CENTRAL VENOUS ACCESS DEVICES

Self Directed Learning & Resource Book

Registered Nurses and Midwives

First Edition, January 2011

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Professional Development Unit
Author: Elizabeth Culverwell  IV Nurse Educator - Central Venous Access Devices
             Professional Development Unit, Christchurch Hospital

Reviewed by:

Dr Heather Byrne  Nurse Manager PDU
Wendy Jar  CNS Bone Marrow Transplant Unit
Sarah Ellery  CNS Oncology
Robyn Beach  CNS Respiratory
Ruth Barratt  CNS Infection Prevention and Control
Philippa Francis  CNM Radiology
Kerry Davis  Nurse Educator
Dr Simon Burrows  Consultant Anaesthetist
Becky Conway  NE Child Health
Germaine Sandford  NE ICU
ICU CLAB team  Intensive Care Unit

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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).

The CDC-Guidelines for the Prevention of Intravascular Catheter–Related Infections Vol:51 No RR-10 2002, (p5) state ‘inexperienced staff increase the risk for catheter colonization where as well organized Quality Assurance and Continuing Education programmes enable health-care institutions to provide, monitor and evaluate care and to become educated for successful outcomes. Specialised teams have shown unequivocal effectiveness in reducing the incidence of CRI and complication’. 
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. A three (3) yearly recertification required. It is a prerequisite to have obtained the initial Intravenous Therapy Certification (Level 1).

Components of CVAD Certification:

1. CVAD Self-directed Learning package
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-a-caths® if require for area of practice

Follow the Instructions for CVAD Certification on MOODLE:

1. Review the Self-Directed Learning package and education resources power point.
2. Complete Multi-choice Theory Test for non implanted or implanted devices as applicable. This is an ‘open book’ test the answers can be found in this Self-Directed Learning package and the education resource power points. 100% pass mark is required.
3. Print off the Certificate of Completion
4. Print off the Practical Skills Assessment Checklist and complete with a NE, CNS, IV Link Staff whose CVAD competency remains current on the training data base.
5. Return the completed form 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: The Port-a-cath® competency is a separate competency Complete the non implanted device competency and the Port-a-cath® competency. Your name will be entered into both Competency Training Databases. Complete this competency if you use Port-a-caths® on a regular basis and are required to access and de-access them.

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

This comprehensive Self-Directed Learning Package and resource book is designed to assist Registered Nurses and Midwives develop critical thinking skills to demonstrate knowledge in assessment, management, maintenance and care of Central Venous Access Devices (CVAD). At the completion of this package 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 Insertion and Management Care Plan’ 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 1/3\textsuperscript{rd} 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
Tip positions of CVAD must be radiologically verified prior to use

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**)
- Hickman® skin tunnelled catheter
- Central Venous Catheter (short term non-tunnelled referred to as **CVC**)
- Port-a-cath® implanted port and Power Port® (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.
**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.
**NOT TO BE ACCESSED BY unauthorized staff.**

**Groshong® Tunneled 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**

*Insertion of all CVADs is carried out under Maximal Sterile Barrier (MSB) conditions*

**PICCs:**
1. Inserted in the Radiology Department by the nurse led 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

**Port-a-caths®**
Inserted in Operating Theatre by a Vascular Surgeon or Paediatric Surgeon

**Non tunnelled 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**

Fig.3: Device Selection Algorithm

Source: Johnson and Johnson Medical

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

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


**Catheter Material is Either Silicone or Polyurethane**

Silicone: Is soft and pliant and is resistant to many chemicals, 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. The tip can migrate or become malpositioned in 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

![Diagram of Major Central Veins](image-url)

**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. The CVAD most affected by mechanical phlebitis is the PICC. Mechanical phlebitis is a result of catheter movement within the peripheral vein and is often referred to as ‘pistoning’ or moving back and forth resulting in irritation to the vein lining.

Another contributing factor is overuse of the arm which causes the muscles to squeeze on the vein where the PICC is indwelling irritating the vein wall initiating mechanical phlebitis.
Physiology of the inflammatory process

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

Fig. 7: Inflammatory Process

Source: Johnson & Johnson Medical
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 20mm in diameter and has a high blood flow of approximately 2000mL/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

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

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.

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)

Warning: 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

### Table 3: CVAD insertion principles

<table>
<thead>
<tr>
<th>Central Line Management</th>
<th>Follow these important principles when inserting any central venous vascular access device:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S</strong></td>
<td>Crupulous HAND HYGIENE Before and after contact with vascular access device and prior to insertion.</td>
</tr>
<tr>
<td><strong>A</strong></td>
<td>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></td>
<td>IGOROUS disinfecting of insertion site with Chlorhexidine 2% with 70% alcohol.</td>
</tr>
<tr>
<td><strong>E</strong></td>
<td>NSURE line is removed when no longer necessary.</td>
</tr>
</tbody>
</table>

*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)

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 the 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!
PRINCIPLES OF MAINTENANCE AND CARE

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 SLP)
- 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 and BLUE side uppermost. *Exception for children and ICU patients – Biopatch® is not routinely used*
- Catheter securement device in place
- MaxPlus® positive displacement devices (PDD) are securely attached to the catheter lumens. Flush all catheter lumens with 0.9% sodium chloride 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 package*
- Document any variances on the ‘CVAD Insertion & 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 MaxPlus® (PDD) 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, hand and axillary area for swelling or phlebitis. Observe the external catheter length daily and document findings in the clinical notes. Measure and document the external catheter length at each weekly dressing change
- Ports: the Portal pocket
- Document any variances in the ‘CVAD Insertion & 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 glad 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 at each routine dressing change every 7 days or whenever the dressing requires replacement. A BIOPATCH® is only used for PICC’s if 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.

