is the responsibility of the practitioner inserting the catheter to ensure that all potentially contaminated parts are discarded and the procedure restarted from a point before the breach occurred with new equipment.

All breaches of asepsis need to be documented on the CVC Insertion Checklist and in the patient's medical notes together with the rationale for subsequent action.

5.4 Use of Ultrasound during and after CVAD insertion

Ultrasound should be used both to ensure the presence of a suitable patent vein, and to establish correct needle, guidewire and catheter placement in the target vein. Access at all the commonly used sites for CVADs (jugular, axillary/subclavian, femoral, peripheral upper arm) is safer and faster overall with the use of 2-D ultrasound. Audio-guided Doppler ultrasound is not recommended to assist in CVAD placement (NICE 2002).

In order to maintain asepsis a single-use sterile long probe cover should be used, along with single-use sterile ultrasound gel.

A 'Landmark' technique should be reserved for true emergency use or the very rare situations where ultrasound guidance is impractical e.g. massive subcutaneous air emphysema.

Ultrasound is of limited use in the peripheral insertion of catheters into the limbs of infants and small children.

In order to minimise complications associated with the use of guide wires and dilators:

- Guidewires should only be inserted as far as the position required for the catheter tip, unless X-ray screening is used.
- The dilator should only be inserted far enough to open the vessel puncture site and NOT pushed to its full length. Excessive force should not be used.

5.5 Confirmation of placement of the CVAD

Confirmation of placement requires elements of the following checks:

1. Confirmation that the catheter is intravenous
    a) Catheters and guide wires should be visualised in the proximal target vein with ultrasound.
    b) Low pressure dark venous blood should be able to be aspirated from all lumens. Pressures in catheter lumens can be checked with a column of fluid (e.g. using catheter itself, a manometer U tube or IV administration set) or by connection to a pressure transducer and monitor to measure pressures and observe the waveform (use central venous pressure settings).
    c) Blood gas analysis can demonstrate arterial patterns of oxygenated blood and if so would suggest positioning in an artery (this would be inaccurate in the presence of some cardiac abnormalities e.g. AV fistula or intracardiac shunt).

2. Confirmation that the catheter is centrally placed;
    Radiological imaging, ultrasound, electromagnetic or ECG guidance is used to demonstrate central passage of the catheter in upper body catheters. It may not, however, confirm that the catheter is intravenous. The close proximity of major arteries, mediastinal structures and the pleura means that the catheter can lie in these and appear to be in the correct position.

In acute settings and theatre use devices are often used immediately after insertion, following the checks listed above, with X-ray imaging performed later prior to longer term use. Catheters from the femoral vein are not usually imaged unless problems are apparent.

Post procedural X-ray is not required for PICC line insertion if tip location is verified using ECG technology and the line is positioned where maximal P-wave is observed. PICCs are safe to use immediately post procedure once confirmed in correct position using ECG as the risk of post insertion pneumothorax is minimal. If the patient has AF or is found to have no observable P wave during the insertion or there are any other concerns the tip location should be confirmed by X-ray imaging post procedure (Oliver and Jones 2016; Pittiruti et al 2013).

There is an algorithm developed within LTHT which sets out the steps by which correct positioning of a CVAD may be confirmed ***(Appendix 3: CVAD Insertion Algorithm).***

If any doubt exists seek senior specialist advice (from radiology, anaesthetics, or other specialists with an interest in vascular devices) to confirm position via fluoroscopy (with X-ray contrast injection) or other radiological imaging (e.g. CT) and seek the safest option for removal if this is indicated.

In preterm neonates the catheter (e.g. Vygon premi-cath) may be too small to allow blood to be aspirated. If blood flows freely from the catheter into the giving set/syringe then there should be suspicion of arterial placement. In all cases the line position must be confirmed on X-ray using contrast before it is used. This is detailed in the Standard Operating Procedure for the Insertion and Maintenance of Peripherally Inserted Central (PIC) Lines in Neonates http://nww.lhp.leedsth.nhs.uk/common/guidelines/detail.aspx?ID=917

5.6 Securing the CVAD

The CVAD should be secured immediately following insertion.

Non tunnelled CVADs will either be sutured at the exit site, or secured with a sutureless catheter securement device (e.g. 'StatLok'; an adhesive device or 'Securacath' a subcutaneous fixation device which may be used unless the patient is allergic to Nickel).

In longer duration tunnelled CVADs buried absorbable sutures are usually used for skin closure and these devices are also secured at the exit site through either sutures or a dedicated sutureless catheter securement device.

