ICU Medical Officers Handbook on Central Venous Catheterisation

Developed by;
Tim Spencer
Clinical Nurse Consultant
Central Venous Access & Parenteral Nutrition
Dept. of Intensive Care
Liverpool Hospital

- Revised: 25/02/13

Aims

1. To assist medical officers to possess competencies in the insertion, care and management of patients with central venous catheters (CVC).
2. To enhance the medical officers knowledge and skills in the management of patients with a CVC.
3. To develop the medical officers skills in choosing the appropriate type of central venous catheter for the types of therapies required.
4. To perform central venous catheterisation utilising imaging technology to provide safe and efficient clinical practice with improved patient outcomes.

Objectives

At the end of the programme, it is anticipated that the medical officers should be better able to:

1. Differentiate between the types of catheters in terms of their characteristics and use.
2. Identify situations where the need for a CVC is indicated.
3. Compare and contrast the different sites of insertion of a CVC and its associated complications.
4. Identify the usage of the different lumens of a CVC.
5. Compare appropriate measurements to prevent complications associated with CVC's.
6. Identify possible complications of a CVC in the hospitalised patient.
7. Utilise appropriate principles and guidelines in the care and maintenance of the CVC including the following;
    - ***** Dressing techniques
    - ***** Skin preparation/antiseptic solutions/maximal barrier precautions
    - ***** Troubleshooting of problems during insertion
    - ***** Infection control guidelines
    - ***** Catheter removal
    - ***** Documentation

Types of Catheters

Single Lumen Catheters (SLC) - can be capped and used for intermittent or continuous infusions of medication or fluids. CVC placement with a single lumen catheter is indicated when there is no peripheral venous access, when a viscous or hyperosmolar infusion is prescribed. This type of line may be used within the general or critical care setting or for long term access to a central vein for antibiotics or chemotherapy, where only one lumen is required – this helps reduces risk of infection by placing a device with less numbers of lumens.

Triple/Multi Lumen Catheters (TLC/MLC) - a MLC multiplies the advantages of a SLC. The number of lumens within a MLC may vary from 2 to 4 and allows for many treatments to be performed through one venous access site. Therapy may be intermittent or continuous. The multiple ports allow for the administration of medications, blood products, fluid replacement and venous sampling. Some catheters allow for monitoring and visualisation of cardiovascular anatomy. Also, the risk of infection increases with the more lumens available.

Peripherally Inserted Central Catheters (PICC) - are inserted in the arm using Ultrasound (US) via the basilic or cephalic vein and are advanced until the tip of the catheter is located in the Superior Vena Cava (SVC) or cavo-atrial junction. The catheter may contain 1 or 2 lumens and can be used to deliver continuous or intermittent therapy. PICC's may be used in the general or critical care setting, but have been most popular as a long-term venous access for nutritional support, chemotherapy and antibiotic therapies. Like any central line, PICC placement is checked by an erect CXR.

Implantable Catheters - when there is a need for a prolonged therapy, the central venous catheter of choice are those that are implantable under the skin. The tunnelled lines have 1 or 2 lumens and are sutured into a subcutaneous pocket on the chest or arm and constitute a completely closed system. Both catheter types may be used for the long-term infusions of antibiotics, TPN, chemotherapy, or other fluids and medications.

Indications for Central Venous Access

- Patients lacking useable peripheral venous access
- Patients requiring parenteral nutrition
- Patients receiving incompatible medications
- Patients requiring multiple infusions of fluids, medications, or chemotherapy
- Patients requiring a temporary access site for haemodialysis
- Patients receiving infusions that are hypertonic, hyperosmolar or infusions that have divergent pH values
- Patients who require critical care measures - inotropes, multiple therapies, etc.

Sites of Insertion

The insertion sites most frequently used are those listed in the tables below;

Site	***Advantages***	***Disadvantages***
Internal Jugular	Large vessel Easy to locate Easy access Short, straight path to the SVC (Right side) Low rate of complications	Uncomfortable for patient Hard to maintain dressing Close proximity to carotid artery Highest infection rate of insertion sites Problematic in patients with tracheostomies
Subclavian	Large vessel with high flow rate Lower infection rate Easy to dress and maintain Supra- or infraclavicular approaches Less restricting for the patient	Lies close to the lung apex (pneumothorax risk) Close proximity to subclavian artery Difficult to control bleeding (noncompressable vessel)
Femoral	Easy access Large vessel Advantageous during resuscitation	Decreased patient mobility Increased rate of thrombosis, phlebitis and infection Risk of femoral artery puncture Dressing may be problematic
Basilic	Low incidence of thoracic complications Direct route to the central venous system with arm at 90^{o} angle	Increased incidence of phlebitis Catheter tip movement related to patient arm movements
Cephalic	Easy access Low incidence of thoracic complications	More tortuous than basilic vein Increased incidence of phlebitis May be compressed with the clavicle by anatomical positioning Catheter tip movement related to patient arm movements

