CENTRAL VENOUS ACCESS DEVICES

Resource Book

First Edition, January 2011

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Central Venous Access Devices (CVADs) have been used successfully for over 40 years in a wide variety of settings. In the acute care setting they provide a route for rapid and reliable intravenous administration of drugs, fluids, blood products and Parenteral Nutrition (PN) and may be used to monitor Central Venous Pressure. They are also used for patients who require long term IV access undergoing continuous/intermittent complex IV therapies such as chemotherapy and blood sampling and Parenteral Nutrition (PN) (Dougherty, 2000).

With increased use we now see a diversity of catheter devices available to provide central venous access. However, these catheters are not without risk.

All types of IV catheters are associated with catheter related blood stream infection (CRBSI). CVADs are associated with a higher rate of CRBSI than peripheral IV catheters therefore interventions to reduce the rate of CRBSI are especially important for their management and care (Maki, et. al, 2006). Elsewhere CRBSI is also referred to as Central Line Associated Bacteraemia (CLAB), catheter related infection (CRI).

The NZ Auditor-General’s Report, Management of Hospital Acquired Infections. (2003 Vol:1&2 p.27-28) state ‘one in 10 patients admitted to hospital will acquire an infection as a result of their hospital stays. The rate may well be higher due to under reporting (p.271.21).

Blood stream infections comprise 5-10% of Healthcare Associated Infection (HAI) and can have very high mortality rates, higher than 30%. Patients with Healthcare Acquired Blood Stream Infections (HABSI) tend to stay longer in hospital and cost more to treat (p 51, 2.53). Almost 80% of HABSI occurred in six large District Health Boards with complex services at an estimated cost of $19 million each year (NZ Auditor - General's Report, 2003).

CVAD complications range from mild local irritation to blood stream infections associated with significant mortality and morbidity. It is imperative that nurses and midwives involved in the care of CVADs are competent to do so, because practice vigilance is critical in reducing and preventing complications (Robert, et al., 2000).
Registered Nurses must meet the standards outlined in the Competencies for entry to the Register of Comprehensive Nurses (Nursing Council of NZ 2002) and Midwives (NZ Midwifery Council) this applies to all nurses currently practicing.

Definition: Competence is the combination of skills, knowledge, attitudes, values and abilities that underpin effective performance as a nurse (NZNC, 2003).

With an increased scope of practice professional accountability is established through:

1. Demonstrating a level of practice and professional accountability, appropriate to level of skills
2. Having a sound knowledge of the management and care of CVADs
3. Having knowledge of medication and IV fluid treatment modalities
4. Performing accurate assessment through identifying catheter specific indications, contraindications and associated risks
5. Utilising critical thinking skills and evidence based practice to achieve best patient outcomes
6. Confidently articulating scope of practice, identifying and acknowledging limitations and seeking assistance appropriately
7. Patient education
The CDHB Central Venous Access Device (CVAD) Certification is a second level competency. 
*Recertification* is required three (3) yearly. To recertify complete the online test and practical assessment. The prerequisite is a current initial Intravenous Therapy Certification (Level 1).

**Components of CVAD Certification and Recertification:**

1. CVAD Resource Book
2. Review Multi choice Theory Test. (100% pass is required)
3. Practical Skills Assessment for:
   - Non implanted Devices - PICC, CVC, Hickman® catheters
   - Implanted Devices – standard and power injectable Port if require for area of practice

**Follow the Instructions for CVAD Certification on the healthLearn site**

1. Review the CVAD Resource Book and education power point resource
2. Complete Multi-choice Theory Test for non implanted or implanted devices as applicable. The answers can be found in the CVAD Resource Book or the education resource power point. 100% pass mark is required.
3. Print off the Practical Skills Assessment Checklist and complete with a NE, CNS, and IV Link Staff whose CVAD competency remains current on the training data base
4. Complete the course evaluation then print off the Certificate of Completion
5. Return the completed Practical Skills Assessment to the IV Nurse Educator CVAD PDU. On completion of this process you will receive 8 hours towards professional development.

**Non Implanted Devices:** On completion of this competency your name will be entered into the ‘CVAD’ Competency Training Data base as competent in managing the following devices:

- PICC
- CVC
- Hickman® Catheter

**Implanted Devices:** This competency is a separate competency. The pre-requisite is a non-implanted device competency. Once the implanted device competency is completed your name will be entered into the Port Competency Training Databases. *Complete this competency if you use implanted ports on a regular basis and are required to access and de-access them.*

**NB.** Only nurses with an Implanted Port competency may access (insert the needle) and de-access (remove the needle). All nurses with non implanted device CVAD competency may use an implanted port to deliver medications/infusions / blood samples once the port has been accessed by a Port certificated nurse. Always refer to the implanted port section to guide your practice.
LEARNING OBJECTIVES

This comprehensive resource book is designed to assist all clinical staff develop critical thinking skills to demonstrate knowledge in assessment, management, maintenance and care of Central Venous Access Devices (CVAD). At the completion you should be able to:

- Identify types and definitions of CVADs
- Describe the anatomy and physiology of blood flow in relation to CVADs
- Describe the advantages and disadvantages of each device
- Describe the principles of infection prevention and control
- Identify complications and describe prevention and management of each
- Understand the action of medications and drug precipitates
- Accurately document using the ‘CVAD Management Form’
- Understand the principles of patient education
- Describe catheter considerations when administering Parenteral Nutrition (PN) (as applicable to your area of practice)
- Identify key differences in caring for a child or infant with a CVAD

Throughout this package are Alerts, Actions and Further Reading

⚠️ This symbol indicates ‘important alerts’

_ACTION_ This symbol indicates ‘important actions’

📖 This symbol indicates ‘for further reading’
CHILD HEALTH CONSIDERATIONS

Many children experience a range of emotions at the prospect of a nurse carrying out a procedure on their CVAD. Children might be distressed by dressing removal, cleaning around the insertion site and needle access. It is important for the nurse to understand that:

- younger children may see the intervention as punishment \(^1\)
- the language used to explain and prepare the child needs to be developmentally appropriate
- parents also need to be involved and prepared for the procedure
- children sometimes move unexpectedly during procedures—more than one nurse will usually be required to help with the procedure
- children with chronic illnesses may become particularly sensitised to painful procedure \(^2\)—they don’t just get used to it
- coping is increased by enabling children to have a degree of control during the procedure (e.g. holding the blood tube)

**Preparation**

- CVAD procedures are usually carried out in the treatment room because the child’s bed is considered to be a ‘safe’ place
- Always explain to parents and care givers what the procedure will involve. The parents or caregivers should not be used to restrain the child or be an extra pair of hands. Their role is to support their child
- Hospital Play Specialists should be involved (distraction, support of the child and therapeutic play) whenever possible and this is best achieved with prior organisation
- All equipment should be prepared before the child is brought to the treatment room
- Avoid unnecessary delays

**Associated Reading**

Restraint minimisation, Child Health E-guidelines


A Central Venous Access Device (CVAD) is described as a short or long term intravenous catheter inserted into a centrally located vein with the tip residing in the lower 1/3rd of the Superior Vena Cava (SVC) (Infusion Nurses Society (INS) Standards of Practice, 2006).

Although there are many veins in the body only a few are suitable for CVAD.

The most commonly used insertion sites are (see Figure 1):
- Neck (internal jugular vein)
- Upper chest (subclavian vein)
- Mid upper arm (basilic vein)
- Femoral vein

CVADs are used for the infusion of:
- Hypotonic and hypertonic solutions
- Solutions with extremes of pH and osmolality
- Vesicant and irritant medications and solutions e.g. cytotoxic therapy or antibiotics
- Complex drug therapy regimes
- Rapid hydration of fluid or blood /blood products
- Parenteral Nutrition (PN)
- CVP monitoring
- Blood sampling
- Therapeutic procedures
- Long term antibiotics
- IV therapy in the community
CVADs come in different sizes with either single or multiple lumens. With multiple lumens, each lumen provides independent access to the venous circulation. This allows two incompatible drugs or fluids to be infused simultaneously. As a general principle the lumen diameter and number of lumens should be kept to a minimum as multiple large bore catheters are associated with a higher risk of infection and thrombosis (Simcock, 2001). However, in the high dependency settings, multiple lumen large bore catheters tend to be used because they are essential for management of acutely ill patients.

The following CVADs are used in the Canterbury District Health Board (refer Figure 2):

- Peripherally Inserted Central Catheter (referred to as a **PICC**) standard and power injectable
- Hickman® skin tunneled catheter
- Central Venous Catheter (short term non-tunneled referred to as **CVC**)
- Implanted ports (standard and power injectable)
- Dialysis & Apheresis catheters which are procedure specific
- Antibiotic and antimicrobial coated catheters

*Information regarding the management and care these catheters can be found in the section on ‘Catheter Specific Information’.*

![Fig.2: CVAD used in the CDHB](source: Original Photo)
ADDITIONAL CATHETER INFORMATION:

**Apheresis Catheter (hard wall):** Is used for therapeutic procedures such as plasma exchange or Peripheral Blood Stem Cell Harvesting. These are for short term access only (2-3 days) and are used and maintained by the NZ Blood Service Apheresis Nurses only.

**NOT TO BE ACCESSED by unauthorized staff.**

**Dialysis Catheter:** Is used for the haemodialysis of renal patients. These are accessed and maintained by the dialysis technicians and dialysis / renal nurses and ICU only.

**NOT TO BE ACCESSED BY unauthorized staff.**

**Groshong® Tunnelled Valved Catheter:** Is a device used in haematology patients at Auckland Hospital. Occasionally these patients are transferred to Christchurch Hospital to continue their treatment and will present with this catheter in situ.

*For further information on all CVAD please refer to the section in this package on ‘Catheter Specific Information’.*

**DEPARTMENTS RESPONSIBLE FOR INSERTION OF CVAD**

**PICCs:**
1. Inserted in the Radiology department by the PICC nurse inserter service using an image intensifier and ultra sound
2. Anaesthetists also insert PICCs in operating theatre.

**Hickman® catheters:**
1. Inserted in the Radiology department using an image intensifier by the Interventional Radiologist (adults & adolescence).
2. Inserted mostly in Interventional Radiology and occasionally in Operating Theatre (Paediatrics)
3. **Tunneled Dialysis catheters:** Inserted in the Radiology Department using an image intensifier by the Interventional Radiologist

**Implanted Ports**
Inserted in Operating Theatre by a Vascular Surgeon or Paediatric Surgeon

**Non tunneled CVC**
Inserted in Operating Theatre, ICU, Anaesthetists, Emergency Department

*The best patient outcome is the successful use of a minimal number of vascular access devices to administer the complete therapy with minimal complications*
**DEVICE SELECTION ALGORITHM**

![Device Selection Algorithm Diagram]

Source: Johnson and Johnson Medical

**Table 1: Equivalent Gauge and French size**

<table>
<thead>
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<th>Equivalent Gauge and French sizes of vascular access devices</th>
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<tbody>
<tr>
<td>Gauge (G)</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>23 g</td>
</tr>
<tr>
<td>20 g</td>
</tr>
<tr>
<td>18 g</td>
</tr>
<tr>
<td>16 g</td>
</tr>
<tr>
<td>11 g</td>
</tr>
<tr>
<td>10 g</td>
</tr>
<tr>
<td>7 g</td>
</tr>
</tbody>
</table>


**CATHETER MATERIAL IS EITHER SILICONE OR POLYURETHANE**

**Silicone**: Is soft and pliant and is resistant to many chemicals such as ethanol, is less thrombo-resistant, has poor tolerance to pressure (ruptures easily) and drugs can leach into material

**Polyurethane**: Has good tensile strength, is wear and kink resistant, softens in the vein, is thrombo-resistant, has higher flow rates and a high degree of biocompatibility
Knowledge of anatomy, physiology and the principles of blood flow are essential for safe management of all Central Venous Access Devices.

Figure 4 below shows the major veins of the central vasculature where CVAD are placed.

CVADs can become displaced although displacement is more likely to be seen with a PICC. This is due in part to its smaller diameter compared to the larger CVADs. Tip migration or malposition may occur most commonly, but not restricted, the following veins:

- Internal jugular
- Contralateral brachiocephalic (opposite to the vein the catheter has been inserted into)
- Azygos

**Action:** Locate the 3 veins above on the diagram below

![Major Central Veins](source.png)

**Fig.4: Major Central Veins**

Source: Medical Illustrations, Christchurch Hospital
Veins and Valves

Veins are known as reservoir vessels with approximately 65% of blood volume found in the venous circulation system. The vein walls distend six to ten times more than arterial walls with only the smallest amount of pressure. This means that normal pressure is re-established quickly, for example following the release of a tourniquet. This is referred to as a ‘Stress Relaxation Phenomena’.

The veins also have what is referred to as a muscle or venous pump. When muscles contract they compress the vein. This helps return blood to the heart. When a muscle contracts, proximal valves open while distal valves close. This action can specifically affect the PICC causing it to migrate either in or out of its correct tip position if it is not well secured.

Muscle action is also responsible for reflux of blood into the tips of CVADs. Pressure from the contracting muscle forces the 'locking fluid' out of the catheter lumen allowing blood to reflux into the CVAD when the muscle relaxes. The vein and catheter are two distinct flow systems, each vulnerable to occlusion (Hadaway, 2005).

Valves are structures within the lumen of the vein which are formed by the endothelial lining of the Tunica Intima. They are present as bumps usually found at vein bifurcations and predominantly found in large veins of the extremities (refer to figure 6). There are approximately 40 venous valves between the hand and the axillary vein. Larger veins of the central vasculature do not have valves.

Veins have three layers and each plays an important role in catheter placement and catheter dwell (refer to figure 5). These are:

- Tunica Intima - inner lining
- Tunica Media - middle layer
- Tunica Adventitia - outer layer
The Tunica Intima is the delicate inner lining of the vein which can become damaged by mechanical, chemical or bacterial means.

When the Tunica Intima is damaged, bleeding occurs into the interstitial compartments of the basement membrane.

The Tunic Adventitia, rich in nerves provides the pain pathway.

All three layers can be affected giving rise to phlebitis. PICCs are most affected by mechanical or bacterial phlebitis because a portion of the catheter lies in a peripheral vein in the upper arm.
Phlebitis is the result of an inflammatory process in the intima of the vein due to irritation to the endothelial cells (refer figure 7). It is classified according to its causative factors. The four causative factors are:

- chemical
- mechanical
- bacterial
- post infusion
PHYSIOLOGY OF BLOOD and BLOOD FLOW RATES

CVAD are inserted into an appropriate vein and advanced along the venous system until the catheter tip reaches its destination in the lower 1/3rd of the superior vena cava. The superior vena cava is on average 20 mm in diameter and has a high blood flow of approximately 2000 mL/min which is far greater than in a peripheral vein (refer to table 2).

This means that irritant drugs and fluids, those with concentrations of solutions with extremes of pH or osmolality can be infused without damaging the SVC vein wall due to this increased haemodilution.