There is little evidence as to the advantage of either sutures, or sutureless devices in the prevention of dislodging devices, or in infection rates.
If a 'StatLok' is used to secure a tunnelled catheter, or a PICC, it should be changed after 7 days using an aseptic technique. It may be removed after 4-6 weeks, once the cuff of the catheter has had chance to bind to the tissues.
If sutures are used to secure the catheter, they can remain in situ unless the site becomes red or inflamed. They should be removed once the cuff of the catheter has had chance to bind to the tissues. 'Securacath' devices should remain in place until the PICC is removed.

If a cuffless CVAD is used, the fixation device should not be removed whilst the line is in place.

Sutureless catheter securement devices are contraindicated in patients with known adhesive or tape allergies. As these devices are adhesive-based they may not be sufficiently effective in patients with greasy, sweaty or flaky skin. For these patients 'Securacath' subcutaneous fixation device should be considered.

In patients with a Totally Implanted Venous Access Device, buried absorbable sutures will typically be used for skin closure at both the entry and exit sites.

5.7 Dressing the newly inserted CVAD

The CVAD should be dressed as soon as it is secure with sterile, transparent, semi-permeable polyurethane dressing (EPIC3 2014 IVAD17).

If the entry site is oozing or bleeding a sterile gauze dressing should be used. It should be changed daily to allow inspection of the site, or more frequently if it becomes damp or soiled. It should be replaced as soon as possible with a transparent semi-permeable dressing.

If a patient has, or develops an allergy or sensitivity to polyurethane dressings a sterile 'all in one' occlusive dressing may be used. This should be taken down and inspected every day immediately post insertion (for the first five days).

A chlorhexidine impregnated sponge dressing may be used(**alternative if patient is allergic to chlorhexidine, NOT bio patch as it is chlorhexidine inpregnated)** in specific adult patient groups if part of a local strategy agreed with IPC to reduce CRBSI infections (EPIC 3 2014 IVAD 20). They may also be considered in both the adult and paediatric critical care setting.

An implanted port may be used immediately following insertion; if this is to be the case it is recommended that the CVAD insertion operator is informed. The port can therefore be accessed in theatres and the gripper needle left in place, this will reduce discomfort for the patient. However, care needs to be taken with the adjacent wound, until this is well healed. A sterile, transparent, semi-permeable polyurethane dressing should be placed over a port site which is accessed.

It takes about a week for the port site to settle and tenderness on palpation to disappear, so if not accessed in theatre it may be difficult or painful to access until healing has occurred.

5.8 *Documentation*

5.8.1 Key points

Full documentation of the insertion procedure should appear in the patient case notes, and a CVAD insertion checklist should be completed ***(Appendix 2; CVAD Insertion Checklist).*** Documentation should include:

- the site(s) of insertion or attempted insertion
- the number of attempts at different sites
- the technique followed
- infection prevention and control precautions adopted
- all complications or difficulties encountered
- any checks made to ensure correct catheter placement (including the placement of the tip of the CVAD)
- any deviations from these guidelines and the rationale for these deviations

5.9 'Emergency' insertion of a CVAD

An emergency is defined as a situation that is immediately life-threatening to the patient. Examples include cardio-respiratory arrest, near-arrest situations and severe trauma. During an emergency, inserting or using a CVAD may be an essential aspect of that patient's immediate treatment, and adhering to all the precautions outlined in this document might result in increased risk to the patient.

In an emergency situation it may be necessary to deviate from these guidelines. For example, if the sterile field is compromised during the final stages of catheter insertion during an emergency it may not be in the patient's best interests to restart the procedure. Such deviations from guidelines, and their rationale, must be clearly documented retrospectively in the patient's medical notes. If the patient is then transferred to another area, these deviations must be communicated to the receiving staff.

CVADs that have been placed in sub-optimal conditions should be removed, and replaced if needed, as soon as possible. Usually this will mean following admission to critical care and a period of stabilisation and the presence of a competent operator with the time and expertise to replace the catheter in optimal circumstances.

6. Ongoing care of the CVAD

Key points

On-going care has three aims:

- Minimising the opportunity for complications.
- Prolonging the life of the device.
- Frequent consideration of the utility of the device.

6.1 Site inspection

Both the insertion site and the exit site of CVADs should be inspected at least daily whilst patients are in hospital.
The 'Central Line Entry Site Score (CLESS) should be used in adults; the Visual Central Venous Catheter Score (VCVC) should be used in children (***Appendix 4: CLESS and VCVC***).
This score should be documented on a CVAD Care Plan.