SECURMENT (Statlock® or Grip Loc®) is used to:

- Secure the CVAD
- Minimize catheter movement
- Prevent catheter migration
- Prevent tension on the dressing causing the dressing to lift
- Prevent catheter lumens hanging below waist line

NB: do not use tape to secure the catheter

CLEANING THE EXIT SITE, SURROUNDING SKIN and the CATHETER

- Use 2% Chlorhexidine & 70% alcohol swab sticks
- Clean the skin using friction
- 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)
- Either circular or grid method is acceptable (INS.2010). The important point is to use friction. 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 where the dressing will be placed to prevent the dressing lifting. A sterile occlusive transparent Semi-permeable dressing is applied to the insertion site to protect the area and allow for visualization and early detection of complications.

Do not apply CAVILON® to the area directly at 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 occlusive dressing
- If the **foam side is upper most** REMOVE IMMEDIATELY and replace with a new one

*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 Chlorhexadine 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
- Bio-occlusive dressing
- Solu-IV® wipe
- Solu IV® swab sticks
- Grip Loc® PRN
- Cavilon® Skin protectant wand
- Sterile water (to remove any blood)

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

   ![Flowchart](image)

   **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

   ![Flowchart](image)

   **Still Reacting**

3. Discontinue **alcohol** skin antisepsis. Change to povidine-iodine. *Ensure a skin patch test has been done for sensitivity BEFORE using it*

   ![Flowchart](image)

   **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

The CDHB policy requires all CVADs to have positive displacement devices (PDD) attached to the catheter hub (exception Child Health and Dialysis Catheters). Inpatients change 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

Because 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 replacing 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).

CDHB DESIGNATED CHANGE DAYS FOR MaxPlus® PDD ACCESS DEVICES ARE:

- **INPATIENTS**: TUESDAY and FRIDAY
- **OUTPATIENT**: weekly (or 72hrly depending on number of accesses if receiving treatment)

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 10mL 0.9% pre-filled sodium chloride 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 & flush catheter
- Disconnect syringe – count to 5 – now clamp catheter
FLUSHING THE CATHETER

Flush all lumens to:
- maintain catheter patency
- prevent contact between incompatible medications /fluids
- reduce of intra-luminal biofilm

CVADs must never be forcefully flushed as this can lead to catheter damage, mal-positioning and complications. Using 10mL syringes or larger create less positive pressure within the catheter lumen therefore 10mL syringes are used to flush the catheter. Syringes 10mL or larger are used to administer medications through CVADs.

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 central lines 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 (MaxPlus®)
- Using the appropriate flushing technique for that device
- Correct catheter clamping sequence
- Correct use of the syringe – (standard versus pre-filled)
- Cleaning injection surface before connecting

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 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 10mL sodium chloride 0.9% to maintain patency. Adult Outpatients: CVAD must be flushed once weekly if not in use with10mL sodium chloride 0.9% to maintain patency Child Health please refer to the CVAD ‘Locking solution’ chart page 32
USING A POSITIVE DISPLACEMENT DEVICE

A pulsating flush method using 0.9% sodium chloride is required to effectively clear the MaxPlus® 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 – 10mL 0.9% sodium chloride
- Hickman® – 10mL 0.9% sodium chloride
- Groshong® - 10mL 0.9% sodium chloride
- Non tunneled CVC – 10mL 0.9% sodium chloride
- Portacaths- heparin 500iu in 0.9% 5mL sodium chloride (ref Portacath section)
- Dialysis and apheresis catheters (refer 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 10mL 0.9% sodium chloride</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Outpatient flush weekly with 10mL 0.9% sodium chloride</td>
</tr>
<tr>
<td>Non Tunneled CVC</td>
<td>Heparin/saline 50iu in 5mL</td>
<td>&lt;1yr 0.5mL ≥ 1yr 2mL</td>
<td>Weekly heparin lock 50 iu/5mL</td>
</tr>
<tr>
<td>Hickman</td>
<td>Heparin/saline 50 iu/5mL when is regular use</td>
<td>&lt; 1yr 0.5mL ≥ 1yr 2mL</td>
<td>Weekly heparin lock 500 iu/5mL</td>
</tr>
<tr>
<td>Implanted Port</td>
<td>Heparin/saline 500 iu/5mL when in regular use</td>
<td>2mL</td>
<td>Monthly heparin lock 500 iu/5mL</td>
</tr>
</tbody>
</table>
Flushing a catheter requires the following flushing regime. This is referred to as the ‘S.A.S.’ method.

**S.A.S METHOD**

**S.** Saline pre-flush using 10 mL  
**A.** Administer medication / IV fluids  
**S.** Saline post flushes using 10mL pulsatile flush

Remember to always use 2 x 10mL 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 rebounds 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 2-3mLs 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  
Pre-filled syringe = zero reflux

Source: BD Medical Systems
2. Needleless connectors. The MaxPlus® PDD access device is termed 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 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 intrathorasic 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 35mm Hg; at the upper arm it is about 8mm Hg; in the SVC it is 0mm Hg. Infusion pressure must be great enough to overcome venous pressure so that IV fluids can enter the systemic circulation. Fluid infusing by gravity from 120cm above the patient exerts about 100mm Hg of pressure. When the infusion bag empties, the infusion pressure is 0mmHG which allows blood to flow back into the catheter lumen. Most infusion pumps will maintain positive pressure and thus prevent blood reflux occurring.

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

Blood sampling from catheters is common practice. However 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 5-10mLs 0.9% sodium chloride 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 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. gentamycin 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 20mL sodium chloride prior to blood sampling then aspirate blood discard sample before taking required blood tests (Boodhan, 2006).

Hickman® catheters, non tunnelled CVCs and Portacaths have larger lumens therefore both the syringe and vacutainer method is suitable for obtaining samples. PICC are also suitable for both methods and whilst both methods may be used, the vacutainer method may not be as reliable as it creates more negative pressure resulting in difficulty in obtaining blood samples. A more reliable method of obtaining blood samples from PICC’s is by using smaller syringes i.e. 5mL which create less negative pressure enabling blood to be drawn into the syringe.