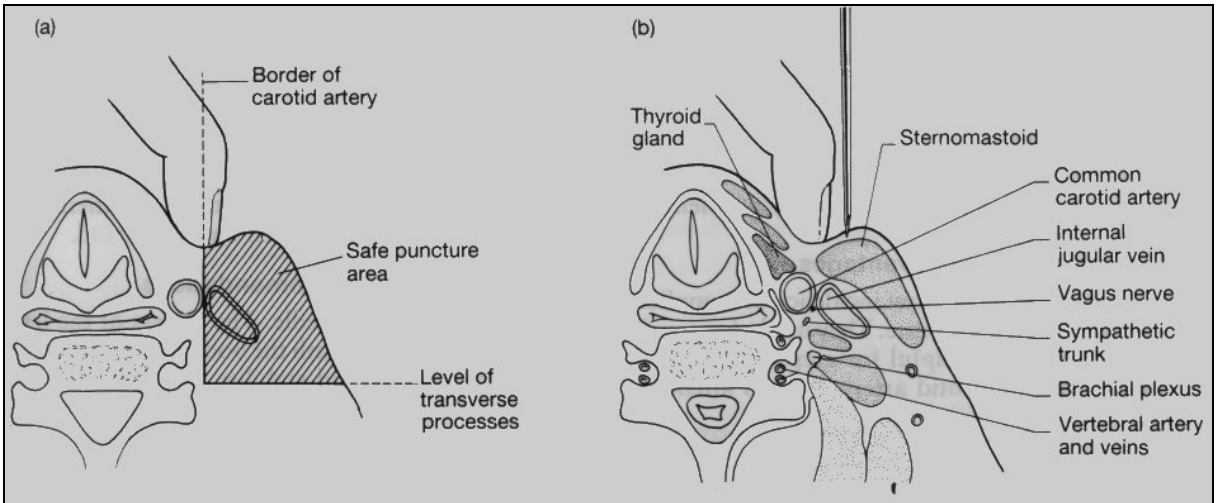


Figure 6.7. Cross-section of the neck. The direction of the fingers during palpation is perpendicular to the coronal plane. The direction fo the catheter is parallel with the patient's sagittal plane. The catheter should not be directed medially and should not be advanced deeper than transverse process of the cervical vertebra. The safe puncture area is also indicated schematically by hatching. From Oda *et al.* (1981)[6].

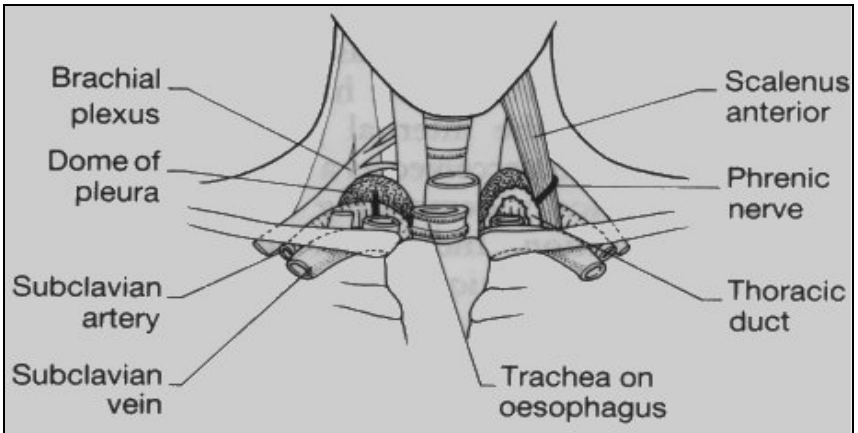


Figure 5.1. Anatomy of the subclavian vein.