It is important for the user to be careful with the score in people with dark skin. Heavily pigmented skin is less prone to developing erythema in the presence of an irritant, and any erythema that has developed is more difficult to visualise. The score for those with dark skin is therefore less accurate and liable to under-report.

6.2 Chlorhexidine wash

Consider the use of a daily wash with chlorhexidine (*either 2% impregnated cloths or 4% solution*) in adult patients as part of a locally agreed strategy to reduce CRBSI (EPIC3 2014 IVAD 21). **Establish patient's allergy status, use alternative to chlorhexidine.**

6.3 Dressings

There may be two dressings in place after insertion of a tunnelled line, entry site and exit site. The entry site dressing is generally removed between 5 – 7 days (or sooner if it becomes dislodged and the site is healed) and the suture is left exposed. The exit site dressing generally stays in place at least until the wound has healed. A sterile, transparent, semi-permeable polyurethane

dressing should be used. It should be changed every 7 days or sooner if it is no longer intact, becomes soiled, or is leaking or oozing.

If the entry site is oozing or bleeding then the preferred dressing is one that contains sterile gauze. A gauze dressing should be removed at least every 24 hrs, or sooner if it is visibly soiled, and the site inspected and cleaned. If the site continues to ooze or bleed then it should be re-dressed with another sterile gauze; if oozing has stopped then use a sterile, transparent, semi-permeable polyurethane dressing. Continued bleeding can often be stopped by sustained pressure or a fine (5/0) purse string suture around the exit site.

If a patient has, or develops an allergy or sensitivity to polyurethane dressings a sterile 'all in one' occlusive dressing may be used. The dressing should be changed every 7 days or sooner if it is no longer intact, becomes soiled, or is leaking or oozing.

If a CVAD is placed in the upper limbs the dressing should not encircle the whole of the upper arm (*this is critical in neonates and critical care areas where the circulation may be compromised and patients unable to indicate distress).*

The CVAD insertion site should be cleaned at any dressing change. Use a single-use application of 2% chlorhexidine gluconate in 70% isopropyl alcohol (EPIC3 2014 IVAD 23). **Or alternative if patient has chlorhexidine allergy** Povidone-iodine in alcohol solution should be used for patients with a history of Chlorhexidine sensitivity.
Aqueous Chlorhexidine Gluconate, (or a water based Iodine solution) should be used in patients with a history of sensitivity to topical alcohol.

The site should be cleaned using a 'cross-hatching' pattern to ensure complete coverage, before moving outwards until the area that is cleaned extends beyond the edges of the dressing. The site should be left to dry in air before redressing.

Dressings may be removed from tunnelled lines when the exit sutures have been removed/dissolved and the site is healed, but many patients will prefer to have a dressing in place. Most children and some confused patients will require a dressing to remain in place for security; the line should be looped and secured to prevent accidental dislodgement in both adults and children.

The dressing on a PICC line in a neonate is not routinely redressed. If a dressing becomes soiled or dislodged it should be changed using a full aseptic technique.

6.3.1 Impregnated dressings

Consider the use of a chlorhexidine impregnated sponge dressing in specific patient groups as part of an agreed strategy to reduce CRBSI infections (EPIC 3 2014 IVAD 20). They are currently recommended in both the adult and paediatric critical care setting. **Establish patient's allergy status, use alternative to chlorhexidine.**

When considering the use of an impregnated dressing, one should be chosen that allows undisturbed visualisation of the entry site to allow for regular inspection.

6.3.2 *The use of 'Parafilm'*

'Parafilm'™ is a non-adhesive barrier film which in some settings may be used to cover needle-free ports at the connection points of administration sets. It may be used to reduce the risk of contamination from body fluids, and the risk of accidental disconnection. It has been used primarily in the setting of TPN patients where there is less need for repeated access of the CVAD.

6.4 Implanted Ports

Implanted Ports should always be accessed using a non-coring 'gripper' needle. Although the manufacturer's guidelines recommend needles should be changed weekly, audit undertaken both externally and within LTHT has demonstrated that a port can remain accessed without the needle being changed for a period of up to two weeks (Hempsey et al 2011).

6.5 Needle-free devices

Needle-free access devices reduce the risk of sharps injuries; there is limited evidence that they may reduce the risk of CVAD infection rates. In some cases their design may pose an additional risk of contamination (EPIC3 2014).

All ports on a CVAD should be covered with a needle-free device to ensure that the system remains closed, and all components of a closed system should be compatible in order to ensure against leaks and breaks in the system.

There are exceptions to the use of such devices, for example when carrying out CVP monitoring, or during renal dialysis.