ACTION
1. If blood does not flow into the blood tube or syringe have the patient cough, hold their breath, change position, or lift their arm
2. Flush with 10mL 0.9% sodium chloride and then attempt to withdraw blood again
3. Replace blood tube with a new tube (the tube may have lost its vacuum)

ORDER OF DRAW
Always ensure blood sample collection tubes are used in the correct order of draw. This avoids cross contamination of anticoagulants 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 then the ‘discard blood’ samples are used. These are placed in blood culture bottles. The remaining blood samples are then taken in correct order of draw.

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 MaxPlus® access device with chlorhexidine 2% & alcohol 70%
4. Allow to dry – 15-30 seconds
5. Unclamp catheter
6. Withdraw 10mL of discard blood – Hickman®, CVC, Port-a-cath
7. Clean access device then attach 10mL syringe and withdraw blood sample/s. The maximum fill is found on the tube. For PICCs, withdraw 3-5mL discard blood before taking samples.
   withdrawal 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
9. Gently mix blood tube/s
10. Vigorously clean the MaxPlus® port access, as above and allow to dry
11. Pulsatile flush catheter with 2x 10mL 0.9% sodium chloride
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

PICCs may require a firm flush of 10mL 0.9% sodium chloride to initiate flow prior to taking a blood sample. Attach a 10mL standard syringe filled with 5-10mL sodium chloride to the access device, administer a firm flush then gently aspirate back to establish flow. If blood return is achieved then discard sample & attach a 5mL syringe/s 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
- 10mL syringes as required
- PICCs 5mL syringes to withdraw blood
- Blood transfer device (pink tip)
- 2x 10mL 0.9% pre-filled sodium chloride syringes for flushes
- Blood tubes
- Blood culture bottles if required

Fig.22: Blood sampling equipment  Source: Original Photo
VACUTAINER METHOD

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 MaxPlus® access device with chlorhexidine 2% & alcohol 70%
4. Allow to dry – 15-30 seconds
5. Unclamp catheter
6. Attach the blue tip vacutainer holder to the MaxPlus® access device and insert a plain 10mL blood tube (RED) to collect discard blood. Remove tube and discard
7. Insert blood tubes in correct order of draw
8. Gently mix blood tubes
9. Remove vacutainer from access device
10. Vigorously clean MaxPlus® PDD and allow to dry
11. Flush with 2x 10mL 0.9% pre-filled sodium chloride syringes
12. Disconnect syringe count to 5 and allow for displacement to occur
13. Clamp catheter

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

- Non sterile gloves
- Chlorhexidine 2% & alcohol 70% wipe
- Sterile gauze
- BLUE tip vacutainer holder
- 2x 10mL 0.9% pre-filled sodium chloride 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 and prior to commencing a new infusion. This gives a more accurate picture of the biochemistry profile. 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 0.9% sodium chloride
✔ Wait 1 minute
✔ Withdraw 10mL discard blood
✔ Take required blood sample/s
✔ Flush catheter lumen with 2x 10mL sodium chloride
✔ Recomence PN

Fig. 24: Obtaining blood samples during PN administration
**OBTAINING BLOOD CULTURES FROM CVADs**

Blood cultures are taken from each catheter lumen/Port-a-cath® and from a peripheral vein on the opposite side to the catheter insertion site. The peripheral sample must be taken at the same time as the catheter sample.

Use an aseptic technique and vigorous clean the skin (for peripheral access), catheter access devices (PDD) and the rubber bungs of the blood culture bottles.

The 'blood discard' sample is used for the culture specimens. If additional blood tests are required these are taken after the blood culture samples. Follow the set up and steps in the section on blood sampling page 38.

**Note:** It is important to withdraw an equal amount of blood from all catheter lumen/s and the peripheral site. A volume of between 8mLs -10mL of blood is required for each bottle. (ref. fig 25). Where indicated 5mL of blood is the minimum volume per bottle that can be used.

**THE SYRINGE METHOD IS USED** to avoid inadvertently inoculating the catheter lumen with culture medium from the bottles.

Aseptically inoculate the PURPLE (anaerobic) bottle first. Do not allow air to enter the purple bottle.

To avoid air entering the PURPLE bottle draw back 10mL of blood and inject 9mL of blood into the bottle leaving 1mL blood in the syringe.

Repeat the above steps inoculating the BLUE (aerobic) bottle with the same volume of blood.

Clearly label each bottle with the catheter lumen and peripheral site the blood was taken from.

Place blood culture bottles in a biohazard bag with a completed blood request form and send to the laboratory.

When taking peripheral blood cultures use the vacutainer method and a butterfly. Aseptically inoculate the aerobic (BLUE) bottle first to eliminate any air in the butterfly tubing, and then inoculate the anaerobic (PURPLE) bottle. Ensure you remove the bottle to avoid any air entering it and before the butterfly is removed from the patient’s vein.

![Blood culture bottles & set up](image)

**Fig. 25: Blood culture bottles & set up**

**ACTION:** ICU please refer to departmental protocol
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 staffs 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 for the respiratory compromised)

Registered Nurses and Midwives with appropriate knowledge and skill 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 tunnelled catheter to prevent air entering along the catheter tract.

- Position patient in supine or semi supine
- 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 70% alcohol wipe (if oozing or discharge present take a swab for culture)

**CVC**: ask patient to perform Valsalva’s manoeuvre and using gentle even pressure, slowly withdraw catheter with dominant hand, while holding sterile gauze over exit site (refer figure 26)

**PICC**: slowly withdraw PICC. 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

- Apply finger pressure to the site using sterile gauze for 30-60 seconds
- Cover site with a sterile occlusive dressing with dressing pad. Remove at 24 hours.
- Patient should remain in supine position for 30 minutes
- Inspect the catheter 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.