Blood comprises:

- Viscosity
- Osmolality
- pH
- Coagulation

### Table 2: Vein flow rates

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<thead>
<tr>
<th>VEIN</th>
<th>DIAMETER</th>
<th>FLOW RATE</th>
<th>LENGTH</th>
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<tr>
<td>Cephalic</td>
<td>6 mm</td>
<td>40-60 mL/min</td>
<td>38 cm</td>
</tr>
<tr>
<td>Basilic</td>
<td>8 mm</td>
<td>60-95 mL/min</td>
<td>24 cm</td>
</tr>
<tr>
<td>Axillary</td>
<td>16 mm</td>
<td></td>
<td>13 cm</td>
</tr>
<tr>
<td>Subclavian</td>
<td>19 mm</td>
<td>150 mL/min</td>
<td>2.5 cm</td>
</tr>
<tr>
<td>Innominate</td>
<td>19 mm</td>
<td>800 mL/min</td>
<td>6 cm</td>
</tr>
<tr>
<td>Superior Vena Cava</td>
<td>20 mm</td>
<td>2000 mL/min</td>
<td>7 cm</td>
</tr>
</tbody>
</table>

Source: Intravenous Therapy; Clinical Principles & Practice, J Terry 1995
The pH and TONICITY of INFUSATES IN RELATION TO BLOOD

Fig. 8: The pH of common drugs

Source: Intravenous Therapy; Clinical Principles & Practice, J Terry 1995

Fig. 9: The tonicity of common drugs

Source: Intravenous Therapy; Clinical Principles & Practice, J Terry 1995
BLOOD FLOW

Blood flow is primarily affected by the following:

- **Diameter and shape of the vessel.** When the vessel doubles in diameter, the flow rate increases sixteen times and is known as ‘Poisuille’s Law’ or ‘Fourth Power Law’ (refer to figure 10.)
- **Blood viscosity.** As blood viscosity increases, flow rates decrease due to resistance.
- **Flow rates.** Described as either laminar or turbulent.

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**Fig.10: Poisuille’s Law**

Source: Johnson & Johnson Medical
LAMINAR AND TURBULENT FLOW THOUGH A VESSEL

Laminar Flow
This is described as the normal movement of blood through a cylindrical vessel while taking account of the resistance exerted by the walls. In simple terms the blood touching the vessel wall moves slightly slower because of friction from cells lining the vessel wall. Blood in the centre of the vein moves the fastest and with least resistance for example the flow in small peripheral veins. This gives a theoretical surface tension that can be represented as a curve (refer to figure 11).

Turbulent Flow
This describes a flow pattern which is created in a variety of circumstances. For example when the inner layer of the blood vessel is rough; an obstruction is present; when there is a sharp turn in a vessel or when the flow rate is greatly increased. Higher velocity of blood flow, larger diameter of the vessel and lower viscosity all increase the potential for turbulent flow for example the flow in the SVC (refer figure 11).

Fig.11: Laminar and turbulent flow

Source: Johnson & Johnson Medical
CVADs are frequently used in healthcare, but as they breach the body’s skin defences they create a potential entry point for infection. Around 20% of healthcare associated blood stream infections are linked to the use of a CVC – referred to as catheter related blood stream infection (CRBSI) and also CLAB. CRBSI occur when bacteria grow in an intravenous central line and spread to the patient’s bloodstream. The microorganisms that colonise catheter hubs, access devices and the skin adjacent to the insertion site are the source of most CRBSI along with the colonised hands of healthcare workers (refer to figure 12). These infections worsen the patient’s underlying health problem, prolong hospitalisation and increase the cost of care. In addition the mortality rate attributed to CRBSI is around 10%.

Fig 12: Sources of infection

Source: Unknown

⚠️ 85% OF BACTERIA FOUND ON THE SKIN ARE RESPONSIBLE FOR CRBSI (Maki)
An evidence-based approach underlies the strategies for the prevention of CRBSI. Interventions are based on the concept of ‘bundles' of care components which incorporate individual practices that together result in greater improvements than when used individually.

There are two care bundles of components aimed at the prevention of CRBSI (Institute for Healthcare Improvement, 2008).

**CVAD insertion bundle**
- Hand hygiene
- Maximal barrier precautions
- Chlorhexidine skin antisepsis
- Optimal catheter site selection

**CVAD maintenance bundle**
- Daily review and documentation of line necessity and prompt removal of unnecessary lines
- Dedicated lumen for Parenteral Nutrition (PN) This is the WHITE lumen of a multiple lumen catheter
- Access the CVAD lumens aseptically using chlorhexidine 2% and alcohol 70% wipes with vigorous friction prior to access, allow to dry
- Review and document each shift the entry site (CVC/PICC) exit site (Hickman) and surrounding area for inflammation
- Other CVAD infection prevention principles include:
  - Hand hygiene before and after manipulation of CVADs and administration set using the 5 Moments approach (refer to table 4)
  - Aseptic and non-touch technique (ANTT) for all CVAD access and medication preparation
  - The use of personal protective equipment

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**Table 3: CVAD insertion principles**

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<td><strong>S</strong> crupulous HAND HYGIENE Before and after contact with vascular access device and prior to insertion.</td>
</tr>
<tr>
<td><strong>A</strong> SEPTIC TECHNIQUE During catheter insertion: Wear a surgical mask and hat. Wear a sterile gown and gloves. Use a large sterile drape.</td>
</tr>
<tr>
<td><strong>V</strong> IGOROUS disinfecting of insertion site with Chlorhexidine 2% with 70% alcohol.</td>
</tr>
<tr>
<td><strong>E</strong> NSURE line is removed when no longer necessary.</td>
</tr>
</tbody>
</table>

Source: Johnson & Johnson Medical

Source: Institute of Healthcare Improvement 2008
Table 4: Five CVAD moments for hand hygiene

Moment 1: Before Touching a Patient
  • Touching a patient in any way or any invasive medical device connected to the patient (e.g. IV pump)

Moment 2: Before a Procedure / Aseptic technique
  • Insertion of a needle into an invasive medical device e.g. port access, IV flush
  • Preparation and administration of any medications given via an invasive medical device, or preparation of a sterile field
  • Insertion of, or disruption to, the circuit of an invasive medical device

Moment 3: After a Procedure or Body Fluid Exposure Risk
  • After accessing a CVAD or undertaking the dressing

Moment 4: After Touching a Patient

Moment 5: After Touching a Patient’s Surroundings
ASEPTIC NON TOUCH TECHNIQUE (ANTT)
Aseptic Non Touch Technique (ANTT) is a technique that maintains asepsis and is non-touch in nature and performed in a logical order.
- Always wash hands effectively
- Never contaminate key parts
- Touch non key parts with confidence
- Take appropriate infection prevention precautions

Non sterile gloves are usually the logical choice however *if it is necessary to touch key parts of equipment directly then use sterile gloves.*

ANTT is used when:
- Drawing up from plastic poly amps
- Transferring diluents into drug bottles
- Drawing up from drug bottles and transferring drugs to IV bags
- Administering medication via the access device on a CVAD
- Flushing a CVAD
- Blood sampling from a CVAD
- Cleaning all access ports with friction using chlorhexidine 2% and alcohol 70%

**ACTION:** Identify key parts of the equipment you are using and do not contaminate (Rowley, 2001; INS, 2010). The circles in figures 14a, 14b, 15 and 16 below indicate key parts of equipment.

---

*Fig.14a* Source: BD Medical

*Fig.14b* Source: Original Photo

*Fig.15* Source: Original Photo

*Fig.16* Source: Original Photo

⚠️ Your Shortcuts can result in infections, loss of the ‘line’, the ‘patient’ quality of life and possibly their life!
Management of Central Venous Access Devices requires us to maintain the patency of the catheter and vein (Hadaway, 2005).

Knowledge and good assessment skills are essential when caring for a CVAD.

**NB. For the management and care of Implanted Ports refer to the ‘Catheter Specific’ section on Implanted Ports**

Formal written consent by the patient must be obtained prior to the insertion of a CVAD

**PRE-INSERTION**

**Education:**

*Patient education is essential to achieve best patient outcomes*

- Ensure the patient and / or family / whanau understand what is involved in the process and what to expect during and following insertion
- For children this will include an-age appropriate explanation and involvement with the hospital play specialist
- Use a catheter diagram to explain what the catheter looks like, where it will be inserted and where the tip will reside (this can be sourced from this book)
- Explain how the catheter will be cared for i.e. flushing, dressing and securement
- Encourage the patient to report anything that doesn’t ‘feel right’ or concerns them
- Ensure the patient is given the appropriate CVAD patient information booklet
- Instruct the patient and /or family/ whanau to always wash their hands prior to touching the catheter

**Hydration:**

- Encourage oral fluids at least 1-2 litres or maintain prescribed IV fluids
- This helps reduce insertion trauma to the vein which can result in phlebitis
- Dehydration increases venous problems and viscosity which may make cannulation of the vein difficult

**Warmth:**

- Ensure the patient is kept warm. Use a warm blanket for this purpose
- This helps to dilate the veins by increasing blood flow and venous return to larger veins
POST INSERTION

Check catheter insertion site for:
- Bleeding
- Swelling
- Bruising
- Pain or discomfort
- Dressing integrity
- BIOPATCH® in correct position around catheter at exit site with BLUE side uppermost.

Exception for children and ICU patients – Biopatch® is not routinely used
- Catheter securement device in place
- Positive displacement devices (PDD) are securely attached to the catheter lumen/s. Flush all catheter lumens with sodium chloride 0.9% to ensure patency is established before using catheter. For Child Health please follow the CVAD ‘locking solution’ chart found in the Flushing section of this book
- Document any variances on the ‘CVAD Management Form’

⚠️ If the exit site bleeds the dressing must be replaced immediately. A wet surface provides a pathway for bacteria to travel to the wound.

ONGOING ASSESSMENT OF THE CVAD

The CVAD must be assessed at least once eight hourly when not in use and in addition:
- Prior to administration of medications and fluids
- During continuous infusions
- During the administration of vesicant drugs
- During dressing changes
- During access device changes

The appropriate way to assess the insertion site for infection is to visually inspect it and palpate it through the dressing (category IB, CDC Guidelines 2002)

Assess the insertion site and area beyond
- For signs of infection, redness, leaking, swelling, induration
- The neck, shoulder and extremity on side of catheter insertion for swelling, pain, thrombosis
- PICCs: all the above plus the mid upper arm, axillary area and hand for swelling or phlebitis.
  Check the external catheter length each shift and document findings in the ‘CVAD Management Form.’
- Ports: the portal pocket
- Document any variances in the ‘CVAD Management Form’

Protect the catheter during showering
- Avoid the catheter and dressing becoming wet. Don’t submerge the catheter in water. Teach the patient how to protect the catheter by covering it with plastic wrap or a plastic sleeve (for PICCs) and avoiding direct water contact for other devices (category IB, Centre for Infectious Disease (CDC) Guidelines, 2002)
**DRESSINGS AND SECUREMENT**
An aseptic non touch technique (ANTT) is used when dressing the catheter. Where a BIOPATCH® is used place it around the catheter at the insertion site and replace it at each routine dressing change every 7 days or whenever the dressing requires replacement. BIOPATCH® is not routinely used with each PICC dressing replacement unless clinically indicated.

*BIOPATCH® is NOT used for CVADs inserted into children or routinely used in ICU.*

*BIOPATCH® is NOT used where antimicrobial or antibiotic coated catheters are used.*

**ADDITIONAL DRESSING CHANGES will be required when the dressing is:**
- Loose
- Visibly soiled
- Lifting from site
- Excess oozing at insertion site
- BIOPATCH® shows signs of fluid absorption (has increased in size) or has been incorrectly applied
- Where skin reactions have occurred refer to the ‘Skin Reaction Flow Chart’ on page 30 as a guide.

**SECUREMENT** is used to:
- Secure the CVAD and minimize catheter movement
- Prevent catheter migration
- Prevent tension on the dressing causing the dressing to lift
- Prevent catheter lumens hanging below waist line (for chest inserted CVAD)

*NB: do not use tape to secure the catheter lumens*

**CLEANING THE EXIT SITE, SURROUNDING SKIN and the CATHETER**
- Use 2% Chlorhexidine & 70% alcohol swab sticks
- Clean the skin using friction. Either circular or grid method is acceptable (INS.2010).
- Do not contaminate the insertion site. Clean along catheter length that sits under dressing
- Allow to air dry for 15-30 seconds. Do not wipe the solution off (CDC Guidelines Recommendations)
- If blood is present at or around the insertion site, use STERILE WATER to clean and remove blood, then clean site with 2% Chlorhexidine & 70% alcohol swabs.

*Chlorhexidine 2% has demonstrated continued activity for up to six hours after application*

Cavilon® skin protectant is applied to the area around the insertion site extending out beyond the dressing edges to help prevent the dressing lifting. A sterile occlusive transparent semi-permeable dressing is applied to the catheter insertion site to protect the area and allow for visualization and early detection of complications.

*Do not apply CAVILON® to the area over the insertion site or where the BIOPATCH ® or CHG gel pad is to be placed.*
Do not apply topical ointments to the insertion site as they promote fungal infection and antimicrobial resistance (CDC Guidelines Recommendations, 2010)

THE CORRECT APPLICATION OF BIOPATCH® (refer to figure 17)

- **BLUE** grid side up
- Place around catheter for maximum effect
- Cover with an bio occlusive dressing
- If the foam side is upper most REMOVE IMMEDIATELY and replace with a new patch

The BIOPATCH® remains in place around catheter at the insertion site for up to 7 days and during this time it releases 25% of its loading dose of Chlorhexidine around the insertion site.

**Tegaderm® CHG dressing** has an integrated Chlorhexidine 2% gel pad may also be used. Its advantage is that it provides a one step dressing application.
### EQUIPMENT REQUIRED FOR DRESSING CVAD’S

#### HICKMAN ® what you need

- Dressing Pack contents
- Non-sterile gloves
- Sterile gloves
- CHG dressing
- Alternate dressing Biopatch® & Bio-occlusive dressing
- Solu IV® swab sticks
- Statlock®
- Cavilon® Skin protectant wand
- Sterile water (to remove any blood)

#### PICC/CVC Dressing pack oracle code 124262

- Dressing Pack content
- Non-sterile gloves
- Sterile gloves
- Sorbaveiw dressing
- Solu-IV® wipe
- Solu IV® swab sticks
- Grip Loc® PRN
- Cavilon® Skin protectant wand
- Sterile water (to remove any blood)

---

[Images of Statlock®, CHG dressing, and Tubing Anchor®]

**Additional securement device for PICCs and CVCs**

Either Grid or Circular motion to clean insertion site is acceptable. The important point is to use vigorous friction.
The following flow chart is a step by step guide in the event that a patient develops skin reaction problems. For further reading refer to reference section –Kutzscher,L.2012

**CVAD DRESSING FLOWCHART for SKIN REACTION**

1. 1. Assess type of skin reaction  
   2. Ensure Cavilon® no sting barrier skin protectant has been used  
   3. Monitor site closely  
   4. Accurately document change in the skin integrity

   **Skin Reacted**

2. 1. Discontinue chlorhexidine skin antisepsis  
   2. Use alcohol 70% only to clean the insertion site  
   3. Continue to use the same dressing  
   4. Consider an oral non sedating antihistamine for pruritis

   **Still Reacting**

   *Ensure a skin patch test has been done for sensitivity BEFORE using it*

   Discontinue dressing and document brand name
   1. Daily assessment and documentation of skin integrity  
   2. Continue to use povidine-iodine if there is no sensitivity  
   3. Implement dressing guide as shown in **box 4**

   **Reaction Continues**

4. If skin reaction occurs within the week of dressing placement **change dressing** using the step by step guide in the order below:
   1. Bioclusive® 10.2x12.7cm oracle code:107172  
   2. Mepore Film 10cmx12cm oracle code:162243  
   3. Mepitel Film 10cm x 12cm oracle code:161349  
   4. Cutiplas® 15cmx8cm oracle code:113552  
   5. Sterile gauze dressing and secure with silicone tape* and co plus bandage*  
   6. 3M Kind silicone tape* 2.5cm x 5m oracle code: 161800  
   7. Co plus bandage* 7.5cmx3m oracle code: 109765

   **Maintain the same skin preparation regime** as indicated in **box 3**
POSITIVE DISPLACEMENT (PDD) ACCESS DEVICE CHANGES

All CVADs have positive displacement devices (PDD) attached to the catheter hub (exception Dialysis Catheters). For inpatients, change these no more frequently than 72hrs (CDC, 2002). It is important to establish regular change days. This ensures the catheter is not compromised and minimizes the potential for infection. Strict hand hygiene and the wearing of non sterile gloves are required for this procedure.