6.6 Multiway connectors

The number of access ports should be kept to the minimum needed to provide therapy. The use of multi-way connectors and devices is acceptable, provided that this does not result in unnecessary, unused ports.

6.7 Extensions

The use of extension lines on CVADs is discouraged because they increase the dead space in the system and they make misidentification of lines more likely, increasing the risk of incompatible drugs on the same line and inadvertent boluses.

- Extension lines may occasionally be used to make longer-term CVADs more tolerable to the patient.

6.8 *Accessing the CVAD*

Prior to accessing any CVAD, the exit site should be checked for any signs of infection and possible line migration. Assess the patient for;

- Pain in tunnel site, neck, shoulder or chest
- Swelling of chest wall, arm, neck
- Shortness of breath
- Line migration (i.e. line longer at exit site than it was on insertion)
- Signs of redness, swelling or exudate

If any of these signs are seen, STOP and refer to section below on CVAD '*complications*'.

Key points

- Appropriate hand hygiene should always be performed before and after accessing the CVAD.
- "Scrub the hub" with a sterile single-use application of 2% chlorhexidine gluconate in 70% isopropyl alcohol before and after accessing a CVAD **or alternative if patient has an allergy to Chlorhexidine**.
- Asepsis should be maintained whenever the CVAD is accessed. Asepsis should be maintained either through employing a Full Aseptic Technique, or an Aseptic Non-Touch technique:

    - **Full Aseptic Technique** involves the use of a sterile field e.g. a cleaned trolley with an opened out dressing pack; sterile gloves are worn. A non-touch technique is used to protect key parts and key sites.
      This technique should be used whenever the hub is exposed; (e.g. changing a needle free device) and when there are multiple key parts to protect, e.g. setting up TPN or multiple infusions.
      Local guidelines may require the use of a full aseptic technique for any intervention related to a CVAD.

    - **Aseptic Non-Touch Technique (ANTT)** involves the use of a clean field e.g. container or tray designed for either single use or for re-use following (local) decontamination; non-sterile gloves are worn. A non-touch technique is used to protect key parts and key sites. This technique may be used when the CVAD remains 'closed'.

6.8.1 Hand hygiene

Hands must be decontaminated before accessing or dressing a CVAD. Hand decontamination is achieved by using alcohol hand rub on clean hands. If hands are not clean, (visibly soiled or potentially contaminated with dirt or organic material) soap and water must be used before the alcohol hand rub.

6.8.2 Personal protective equipment

Gloves and apron must always be worn when accessing the CVAD.

6.8.3 Maintaining Asepsis

An aseptic technique or ANTT must be used when accessing a CVAD

- *Before* accessing the catheter the end of the needle-free device should be decontaminated by a vigorous scrubbing for 15 seconds with a sterile single-use application of 2% chlorhexidine gluconate in 70% isopropyl alcohol**(or alternative if patient has an allergy to Chlorhexidine)**. The solution must be given time to dry before accessing the system (EPIC 3 IVAD 30).
- *After* accessing the catheter it should again be decontaminated by a vigorous scrubbing for 30 seconds with a sterile single-use swab impregnated with chlorhexidine 2% in 70% isopropyl alcohol. This will prevent leaving any residues on the needle-free device which may prove impossible to shift once dry.

6.8.4 Flushing a CVAD

There is limited evidence regarding the frequency and composition of flushes. Evidence and best practice guidelines have been reviewed and the following recommendations are based on expert consensus and manufacturer's guidance. (*Practice may differ in specific areas provided that local protocols are in place).*

- When a patient with a CVAD is in hospital the CVAD should be flushed as a minimum once a day with between 5-10 mL of Sodium Chloride 0.9%.
    - In children or where patients are fluid restricted this can be reduced to the 'fill' volume of the CVAD in use (***Appendix 5: Fill volumes of commonly used CVADs***)
- Except where very small flushes would make it impractical, the syringe used for flushing must have a capacity of 10ml or greater to reduce the possibility of pressure-related lumen failure.
- Flushing lines should be performed with care and without exerting undue pressure; excess pressure can cause catheter rupture. Smaller syringes exert a greater pressure than when the same force is applied to a larger syringe.
- The flush should be administered using a stop-start technique of rapid small boluses; this is termed a '***pulsated flush'***. This technique promotes a turbulent flow, reducing the possibility of precipitates or other residues adhering to the internal lumen of the catheter.
- If the CVAD is not going to be immediately used after a flush then the following two steps need to be followed:
    - Inject the last 10% of the flush slowly, and clamp the lumen before this 10% is finished in order to minimise the possibility of backflow of blood into the lumen during disconnection of the syringe ('*positive pressure clamp'*).
    - Disconnect the syringe and decontaminate the needle-free device
- **On discharge**
    - Tunnelled lines should be flushed with 10ml Sodium Chloride 0.9%.
    - Implanted devices should be flushed with 4-6mL of Heparin (100 units per ml).
    - PICC lines should be flushed with 10ml Sodium Chloride 0.9% and 5mls Heparin (10 units per ml).