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’

To plan an educational intervention that will be effective and family/Whanau patient-centred, the following objectives should be considered:

- Determine a clear understanding of what the patient needs to learn
- Determine barriers to learning
- Determine 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
- ‘PINCH OFF’ SYNDROME
- THROMBOSIS
- CATHETER MIGRATION
- MAL POSITION / VESSEL EROSION
- CARDIAC TAMPONADE
- AIR EMBOLISM

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
- Substandard equipment
- Non adherence to maximal sterile barrier technique
- 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
- 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/no 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**
  Bacteraemia/fungemia/ +ve blood culture
  Fever /chills/ hypotension
  Same organism isolated from catheter segment & blood  
  O’Grady et al 2002

**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.

There is a new understanding regarding biofilm formation. This is a process where microorganisms 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
Detecting 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 a blood cultures are taken from each catheter lumen and a peripheral sample is taken from the arm opposite to the catheter insertion site. 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
- In some instances the catheter will require removal with the tip 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 PN, Ciclosporin(CSA) 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, CSA, Maintenance fluids, Heparin, Insulin
- Maintaining a ‘closed system’ during Parenteral Nutrition (PN) administration and using a dedicated catheter lumen – this is 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 (ETOH)
Ethanol is used on a regular basis to prevent catheter related infections in the immune - compromised patient. Locks made up of ETOH 70% are instilled into each catheter lumen and left in the catheter lumens for 2hrs. The locks are withdrawn or can be flushed through the catheter using 10mLs 0.9% sodium chloride (Chambers, Peddie & Pithie, 2006).
ETOH 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 12hrs (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.

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
- Sluggish infusion
- Complete inability to flush or infuse
- Increasing alarm occlusion with electronic infusion devices

ACTION

When a catheter is partially occluded immediate action is required to restore patency or the line may need to be removed and/or replaced. It is easier to restore patency in a partially occluded line than one that has become totally occluded.

Education and knowledge is a key element to successful management in overcoming such problems 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:

Risk factors include:

- Coagulation abnormalities, blood viscosity, dehydration
- Anatomy and physiology
- The catheter gauge and length
- The characteristics of drugs and blood products
- The type of occlusion
- The way occlusion occurs either sudden or gradual

DON'T IGNORE SYMPTOMS, OCCLUSIONS DO NOT RESOLVE OF THEIR OWN ACCORD
THROMBOTIC OCCLUSION

Four categories of thrombotic occlusions are commonly described and are explained in table 7.

1. intra luminal
2. fibrin tail
3. fibrin sleeve
4. mural thrombus

Table 7: Thrombotic occlusions

<table>
<thead>
<tr>
<th>Intra luminal</th>
<th>Fibrin Tail</th>
<th>Fibrin Sleeve</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Signs:</strong></td>
<td>Fibrin encases the catheter</td>
<td>Fibrin totally encases the entire external length catheter surface</td>
</tr>
<tr>
<td>Sluggish flow or unable to infuse</td>
<td>Gradual onset</td>
<td>Gradual onset</td>
</tr>
<tr>
<td>Sudden / gradual onset</td>
<td></td>
<td></td>
</tr>
<tr>
<td>History of:</td>
<td>Allows for infusion</td>
<td>Persistent withdrawal occlusion (PWO)</td>
</tr>
<tr>
<td>Transfusion</td>
<td>Inability to aspirate blood</td>
<td>Retrograde flow at insertion site – leaking at insertion site</td>
</tr>
<tr>
<td>Blood sampling</td>
<td>Length of catheter dwell time</td>
<td></td>
</tr>
<tr>
<td>Poor flushing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Empty infusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient diagnosis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mural Thrombus

A mural thrombus is caused by irritation of the catheter tip against the intima of the vein, leading to an accumulation of fibrin. This causes the catheter to adhere to the vessel wall and may lead to deep vein thrombosis.

Source: Steiger, 2006.
PREVENTION OF THROMBOTIC OCCLUSION

INTRA LUMINAL
Intra luminal thrombotic occlusion may be prevented and is usually caused by reflux of blood flowing back into the catheter tip.

Prevention Strategies:
- Use correct flushing technique in a pulsating flush
- Use pre-filled normal saline syringes which have zero reflux
- Use a positive displacement device (PDD)
- Use the correct clamping sequence
- Treat partial occlusions as they occur using Actilyse® (t-PA)

FIBRIN TAILS
Fibrin tails usually result in persistent withdrawal occlusion (PWO). Fibrin can be lysed/dissolved by very slowly by instilling t-PA into the catheter lumen/s and leaving for 2 hrs. The ‘over fill technique’ (described on page 54) can also be used and will successfully re-establish catheter patency. If clearance is not achieved then snaring of the fibrin can be carried out 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. Often the ‘over-fill technique’ will be successful in re-establishing catheter patency and flow. Interventional radiology may be used to snare the sleeve however it is dependent on the length of the sleeve. If the sleeve interferes with catheter flow then 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 requiring catheter removal.

⚠️ Mal positioning of a catheter tip may cause occlusion problems preventing blood withdrawal. The catheter tip may be resting against the vein wall blocking blood withdrawal. This is suspected when difficulty in blood aspiration is resolved with a cough, Valsalva’s maneuver, or change of a body position. Persistent inability to obtain blood return may indicate poor catheter tip placement, catheter migration or fibrin tail or sleeve formation.
MANAGEMENT OF OCCLUSIONS

The appropriate method for installation of Actilyse® (t-PA) should be determined by whether the catheter is partially or completely occluded. The standard protocol for instilling t-PA for incomplete occlusion or withdrawal occlusion found on page 53 refers to the ‘restoring catheter patency’ flow chart. This flow chart can also be used for instilling agents for non thrombotic occlusions. In the case of a complete occlusion follow the alternative methods found on pages 55-56. It is a medical responsibility to prescribe the appropriate catheter restoration agent.

In both adults and children the only recommended technique for complete occlusion is the 3 way tap method

⚠️ Clots that persist for more than seven days become resistant to thrombolytic treatment (Steiger, 2006), therefore thrombotic occlusions should be treated as soon as they are identified.