Child Health please refer to the CVAD locking solutions in Flushing Section

SCRUB THE HUB

Organisms can be introduced via the catheter hub. It is essential to vigorously clean the hub and its luer threads using an antimicrobial wipe before placing a new access device.

Catheter hubs carry the highest risk for infection and should be protected from contamination at all stages of the changing procedure (CDC Guidelines 2010).

DESIGNATED CHANGE DAYS FOR PDD ACCESS DEVICES ARE:

- INPATIENTS: TUESDAY and FRIDAY
- OUTPATIENT: weekly (or 72hrly depending on number of accesses if receiving treatment)
- If the PDD is not cleared of blood following flushing change the device

Dressing changes can be timed to coincide with PDD access device changes and catheter flushing and catheter assessment and patency flow checks. An aseptic non touch technique is used when changing PDD access devices. Ensure that all key parts of the equipment are protected and not contaminated during the procedure. (Refer to figure18)

Key parts of equipment are considered to be:

- Luer lock end of the syringe and IV administration set
- Catheter hubs
- Positive Displacement device luer lock area
- Positive Displacement device access port

Fig.18: Key parts of equipment  Source: Original Photo
STEP-BY-STEP GUIDE TO CHANGING POSITIVE DISPLACEMENT DEVICES

**Equipment required**
- Non-sterile gloves
- Sterile gauze
- Chlorhexidine 2% / 70% Alcohol wipes
- MaxPlus® (PDD)
- 1x 10 mL pre-filled sodium chloride 0.9% syringes

**Antimicrobial wipe is placed onto the sterile gauze to hold the catheter hub**

**STEP 1**

**STEP 2**
- Ensure catheter is clamped
- Hold catheter hub with gauze and antimicrobial wipe
- Remove PDD as demonstrated

**STEP 3**
- Vigorously clean catheter hub & luer lock threads

**STEP 4**
- Allow catheter hub to air dry
- Protect the hub from contamination using the gauze and antimicrobial wipe

**STEP 5**
- Attach primed PDD without contaminating key parts of equipment
- Unclamp & flush catheter
- Disconnect syringe – count to 5 – now clamp catheter
FLUSHING THE CATHETER

CVADs must never be forcefully flushed as this can lead to catheter damage, mal-positioning and complications. 10 mL syringes are used to flush the catheter because they create less positive pressure within the catheter.

Syringes 10 mL or larger are used when administering medication by this method.

The flushing procedure involves significant manipulation of the access device site. Organisms can be introduced during this procedure therefore disinfection is important to eliminate this potential. Infections are transmitted via bacteria found on the skin and hands. Non sterile gloves should be worn when accessing CVADs to administer flushes or medication and when changing PDD access devices. This protects the hands from blood contamination and descaling of bacteria from the skin onto key parts during the procedure (Rowley, 2001).

Numerous factors affect the flushing procedure. These include:
- Knowledge of the positive displacement device
- Using the appropriate flushing technique for that device
- Correct catheter clamping sequence
- Correct use of the syringe – (standard versus pre-filled)

Points to consider when flushing catheters
- Catheter length adds resistance to fluid flow
- Never flush against resistance
- Flushing should not feel ‘hard’
- Resistance requires careful assessment to determine the cause
- The inner diameter of the catheter dictates the:
  - flow rate
  - amount of pressure the catheter can tolerate
  - priming volume for the lumen

MAINTAINING CATHETER PATENCY

Regular flush regimes are important in maintaining catheter patency. These should be carried out prior to administration of medications to check catheter patency; following the completion of medication and fluid administration; in-between medications; blood product administration; PN; blood sampling and at access device changes. **NB. Adult Inpatients:** When CVADs are not in use daily then the catheter must be flushed once daily using 10 mL sodium chloride 0.9% to maintain patency. **Adult Outpatients:** CVAD must be flushed once weekly if not in use with 10 mL sodium chloride 0.9% to maintain patency. **Child Health please refer to the CVAD ‘Locking solution’ chart page 34**
USING A POSITIVE DISPLACEMENT DEVICE

A pulsating flush method using sodium chloride 0.9% is required to effectively clear the PDD and catheter lumen. Flushing small volumes continuously in a *pulsatile* flush is more effective in completely clearing the PDD access device than using a laminar flush (Manufacturer’s recommendations). If the access device is not clear then the catheter is not clear (refer to figures 19 & 20).

ADULT CVAD LOCKING SOLUTIONS

- PICC – 10 mL sodium chloride 0.9%
- Hickman® – 10 mL sodium chloride 0.9%
- Groshong® - 10 mL sodium chloride 0.9%
- Non tunnelled CVC – 10 mL sodium chloride 0.9%
- Ports- heparin 500 units/sodium chloride 0.9% 5 mL (ref Port section)
- Dialysis and apheresis catheters (ref Catheter Specific Section)

CHILD HEALTH CVAD LOCKING SOLUTIONS

<table>
<thead>
<tr>
<th>Catheter Type</th>
<th>Heparin Strength for regular use</th>
<th>Heparin Volume</th>
<th>Heparin strength when not in use</th>
</tr>
</thead>
<tbody>
<tr>
<td>PICC</td>
<td>No heparin</td>
<td>N/A</td>
<td>Inpatient flush daily with 10 mL sodium chloride 0.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Outpatient flush weekly with 10 mL sodium chloride 0.9%</td>
</tr>
<tr>
<td>Non Tunneled CVC</td>
<td>heparin /saline 50 units in 5 mL</td>
<td>&lt;1yr 0.5 mL</td>
<td>Weekly heparin lock 50 units/5 mL</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥ 1yr 2 mL</td>
<td></td>
</tr>
<tr>
<td>Hickman</td>
<td>heparin /saline 50 units/ 5mL</td>
<td>&lt; 1yr 0.5 mL</td>
<td>Weekly heparin lock 500 units/5 mL</td>
</tr>
<tr>
<td></td>
<td>when is regular use</td>
<td>≥ 1yr 2 mL</td>
<td></td>
</tr>
<tr>
<td>Implanted Port</td>
<td>heparin /saline 500 units/5 mL</td>
<td>2 mL</td>
<td>Monthly heparin lock 500 units/5 mL</td>
</tr>
<tr>
<td></td>
<td>when in regular use</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ACTION:** Before using a CVAD that has been heparin locked remember to withdraw the heparin.

For children usually 3-5 mL discard is sufficient. If blood cultures are required use this discard sample.
Checking for blood return before administering medications:

Checking for blood return is a reliable indicator that the catheter tip is correctly placed. Gently aspirate to observe for brisk blood return before administering any medications. The absence of free flowing blood is an indication of catheter malfunction. Flushing alone does not confirm catheter patency flow. Refer to the Occlusion Algorithm chart page 51 for assistance.

Flushing and observing blood return from a catheter requires the following flushing regime. This is referred to as the ‘S.A.S.’ method.

**S.A.S METHOD**

S. sodium chloride 0.9% 10 mL flush then aspirate until blood return is observed. Remove syringe and discard. Flush catheter with 10 mL 0.9% sodium chloride then -

A. administer medication / IV fluids

S. saline pulsatile post flush using 1-2x 10 mL sodium chloride 0.9%

INS policies and Procedures for infusion nursing – evidence based approach 3rd edition 2010

Remember to always use 2 x 10 mL flushes following:

- Blood transfusion
- Blood products
- Blood sampling
- PN

**HOW BLOOD REFLUX OCCURS LEADING TO CATHETER OCCLUSION**

Several factors can cause unintentional reflux of blood back into the catheter lumen leading to partial or complete occlusion. These factors are:

1. **Syringe design.** Injecting all the fluid from a standard syringe into a catheter compresses the tip on the syringe barrel. When the pressure is released the plunger rod re-bounds drawing blood back into several centimeters of the catheter lumen. The narrower the catheter the longer the reflux distance. (Refer to figure 21)

   a) **STANDARD SYRINGES:** When using the standard syringe to administer a saline flush NEVER FULLY EMPTY THE SYRINGE. Always leave at least 2-3 mL in the syringe, then disconnect in the usual manner.

   b) **PRE-FILLED SYRINGES:** These have ZERO reflux. This is due to the shape and design of the syringe. When flushing a catheter with a pre-filled saline syringe, the syringe can be fully emptied then disconnected in the usual manner.

![Fig. 21: Standard Syringe = reflux](image1)

![Pre-filled syringe = zero reflux](image2)

Source: Original
2. **Needleless connectors.** A PDD access device is referred to as a positive displacement device (PDD). This device withholds a small amount of fluid to overcome blood reflux. Disconnecting the syringe forces the reserve fluid into the catheter lumen.

![REMEMBER](image)

> **REMEMBER** to disconnect the syringe, count to 5 to allow for the fluid displacement to occur, and then clamp the catheter.

3. **Aggressive Flushing**
Aggressive flushing can shear off biofilm or thrombus and propel it into the blood stream. It can also be responsible for mal positioning the catheter resulting in incorrect tip position and ‘whipping of the catheter within the vein leading to perforation of the vessel.

4. **Changes in intra-thoracic pressure**
Because no valve is located between the vena cava and the right atrium, some of the blood flows retrograde (backwards) with every heart beat. Coughing, sneezing, vomiting, lifting heavy objects or heart failure can increase intrathoracic pressure, forcing blood into the catheter lumen. For example, if the patient coughs while the catheter isn’t ‘locked’ blood moves into the lumen.

5. **Muscle contraction**
Muscles act as a venous pump that helps the blood return to the heart. When a muscle contracts, proximal valves open while distal valves close. Pressure from the contracting muscle forces the locking fluid out of the catheter lumen allowing blood to reflux when the muscle relaxes. Therefore avoid strenuous activities that involve arm movement in patients with PICCs.

6. **Changes in Infusion Pressure**
Venous pressure in the hand is about 35 mmHg; at the upper arm it is about 8 mmHg; in the SVC it is 0 mmHg. Infusion pressure must be great enough to overcome venous pressure so that IV fluids can enter the systemic circulation. Fluid infusing by gravity from 120 cm above the patient exerts about 100 mmHg of pressure. When the infusion bag empties, the infusion pressure is 0 mmHg which allows blood to flow back into the catheter lumen. Most infusion pumps will maintain positive pressure and thus prevent blood reflux occurring.

![Warning](image)

> It is important to note when fluids are free flowed they allow blood to reflux (flow back) into the CVAD contributing to catheter occlusion. To prevent this medications and IV fluids are administered via an infusion pump to prevent this complication.
BLOOD SAMPLING

Blood sampling from catheters is common practice. It is important to recognise that blood withdrawal can contribute to thrombotic catheter occlusion if the catheter is not adequately flushed. The INS ‘Flush Protocols’ recommend 5-10 mL sodium chloride 0.9% after any blood withdrawal from a CVAD. The most common method used to obtain blood is the discard method. The first aspirate of blood is discarded to reduce the risk of drug concentration or a diluted specimen (Boodhan, 2006). When a CVAD has more than one lumen, the largest lumen should be used for obtaining specimens.

⚠️ The accuracy of samples can be altered when blood is drawn from silicone catheters. Some drugs leach into the silicone e.g. gentamicin and tobramycin (Boodhan, 2006). If bloods tests for aminoglycocides levels or coagulation profiles are required from a single lumen CVAD, flush the catheter / Port first with 20 mL sodium chloride 0.9% prior to blood sampling then aspirate blood discard sample before taking required blood tests (Boodhan, 2006).

The syringe and/or vacutainer method is suitable for obtaining samples from all CVADs including PICCs. The vacutainer method may not always be as reliable because of the PICCs smaller lumen.

ACTION

1. Aspirate discard blood using a 5-10mL syringe to assess catheter flow and act as a prompt to identify which method is suitable for collecting blood samples – syringe or vacutainer
2. If blood does not flow into the blood tube or syringe have the patient cough, hold their breath, change position, or lift their arm
3. Flush with 10 mL sodium chloride 0.9% and then attempt to withdraw blood again
4. Replace blood tube with a new tube (the tube may have lost its vacuum)
5. Try a smaller syringe e.g. 5mL

ORDER OF DRAW

Always ensure blood collection tubes are used in the correct order of draw. This avoids cross contamination of additives used in the different tubes and ensures integrity of the sample. NB. The order of draw can be found on the laboratory blood request form.

If blood cultures are required use the ‘discard blood’ for this purpose then take remaining blood samples in correct order of draw. Click on hyperlinks below for the CLAB Guidelines and a step by step guide to collecting blood cultures Click Here & Click Here

METHODS OF OBTAINING BLOOD SAMPLES

Two recommended methods can be used to withdraw samples (INS, 2010). These are:

- The syringe method (page 38)
- The vacutainer method (page 39)
SYRINGE METHOD

Please note the syringe method is always used for blood sampling in Child health

1. Check blood tests requested
2. Hand hygiene and use non sterile gloves
3. Vigorously clean the access device with chlorhexidine 2% & alcohol 70%
4. Allow to dry – 15-30 seconds
5. Unclamp catheter
6. Withdraw 5-10 mL of discard blood – Hickman®, CVC, Port-a-cath. For PICCs, withdraw 3-5 mL discard blood before taking samples.
7. Clean access device then attach 10 mL syringe and withdraw blood sample/s.
8. Attach syringe to a blood transfer device (PINK TIP) and insert blood tubes in order of draw and allow tubes to fill. The maximum fill is found on the tube.
9. Gently mix blood tube/s
10. Vigorously clean the access device as above and allow to dry
11. Pulsatile flush catheter with 2x 10 mL sodium chloride 0.9%
12. Disconnect syringe, count to 5 and allow displacement to occur
13. Clamp catheter
14. Label blood tubes with patient details and send to laboratory with blood request form

Practice Tip: PICCs may require a firm flush with 5-10 mL 0.9% sodium chloride to initiate flow prior to taking a blood sample. Attach a 10 mL syringe filled with 0.9% sodium chloride, administer a firm flush then gently aspirate back to establish flow. If blood return is achieved then discard the syringe sample & attach a syringe or vacutainer (as appropriate) and take blood samples.

Equipment used to perform blood sampling using syringe technique. (Refer to figure 22)

- Non sterile gloves
- Chlorhexidine 2% & alcohol 70% wipe
- Sterile gauze
- 10 mL syringes as required
- If flow is sluggish try a 5 mL syringes to withdraw blood from PICCs
- Blood transfer device (pink tip)
- 2x 10 mL sodium chloride 0.9% pre-filled syringes for flushes
- Blood tubes

Fig.22: Blood sampling equipment  Source: Original Photo
Please note the vacutainer method is never used for blood sampling in Child health

**ACTION** The sterile vacutainer with a BLUE ‘MALE’ Luer Lock is used for this procedure. If the blood collection is unsuccessful then the vacutainer must be discarded and replace with a new sterile vacutainer.