- Following discharge, flushing should occur at intervals, and with solution recommended by the manufacturer. The following recommendations are drawn from the range of devices commonly used at LTHT:
    - PICC: weekly (Sodium Chloride 0.9% and 5 mls Heparin (10 units per ml); 'valved' PICC Sodium Chloride 0.9% only)
    - Long-term tunnelled CVADs: weekly (Sodium Chloride 0.9%).
    - Ports: monthly (4-6mL of Heparin (100 units per ml).
        - There is limited evidence (Hempsey et al) that Ports can be flushed every 8 weeks; where this practice is adopted it should be supported by a robust local protocol and audit process

6.8.5 Changing Administration Sets

If an administration set is detached from the CVAD then it should be discarded and replaced with a new, sterile set. Never re-attach a detached giving set to a CVAD.

If an administration set is used to allow the administration of a slow bolus of a drug, for example giving an antibiotic over 1-2 hours then once the bolus is finished the set should be discarded and the catheter flushed, or an infusion left running at a minimum of 'To Keep Vein Open' rate. Leaving an unused administration set attached increases the risk of catheter occlusion.

Giving sets being used for *continuous infusions* must be replaced as detailed in the following table (EPIC 3 IVAD 37-39).

Product	**Replace giving set:**
Blood or blood products	When the transfusion episode is complete, or every 12 hours (whichever is sooner).
Solutions containing lipid emulsions - e.g. Propofol or TPN.	Every 24 hours
Solutions that do not contain blood products or lipids	Every 96 hours

There may be pharmacological reasons or manufacturers guidance as to why particular solutions require more frequent administration set changes.

Administration sets should be clearly labelled at the end nearest to the patient with date, time and infusion contents.

6.9 Medication administration

Medications should be prepared and administered using Aseptic Non Touch Technique (*refer to LTHT 'Injectable Medicines Code'*: http://lthweb.leedsth.nhs.uk/sites/medicines-management-and-pharmacy/information-on-medicines/dat/medicines-guidance-and-policies/Injectable%20Medicines%20Code.pdf)

If medications are prepared away from the bedside, preparation and administration should be considered as two separate procedures. PPE should be changed between preparation and administration, and hand hygiene undertaken at all steps in the pathway; 'key parts' must be protected at all times.

The injection port must be cleaned and flushed prior to the administration of any intravenous medication.

6.9.1 Principles of medication administration via a CVAD

- The patency and placement of the CVAD must be checked before administering a drug by aspirating and checking for blood return unless a locally agreed protocol states otherwise. There is no need to withdraw or discard this blood unless the line is 'locked' with an antimicrobial, concentrated Heparin lock, or any other medication.
    - If there is a 'line lock' in place the CVAD should be aspirated, withdrawing 5mls, or the 'fill' volume of the device, and this aspirate should be discarded prior to administering a flush.
- **Caution** should be used when administering medication through a CVAD (e.g. Renal Dialysis catheters) where a concentrated Heparin lock may be in place; the lock should be aspirated and the aspirate discarded prior to medication administration or flushing
- Flushes and IV medications should be stored, prescribed, dispensed and prepared appropriately.
- The CVAD must be flushed before administering medication; between different medications; after giving medications.
- A separate syringe should be used for each flush administered
- Sodium Chloride 0.9% is the preferred flush solution.
- Heparin-based solutions should not be routinely used.
- Sodium chloride is not compatible with all medications. In the event of incompatibility an alternative flush solution must be used. Consult the IV Monographs (Medusa): http://lthweb/sites/medicines-management-and-pharmacy/information-on-medicines/iv-monographs) for medication-specific information

6.9.2 ***Infusions***

Incompatible products must not be given simultaneously via the same lumen. Compatibility information may be found on the intranet at http://lthweb/sites/medicines-management-and-pharmacy/information-on-medicines/iv-monographs.

The injection port must be flushed with Sodium Chloride 0.9% (see above) prior to connecting an infusion, and immediately after disconnection. Unless there is a possibility that an infusion may need to be restarted quickly (for example during the titration of inotropes) then the infusion should be taken down and the catheter flushed as soon as possible.