Actilyse® (t-PA) is a recombinant form of the normal blood component tissue-type plasminogen activator (t-PA), which causes thrombolysis. t-PA binds to and activates plasminogen, producing plasmin. Plasmin dissolves fibrin, releasing fibrin degradation products and causing the clot to dissolve as shown in figure 27.
Before administering Actilyse® t-PA check patients platelet count (haematology only)
Have Actilyse® prescribed on medication chart
Reconstitute Actilyse® t-PA 10mgs/10mL with the diluent provided, mix well, place the patients ID label on vial with date and time.
Draw up 2mL into a 10mL syringe. Put remainder of labelled vial in fridge should a second dose be required.

This must be discarded after 8 hours if not used

Instil 2mL Actilyse® t-PA into catheter lumen/s (Label catheter lumen/s with red drug label and include “Declotting agent in place do not use”) Leave t-PA for two (2) hours
Aspirate t-PA from catheter (5-10mL blood). If unable to aspirate, flush through the catheter using 10mls 0.9% normal saline, then aspirate back.

Is patency restored?

YES

NO

Re-instill second dose of t-PA 2mL into lumen for an additional 90mins (or overnight) - then attempt withdrawal.
Attach a RED drug label complete with date & time instilled & ‘Do not use catheter’ to the lumen/s to indicate it contains t-PA.

Is patency restored?

YES

NO

Catheter malfunction remains

Consider dye studies (Radiology) to determine type of occlusion and check catheter position

May require repositioning or removal If fibrin tail – then removal by snaring may be possible

Flush catheter with 2 x 10mL normal saline. Then put new primed access device onto catheter No further action required

If catheter presents with a complete occlusion use the 3-way tap technique to create negative pressure in the catheter lumen. The vacuum draws the t-PA into the catheter lumen (use this flow chart and refer to diagrams on page 56).

Source: The Haematology Red Book Christchurch Hospital
TECHNIQUES TO RESTORE CATHETER PATENCY

The following three methods have been described extensively in literature and provide reduced risk of catheter rupture or complications (Hamilton, 2006; Infusion Nurses Society, 2006, Simcock, 2001). Both the negative pressure (refer figure 28) and three way tap methods refer to figure 29 can be used to instil thrombotic and non thrombotic catheter restoration agents.

8. NEGATIVE PRESSURE SYRINGE TECHNIQUE

1. Attach a 10mL syringe to the access device of the obstructed lumen
2. Draw syringe barrel back to 10mL, clamp catheter to generate a negative pressure in the line.
3. Remove syringe
4. Attach a 5mL syringe containing the appropriate catheter restoration agent
5. Unclamp catheter allowing the solution to be drawn into the catheter lumen
6. Leave for the recommended length of time up to 2 hours
7. Aspirate declotting agent from catheter lumen or flush it through catheter
8. Flush catheter with 2x 10mL 0.9% sodium chloride syringes

Fig.28: Negative pressure syringe technique  
Source: Original Photo

ACTION Following the instillation of catheter restoration agents into catheter lumen/s, always ensure the catheter lumen/s are clearly labeled with “Declotting Agent in place DO NOT USE”

THE ‘OVERFILL TECHNIQUE’ USED FOR PWO (Andris & Kyzywda, 1999)

This is used to restore patency where a fibrin sheath is present. This is demonstrated by a persistent withdrawal occlusion (PWO). Often, this ‘overfill technique’ will be successful in re-establishing catheter patency. It is important to know the volume of the catheter lumen you are to treat using this method.

NB. Most catheter lumens are approximately 1mL – 1.8mL always refer to the catheter specific section in this package

1. Slowly instil a 2mL volume of t-PA to overfill the catheter lumen/s. It is imperative that the thrombolytic agent has contact with the fibrin sleeve or tail
2. The catheter lumen is over filled with t-PA in order to reach the sleeve
3. If the catheter has more than one lumen then, each lumen will need to be treated simultaneously
4. Leave t-PA in catheter for two hours then attempt aspiration. If flow not restored then re-instil t-PA and leave overnight.
5. If catheter flow is restored flush catheter lumen/s with 2x 10mL 0.9% sodium chloride syringes.
STEP 1: CREATING A VACUUM IN THE CATHETER
1. Clamp catheter lumen
2. Remove PDD access device, clean catheter hub using antimicrobial wipe on sterile gauze
3. Attach the luer lock end of a 3 way tap to the catheter hub. Ensure 3-way tap is in the OFF position to patient
4. Attach an empty 10mL luer lock syringe with all air expelled onto the 3-way tap port that lies in line with the catheter.
5. To the other port attach the syringe containing the t-PA
6. Turn 3-way tap OFF to the syringe containing t-PA
7. Withdraw empty syringe (negative aspirate) barrel back to the 10mL mark to create a vacuum. This can be repeated at least three times to ensure the vacuum is established. Remember to expel the air between each aspiration and ensure negative pressure is been maintained.
8. Clamp the catheter while maintaining negative pressure in this syringe
9. Now turn 3-way tap OFF to the negative aspirate syringe

STEP 2: INSTALLATION OF t-PA USING VACUUM IN CATHETER
10. Turn 3-way tap ON to the 5mL syringe containing t-PA and unclamp catheter.
11. Allow the vacuum to draw the t-PA into the catheter lumen. The syringe barrel may need to be gently pushed at this stage to assist the uptake of the t-PA
12. Once the t-PA is drawn into the catheter turn the 3-way tap to close the flow
13. Clamp catheter

STEP 3: REMOVAL OF 3 WAY TAP AND LABEL CATHETER
14. Remove 3-way tap and syringes
15. Attach a new primed PDD to catheter
16. Place RED medication label on catheter stating “Declotting agent in place DO NOT USE”
17. Allow t-PA to dwell in the catheter for 60 -120 minutes before checking CVAD patency
18. The longer the t-PA is left in catheter the more likely it will be successful in restoring flow. NB: t-PA may be left in the catheter overnight if required