1. Check blood tests requested
2. Hand hygiene and use non sterile gloves
3. Vigorously clean the access device with chlorhexidine 2% & alcohol 70%
4. Allow to dry – 15-30 seconds
5. Unclamp catheter
6. Attach a 5-10mL syringe to collect discard blood and assess catheter flow. Remove and discard
7. Attach a BLUE tip vacutainer to the access device and insert blood tubes in correct order of draw
8. Gently mix blood tubes
9. Remove vacutainer from access device
10. Vigorously clean PDD and allow to dry
11. Flush with 2x 10 mL pre-filled sodium chloride 0.9% syringes
12. Disconnect syringe count to 5 and allow for displacement to occur
13. Clamp catheter
14. Label blood tubes with patient details and send to laboratory with blood request form

**Equipment used to perform blood sampling using a vacutainer. (Refer to figure 23)**

- Non sterile gloves
- Chlorhexidine 2% & alcohol 70% wipe
- Sterile gauze
- 10mL or 5mL syringe to take discard blood
- BLUE tip vacutainer holder
- 2x 10 mL sodium chloride 0.9% pre-filled syringes
- Blood tubes

**Fig.23: Vacutainer equipment**

Source: Original Photo
BLOOD SAMPLING AND PARENTRAL NUTRITION

It is recommended that blood tests should be taken from a peripheral vein in patients receiving PN unless the patient is venous compromised or it is clinically indicated.

If using a CVAD to obtain blood samples it is recommended that these should be taken at the completion of each cycle of PN infusion to give a more accurate picture of the biochemistry profile, and prior to commencing a new infusion or at the recommendation of the Dietitian.

Refer to Adult Parenteral Nutrition Prescription QMR114 for guidelines on monitoring Parenteral Nutrition (PN).

ACTION: There are some exceptions to obtaining peripheral blood samples. Haematology, Oncology and Child Health patients’ are usually venous compromised due to disease management and administration of complex IV therapies. In addition children find repeated peripheral blood sampling traumatic. The CVAD is therefore the appropriate method of obtaining blood samples. If blood samples are required during administration of PN figure 24 demonstrates the correct method.

TAKING BLOOD SAMPLES FROM THE CATHETER

To ensure integrity of blood results i.e. Mg+, glucose, always take blood samples from the catheter lumen not used to administer PN.

Remember that the WHITE lumen is dedicated to the administration of PN

- Stop infusion from the white lumen
- Flush lumen that the blood samples will be taken from with sodium chloride 0.9%
- Wait 1 minute
- Withdraw 10 mL discard blood
- Take required blood sample/s
- Flush catheter lumen with 2 x 10 mL sodium chloride 0.9%
- Recomence PN

Fig. 24: Obtaining blood samples during PN administration
COLLECTING BLOOD CULTURES from a CVAD

If the CVAD is the suspected source of sepsis taking blood cultures from the CVAD is appropriate.

Blood cultures should be taken from a CVAD in combination with a separate peripheral IV sample when investigating potential central venous catheter-related septicaemia. Samples should be taken from one lumen and clearly labelled as to which lumen the sample has been obtained from.

The peripheral vein sample should be collected first. Sets taken from either CVAD, peripheral or both sites should be obtained sequentially or within 12 hours of each other.

**ALERT:** The access device must be removed and replaced with a new device. This is thoroughly cleaned before attaching the syringe to collect the blood culture sample. This action prevents false positive results. Refer to the CLAB Guidelines.

The volumes of blood obtained from both sites must match to ensure accuracy e.g. if only 10mL is obtained from the peripheral vein, obtain 10mL from the CVAD.

When taking blood from both the CVAD and from a peripheral vein, ensure that the site of each sample is clearly labelled on the culture bottles and the request form.

If additional blood tests are required these are taken after the blood culture samples.

For a step by step guide on equipment required and how to carry out the procedure click on the hyperlinks below.

**Procedure for taking blood cultures**

**CLAB Guidelines for blood cultures**

Clinical Haemotology/Oncology refer to Local Policy Guidelines.

### BLOOD CULTURES - RECOMMENDED VOLUMES

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Total Volume</th>
<th>Aerobic Bottle</th>
<th>Anaerobic Bottle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult/Adolescent (peripheral)</td>
<td>20mL (recommended)</td>
<td>10mL</td>
<td>10mL</td>
</tr>
<tr>
<td>Adult/Adolescent (CVAD)</td>
<td>20mL (recommended)</td>
<td>10mL</td>
<td>10mL</td>
</tr>
<tr>
<td>Older children</td>
<td>5 mL maximum</td>
<td>5mL(optimal)</td>
<td>paediatric pink bottle</td>
</tr>
<tr>
<td>Infants</td>
<td>1-3mL maximum</td>
<td>3mL(optimal)</td>
<td>paediatric pink bottle</td>
</tr>
<tr>
<td>Neonates</td>
<td>1mL(min)-3mL according to weight</td>
<td>1mL(min)-3mL</td>
<td>paediatric pink bottle</td>
</tr>
</tbody>
</table>

**Fig. 25: Blood volumes**

It may not always be possible to obtain 20mL of blood from an adult. In that case divide the volume in half for each culture bottle. A minimum volume for adults is 5mL per bottle. Follow instructions page
CVADs should be removed as soon as they are no longer required. Daily review of the catheter with prompt removal of unnecessary catheters is one of the components of the Maintenance Bundle as originally defined and promoted by the Institute of Healthcare Improvement (IHI, 2008). It is the responsibility of Medical staff to authorise catheter removal. Medical staff are responsible for the removal of the following CVADs.

- Tunneled Hickman catheters
- Central Venous Catheters (CVC) non tunneled catheters

The Vascular surgeon is responsible for the removal of:

- Implanted ports (N.B. this may be performed under a general anaesthetic or sedation if respiratory compromised)

Registered Nurses and Midwives who have a CVAD competency may remove:

- Central Venous Catheters (CVC) non tunneled catheters
- PICCs

**KEY POINTS OF CVC AND PICC CATHETER REMOVAL**

Use caution when removing either a PICC or CVC non tunneled catheter to prevent air entering along the catheter tract. Place the patient in a supine (flat) position ideally with head tilted slightly down and breath held at the end of exhalation. If patient is unable to lie flat, the low semi-fowler position may be used. The head should be no greater than 30° head-up position and the catheter removed with the breath held at end of exhalation.

- For PICCs ensure the arm is at 90° angle if a Basilic placement and a 45° angle if Cephalic
- Use a dressing pack and aseptic technique to prepare site
- Remove dressings, securement devices and/or sutures
- Clean exit site with chlorhexidine 2% and alcohol 70% wipe (if oozing or discharge present take a swab for culture)

**CVC:** using gentle even pressure, slowly withdraw catheter with dominant hand, while holding sterile gauze over exit site (refer figure 26)

**PICC:** slowly withdraw and if resistance is encountered wait for 1 minute then continue procedure. If resistance persists use warm compresses over upper arm to dilate vein then reattempt removal. If resistance persists, seek help

- Cover insertion site with sterile gauze, applying finger pressure to the site for five minutes
- Cover site with an air tight sterile occlusive dressing with dressing pad to seal the skin-to-vein tract and reduce the risk for air embolus for at least 24 hours.
- Patient should remain in supine position for 30 minutes following procedure
- Inspect the catheter and measure to ensure all the catheter has been removed.

**Documentation of procedure should include:**

- catheter length and intact catheter
- exit site appearance
- dressing applied
- patients response (INS Infusion Nursing: an evidence based – approach, 2010)
Nurses and Midwives are responsible for assessment of the patient; development of the nursing plan of care to reach established goals and evaluate the effectiveness of the care given. The CVAD Insertion and Maintenance form is used for this purpose.

Clinical effectiveness is about doing the right thing in the right way and at the right time for the patient (Royal College of Nursing, 2006). The importance of central line assessment and documentation of findings is often overlooked and can lead to complication which can be avoidable. Effective documentation is an integral part of good patient care (INS, 2010).

Documentation provides a pathway to continuity of care. Each point of care reveals the patient’s clinical picture therefore documentation on the ‘CVAD Insertion and Management Form’ C270118 /9 should accurately include the following:

- Patient assessment
- Catheter site assessment
- Catheter flow assessment
- Catheter care assessment
- Length and gauge size of non coring needle used to access Port-a-cath®
- Review of medications and infusates
- Any complications
- Interventions performed
- Evaluation of interventions including ‘care bundles’
- Outcomes

**PATIENT EDUCATION**

Based on a thorough assessment of the patient’s needs, a plan is devised based on what needs to be taught; how the patient will be taught; overcoming barriers to effective teaching; and when and in what time frame the patient will be taught (INS, 2010). Use the appropriate catheter ‘Patient Information booklet’ for this purpose.

Educational should be effective and family/whanau patient-centred and include the following objectives:

- Determine a clear understanding of what the patient needs to learn
- Determine barriers to learning and how the patient best learns
- Determine the goals for catheter maintenance
- Written information that will help the patient and family/whanau learn how to identify problems
- Deconstruct treatment information into understandable manageable units
- Promote self-care skills where appropriate

**ACTION:** Initiate the patient’s education from the day of admission or as soon as possible.
The presence of a Central Venous Access Device (CVAD) places the patient at risk not only during the insertion procedure but for as long as the catheter remains within the vascular system. Key to identifying and managing post insertion complications is a comprehensive understanding and knowledge of signs and symptoms, related complications, preventive interventions and appropriate actions. Table 5 lists common complications associated with post insertion of CVADs.

**Table 5: Common complications post CVAD insertion**

- **INFECTION**
- **OCCLUSION**
  - Thrombotic
  - Non-thrombotic
  - Mechanical ‘PINCH OFF’ SYNDROME
- **THROMBOSIS**
- **CATHETER MIGRATION**
- **MAL POSITION / VESSEL EROSION**
- **CARDIAC TAMPONADE**
- **LYMPH VESSEL DAMAGE**
- **PHLEBITIS**

Although observing and evaluating the signs and symptoms of complications is important, prevention through good patient assessment and evaluation is the key to successful outcomes. These outcomes should be established on evidence based interventions which protect the patient from risks associated with infusion therapy. It is important to document patient and catheter assessment and interventions that have been initiated along with the outcomes.
Infection interrupts the patient’s prescribed therapy, impacts on the length of therapy the patient requires or receives and increases the length of hospital stay and cost. Skin is the primary source of contamination. The source can either be from the patient’s skin or hands of health care workers. Infection can be local or systemic. Risk factors for infection are institution related, patient related or a combination of both.

**Institution Related Risk Factors**
- Lack of hand hygiene
- Lack of asepsis
- Skill of inserter
- Non adherence to maximal sterile barrier technique
- Substandard equipment
- Catheter material and number of lumens
- Maintenance and care

**Patient Related Risk Factors**
- Immune suppressed
- Neutropenic
- Multiple blood product administration (Hanna & Raad, 2001)
- Poor nutrition
- Parenteral nutrition (Penel et al, 2007)
- Renal failure (Hosoglu, 2004)
- Chronic infection
- Diabetes
- Obesity
- Short bowel syndrome
- Oedema
- Vascular disease
- Self care deficit – poor hygiene and ability to manage cares
The categories of infection have been described by O’Grady et al. (Refer to table 6).

**Table 6: Categories of infection**

- **Exit site infection**
  - 2cm redness/absences of BSI/nc purulence
- **Clinical Exit site infection**
  - 2cm -Red/tender/site induration along catheter tunnel (Hickman)
  - Absence of BSI
- **Pocket Infection**
  - Purulent fluid in pocket of implanted port
- **Infusate related BSI**
  - Concordant growth –from infusate & Blood culture
  - No other identified source of infection
- **Catheter related BSI**
  - Bacteraemis/fungemia/ +ve blood culture
  - Fever/chills/hypotension
  - Same organism isolated from catheter segment & blood

**PRESENCE OF BIOFILM IN THE CATHETER**

Biofilm is one source of infection. Attacks from within the catheter are linked to biofilm formation attaching to the internal surface of the catheter lumen. This is responsible for promoting adherence of Staphylococci and Candida species which increase the risk of catheter related bacteraemia (CRB) (Shanks, 2006). This may account for acute febrile episodes experienced by the patient. Intra-luminal biofilm is responsible for rigors that occur when the catheter is flushed.

Biofilm formation is a process where micro-organisms attach to a solid surface and grow into complex communities encased within a polysaccharide matrix. Heparin enhances Staphylococcus Aureus biofilm formation. In this setting microbial metabolism is deranged and antibiotics are repelled (Shanks et al, 2006).
DETECTING INFECTION
Detection requires daily assessment and monitoring of the following:
- The catheter exit site for redness and/or discharge
- Tunnel area of tunneled catheters for swelling and induration.
- The portal pocket for swelling and redness
- Neck and upper arm for swelling, pain, redness

Monitoring for systemic changes such as:
- Fever
- Hypotension
- Tachycardia
- Chills/rigors
- Vomiting

MANAGEMENT OF INFECTION
If symptoms of an infection develop, peripheral vein blood cultures are taken first from the arm opposite to the catheter insertion site then from each catheter lumen. In addition the following is also carried out:
- A swab is taken from the catheter insertion site if exudate is present
- A mid-stream urine specimen may be obtained and other test may be ordered such as a chest x-ray
- Antibiotics will be prescribed and depending on the blood culture result the antibiotics may be reviewed and replaced with target antibiotics
- A clinical decision to remove the catheter may be made and if so the tip is sent to the laboratory for culture.

PREVENTION OF INFECTION
Knowledge of patients most likely at risk, good nursing assessment and infection prevention strategies are the key to preventing infection. They are:
- Monitoring the patient for any changes in the vital signs and documenting outcomes
- Effective hand hygiene
- Aseptic non touch technique (ANTT)
- Vigorous cleaning of all catheter and infusion set access ports, allowing time to dry before connection
- Changing access devices on designated days or if the access device is unable to be cleared of blood or drugs
- Replacing the catheter dressing if it becomes compromised
- Infusion set changes every 72 hours. Exceptions are following blood products, PN, cyclosporine and some other drugs where the IV sets are changed at 24 hours or single use only
- Labeling IV administration sets to identify the infusion in progress e.g. PN, cyclosporine, Maintenance fluids, heparin, insulin
- Maintaining a ‘closed system’ during Parenteral Nutrition (PN) administration and using a dedicated catheter lumen – the WHITE LUMEN
- Consider an antimicrobial/antiseptic coated catheter for high risk patients in ICU
- Good documentation of the patient and their vital signs, catheter site, catheter care and catheter function
PROPHYLACTIC CATHETER LOCK SOLUTIONS

Prophylactic catheter lock solutions are referred to as ‘locks.’ They are used to prevent catheter related infection (CRI) occurring in CVADs by reducing the bacterial biofilm that forms on catheter surfaces. They eradicate the microorganisms within the catheter lumen. The use of routine lock solutions is recommended for patients with a history of recurring CRI and who are at risk for serious consequences from these infections. The following ‘locks’ solutions are commonly used.

ETHANOL
Ethanol is used on a regular basis to prevent catheter related infections in the immune-compromised patient. Locks made up of ethanol 70% are instilled into each catheter lumen and left in the catheter lumens for 2 hrs. The locks are withdrawn or can be flushed through the catheter using 10 mL sodium chloride 0.9% (Chambers, Peddie & Pithie, 2006). Ethanol locks are made up in pharmacy.

ANTIBIOTIC
Antibiotics are used to prevent infection in Dialysis catheters. This involves instilling highly concentrated antibiotics into the catheter lumens for up to 12 hrs (Bagnall-Reeb, 2004).