A gravity infusion should be disconnected as soon as it is finished; if an empty gravity infusion is left connected backflow of blood may lead to occlusion of the lumen. Volumetric pumps should be used in children, and in areas where

it cannot be guaranteed that a gravity infusion can be immediately disconnected once finished.

PICCs are particularly prone to occlusion and gravity infusions should not be used. The volumetric pump will only prevent occlusion if it is either running an infusion or has switched to KVO mode. A volumetric pump that is switched off is not protecting the PICC from occlusion.

The administration set for a volumetric pump may contain as much as 25ml of fluid. This should be accounted for when giving infusions, particularly small volume infusions of 250ml or less, otherwise the patient may receive significantly less medication than was prescribed. When the infusion appears to have finished it may be necessary to flush the contents of the administration set by attaching a small bag of a suitable fluid and delivering an appropriate volume via the pump.

If the rate of administration of a medication needs to be limited then the post medication flush should be given at the same rate until the catheter is clear. This will prevent inadvertent bolus.

6.9.3 Parenteral Nutrition including TPN

If a multilumen catheter is used then identify and label one port specifically for the use of parenteral nutrition / TPN alone where this is possible.

6.9.4 Blood sampling

- When sampling a CVAD for routine bloods a discard of at least the volume of the device should be taken (approximately 5-10ml in adults; see Appendix 5 for 'fill' volumes for CVADs in use in children and infants).
- If obtaining blood for cultures, the initial blood withdrawn from the CVAD gives important microbiological information and therefore should not be discarded and should be used for the 'central' line cultures.
- If blood samples are taken from a CVAD which has recently been used for the administration of drugs or fluids particular care should be taken in flushing the line and taking a discard as this could result in an inaccurate biochemical analysis or drug level analysis. Prior to taking the sample the CVAD should be flushed with Sodium Chloride 0.9% (ideally 10 ml or twice the prime volume of the CVAD). A discard sample of twice the prime volume of the CVAD should then be taken before aspirating the blood sample.
- If withdrawing blood the larger the syringe the greater the force required to withdraw fluid, without creating a vacuum. If there is difficulty in aspirating blood, a smaller syringe may result in success.
- The CVAD should be flushed with Sodium Chloride 0.9% after the sample has been taken.

7 Management of complications

Complications are common and may occur even if great care is taken with insertion and management of a CVAD (Bodenham et al 2016). The management of common complications is detailed below. The full range of

complications lies outside the scope of this guideline and senior expert help should be sought in managing the range of complex clinical interventions (Bodenham et al 2016). Complications of CVADs include:

- Infection (localised &/or bloodstream)
- Occlusion
- Catheter fracture or dislodgement
- Thrombosis
- Catheter migration
- Incorrect catheter tip position
- Pneumothorax
- Air embolism
- Pleural effusion
- Arterial puncture/catheterisation
- Great vein perforation
- Damage to neighbouring structures
- Cardiac arrhythmias (notably tamponade)
- Mechanical phlebitis
- Extravasation and Infiltration

In the event of cardiovascular collapse in a patient with an in-situ or recently removed CVAD the possibilities of venous or arterial perforation and haemorrhage, pericardial tamponade, air embolism, arrhythmia, haemothorax or pneumothorax must always be considered.

7.1 Infection

A high index of suspicion of CRBSI should be maintained in patients with a CVAD and a fever but without an obvious source, especially if the patient does not respond to apparently appropriate antimicrobial therapy.
Typical warning signs include*;*

- Inflammation or discharge at exit site, with or without tracking up the line
- Inflammation or discharge at entry site, and raised CLESS/VCVC score (*see Appendix 4*). The entry site is only one possible factor in the development infection, and therefore a low score does not rule out the possibility of localised infection or CRBSI.
- Fever (over 38^{o}C), rigors, (especially related to CVAD flushing) and other signs of sepsis
    - In Neonates, signs of infection also include, temperature instability, increasing apnoea, desaturations and bradycardia, irritability, lethargy, hypotension, feed intolerance, low/high blood sugar
- Blood cultures which grow bacteria frequently associated with line infection, such as coagulase-negative staphylococci and diphtheroids, may indicate infection of a line, as can cultures positive for other types of bacteria or yeasts where there is no immediately recognisable focus of infection

Resolution of signs or symptoms of infection following line removal indicates the possibility of a CRBSI; culture of the tip following removal of the device may give a definitive answer.