STEP 4: EVALUATION CATHETER FLOW
19. Attempt blood aspiration if successful then flush catheter with 2x 10mL 0.9% pre-filled sodium chloride syringes
20. Document procedure and outcome in clinical notes and patients care plan

Repeat installations can be carried out using the 3 way tap procedure. If the CVAD remains partially occluded a repeat dose of t-PA can be instilled using the syringe only technique (Refer to flow chart page 53)
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 patient
- Attach empty 10mL syringe to the port on 3-way tap in line with the catheter
- Attach 5mL syringe containing t-PA to the other port and ensure 3-way tap is now OFF to the syringe containing t-PA

- Unclamp catheter
- Ensure 3-way tap is ON to the patient
- Withdraw the empty 10mL syringe barrel back to the 10mL mark to create vacuum. *This may need to be repeated up to 5 times to ensure the catheter is collapsed.*
- Maintain negative pressure in syringe and clamp catheter simultaneously
- Turn 3-way tap OFF to 10mL negative aspirate syringe

- Turn 3-way tap ON to syringe containing t-PA
- Unclamp catheter
- Vacuum will draw t-PA into catheter
- Once t-PA is in catheter turn 3-way tap to close flow
- Clamp catheter

- Remove 3-way tap and syringes
- Aseptically attach PDD
- Ensure catheter lumen/s have a medication label attached indicating declotting agent in place

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.

The flow chart on page 53 can be used as a guide for restoring catheter patency where lipid or drug precipitates have occurred. For appropriate catheter restoration agents (refer to table 8).

<table>
<thead>
<tr>
<th>Lipids</th>
<th>Drug Precipitates /pH sensitive drugs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradual onset</td>
<td></td>
</tr>
<tr>
<td>- Waxy build up in lumen</td>
<td></td>
</tr>
<tr>
<td>- PN infusion</td>
<td></td>
</tr>
<tr>
<td>- Clear with ETOH 70% (Prepared by pharmacy)</td>
<td></td>
</tr>
<tr>
<td>Sudden Onset</td>
<td></td>
</tr>
<tr>
<td>- Precipitates high pH: calcium, diazepam, phenytoin, calcium-phosphorous incompatibility</td>
<td></td>
</tr>
<tr>
<td>Use: Sodium bicarbonate – neutralize</td>
<td></td>
</tr>
<tr>
<td>- Precipitates low pH Vancomycin</td>
<td></td>
</tr>
<tr>
<td>Use: Hydrochloric acid N.HCL 0.1%</td>
<td></td>
</tr>
<tr>
<td>- Incompatible drugs [aminoglycosides/heparin]</td>
<td></td>
</tr>
</tbody>
</table>

NB. Some drugs are sensitive to pH of solution used for diluent e.g. Vancomycin, and if the pH is raised will precipitate in catheter

Fig. 30: Non Thrombotic Occlusions
Source: Andris & Kyzywda, 1999

Table 8: AGENTS USED FOR CATHETER CLEARANCE

<table>
<thead>
<tr>
<th>Precipitate/Occlusion</th>
<th>Clearing Agent</th>
<th>Dose</th>
<th>Fill Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low pH drugs (pH 1-5)</td>
<td>Hydrochloric acid</td>
<td>0.1% 60 minutes</td>
<td>Capacity of catheter</td>
</tr>
<tr>
<td>High pH drugs (pH 9-12)</td>
<td>Sodium bicarbonate</td>
<td>1 mEq/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>
<tr>
<td>Blood product</td>
<td>t-PA</td>
<td>1-2mg/2ml 2 hours</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 or passes through the subclavian vein and is compressed by the clavicle and first rib. Catheters that pass through this route and can be affected are:

- PICCs
- 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,

![Fig.31: Recommended insertion area](image1)

![Fig.32: Catheter affected by ‘Pinch off’](image2)

Source: unknown
VESSEL 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 thrombus. 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, malignancy and post operative states.

Left sided catheter placement is associated with thrombosis in tunneled catheters (Brown-Smith, Stoner, Barley, 1999). PICCs appear to have a greater risk of thrombosis than catheters placed via the subclavian or jugular route. The catheter tip position is a factor and 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)

Management of thrombosis:
- Dye studies to verify catheter placement
- The catheter does not routinely require removal if it is functioning and necessary.
- Systemic anticoagulants
- Antibiotics
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

⚠️ The catheter can migrate into the following veins: internal jugular, azygos or contra lateral brachiocephalic. The catheter tip may impinge on the vein wall including the SVC 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.

BARIATRIC PATIENTS: Always consider the potential for PICC migration where there are excessive skin folds on the upper arm

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
- Secure external catheter using a securement device (or sutures) and a dressing
- Palpate for correct cuff position with tunnelled catheters
- X-ray to verify tip location and repositioning under fluoroscopy
- 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 beyond 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

CARDIAC TAMponade IS A MEDICAL EMERGENCY
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 a supine position during CVAD removal
- Ask the patient to take a deep breath and hold it during catheter removal
- Slowly remove the catheter and place pressure over the exit site for at least 30-60 seconds
- 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

---

**Fig.33: Intracardiac air lock**

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. In the CVAD group of catheters PICCs are most likely to be effected by mechanical phlebitis because the catheter passes along a peripheral vein in the upper arm. Movement of the upper arm muscles is also a contributing factor.

**Causes of mechanical 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

**Signs and Symptoms of mechanical phlebitis:**
- Redness and pain along the cannulated vein (refer to figure 34)
- 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 mechanical 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 in the CVAD Insertion & Maintenance Form
- Remove the PICC if symptoms do not resolve within 72 hours

**Prevention of mechanical phlebitis involves:**
- Good assessment skills
- 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
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 tunneled)

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 line 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 55cms in length with measure markings at 1cm intervals along the catheter. PICCs inserted into adults in the CDHB are 4fr or 5fr. For children 3fr or 4fr may be used.