TETRASODIUM EDTA (Kite, P 2013)

CITRATE
Citrate is used to prevent infection and minimise biofilm build up in Dialysis catheters. Zuragen™ a combination of citrate, paraben and methyl blue has been found to be effective in reducing bio-burden build up in dialysis catheters (Ash et al ASN, 2009).

Locks must be prescribed by a Medical Officer. When ‘locks’ are instilled into a catheter lumen, the RED medication label is used to identify the ‘lock’ solution. The label must also include the following wording “DO NOT USE (specify lock) LOCK IS PRESENT IN THIS CATHETER LUMEN”. The labels are then attached to each catheter lumen.
CATHETER OCCLUSION

Catheter occlusion is defined as a partial or complete obstruction of the catheter that limits or prevents the ability to withdraw blood, flush the catheter, and/or administer medications or solutions. It is a significant complication that may delay or interrupt therapy. Catheter occlusions may be due to thrombotic, non-thrombotic or mechanical causes (INS, 2010) It is imperative to recognise the **TYPE OF OCCLUSION** and how it occurred so that it is managed appropriately. Clots that persist for more than seven days become resistant to thrombolytic treatment (Steiger, 2006), thrombotic partial or complete occlusions should be treated as soon as they are identified

**Signs of Occlusion:**
- Ability to flush but not aspirate blood is called a persistent withdrawal occlusion (PWO)
- Ability to aspirate but not flush is called a reverse ball occlusion (Ports)
- Resistance to flushing or sluggish infusion
- Complete inability to flush or infuse
- Increasing alarm occlusion with electronic infusion devices

**ACTION** Do not leave partial occlusions untreated. Prompt action should be taken as soon as a partial occlusion is suspected to restore full patency and avoid a complete occlusion and possible catheter removal.

**Education and knowledge is a key element to overcoming problems such as:**
- Insufficient or incorrect flushing technique and clamping sequence to maintain catheter patency
- Knowledge deficit with equipment and catheter add on devices
- Knowledge deficit regarding catheter blood reflux
- Late recognition of problems / ignoring problems
- Inadequate assessment of occlusions
- Underestimating drug precipitate problems and lack of comfort with new drugs

**Risk factors include:**
- Coagulation abnormalities, blood viscosity, dehydration
- Chronic renal failure
- Inflammatory process
- The catheter type, gauge and length
- The characteristics of drugs - e.g. chemotherapeutic, nimodipine, vacomycin
- Blood products
- The type of occlusion and the way occlusion occurs either sudden or gradual

**Prevention of Occlusion:**
- Use correct flushing technique in a pulsating flush
- Use pre-filled sodium chloride 0.9% syringes which have zero reflux
- Use a positive displacement device (PDD)
- Use the correct clamping sequence
- Treat partial thrombotic occlusions as they occur with alteplase (tissue plasminogen activator)
<table>
<thead>
<tr>
<th>Type of Occlusion</th>
<th>Symptoms/Signs</th>
<th>Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partial</td>
<td>Decreased ability to infuse or flush into the CVAD</td>
<td>Mechanical, Thrombotic or Chemical occlusion</td>
</tr>
<tr>
<td>Withdrawal</td>
<td>Inability to aspirate blood but able to flush without resistance Lack of free flowing blood return</td>
<td>Mechanical or Thrombotic Occlusion, fibrin tail</td>
</tr>
<tr>
<td>Complete</td>
<td>Inability to infuse or withdraw blood or fluid into the CVAD</td>
<td>Mechanical, Thrombotic or Chemical occlusion</td>
</tr>
</tbody>
</table>

Table 7: Types of occlusions

**Four Categories of Thrombotic Occlusion**

**INTRA-LUMINAL**
This occurs when back flow of blood into the catheter tip leads to the formation of an intra-luminal thrombus. This causes partial blockage of the catheter with decreased ability to flush and aspirate. If untreated it will lead to a complete catheter occlusion.

**FIBRIN TAILS**
Fibrin tails usually result in persistent withdrawal occlusion (PWO). Fibrin can be dissolved by very slowly by instilling alteplase into the catheter lumen/s using the ‘over fill technique’. If clearance is not achieved the fibrin can be removed under radiology guidance in Interventional Radiology.

**FIBRIN SLEEVE**
A fibrin sleeve can also result in PWO. Because of the way this occlusion develops removing the fibrin becomes a challenge. Interventional Radiology may be able to remove the fibrin under radiology guidance however it is dependent on the length of the sleeve. If the sleeve interferes with catheter flow then catheter removal may be the only solution.

**MURAL THROMBUS**
A mural thrombus occurs when irritation by the catheter causes damage to the vein wall and an accumulation of fibrin also builds up in the catheter. The catheter adheres to the vein wall which may lead to a deep vein thrombosis. Catheter removal may be required.

**MANAGEMENT OF OCCLUSIONS**
Ensure that the source of the occlusion is not mechanical or drug/lipid precipitate in nature. The following techniques should be attempted first.

1. Deep breath – the catheter tip could be resting against vessel wall
2. Ask patient to lie down or sit up – it may be positional
3. Ask patient to cough
4. Administer a brisk flush then check for blood return

If these do not prove successful then refer to:

**Algorithm for Management of Partial, Persistent Withdrawal or Complete Occlusion** [click here](#)

Alteplase is a recombinant form of the normal blood component tissue-type plasminogen activator (t-PA), which causes thrombolysis. Alteplase binds to and activates plasminogen, producing plasmin. Plasmin dissolves fibrin, releasing fibrin degradation products and causing the clot to dissolve.

Clots that persist for more than seven days become resistant to thrombolytic treatment (Steiger, 2006)
TECHNIQUES TO RESTORE CATHETER PATENCY

The following methods have been described extensively in literature and provide reduced risk of catheter rupture or complications (Hadaway, 2012; Hamilton, 2006; Infusion Nurses Society, 2006, Simcock, 2001). The direct instillation method is used when a catheter can still be flushed but flow is sluggish or aspiration of blood isn’t possible due to intraluminal partial red cell occlusion or fibrin. Both the Negative aspirate, single syringe (refer figure 27) and three way tap methods for total occlusion use a negative pressure approach (refer to figure 28) to instil thrombotic and non thrombotic catheter restoration agents.

DIRECT INSTALLATION METHOD (partial thrombotic or non-thrombotic occlusions)

1. Stop all infusions where possible when treating a suspected FIBRIN TAIL/SHEATH to ensure optimum thrombolysis during dwell time to facilitate maximum contact with fibrin.
2. Thoroughly disinfect the needleless connector with an antiseptic wipe using friction for at least 5 seconds and allow it to dry
3. Maintaining sterility of the syringe tip, attach the syringe containing alteplase to the needleless connector
4. Unclamp the catheter and slowly instil alteplase to ensure it comes in contact with the thrombus or clot burden and is ‘soaked up’ by the thrombus for maximum effect.
5. Remove and discard the syringe. Clamp the catheter. Place a red drug label on the catheter lumen which has written on it “Declotting agent in place DO NOT USE” and include the date, the time, and your initials (as shown)
6. Leave in the catheter for 60 -120 minutes then assess catheter patency. Thoroughly disinfect the needleless connector with an antiseptic wipe using friction for at least 5 seconds and allow it to dry.
7. Maintaining sterility of the syringe tip, attach an empty 10-mL syringe to the needleless connector, unclamp the device, and attempt to aspirate for blood return. Brisk blood return indicates patency
8. Sluggish or no blood return indicates that the occlusion is still present. A second dose of alteplase may be necessary.

NEGATIVE ASPIRATE METHOD (complete occlusion)

1. Use a 10mL standard sterile syringe containing 5mL 0.9% sodium chloride.
2. Thoroughly clean the needleless connector with an antimicrobial wipe for at least 5 seconds and allow to dry.
3. Attach to the syringe to the needleless connector and apply negative pressure by withdrawing the syringe plunger back 8-10mL repeat this process until blood is observed in the syringe
4. Once patency is re-established with brisk blood return then
5. Flush catheter lumen/s with 2 x 10 mL sodium chloride 0.9%.
SINGLE SYRINGE METHOD (complete occlusion)

1. Thoroughly clean the needleless connector with an antimicrobial wipe for at least 5 seconds then allow to dry.
2. Attach a 10 mL syringe containing alteplase to the needleless connector of the obstructed lumen.
3. Unclamp catheter.
4. Hold the syringe vertically. Make sure the solution is in the end of syringe closest to the catheter.
5. Draw syringe barrel back to 8mL mark.
6. Keep syringe in vertical position and slowly release the plunger to instil the alteplase into the occluded catheter lumen.
7. Remove the syringe and clamp catheter.
8. Place red drug label on catheter lumen which has written on it ‘Declotting agent in place DO NOT USE’.
9. Leave for 60-120 minutes then assess catheter patency. Thoroughly clean the needleless connector with an antimicrobial wipe for at least 5 seconds then allow to dry.
10. Unclamp the device, attach a 10mL sterile syringe and attempt to aspirate for blood return. Brisk blood return indicates that declotting was successful.
11. Flush catheter lumen/s with 2 x 10 mL sodium chloride 0.9%.

Sluggish or no blood return indicates that the clot is still present. A second dose of alteplase may be necessary.

Fig.27 a: Negative pressure syringe technique & 27 b: aspirating blood return  
Source: Original Photo
THE THREE WAY TAP METHOD (complete occlusion)

**STEP 1: CREATING A VACCUM IN THE CATHETER**

- Thoroughly disinfect the junction of the central venous access device and the needleless connector with an antiseptic pad using friction for at least 5 seconds and allow it to dry.
- Clamp the catheter, remove the needleless connector, and then attach a sterile three way tap to the catheter hub. Turn the 3 way tap off to the patient and catheter hub.
- Maintaining sterility of the syringe tip, attach an empty 10-mL syringe to a 3 way tap port.
- Maintaining sterility of the syringe tip, attach the alteplase-filled syringe to the remaining port on the 3 way tap
- Open the 3 way tap to the port connected to the empty syringe.
- Unclamp the catheter while holding the syringe vertically, and then gently pull the plunger back to about the 8-mL mark and maintain negative pressure by holding the plunger position, close the 3 way tap to the port to maintain negative pressure within the catheter lumen.

**STEP 2: INSTILLATION OF ALTEPLASE USING VACCUM IN CATHETER**

- Turn 3-way tap ON to the 3 mL syringe containing alteplase and unclamp catheter.
- Allow the vacuum created within the catheter to draw the alteplase into the catheter lumen.
- The syringe barrel may need to be gently pushed at this stage to assist the uptake of the alteplase
- Once the alteplase is drawn into the catheter turn the 3-way tap to close the flow
- Clamp catheter

**STEP 3: REMOVAL OF 3 WAY TAP AND LABEL CATHETER**

- Remove 3-way tap and syringes
- Thoroughly disinfect catheter hub allow to dry then attach a sterile combi loc to catheter hub
- Place RED medication label on catheter stating “Declotting agent in place DO NOT USE”
- Allow alteplase to dwell in the catheter for 60 -120 minutes before checking CVAD patency
- The longer the alteplase is left in catheter the more likely it will be successful in restoring flow. NB: alteplase may be left in the catheter overnight if required

**STEP 4: EVALUATION CATHETER FLOW**

- Hand hygiene and put on non-sterile gloves
- Remove the combi loc thoroughly disinfect hub and attempt blood aspiration using a 10mL sterile syringe which has 5mL sodium chloride 0.9% in. If blood return is not immediate flush catheter using a quick ‘push’ then attempt aspiration.
- If successful then flush catheter with 1x 10 mL sodium chloride 0.9% pre-filled syringe
- Attached a newly primed PDD to catheter hub and flush with a second 10 mL sodium chloride 0.9% pre-filled syringe
- Document procedure and outcome in CVAD Management form

Source: INS. Infusion Nursing: An evidence–based approach 2010
A STEP-BY-STEP GUIDE TO THE THREE WAY TAP TECHNIQUE

- Clamp catheter and remove PDD
- Attach a 3-way tap directly to the catheter hub
- Ensure 3-way tap is OFF to catheter
- Attach empty 10 mL syringe to the port on 3-way tap in line with the catheter
- Attach 3 mL syringe containing alteplase to the other port and ensure 3-way tap is now OFF to the syringe containing alteplase

- Unclamp catheter
- Ensure 3-way tap is ON to catheter
- Aspirate 10 mL syringe back to the 10 mL mark to create vacuum within catheter lumen
- Maintain negative pressure on syringe while turning 3 way tap OFF to negative aspirate and ON to syringe containing alteplase

- Vacuum will draw alteplase into catheter
- Once alteplase is in catheter turn 3-way tap to close flow
- Clamp catheter

- Remove 3-way tap and syringes
- Aseptically attach sterile combi loc to catheter hub
- Ensure catheter lumen/s have a medication label attached indicating ‘declotting agent in place do not use’
- Leave alteplase in catheter for 60-120min

Source: Original Photo
NON THROMBOTIC OCCLUSIONS

Non thrombotic occlusions include drug precipitates and lipid deposits. Drug precipitates may cause obstruction when incompatible medications or fluids are administered without flushing the catheter. One container of PN can cause a waxy build up of lipids on the internal lumen of the catheter leading to occlusion.

Use the Algorithm on page 51 as a guide for restoring catheter patency where lipid or drug precipitates have occurred. For appropriate catheter restoration agents (refer to table 8).

Always confirm you have the correct product before you instill it into the catheter

<table>
<thead>
<tr>
<th>Precipitate/Occlusion</th>
<th>Clearing Agent</th>
<th>Dose</th>
<th>Fill Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>High pH drugs(pH7-12)</td>
<td>sodium bicarbonate 8.4%</td>
<td>1 mmol/mL 60 minutes</td>
<td>Capacity of catheter</td>
</tr>
<tr>
<td>Fat /PN deposits</td>
<td>ethanol</td>
<td>70% 2 minutes</td>
<td>Capacity of catheter</td>
</tr>
</tbody>
</table>

Source: INS Infusion Nursing: an evidence-based approach 3 ed. 2010
MECHANICAL OCCLUSION

‘Pinch off syndrome’ is a significant complication involving catheters and is often unrecognized. It occurs when a catheter is inserted into the subclavian vein and is compressed by the clavicle and first rib. The following catheters may be affected.

- Subclavian CVCs
- Implanted Ports

Catheter compression causes intermittent or permanent catheter obstruction and can result in catheter tearing, transection and catheter embolus most often to the right side of the heart or pulmonary artery (Masoorli, 2002; Mirza et al, 2004).

Signs and Symptoms:

- Intermittent and positional occlusion
- Difficulty with flushing, infusing, or aspirating
- Frequent occlusion alarm
- Occlusion relieved by specific postural changes such as rolling the shoulder back or raising the arm. This opens the angle of the costoclavicular space.
- Patient may experience chest pain, palpitations, swelling in the area of the CVAD
- Pain with flushing

Management:

- Supine chest x-rays at regular intervals is recommended for the first 6 months of placement to identify late occurrences.
- Interval between insertion and diagnosis can range from the day of insertion to 60 months with an average of 5 months.
- Catheter removal is recommended once diagnosed,
- Retrieval of embolised segment

Some patients have been reported as having no symptoms when the catheter partially or completely transects,
DEEP VEIN THROMBOSIS

The normal physiological response to a foreign body (such as a central venous catheter) in a vein is for aggregation of platelets and the accumulation of fibrin. This process can take weeks or months to occur. As well as causing problems within the catheter, it can cause thrombosis of the central veins. Thrombosis is where the blood has changed from a liquid state into a solid state producing a blood clot.