Line salvage may be possible using antimicrobial lock treatment. Senior expert microbiology advice should always be sought. It is not normally appropriate to attempt to salvage a “short-term” CVAD. Removing or replacing a CVAD also carries risk, particularly in those areas that use long-term catheters in very vulnerable patients. Discussion between senior Microbiologists and Clinicians will be required in decision making for optimal management of vulnerable and high risk patients. Decisions should be clearly documented in the medical notes.

If a patient has a CVAD and a bloodstream infection then CRBSI should be suspected. Microbiological diagnosis should be attempted through ‘paired’ blood cultures - i.e. blood cultures should be taken from the suspected CVAD (each lumen) and from a peripheral site with no delay in collection between the different sites. If there is a significant differential time to positivity (‘DTP’; i.e. a sample collected through the CVAD triggers positive on the incubator two hours or faster than the concurrent peripherally collected sample), then this is suggestive that the CVAD is the source of the bloodstream infection. This test relies upon the cultures being taken at the same time and hence it is important to document the time(s) on the request form. The test also requires the same volume of blood in each bottle. Blood cultures should be taken according to LTHT Guidelines:
Adults:http://nww.lhp.leedsth.nhs.uk/common/guidelines/detail.aspx?ID=1207
Children:
http://nww.lhp.leedsth.nhs.uk/common/guidelines/detail.aspx?ID=3134
Neonates:
http://nww.lhp.leedsth.nhs.uk/common/guidelines/detail.aspx?ID=3143

If the CVAD is removed and CRBSI is suspected then the catheter tip should be sent to microbiology.

If a CVAD exit site infection is diagnosed clinically (localised signs of infection i.e. erythema or discharge at the exit site) then a swab or sample of pus should be sent to microbiology for identification of the pathogen.

Removal of CVAD should be considered when:

1. A definitive microbiological diagnosis has not been achieved and line infection cannot be excluded
2. There is a tunnel infection or
3. In cases of infection with particular microorganisms such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Bacillus* spp., fungi or mycobacteria.

It is recommended that routine surveillance of outcomes from CVADs is conducted, particularly in areas where it is common to attempt to salvage infected catheters.

The management of an infected CVAD should follow local guidelines.

7.2 *CVAD Occlusion*

Occluded lumens predispose the patient to an increased risk of developing subsequent bacteraemia and venous thrombosis. A CVAD with an occluded lumen should not be left in place without considering and documenting a management strategy.

Occlusion may be **partial** (where it is difficult or impossible to aspirate the lumen but where it is still possible to infuse fluids; there may be increased resistance when doing so); or **total**, where there is no flow either in or out through the lumen.

Occlusion is usually a result of:

1. The formation of a precipitate in the catheter lumen caused by inadequate flushing between incompatible medications.
2. Clot formation in the lumen following a delay between an infusion finishing and a flush being given.
3. Mechanical causes such as kinking or pinch-off syndrome.
4. Longer term formation of a fibrin sleeve or clot along the length of the catheter.

Catheter occlusion can be mostly avoided using good 'pulsated flush' technique (see above).

There are four strategies for managing an occluded lumen, all of which should be considered, and are outlined in an algorithm at ***Appendix 6a &b***.

1. The use of mechanical manoeuvres to unblock the lumen.
2. The administration of 'unblocking' agents ***(Appendix 7)***
3. Removal of the CVAD, with or without subsequent replacement of the device
4. In a multi-lumen device, to continue to use the non-occluded lumens. *(This should rarely be done; responsibility for using a catheter with an occluded lumen should be taken by a senior member of the team and the rationale for doing so must be clearly documented)*

7.3 Catheter related thrombosis (external clot formation)

The presence of a CVAD in a vein can result in damage to the lining and thrombus formation.

Thrombi form on CVADs in the first few hours following placement. This can encourage microbial colonisation. It has been reported in the literature that thrombus occurs in large vessels after long term catheterisation in 35-65% of patients. There is no current indication for the use of prophylactic anticoagulation prior to CVC insertion (Schiffer et al 2013).

7.3.1 Symptoms

If a central vein is blocked the patient may have pain, swelling and oedema in the neck and in the upper limb on the side where CVAD is sited. There may be distension of peripheral, neck and chest veins.

7.3.2 Diagnosis

In the event of catheter malfunction a plain chest radiograph should be undertaken to clarify the position of the catheter tip.
Definitive diagnosis of a thrombus requires Doppler ultrasound, CT or contrast venography ('*line-o-gram*').