**Configuration**

- 5 fr Double lumen PICC – each internal lumen is independent from the other and is 0.3mL
- 4 fr Single lumen PICC - internal lumen 0.3mL

**Flow rates:** Lower 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 beneficial 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
- Observe the external length of the PICC each shift and accurately measure during the weekly dressing change. Document your assessment on the ‘CVAD Insertion and Maintenance Form’.

Assessment of early signs of complications can prevent premature removal of the PICC. Following insertion a BIOPATCH® is placed over the insertion site to absorb any bleeding.

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® 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.

**Please note:**
The Arrow brand of PICC is marked with a purple indelible mark (see fig 37a)
The Cook PICC does not require marking with an indelible mark because it has been trimmed to length and is clearly marked at 1 cm intervals from the 5 cm mark up to the insertion site.
The ARROW PICC:

The purple indelible mark on the PICC indicates 2cms from insertion site

TO the last number or mark on the catheter (last insertable length)

FROM the insertion

Figure: 37a
source: original photo

Do not include the area between the hub or blue bifractation and the ‘last mark’ in your measurement ref. figure 37b

Figure: 37b
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 Insertion & Maintenance Form*

**IMPORTANT ACTION IF MIGRATION HAS OCCURRED**

**Internal Migration:** Where a PICC has migrated IN 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 Insertion & 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 2cms or less OUT from the insertion site this is acceptable and the PICC can continue to be used.

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

**PATIENT INFORMATION BOOKLETS**
PICC patient information booklets are available on the PDU internet site [www.cdhb.health.nz/pdu](http://www.cdhb.health.nz/pdu) In the intravenous section. Ref no: 3273. Print off as required
The Hickman® catheter is described as a tunnelled cuffed catheter (see Fig.38 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).

![Fig. 38: The Hickman tunnelled cuffed catheter](source: Original)

**Material and Specifications of Hickman®**
The Hickman® catheter is made of silicone and is 90cms in length (adult) 65cm (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 42) The CDHB use single and double 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 – 10fr 90cm in length – internal lumen 1.3mL. Reinforced area for clamp
Double Lumen – 10fr 90cms in length – internal lumen 1.3mL. Reinforced area for clamps
Triple Lumen – 10fr 90cms in length – internal lumen 1.3mL. Reinforced area for clamps
Catheter Tip to Cuff measurement = 54.6cms. NB: this catheter is trimmed to length.
Flow Rates
Offers high flow rates

Dwell time
Is up to 2 years or longer

Silicone has poor tolerance to pressure and can tear or rupture if excessive pressure is used. Always use syringes no smaller than 10mL 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 DSA 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 DSA

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 >50x10⁹

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 double 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 p.37-39)
- 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 tunnell 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.

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

PATIENT INFORMATION BOOKLETS AVAILABLE AS FOLLOWS

ALL AREAS EXCEPT CHOC: Hickman catheter ® patient information booklet available on www.cdhb.health.nz/pdu in the intravenous section. 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 Statlock®/GripLoc® helps to 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.40: Dacron cuff in catheter tunnel**
Source: Unknown

**Fig.41: Dacron cuff migration at exit site**
Source: Original Photo

**Fig.42: Single, double & triple lumen Hickman®**
Source: Bard Access Systems Information Booklet
NON-TUNNELED CENTRAL VENOUS CATHETER (CVC)

CVCs are non tunelled 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
- 7fr - 8.5fr (standard adult)
- 4fr – 5fr (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 5 days. Consider PICC insertion after the period.

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 p37-40)
- 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 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.46: GripLoc® securement](Image)

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-a-cath® is a long term CVAD placed under the surface of the skin inside a surgically created pocket (see figures 47, 48 & 49). 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-a-cath® 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 50).

Using a 22-20g non coring needle a port can be accessed approximately 2000 times before leakage starts to occur. 19g non coring needles are also available and may be an advantage when blood administration is required to reducing the risk of occlusion. 19g or 20g non coring needles are also used to administer chemotherapy.
Material and Specifications of a Port-a-cath®

- 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
- 4-12fr 125-225cm
- Volume of reservoir ranges from 0.15 -1.3mL

Configuration of a Port-a-cath®

- 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 -17.8mm
- 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 Port 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](image)

**Fig.51: Profile of an Implanted Port**

Source: Unknown
Flow Rates
Flow rates depend on size of the needle used to access the Port.
19g - 1680mL/hr; 20g - 960mL/hr; 22g - 300mL/hr

Dwell time
Designed for long term dwell the Port-a-cath® can remain in place for 5 -10 years

Insertion of a Port-a-cath®
The choice of Port-a-cath® site is discussed with the patient and includes physical characteristics, body image concerns, cosmetic factors and life style. 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-a-cath®
The recommended flush regime for Ports is the SASH method (INS 2010). The installation of heparinised saline into the Port-a-cath lumen and portal body is recommended whenever the Port-a-cath is not continuously in use. (Flush volumes for infants should be discussed with the paediatric team).

| S | Saline pre-flush | 10mL 0.9% pre-filled sodium chloride syringe |
| Administer | Medication |
| S | Saline post flush | 10mL 0.9% pre-filled sodium chloride syringe using pulsating flush (use 20mL following blood sampling or transfusion) |
| H | Heparin lock | Appropriate dose using positive displacement device to activate positive pressure in Port |

**ACTION: Heparin locking of a Port-a-cath®:**
Following intermittent access the Port is 'locked' with heparin/saline 50iu/5mL
Ports that are not in use are "locked" once a month with heparin /saline500iu/5mL (pharmacy)
**ACTION:** In Child Health the Port-a-Cath® is always 'locked' when used intermittently with 2mL of 500 iu/5mL heparin saline – refer to locking chart in the flushing section.

⚠️ Pre-filled 10mL syringes containing heparin 500 iu/5mL saline 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 50 iu/5mL saline pre-filled syringes are not available therefore the heparin/saline lock must be drawn up from the plastic polyamp.

Port-a-cath® 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-a-cath®:**
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.