Three factors are implicated in the development of a deep vein thrombosis (DVT). This is referred to as Virchow’s Triad described as follows:

1. Vessel wall damage or injury. Causes may be trauma; the presence of a central venous catheter or irritating solutions
2. Alteration in the blood flow. Causes include venous stasis associated with immobility; obstruction of veins and heart failure
3. Hypercoagulability. Contributing factors such as decrease in coagulation inhibitors, pregnancy, and malignancy and post-operative states.

Left sided catheter placement is associated with DVT in tunnelled catheters (Brown-Smith, Stoner, and Barley.1999). PICCs appear to have a greater risk of DVT than catheters placed via the subclavian or jugular route. The catheter tip position is a factor. When the CVAD tip is in the upper SVC the risk of DVT is greater than when the tip is at or just above the right atrium (Geerts, 2008).

Signs and Symptoms of thrombosis:
(Kearon et al, 2008)
- Oedema of the arm, shoulder or neck on the side of the catheter placement
- Distended veins – the jugular vein may be quite visible
- Appearance of dilated collateral veins over the chest and upper arm
- Pain around the area and a feeling of pressure
- Difficulty breathing (if the trachea is compressed)
- Darkening of the skin in the upper body
- Changes in colour of the hand on the effected side (plum colour)
- Leaking at the insertion site

Management of thrombosis: (ACCP Guidelines)
- Ultrasound or dye studies to identify thrombosis
- Catheter removal is not routinely required if it is functioning and necessary.
- Systemic anticoagulants
- Antibiotics
- If the catheter is removed and replaced a further DVT can develop
CATHETER MIGRATION / MAL POSITION / VESSEL EROSION

Catheter migration occurs when the internal catheter tip changes position with or without the external length changing. Catheter migration causes the infusion to flow against the direction of blood flow. PICCs are more likely to migrate or become malpositioned due to length and small diameter compared with catheters with larger diameters such as the Hickman® or CVC.

Causes of catheter migration:
- Forceful flushing
- Changes in the intrathoracic pressure from:
  - vomiting
  - coughing
  - constipation
  - sneezing
  - heavy lifting
- Heart failure
- Presence of tumors
- Mechanical ventilation
- The cuff in tunnelled catheters dislodges or fails to adhere to the tissue after insertion

Catheter can migrate into the following veins: internal jugular, azygos or contra lateral Brachiocephalic. The catheter tip may impinge on the vein wall increasing the risk of vein thrombosis and vessel wall perforation. In the elderly and / or obese the azygos vein opening is larger and may contribute to mal position into this vein. BARIATRIC PATIENTS: Always consider the potential for PICC migration where there are excessive skin folds on the upper arm and dressing and securement is compromised.

Signs and Symptoms of catheter migration:
- Inability to flush, infuse, aspirate may be a sign the tip is no longer in the SVC
- Leaking of IV solutions or flushes at insertion site
- Loss of CVP trace or arrhythmia if catheter has migrated into the right atrium
- Changes in the external catheter length
- Gurgling in ear during flushing indicates the tip has migrated to the internal jugular
- Headache; pain; swelling; redness; shoulder, arm or neck discomfort
- Coldness felt in middle of back on flushing indicating tip migration into the azygos vein
- Tunnelled catheters - coiling of catheter in tunnel, able to palpate coil in tunnel

Management of catheter migration:
- Good catheter assessment
- Avoid forceful flushing
- Effective dressing and catheter securement device
- Palpate for correct cuff position with tunnelled catheters
- X-ray to verify tip location. Reposition under fluoroscopy if applicable
- Removal and replacement may be necessary
CARDIAC TAMponade

Cardiac tamponade, in relation to central venous access devices, is where the vein, right atrium or ventricle wall is perforated due to erosion by the CVAD tip. This perforation allows excess fluid to be present between the pericardium and the heart. The fluid causes abnormal pressure and prevents the heart from beating normally (Forauer, 2007).

Signs and Symptoms of cardiac tamponade:
- Unexplained hypotension
- Arrhythmia
- Chest tightness
- Shortness of breath up to one hour post catheter insertion and up to removal of the CVAD if it dislodges from its position

Management of cardiac tamponade:
- An emergency echocardiogram will be required to diagnose cardiac tamponade
- Signs and symptoms should prompt immediate treatment to relieve cardiac compression

Prevention of Cardiac tamponade requires that:
- Catheters are made of less stiff material
- A flexible J-wire is used to aid in avoiding puncturing the heart or SVC wall during insertion
- The tip of the CVAD to be placed above the pericardium reflection to avoid cardiac perforation
- Heart monitoring be carried out which can give an accurate picture of the tip position. CVADs placed using electrocardiograph guidance reduces the need for routine chest radiography after central line placement (Davis, 2008).
- Accurate assessment of the patient post insertion is carried out to ensure appropriate action is taken if indicated
- Accurate documentation is undertaken especially the external length of a PICC

CARDIAC TAMponADE IS A MEDICAL EMERGENCY
The lymphatic system is an essential component of the immune system. A vast network of lymphatic vessels collects excess fluid from the cells and subcutaneous tissue in order to minimise fluid accumulation. Lymph is a watery fluid derived from plasma. It is transported in one direction towards the heart via the lymph system.

In the arm, the main lymph nodes are the superficial supratrochlear gland above the anticubital fossa and the deep glands of the axilla. Both are responsible for lymph drainage of the arms. A network of lymph vessels is responsible for the transportation of lymph fluid between the glands.

The close proximity of lymph vessels to the veins used to place PICCs in the upper arm varies from one individual to another, so it is impossible to predict their location in relation to the vein.

**Cause of lymph fluid drainage from the insertion site:**

- A lymph structure is penetrated during placement. It may not necessarily be recognised immediately during PICC insertion because of the dominant return of blood through the small bore-needle used to access the vein.
- A lymph structure has been inadvertently punctured during insertion. This will lead to the formation of a channel between the lymph structure and the PICC exit site creating a passage for lymph fluid to drain from the vessel towards the exit site.

**Symptoms of a punctured lymph structure:**

- Serous fluid leaking from the insertion site of the PICC
- The fluid may be slightly blood-stained or straw coloured similar to plasma
- There are no signs of infection, redness, swelling or pain
- The exudate may be minimal if a smaller vessel has been punctured or more substantial if the supratrochlear gland is punctured

Source: unknown
Management of a punctured lymph vessel:

- There are no clear guidelines available however management will be dependent of the amount of lymph drainage from the PICC insertion site.
- Excessive drainage may require PICC removal especially where there is a potential for PICC migration
- If the lymph drainage is not excessive then it is suggested a ‘watch and wait’ approach is an appropriate strategy with monitoring of the drainage
- If symptoms last beyond 2 weeks or there is an increase of drainage the PICC should be removed. (Hughes 2013)

**ACTION POINT:**

A consequence of excessive lymph drainage around the exit is erythaema, and excoriation of the skin due to the corrosive effects of the fluid pooling under the dressing.

Consider using a hydrocolloid dressing such a Mepitel film to shield the skin from the fluid.

[Click here](#)
Air embolism is caused by the entry of air into the vascular system creating an intracardiac air lock at the pulmonic valve which prevents the ejection of blood from the right side of the heart. Refer to figure 33.

**Causes of air embolism:**
- Catheter fracture
- Disconnection of IV administration sets
- Deep inspiration during catheter removal/access device change
- Presence of a persistent catheter tract following CVAD removal

**Signs and Symptoms of air embolism:**
- Hypoxia and gasp reflex
- Hypotension
- Pallor
- Palpitations and arrhythmias
- Chest and shoulder pain
- Loss of consciousness
- Distinctive ‘mill wheel’ murmur (churning sound) (Peter & Saxman, 2003) is heard over the precordium caused by right atrial and right ventricular outflow obstruction

**Management of air embolism:**
- Position the patient in left lateral Trendelenburg
- Administer oxygen
- Call for assistance
- Hyperbaric treatment may be necessary

**Prevention of air embolism:**
- Position the patient in supine position or with head slightly tilted down position during CVAD removal
- Ask the patient to hold their breath at the end of exhalation during catheter removal
- Slowly remove the catheter and place pressure over the exit site for a minimum of 5 minutes
- Maintain a supine position for 30 minutes following catheter removal
- Always use luer lock syringes and IV administration sets
- Always clamp the catheter during access device PDD changes and when the catheter is not in use

**Immediate Action is Required for this Medical Emergency**

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**Fig.31: Intracardiac air lock air**  Source: unknown
Phlebitis is described as inflammation of one or all three layers of the vein wall. It is categorized by three types: mechanical, chemical and bacterial. PICCs are more likely to develop phlebitis because of the vein pathway the catheter takes. Peripheral veins of the upper arm are smaller than those of the central vasculature and the presence of a catheter can be the catalyst for intimal damage. Contracting and relaxing of upper arm muscles also contribute by squeezing on the vein in which the catheter lies causing irritation to the vein wall. Movement at the insertion site causes an inflammatory response of oedema and sanguineous fluid secretion. This oedema can result in an enlargement of the puncture site which provides the perfect environment for bacterial migration down the extra luminal pathway.

**Causes of phlebitis:**
- Difficult insertion causing trauma to the vein wall
- Irritation to the vein wall caused by the PICC moving in and out of the vein due to poor securement
- Over use of the arm where the PICC is indwelling causing the muscles to squeeze on the vein and catheter irritating the vein wall
- Infection

**Signs and Symptoms of phlebitis:**
- Redness and pain along the cannulated vein (refer to figure 32)
- Warmth
- Swelling of upper arm, shoulder and neck
- Induration along the vein
- Thrombosed vein may develop if early intervention for management of initial symptoms is not implemented

**Management of phlebitis:**
- Apply a warm compress over the affected area for 24-48 hours and:
  - Rest and elevate
  - Administer analgesia if necessary
  - Perform regular assessment of the insertion site and upper arm. Document findings
  - Consider removing the PICC if symptoms do not resolve within 72 hours

**Prevention of phlebitis involves:**
- Good assessment skills and using ANTT when managing PICC
- Applying warm compresses over the cannulated vein for the first 24 hrs post insertion
- Limiting movement of the arm
- Good dressing and securement to prevent catheter movement

**Fig.32:** Phlebitis  
Source: Original Photo
PARENTERAL NUTRITION

Parenteral Nutrition (PN), formerly known as Total Parenteral Nutrition (TPN), refers to the intravenous infusion of a specialised nutrition solution of high osmolarity. This therapy may be used to provide nutritional support to a person whose gastrointestinal tract is either not functioning or is inaccessible and is unable to receive adequate nutrition with oral feeding, supplements or enteral feeding. PN consists of an all-in-one bag which is produced in the Pharmacy Sterile Production Unit and is referred to as a triple phase system.

PN requires a central vein, allowing rapid dilution of solutions to prevent phlebitis, pain and thrombosis. It is generally recommended that a CVAD be dedicated solely for the use PN (CDC, 2002; INS 2010). This is to minimise the risk of infection or sepsis and prevents drug incompatibility. However, catheters with multiple lumens may be necessary for essential medical management especially where compromised patients are receiving complex therapies in addition to multiple blood sampling.

MINIMISING RISK OF INFECTION ASSOCIATED WITH PN

Due to the nutritional components of the PN solution it has the potential to create an environment that promotes the development of microbial growth. Within the hospital setting this risk of infection will increase as a result of:

- Malnutrition associated with immune suppression
- Graft versus Host Disease (GVHD) mucosa of alimentary tract
- Mucositis of the alimentary tract
- Neutropaenia
- Hyperglycaemia
- Microbial colonisation and contamination of the catheter hub and surrounding skin.

**ACTION:** When PN is administered using CVADs with multiple lumens always ensure the WHITE lumen is used. Attach a PN label to the tubing to identify that PN is being infused. To reduce the potential for catheter related blood-stream infection (CRBSI) always designate one lumen for PN (CDC, 2002).
CONSIDERATIONS WHEN ADMINISTERING CONTINUOUS PN

CVADs used to deliver PN are usually:

- Central venous catheter (non-tunnelled short term CVC)
- Peripherally Inserted Central Catheter (PICC)
- Hickman® catheter (skin tunnelled)

The intended use of the CVAD and the intended length of duration for PN must be considered.

- Administration of PN only (Long Term or Short Term)
- PN in conjunction with other Parenteral therapy
- Blood sampling or CVP monitoring

Nursing considerations for administration of PN

- Always use a dedicated catheter lumen for PN. The WHITE lumen is used where multiple lumen catheters are in place - **No Additives to solution** *(except in Pharmacy under strict sterile conditions)*.
- All PN solutions should be completed within the 24 hour period *(Refer to Dietician Prescription Form)*.
- All administration sets and inline filters to be changed every 24 hours *(Refer to Volume D-Fluid & Medication Manual)*.
- Always maintain a closed system and don’t discontinue or disrupt PN administration.

Administration of PN in Haematology, Oncology and Child Health may be over 20 hours. The rationale for this is:

- Catheter maintenance
- Patient’s freedom from the infusion pump
- Personal cares and showering
- ‘Time out’ for the patient before reconnect
- Routine bloods can be taken during this time giving a more accurate picture of Biochemistry profiles

For further reading and information on PN refer to the references below

References:

CATHETER SPECIFIC SECTION

PERIPHERALLY INSERTED CENTRAL CATHETER (PICC)

HICKMAN® TUNNELED CUFFED CATHETER

NON-TUNNELED CENTRAL VENOUS CATHETER (CVC)

IMPLANTED PORT-A-CATH®

GROSHONG® TUNNELED CUFFED CATHETER

HAEMODIALYSIS /APHERESIS CATHETERS
A PICC is a central catheter that is inserted into a peripheral vein in the upper arm and passed along the veins until the tip resides in the lower 1/3rd of the SVC. The preferred vein for insertion is the basilic vein because it is larger, straighter and offers a less tortuous route to the SVC. Because the insertion is in an area where the skin is generally dryer and less moist infection rates are lower.

**Material and Specifications**

A PICC is made of polyurethane generally measuring 50-55 cm in length with measure markings at 1 cm intervals along the catheter. PICCs inserted into adults in the CDHB are 4 fr or 5 fr. For children 3 fr or 4 fr may be used.

**Configuration**

5 fr 18 g Double lumen PICC - each internal lumen is independent from the other and both are 0.8 mL maximum

4 fr 18 g Single lumen PICC - internal lumen 0.8 mL maximum

Reverse taper i.e. from 4 cm to the purple wings it increases in diameter and trimmed to length

**Flow rates:** generally less flow rates than larger bore catheters due to length and diameter which limits treatment options

**Dwell time:** Up to one year

**Indications for use:** Allows for the delivery of all types of medication/infustates but not complex IV treatment regimes

**Management of a PICC**

- Immediately post insertion keep the upper arm warm and encourage minimal movement
- Application of heat to the upper arm post insertion for 24 hours may be benificial in reducing mechanical phlebitis
- Heat dilates the vein improves blood flow and keeps the vein wall off the catheter (Simcock, 2007)
- No B/P cuffs, tourniquets or scissors are to be used on the arm where the PICC is indwelling
- Protect the external portion of catheter from becoming wet especially during showering by covering the area with a plastic protection cover
Observe the insertion site and upper arm 8 hourly and:
- always prior to administration of medications and IV fluids
- during pre and post access flushing
- during dressing changes
- check the external length measurement and dressing integrity each shift and document the length and your assessment on the ‘CVAD Management Form’.

Assessment of early signs of complications can prevent premature removal of the PICC.