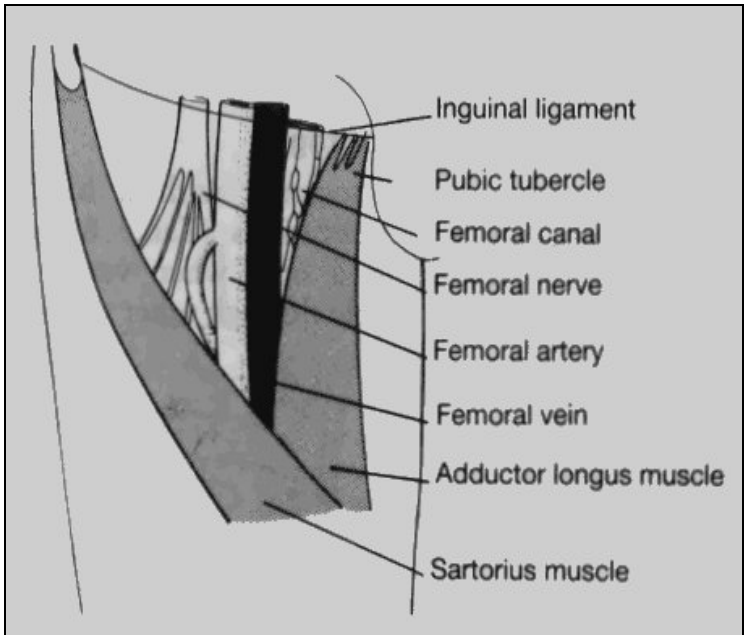
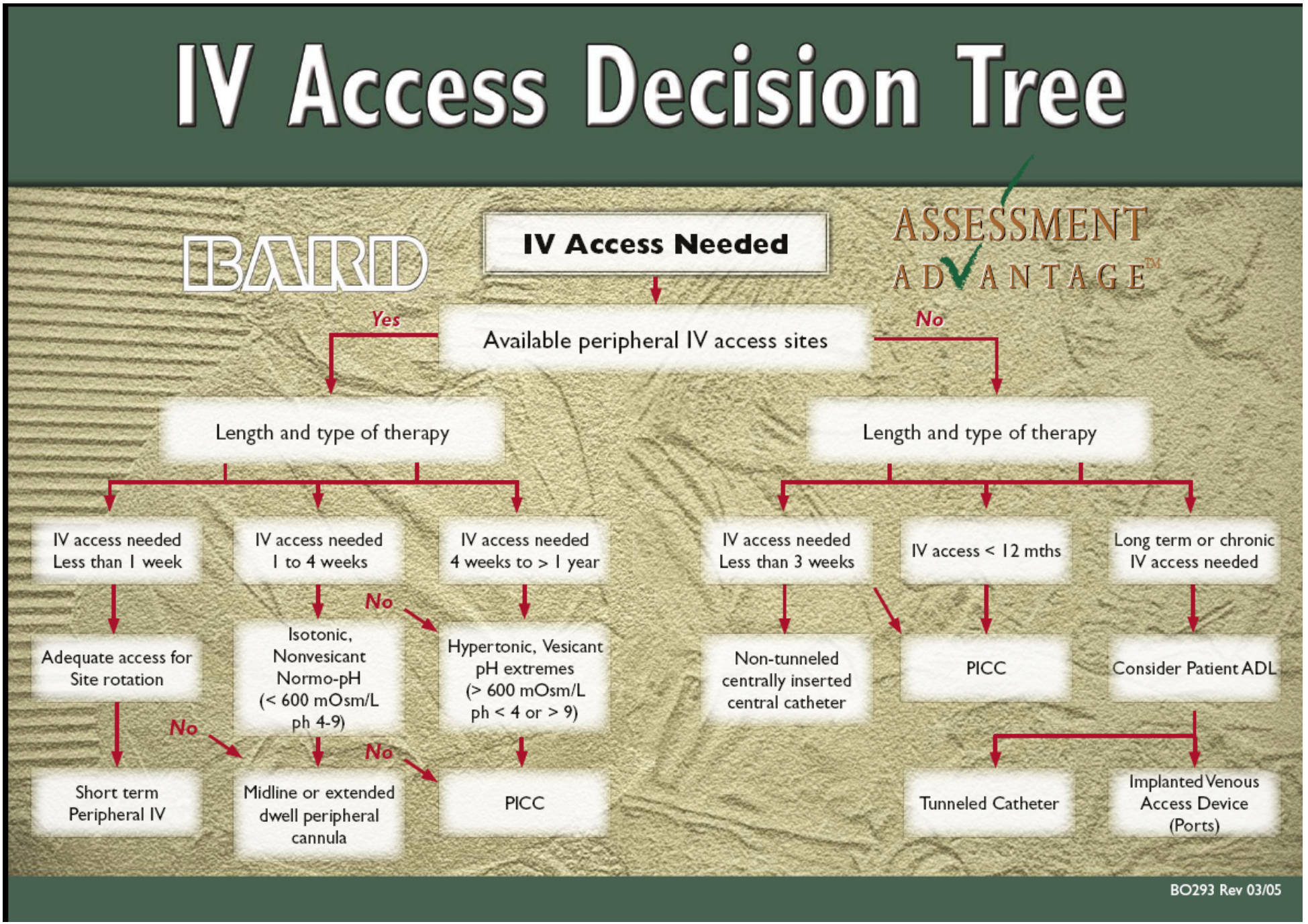


Figure 8.1. Anatomy of the femoral vein.