![Fig.52: Port-a-cath® visible under skin](image)

*Source: Respiratory Department CDHB*

![Fig.53: Triangulating Port-a-cath®](image)

*Source: Unknown*
Blood sampling from a Port-a-cath® (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 20mL 0.9% sodium chloride prior to blood sampling then aspirate blood discard sample the 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 20mls normal saline “Lock” the Port using Heparin saline 500iu/5mL(monthly) Heparin/saline 50iu/5mL(intermittent use)

Management of a Port-a-cath®

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-a-cath®

- 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 Port-a-cath PowerPorts®

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

1. Palpate location of Port and apply local anaesthetic cream to area leave on for 60 minutes
2. Prepare equipment
3. 1x 10mL sterile standard syringe with 5mL 0.9% sodium chloride
4. 2x 10mL pre-filled 0.9% sodium chloride syringes
5. 1x 10mL pre-filled heparin/saline syringe or standard syringe with heparin/saline
6. Attach a MaxPlus® access device to the extension set and non coring needle and prime with 10mL sterile 0.9% sodium chloride syringe (leave syringe attached)
7. Use non-sterile gloves to remove dressing and use gauze to remove local anaesthetic cream
8. Hand hygiene - and aseptic procedure using sterile gloves
9. Clean Port site with Chlorhexidine 2% & alcohol 70% swab stick using a vigorous circular or grid motion
10. Allow to dry for 30 seconds
11. Repeat the above steps using other side of swab stick
12. Locate Port septum by palpation
13. Triangulate port between thumb and first two fingers of non-dominant hand (refer figure 54)
14. Insert needle at a 90° angle aiming for the centre of the Port septum located between your fingers
15. Advance needle through skin & Port septum until reaching the base of the port reservoir(fig.54)

**Fig.54: Advancing needle through port septum**

Source: Unknown

16. Using the syringe attached to the extension set withdraw 3-5mL blood to verify correct Port placement and discard this sample
17. If blood cultures are required use the discard sample for this purpose refer to section on blood sampling
18. Flush using 2x 10mL pre-filled 0.9% sodium chloride syringes & check for presence of pain or swelling
19. 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
20. Secure line with steri-strips (if required)
21. Instill heparin lock unless commencing an infusion, administering drugs or taking blood samples

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

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ensure patient is positioned comfortably</td>
</tr>
<tr>
<td>2.</td>
<td>Hand hygiene</td>
</tr>
<tr>
<td>3.</td>
<td>Prepare equipment</td>
</tr>
<tr>
<td>4.</td>
<td>1x10mL pre-filled 0.9% sodium chloride syringe</td>
</tr>
<tr>
<td>5.</td>
<td>1x 10mL pre-filled 500iu/5mL heparin/saline syringe (for child use 2mL) or draw up heparin/saline 50iu/5mL using standard sterile syringe</td>
</tr>
<tr>
<td>6.</td>
<td>Hand hygiene</td>
</tr>
<tr>
<td>7.</td>
<td>Apply non-sterile gloves</td>
</tr>
<tr>
<td>8.</td>
<td>Saline flush using 10mL pre-filled 0.9% sodium chloride syringe</td>
</tr>
<tr>
<td>9.</td>
<td>Heparin/saline lock (either pre-filled or standard syringe) &amp; disconnect syringe to initiate positive displacement via the MaxPlus® access device</td>
</tr>
<tr>
<td>10.</td>
<td>Remove dressing – do not contaminate needle entry site</td>
</tr>
<tr>
<td>11.</td>
<td>Clean needle site with Chlorhexidine 2% &amp; 70% alcohol stick</td>
</tr>
<tr>
<td>12.</td>
<td>Allow to dry – 30 seconds</td>
</tr>
<tr>
<td>13.</td>
<td>Stabilize Port with two fingers</td>
</tr>
<tr>
<td>14.</td>
<td>Remove needle</td>
</tr>
<tr>
<td>15.</td>
<td>Apply a sterile bio-occlusive dressing over the needle exit site</td>
</tr>
<tr>
<td>16.</td>
<td>Remove non-sterile gloves</td>
</tr>
<tr>
<td>17.</td>
<td>Hand hygiene</td>
</tr>
<tr>
<td>18.</td>
<td>Document procedure &amp; variances in patient’s CVAD Insertion &amp; Maintenance Form</td>
</tr>
</tbody>
</table>

**Fig. 55:** Port-a-cath® placement  
Source: Unknown

**Fig. 56:** Port-a-cath® accessed with needle  
Source: Respiratory Department CDHB
PORT-A-CATH® 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-a-cath®
- 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 10mL syringe with 0.9% sodium chloride, 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 ‘t-PA Catheter Restoration’ flow chart in section on occlusion

Pain on flushing of a Port-a-cath® 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-a-cath®:
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-a-cath® are:
- redness, swelling or tenderness over Port site and tunnel track
- fever
- rigors during flushing of Port

Prevention of a Port-a-cath® 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-a-cath® 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’

PATIENT INFORMATION BOOKLETS

Port-a-Cath ® patient information booklets available on www.cdhb.health.nz/pdu in the intravenous section. Ref no: 3274. Print off as required
HOW TO USE THE GROSHONG® CATHETER

1. Always use a 10mL syringe for flushing or aspirating. The catheter is designed to be flushed with 0.9% sodium chloride only.
2. A flush delivered as a FIRM LAMINAR push 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 t-PA 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 t-PA 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 58, 59 & 60). This is an important consideration when procedures can last for many hours.

Configuration of haemodialysis /apheresis catheters

- The catheters are usually 13-16g. 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 dialysis/apheresis catheter
This group of catheters is problematic in that they are difficult to secure and maintain because of their rigidity and area of insertion. Their large size makes them more painful 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 5000iu
- Citrate (Duraloc™)
- Antibiotics

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

APHERESIS CATHETERS are 'locked' with the following:
Heparin 5000iu 1.3mL 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

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3M Medical. (2008). Skin health guide. www.3m.com/healthcare