Dressing and Securement of a PICC
- The PICC does not require redressing for 7 days if there is nil or minimal bleeding at the site and the dressing remains intact
- Dressings are routinely changed on a weekly basis or if they become compromised
- The BIOPATCH® placed at inserton is removed and NOT replaced at the first dressing change unless clinically indicated e.g. immune compromised, neutropenic or history of catheter infection
- Protect the external PICC site dressing by covering with Netlast®
- Always ensure the PICC is stabilised to prevent migration

Measuring the external portion of a PICC

ACTION: The correct external PICC measurement is taken from the insertion site to the last mark or number on the catheter. All PICCs are trimmed to length and are clearly marked at 1 cm intervals. This portion of the catheter from the 4 cm mark up to the purple wings increases in diameter as it travels towards the insertion site. This is referred to as a reverse taper and is a feature of a power PICC. **Please note:**

Only paediatric PICCs require an indelible mark at 2cm from the insertion site.

![Fig 36 Peripherally Inserted Central Catheter](Source: Original photo)
**PICC Migration:**
Migration and mal position can occur with PICC’s. The external measurement is not always an indication that the PICC has migrated. Document your assessment in the *CVAD Maintenance Form*

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**IMPORTANT ACTION IF MIGRATION HAS OCCURED**

**Internal Migration:** where a PICC has migrated **IN 1-2cms** from the original position follow the steps below:

1. Pull the PICC back to its original mark as documented on the CVAD Insertion & Management Form and document your actions in the CVAD Management Form
2. Chest x-ray to confirm tip location
3. Do not use the catheter wait until Radiology has reviewed the chest x-ray

**EXTERNAL Migration:** where a PICC has migrated **OUT 2cm or less** from the insertion site this is acceptable and the PICC may continue to be used.

**NB. Any migration greater than 2 cm** requires a chest x-ray to confirm PICC tip position before commencing any IV therapy. Document any variances or interventions in CVAD Management Form

Where **EXTERNAL migration is GREATER THAN 4cms** the catheter will need to be removed and replaced if still required. The external catheter portion that has migrated in is a source of infection and cannot be re-inserted.

---

The Hickman® catheter is described as a tunneled cuffed catheter (see Fig. 37 below). Tunnelling is a technique for placing a catheter segment of the catheter inside a subcutaneous tunnel to separate the vein entry site from the skin exit site. This method of insertion allows for lower infection rates and very long dwell times (INS, 2010).

The catheter has a dacron cuff which acts as an internal securement device. It becomes firmly attached by the growth of a connective tissue seal which stabilises the catheter. The internal jugular vein approach offers a sound alternative to the traditional subclavian surgical approach. With minimal complications it is now the generally preferred option with the catheter inserted in the right internal jugular vein because the venous course is less tortuous. Complications associated with subclavian insertion may lead to intimal hyperplasia, venous stenosis, venous thrombosis and catheter fracture due to ‘Pinch off’ syndrome (Lau, 2001).

**Material and Specifications of Hickman®**
The Hickman® catheter is made of silicone and is 90 cm in length (adult) 65 cm (paediatrics). They are either single or multiple lumen and described as ‘open ended’ with all lumens exiting at the same point each providing an independent pathway (ref figure 41)
The CDHB use single, double and triple lumen configurations. The catheter also comes with a dacron cuff to maintain catheter stabilization once the sutures have been removed.

**Configuration of Hickman®**
Single Lumen – 10 fr 90 cm in length – internal lumen 1.3 mL Reinforced area for clamp
Double Lumen – 10 fr 90 cm in length – internal lumen 1.3 mL Reinforced area for clamps
Triple Lumen – 10 fr 90 cm in length – internal lumen 1.3 mL Reinforced area for clamps
Catheter Tip to Cuff measurement = 54.6 cm. NB: this catheter is trimmed to length.

**Flow Rates**
Offers high flow rates

**Dwell time**
Is up to 2 years or longer if needed
Silicone has poor tolerance to pressure and can tear or rupture if excessive pressure is used. Always use syringes no smaller than 10 mL when flushing or administering medication. Clamps should remain on the Protective Clamping Sleeve of the catheter lumen/s to prevent tearing or damage to the silicone.

Insertion
- Insertion is performed under local anaesthetic in IR by a Radiologist. Some patients may require sedation if they are anxious. The insertion is performed under Maximal Sterile Barrier (MSB) conditions.
- The patient has fluids only 4 hours prior to the procedure however if dehydrated then IV fluids may be given
- Remove chest hair on male patients using clippers prior to going to IR

ACTION: In Child Health The Hickman® catheter insertion is carried out under a general anaesthetic

For Haematology patients the coagulation screen for INR and the platelet count is checked and must be > 50x10^9

Indications for use of a Hickman® catheter
- Long term management of all types of IV therapy, which includes complex treatment regimens, PN, bone marrow transplant and CVP monitoring

Blood sampling from a Hickman® catheter
- The RED lumen is generally used for blood sampling from a multiple lumen catheter
  
  This is important because some drugs are given via the white lumen so as not to alter the integrity of the blood sample (refer to blood sampling section)
- Either the syringe or vacutainer method is acceptable. Use the BLUE TIP VACUTAINER for this purpose and always ensure aseptic non touch technique is adhered to. If contamination of the vacutainer tip occurs then a new vacutainer must be used.
- If using the syringe method then use the PINK TIP VACUTAINER holder to transfer blood samples
Management of a Hickman® catheter
Following insertion a sandbag is placed over the insertion site and tunnel area to apply pressure and minimise bleeding and haematoma. This is left in place for up to one hour. The patient should remain supine for 1-2 hours and physical activity should be restricted in the first 24 hours. The catheter has one suture around the exit site (chest) and one suture at the entry site (neck);

- The exit site suture is removed at 3 weeks
- The entry site suture is removed at 10 days

The catheter may be used immediately following insertion. Always assess the catheter patency before using it by flushing and aspirating to ensure flow is established.

![Hickman catheter placement](image)

Observation of the entry and exit site chest and neck area should be carried out at least 8 hourly when the catheter is not in use and:

- always prior to administration of medications and IV fluids
- during administration of cytotoxic agents
- during blood sampling
- during pre and post access flushing and routine maintenance flushing
- during dressing changes
- the exit site observed for cuff migration or curling of the catheter in the tunnel area

**HICKMAN ® Catheter PATIENT INFORMATION BOOKLET AVAILABLE AS FOLLOWS**

ALL AREAS EXCEPT CHOC: Ref no: 3272. Print off as required
Dressing and Securement of Hickman® catheter

- Dressings are routinely changed at 24 hours post insertion then weekly or before if the dressing becomes compromised
- A GripLoc® or Tubing Anchor helps stabilize the catheter, prevents accidental removal and keeps the catheter lumens above waist line

**ACTION:** In Child Health the dressing is not routinely changed for one week unless it has lifted or there is bleeding at the insertion site.
BIOPATCH® is not used around catheter insertion site.
GripLoc® is the preferred securement device for Hickman® catheters in Child health

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**Fig.39:** Dacron cuff in catheter tunnel
Source: Unknown

**Fig.40:** Dacron cuff migration at exit site
Source: Original Photo

**Fig.41:** Single, double & triple lumen Hickman®
Source: Bard Access Systems Information Booklet
NON-TUNNELED CENTRAL VENOUS CATHETER (CVC)

CVCs are non tunneled short term CVADs (see figure 43, 44 & 45). They can be jugular or subclavian. They are for short term use only (3-5 days) and associated with a high infection rate compared to the other CVADs. This is due in part to the method of insertion, i.e. direct from skin into vein and the warm moist environment of the neck and shoulder area.

Material and Specifications of CVCs
They are made of polyurethane which is quite rigid, but softens once indwelling in the vein. Multiple lumen CVC’s have exits at the distal, medial and proximal points and are clearly labeled on each catheter lumen.

Configuration
- Single through to multiple lumen
- 7 fr - 8.5 fr (standard adult)
- 4 fr – 5 fr( paediatrics)
- Single lumen -16 -20 cm in length (adult)
- Multiple lumen – 16 -20 cm in length (adult)
- Other lengths available for paediatric patients

Flow Rates
Deliver high flow rates due to its large lumen and short length

Dwell time
They are for short term access only from 1 and up to 3 days. Consider PICC insertion after this period if CVAD is still required

Fig. 42: Triple Lumen CVC  Source: Original photo

Fig. 43: Triple lumen CVC  Source: Unknown
Insertion

- Insertion of CVC’s is carried under MSB by senior medical officers in ICU, CCU or by an anaesthetist in peri-operative. CVCs may also be inserted in the emergency department. CVADs radiographic tip confirmation is carried out prior to use.
- Either a jugular or subclavian approach may be used. The catheter is secured by a suture at the catheter wings

Non tunnelled CVCs carry a higher risk for insertion complication and infection

Indications for using a CVC

- Infusion of all types of medications, solutions, blood / blood products
- Fluid resuscitation, fluid assessment and accurate fluid management
- PN
- CVP monitoring and blood sampling

Blood sampling from a CVC

The BROWN lumen is used for blood sampling (refer to blood sampling section)

- Either the syringe or vacutainer method is acceptable. If the vacutainer method is used choose the BLUE TIP VACUTAINER for this purpose and always ensure aseptic non touch technique is adhered to. If contamination of the vacutainer tip occurs then a new vacutainer must be used
- If using the syringe method then choose the PINK TIP VACUTAINER holder to transfer blood samples

Management of a CVC

- Following insertion via the jugular vein the entry site is monitored for bleeding and swelling. If a haematoma develops it can cause compression of the sympathetic pathway resulting in drooping of the eye and absence of sweating which indicates Horner’s syndrome. This is associated with jugular placement and upward tracking of the catheter
- The patient should remain supine for 1-2 hours and physical activity should be restricted in the first 24 hours
- The catheter is sutured on either side of the blue bifurcation and these remain in situ until the CVC is removed
- The catheter may be used immediately following X-ray confirmation
- Always assess the catheter patency before using it by flushing and aspirating to ensure flow is established
Observation of the the entry site chest and neck area is carried out at least 8 hourly when not in use and:

- always prior to administration of medications, PN, IV fluids
- during blood sampling
- during pre and post access flushing
- during CVP monitoring
- during dressing changes

**Dressing and securement of a CVC**

- *Dressings are routinely* changed at 24 hours post insertion or before if the dressing becomes compromised
- A BIOPATCH® is placed around the catheter at the insertion site and a bio-occlusive dressing is applied

CVCs can pose a challenge to dress due to the insertion site location and the environment around the site. The correct method of dressing and securing these catheters plays an important part in minimizing complications.

A GripLoc® stabilization device helps to secure the catheter and prevent any movement.

**ACTION:** In Child Health the dressing is not routinely changed unless it has lifted or there is bleeding at the insertion site.

BIOPATCH® is not used around catheter insertion site.

GripLoc® is the preferred securement device for Hickman® catheters in Child health

**Fig.44: GripLoc® securement**

Source: Original Photo
Learning Objectives:

- Identify types of Ports used in the CDHB
- Describe the anatomy of Port placement
- Describe accessing and de-accessing a Port
- Describe the principles of infection prevention & control
- Describe management, care & blood sampling
- Describe complications and describe their prevention management
- Describe the removal of a Port
- Describe assessment and accurate documentation
- Describe the principles of patient education
- Describe catheter considerations when administering Parenteral Nutrition (PN) (as applicable to your area of practice)
The port is a long term CVAD placed under the surface of the skin inside a surgically created pocket (see figures 45, 46 & 47). The pocket is usually created in the upper chest near the clavicle.

To use the device the portal body is palpated and accessed with a non coring needle passed through the skin and into the port septum using a 90 degree angle. The non coring needle is the only needle used for accessing a port and is referred to as a Huber® needle.

Non coring needles have a deflecting point that helps to avoid damage to the septum increasing the life of a port (refer to figure 48).

Using a 22-20 g non coring needle a port can be accessed approximately 2000 times before leakage starts to occur.

19 g non coring needles are also available and may be an advantage when blood administration is required to reducing the risk of occlusion.19 g or 20 g non coring needles are also used to administer chemotherapy.

Fig.48: Non-coring needle for port access
Source: CDHB Patient Information Booklet
Material and Specifications of a Port

- Available in either polyurethane or silicone with single or double ports. The portal body can be round, square or triangular (Power Port®)
- Consist of two parts – the body and the catheter
- 4-12 fr 125-225 cm
- Volume of reservoir ranges from 0.15 -1.3 mL

Configuration of a Port

- The portal body is usually made of titanium, plastic or stainless steel. Stainless steel is quite heavy compared to the other materials. It also interferes with MRIs and for these reasons is no longer used for most portal bodies. Titanium does not cause interference with MRI and is light weight
- Ports come in a variety of sizes, depths and shapes including power ports which are used when high pressure injectors are required
- High profile ports: are deeper
- Low profile ports: are shallower and have a smaller prime volume
- The portal body contains an internal reservoir covered with a septum made of dense, resealable material, usually silicone
- The width of the septum ranges from 6.6 -17.8 mm
- The catheter is made of a radio-opaque silicone or polyurethane. It is also designed to reduce the incidence of fibrin sheath/thrombus formation
- The base of the Port has suture holes around the circumference to enable the Port body to remain stable
- The outlet stem exists from the base of the portal body and provides the attachment for the catheter

Some brands have pre-attached catheters while others are attached during the insertion procedure.

![Profile of an Implanted Port](source: Unknown)
Flow Rates
Flow rates depend on size of the needle used to access the Port.
19 g - 1680 mL/hr; 20 g – 960 mL/hr; 22 g -300 mL/hr

Dwell time
Designed for long term dwell the port can remain in place for 5-10 years

Insertion of a port
The choice of port site is discussed with the patient and includes physical characteristics, body image concerns, cosmetic factors and lifestyle. Implantation of Ports is carried out by a vascular surgeon. This may either be under general anaesthetic or sedation if the patient is respiratory-compromised.

- The port and components are placed under the skin inside a surgically created pocket in the upper chest area
- The port is sutured to the underlying fascia with non-absorbable sutures
- The catheter is inserted into the axillary-subclavian vein either at, or lateral to the mid-clavicular line. This prevents the catheter occluding with certain arm movements and is referred to as ‘Pinch off Syndrome’
- The port is not placed too deeply under the subcutaneous tissue making it easier to palpate and access
- The insertion site is sutured usually with dissolvable sutures which do not require removing

Indications for use are

- patients with chronic disorders requiring long term access e.g. cystic fibrosis,
- the infusion of all types of medication and solutions
- the administration of blood /blood products
- for blood sampling
- for IV contrast via pressure injectable port (Power Port®) in CT

Maintaining patency of a Port
The recommended flush regime for ports is the SASH method (INS 2010). The installation of heparinised saline into the port lumen and portal body is recommended whenever the port is not continuously in use. (Flush volumes for infants should be discussed with the paediatric team).

<table>
<thead>
<tr>
<th>Saline pre-flush</th>
<th>10 mL sodium chloride 0.9% pre-filled syringe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Administer</td>
<td>Medication</td>
</tr>
<tr>
<td>Saline post flush</td>
<td>10 mL sodium chloride 0.9% pre-filled syringe using pulsating flush (use 20 mL following blood sampling or transfusion)</td>
</tr>
<tr>
<td>Heparin lock</td>
<td>Appropriate dose using positive displacement device to activate positive pressure in port</td>
</tr>
</tbody>
</table>

**ACTION: Heparin locking of a Port:**
Following intermittent access the port is ‘locked’ with heparin/saline 50 units/5 mL
Ports that are not in use are “locked” once a month with heparin/saline 500 units/5 mL (pharmacy)
**ACTION:** In Child Health the Port is always 'locked' when used intermittently with 2 mL of heparin saline 500 units/5 mL – refer to locking chart in the flushing section.