7.3.3 Management

Optimal management is not clear in the literature. There are no randomised controlled trials. Immediate removal of the catheter and treatment with unfractionated or low molecular weight heparin (LMWH) is recommended by some professionals. Others argue that in cases where the CVAD is needed, removal will expose the patient to risks associated with reinsertion, including another thrombosis.
If the CVAD remains in place heparin anticoagulation should be started with careful monitoring for extension or embolization of the thrombus.
Management decisions will be influenced by the size and location of the thrombus, the clinical condition of the patient, the need for the catheter and the availability of alternative sites for placement. Decisions should therefore be taken on a case by case basis through discussion between CVC 'operator/inserter' and the treating Clinician, with advice from a Haematologist.

7.4 Management of damaged catheters

All damaged CVADs should be referred immediately for expert advice from operator/inserter of device or a senior clinician.

1. Immediate management of damaged catheter: clamp between the break and skin to avoid back bleeding and air entry into the negative pressure central veins. If clamp unavailable pinch the catheter between the finger and thumb or use a device to 'kink' it e.g. paper clip.
2. Establish what fluid is leaking. If cytotoxic follow local guidance (hazardous waste/ spillage policy) to manage the spillage. Take all necessary measures to protect the patient, carer and staff.
3. If the CVAD has a clamp, move it to a point above the point of leakage.
4. Switch off and disconnect any infusion device.
5. Patients with damaged CVADs should not be discharged home with a temporary clamp in place due to risks of bleeding or air embolism.
6. Document incident in patient's notes

When the external portion of a CVAD is damaged, the device may be repaired according to the manufacturer's guidelines, and using a 'Repair' kit provided by the manufacturer. This should always be undertaken using aseptic technique and observing universal precautions.
CVADs that can be repaired include some (silastic) PICC's and tunnelled central catheters.

7.4.1 Guidewire-assisted CVAD replacement

If a CVAD needs to be replaced there are certain circumstances where this may be achieved by passing a new guidewire through the old CVAD, removing the old CVAD and passing a new catheter over the wire. Although rewiring a CVAD can lead to quicker and safer replacement, it carries a higher risk of early microbial contamination than inserting a new CVAD. The overall risks and benefits of such procedures should be carefully considered and the decision taken documented in the medical notes.

7.5 CVAD Dislodgement

The optimal placement of the catheter tip is in the superior or inferior vena cava or the upper right atrium, with the distal section and tip parallel to the vein, and with no kinks or pinching of the catheter. Tip migration may have occurred if the external portion of the CVAD was inadvertently moved after being snagged, or mishandled.

Tip migration is a particular concern in infants and children, as the anatomy changes with growth, particularly in the neonatal period.

Dislodgement may occur as a result of traction on the external portion of the line, spontaneously or (rarely) following seemingly innocuous activity such as coughing.

Dislodgement is obviously present if the external portion of the catheter changes in length and should be suspected if the line does not appear to be patent, the patient experiences discomfort during flushing, or there is a change in CVP trace.

A CVAD that may be dislodged must have its position checked with X-Ray and expert advice sought. The consequences of continuing to use a dislodged CVAD may include development of a thrombosis, including DVT or PE, and great vein perforation.

7.6 Inadvertent arterial puncture

If the CVAD is identified as being in an artery rather than a vein then it must not be used for any drug administration or infusion. It must be removed safely using the following technique:

- If the vessel has been dilated to larger than 6Fr: leave the catheter in situ and discuss urgently with vascular surgery or interventional radiology (adults or larger children) or plastic surgery (small children and infants) as vascular repair may be required.
- If the vessel has not been dilated, the needle/ guide-wire / catheter can be removed and firm pressure applied to the site until bleeding stops.

In all cases the incident should be documented clearly, handed over to nursing staff and appropriate frequent observations made of adequate limb perfusion according to local protocol. If there is any doubt about on-going limb ischemia discuss with vascular or plastic surgeon urgently (Bodenham et al 2016).

8 Removal or replacement of CVAD

8.1 *Key points*

There is no evidence for routine replacement of a CVAD. The rationale for continuing with a non-tunnelled short-term CVAD should be documented on a daily basis in the medical notes. This documentation should include a statement that either there is no suspicion of a catheter infection, or that there is suspicion/confirmation of infection and the reason for its continuation.
The team responsible for the care of the patient with a non-tunnelled CVAD must, on a daily basis:

- Consider and document the rationale for continuing to use the CVAD.

- Ensure that the CVAD is removed if it is decided that there is no rationale for continuing its use. CVADs should be removed within four hours of the decision to remove and before any transfers to other areas.

- Identify potential barriers to the removal of a CVAD *at the time of the decision to remove* and ensure that a plan is in place to address these barriers, e.g. the lack of alternative IV access. This should be addressed and a plan made at the time of the decision to remove the device.

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Appendix 1: Example of decision making framework