⚠️ Pre-filled 10 mL syringes containing heparin/saline 500 units/5 mL are used to 'lock' ports on a monthly basis when not in use.
These syringes are standard syringes manufactured by BAXTER Healthcare and have a short expiry date of 2 months.
They are obtained from pharmacy or if required after hours then can be sourced from Ward 25.
For intermittent locking of Ports Heparin/saline 50 units/5 mL **pre-filled syringes are not available** therefore the heparin/saline lock must be drawn up from the plastic polyamp.

Port needles have an extension set with clamp and MaxPlus® positive displacement device which delivers a positive bolus into the port on disconnection of the syringe

**Locating the Port:**
To access the port the septum must be located by palpation. Triangulate the port between the thumb and the first two fingers of the dominant hand. Refer to figure 53.

![Port visible under skin](Source: Respiratory Department CDHB)

![Triangulating Port](Source: Child Health CDHB)
Blood sampling from a Port (also refer to section on Blood Sampling p.36-40)

- Always perform hand hygiene and use an aseptic technique for preparing equipment
- The syringe or vacutainer method is acceptable
- If blood tests for aminoglycocides levels or coagulation profiles are required, flush port first with 20 mL sodium chloride 0.9% prior to blood sampling then aspirate blood discard sample then take required blood tests (Boodhan et al, 2006)
- Where BLOOD CULTURES are required DO NOT FLUSH THE PORT. Use the initial discard blood for the blood culture specimens
- Following blood sampling the port is flushed with 20 mL sodium chloride 0.9%
- “Lock” the port using heparin/saline 500 units/5 mL (monthly) or heparin/saline 50 units/5 mL (intermittent use)

Management of a Port:
Prior to accessing a port a topical anesthetic cream is applied one hour prior to the procedure (adults and children).
Correct needle selection is an important factor in preventing complications.
The size and length of needle used to access a port will depend on the type of infusion and how much tissue lies over the port.

a. If the port is easily palpated and visible under the skin, then a ¾” - 1” needle is appropriate.
b. If the port is well covered by tissue and not visible, then a 1” - 1½” needle is preferred.

⚠️ Selection of the correct needle length will prevent complications of inadvertent displacement and extravasation of infusates into surrounding tissues

Extension Set Change for a Port
- If an additional extension set with clamp is required then this is connected aseptically at the time the needle is inserted and this is considered part of the catheter remaining in situ until the weekly needle change.
- Replacement of the extension set is only required if it becomes compromised i.e. worn from over clamping, leakage, contamination or use of blood products.

Power Injectable Ports
Power injectable Ports are used in Oncology because they allow for diagnostic CT using high pressure injectors. Once the Power Loc® needle has been inserted into the Port the area is covered with a bio occlusive dressing to secure the needle. The label shown below is then attached to the dressing to identify that it is a PowerPort®

⚠️ Standard Ports SHOULD NEVER be used for CT using high pressure injectors
Table 9: ACCESSING THE PORT – INSERTING THE NEEDLE

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Palpate location of port and apply local anaesthetic cream to area leave on for 60 minutes</td>
</tr>
<tr>
<td>2</td>
<td>Prepare equipment</td>
</tr>
<tr>
<td>3</td>
<td>1x 10 mL sterile standard syringe with 5 mL sodium chloride 0.9%</td>
</tr>
<tr>
<td>4</td>
<td>2x 10 mL pre-filled sodium chloride 0.9% syringes</td>
</tr>
<tr>
<td>5</td>
<td>1x 10 mL pre-filled heparin/saline syringe or standard syringe with heparin/saline</td>
</tr>
<tr>
<td>6</td>
<td>Attach a MaxPlus® access device to the extension set and non coring needle and prime with 10 mL sterile sodium chloride 0.9% syringe (leave syringe attached)</td>
</tr>
<tr>
<td>7</td>
<td>Use non-sterile gloves to remove dressing and use gauze to remove local anaesthetic cream</td>
</tr>
<tr>
<td>8</td>
<td>Hand hygiene - and aseptic procedure using sterile gloves</td>
</tr>
<tr>
<td>9</td>
<td>Clean port site with Chlorhexidine 2% &amp; alcohol 70% swab stick using a vigorous circular or grid motion</td>
</tr>
<tr>
<td>10</td>
<td>Allow to dry for 30 seconds</td>
</tr>
<tr>
<td>11</td>
<td>Repeat the above steps using other side of swab stick</td>
</tr>
<tr>
<td>12</td>
<td>Locate port septum by palpation</td>
</tr>
<tr>
<td>13</td>
<td>Triangulate port between thumb and first two fingers of non-dominant hand (refer figure 54)</td>
</tr>
<tr>
<td>14</td>
<td>Insert needle at a 90° angle aiming for the centre of the port septum located between your fingers</td>
</tr>
<tr>
<td>15</td>
<td>Advance needle through skin &amp; port septum until reaching the base of the port reservoir(fig.54)</td>
</tr>
<tr>
<td>16</td>
<td>Using the syringe attached to the extension set withdraw 3-5 mL blood to verify correct port placement and discard this sample</td>
</tr>
<tr>
<td>17</td>
<td>If blood cultures are required use the discard sample for this purpose refer to section on blood sampling</td>
</tr>
<tr>
<td>18</td>
<td>Flush using 2x 10 mL pre-filled sodium chloride 0.9% syringes &amp; check for presence of pain or swelling</td>
</tr>
<tr>
<td>19</td>
<td>Place gauze under wings of needle (if required) and cover the needle with a semi permeable occlusive dressing leaving the extension set with access device exposed</td>
</tr>
<tr>
<td>20</td>
<td>Secure line with steri-strips (if required)</td>
</tr>
<tr>
<td>21</td>
<td>Instill heparin lock unless commencing an infusion, administering drugs or taking blood samples</td>
</tr>
</tbody>
</table>

Source: Respiratory Department CDHB
Table 10: DE-ACCESSING THE PORT - REMOVING THE NEEDLE

1. Ensure patient is positioned comfortably
2. Hand hygiene
3. Prepare equipment
4. 1x10 mL pre-filled sodium chloride 0.9% syringe
5. 1x 10mL pre-filled heparin/ saline 500 unit/5 mL syringe (for child use 2 mL) or draw up heparin/saline 50 unit/5 mL using standard sterile syringe
6. Hand hygiene
7. Apply non-sterile gloves
8. Saline flush using 10 mL pre-filled sodium chloride 0.9% syringe
9. Heparin/saline lock (either pre-filled or standard syringe) & disconnect syringe to initiate positive displacement via the MaxPlus® access device
10. Remove dressing – do not contaminate needle entry site
11. Clean needle site with Chlorhexidine 2% & 70% alcohol stick
12. Allow to dry – 30 seconds
13. Stabilize port with two fingers
14. Remove needle
15. Apply a sterile bio-occlusive dressing over the needle exit site
16. Remove non-sterile gloves
17. Hand hygiene
18. Document procedure & variances in patient’s CVAD Insertion & Maintenance Form

Fig.53: Port placement  Source: Unknown

Fig. 54: Port accessed with needle  
Source: Child Health CDHB
IMPLANTED PORT COMPLICATIONS

Complication may affect the implanted port. Many of these interventions are medical responsibilities and the appropriate medical staff should be notified if any of the following complications are suspected.

Total or partial occlusion of a Port:
- Check needle position
- Portal or catheter movement
- Catheter kinking / clamped catheter
- Fibrin sheath formation

Interventions
- Check needle position is fully advanced through the portal septum making contact with the chamber
- Check patency by flushing
- Change needle if incorrect position is suspected
- Using a sterile 10 mL syringe with sodium chloride 0.9%, gently alternate between aspiration and irrigation to ascertain blood return. Do not use excessive pressure as this can cause catheter rupture or force a clot into the circulation
- Have patient reviewed by doctor and/or nurses specialising in the care of ports
- X-ray-dye studies to confirm location of Port and catheter
- If Port and catheter have become separated, surgical intervention is required. DO NOT USE PORT
- If the catheter tip is against the vein wall, but the port is flushing freely, continue to use
- If occluded follow the ‘alteplase Catheter Restoration’ flow chart in section on occlusion

Pain on flushing of a Port could indicate the following:
- separation of the catheter from the portal body
- needle dislodgement from the portal body

Prevention of incorrect needle access or placement:
- always ensure that the needle is adequately secured after accessing
- do not tilt, rock or pull on needle when port is accessed

Symptoms of incorrect needle placement are:
- chest, shoulder or back pain with infusion of fluids or medications
- signs of extravasation such as swelling, pain and redness around the port

Interventions required if pain is experienced during infusions
- stop the infusion/flushing immediately. Do not remove needle. Notify medical team.
- treat extravasation as per medical team
- re-access the port (if appropriate)
Infection of a Port:
Implanted ports may become infected at the insertion site, port pocket, inside the catheter, or along the catheter tunnel track. Infection can be introduced when accessing the port, withdrawing blood samples or by contaminated infusates.

Symptoms of an infected Port are:
- redness, swelling or tenderness over port site and tunnel track
- fever
- rigors during flushing of port

Prevention of a Port infection requires the following:
- effective hand hygiene
- aseptic technique during all port procedures
- changing extension tubing weekly
- maintaining dressing integrity – keep dry, change if it becomes compromised
- changing the needle and dressing weekly

Interventions for a Port infection include:
- prescribing antibiotic therapy – medical orders
- prescribing an antibiotic/heparin lock which may be required prior to de-accessing the port, if infection is present in the portal body or catheter
- removing the port if indicated

For further reading on refer to the ‘Complications Section’

The IMPLANTED PORT PATIENT INFORMATION BOOKLET

HOW TO USE THE GROSHONG® CATHETER

1. Always use a 10 mL syringe for flushing or aspirating. The catheter is designed to be flushed with sodium chloride 0.9% only.

2. The flush is delivered as a FIRM LAMINAR push which OPENS the catheter valve. *This is the correct flushing technique for Groshong® catheters.*

3. Firmly aspirate using a syringe to open the valve and withdraw blood.

4. On disconnection of syringe or IV administration set the valve will close and remain in neutral position.

**ACTION:** Vigorous laminar flushing is recommended for the Groshong® due to its design. This ensures the valve opens and closes correctly otherwise the valve can become incompetent causing leakage of blood into the lumen.

**DO NOT USE POSITIVE DISPLACEMENT DEVICES** on this catheter. Positive displacement devices keep the valve open causing blood to backflow through the valve which becomes incompetent. Blood can be observed in the catheter tubing when this occurs (Mayo 2000)

*Always use a standard SmartSite® luer cap (INS 2010)*

Troubleshooting a Groshong® catheter

- Always access the catheter as in steps 2 & 3 above. This ensures the valve is left in neutral position after syringe disconnection.
- Be aware that clots can form along the valve and cause leakage of blood back into the catheter. If this occurs it can be seen along the external catheter.
- If occlusion from a thrombus occurs in the valve compromising flow the use of alteplase will be necessary to salvage the catheter.
- The method used for declotting a Groshong® is the same as other CVADs. The ‘overfill technique’ can be used to ensure the alteplase reaches the clot. Clots usually form on the external edge of the valve occluding flow.
HAEMODIALYSIS AND APHERESIS CATHETER

Haemodialysis and apheresis catheters are made of polyurethane and are described as being high flow and large bore with a ‘hard wall’ to prevent catheter collapse during procedures (see Fig 56, 57 & 58). This is an important consideration when procedures can last for many hours.

Configuration of haemodialysis / apheresis catheters

- The catheters are usually 13-16 g. They are shorter in length and less flexible than other catheters and are 20 -30 cm long
- The catheters come in double lumen or triple lumen with colour coded hubs

Flow rates of haemodialysis / apheresis catheters

- These catheters offer very high flow rates necessary to process large volumes of blood during dialysis or apheresis

Dwell time of the dialysis / apheresis catheter

- These catheters are designed for short term use only (2-5 days) and are inserted to provide appropriate treatment options

CATHETERS USED BY AUTHORIZED PERSONNEL ONLY

**ACUTE / PERMANENT TUNNELED DIALYSIS CATHETERS:** These are strictly reserved for dialysis, primarily because of many problems associated with occlusion and the increased risk of catheter related infection. These catheters are inserted mostly into the jugular and occasionally into the subclavian vein (permanent tunnelled). Personnel authorized to access and manage these catheters are DIALYSIS NURSES, TECHNICIANS and trained WARD STAFF.

**ICU DIALYSIS CATHETERS:** are inserted into the femoral vein and used for continuous renal replacement therapy. They are strictly reserved for ICU STAFF who perform this procedure.
**APHERESIS CATHETERS:** These are used strictly for the purpose of therapeutic procedures such as plasma exchange and peripheral blood stem cell harvesting for bone marrow transplant. They are inserted into the jugular, or femoral vein. Personnel authorized to access and manage these catheters are the NZ REGIONAL BLOOD SERVICE REGISTERED NURSES.

**Management of apheresis catheters**

This group of catheters is problematic in that they are difficult to secure and maintain because of their rigidity and area of insertion. Their size makes them more uncomfortable and restricts patient movement. The site can bleed easily making it difficult to keep the dressing clean, dry and intact. A BIOPATCH® is placed around the catheter at the insertion site and a bio-occlusive transparent dressing is applied over the site. Femoral vein placement requires the patient’s activities to be restricted to prevent bleeding at the insertion site and/or perforation of the femoral vein.

⚠️ Unauthorized personnel who access these catheters increase the risk for complications such as occlusion and infection, compromising the catheter dwell and the patient’s treatment. The catheter lumens are labelled with a RED drug label to indicate that the 'locking solution' is instilled into the catheter. The catheter lumens are then wrapped together in gauze.

**CATHETER ‘LOCKING’ SOLUTIONS:**

**ACUTE /PERMANENT TUNNELED DIALYSIS CATHETERS** are ‘locked’ with one of the following to fill the volume of the catheter lumens. The fill volume is written on the catheter lumens.

- Heparin 5000 units
- Citrate (Duraloc™)
- Antibiotics

**ICU DIALYSIS CATHETERS** are ‘locked’ with the following:
Heparin 5000 units and the volume is indicated on the catheter lumens

**APHERESIS CATHETERS** are 'locked' with the following:
Heparin 5000 units 1.3 mL into each lumen

⚠️ Dialysis and Apheresis catheters carry a high risk for infection. Always ensure they are managed appropriately and removed as soon as they are no longer required.
For Further Reading on CVAD

Child Health Volume Q. Child Health Policy & Procedure Manual Central Venous Access Devices Management in Children & Young People


LIST OF REFERENCES

Acute Dialysis Department (2010) Christchurch Hospital. Christchurch Hospital; NZ


http://koawatea.co.nz/campaigns/target-clab-zero/


Infection Prevention and Control Service Christchurch Hospital,(2010) Hand hygiene education

Infusion Nurses Society. (2011).Infusion Nursing Standards of Practice. Infusion Nurse, Volume 34,Number 1S


Medical Illustrations Department (2009) Christchurch Hospital, Christchurch: NZ


Respiratory Department Christchurch Hospital (2010) Christchurch : NZ


3M Medical. (2008). Skin health guide. [www.3m.com/healthcare](http://www.3m.com/healthcare)