IV Access Decision Tree



NSW GOVERNMENT Health
South Western Sydney Local Health Network

Complications

It is estimated that approximately 10% of patients who have a central line placed will experience complications secondary to catheter insertion or use. Whether or not complications occur depends upon a number of factors including the experience of the inserting personnel, anatomical distortion at the potential insertion site, and the patients' condition. Each site used, e.g subclavian v's internal jugular v's femoral, has certain risks involved due to the normal anatomy of that particular area.
Other individual patient factors are also important, such as underlying disease, tolerance of Trendelenburg position, laboratory levels associated with bleeding, and the patients mental or emotional status.

The complications are generally divided into two groups, **immediate** or **delayed**, dependant upon the time they appear in relation to the catheter insertion.

Immediate complications are usually associated with catheter placement; however, some may develop later under certain circumstances. **Delayed** complications are usually manifested after the catheter has been indwelling for a period of time.
Only the most frequently encountered complications will be included.

Immediate	**Delayed**
Venous embolism	Catheter-related infections
Cardiac tamponade	Catheter-related thrombosis
Catheter embolus/rupture	Vessel erosion
Arterial puncture	Pneumothorax, haemothorax, hydrothorax
Cardiac arrhythmias	Catheter malposition
Nerve injury	
Catheter malposition	
Pneumothorax, haemothorax	

All ICU doctors inserting CVCs must transduce the cannulating needle/cannula with a pressure transducer and confirm that there is NO arterial waveform prior to guidewire and dilator introduction into the vessel if ultrasound (US) is NOT used.

If unsure, call a Senior ICU Registrar or CNC/CNS for Central Venous Access.

Skin Preparation

Central venous catheters are invasive devices that predispose the patient to complications that are costly in financial terms as well as in patient morbidity and mortality. Methods used in the care and maintenance of the catheter during insertion and while indwelling can have a significant effect upon the incidence of catheter-related complications. It is vital that health care personnel be knowledgable and experienced in the care of central venous catheters, and that policies, procedures and protocols be based upon available scientific studies that support the methods chosen for that care.

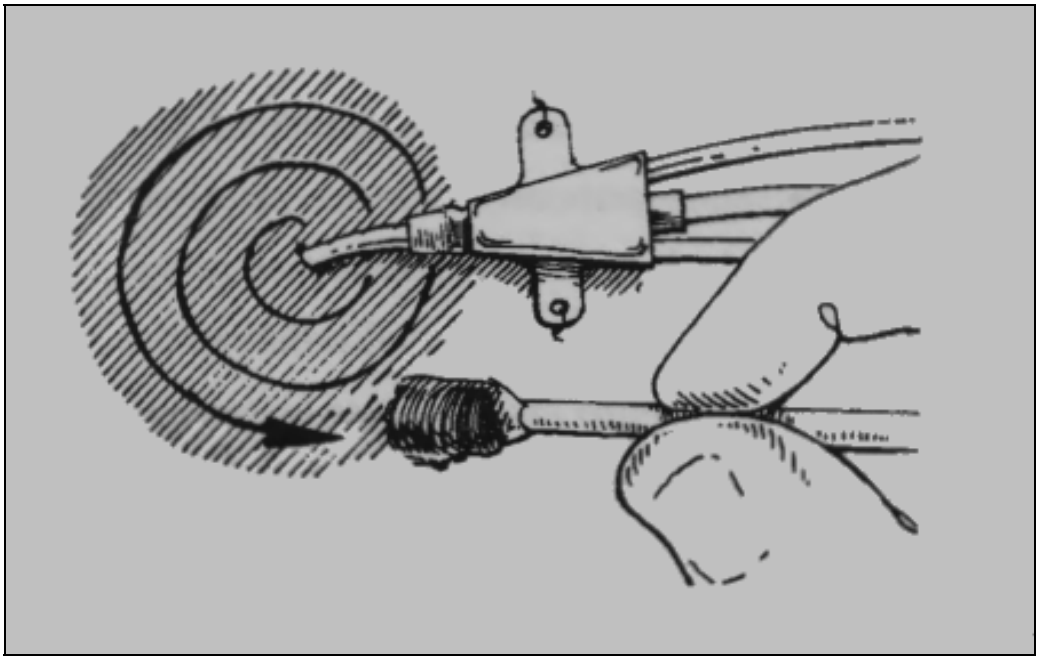
Each time an insertion site is chosen for catheterisation, the surrounding area where the catheter entrance point and anchoring points should be treated with antiseptic solution (tinted Chlorhexidine 2% in 70% isopropyl alcohol). The purpose of using an antiseptic solution is to reduce the number of skin organisms at the insertion site. Chlorhexidine has more recently been shown to also be a more effective agent than Providone Iodine and, unlike others, promotes a longer residual antimicrobial effect after drying.

Defatting the skin- *(non-standard practice)*

The practice is under scrutiny due to patient discomfort and the loss of the proposed anti-microbial effects of the **free fatty acids** on the skin.
NB: Acetone, alcohol and ether have been shown to weaken polyurethane and silicone materials. Defatting the skin is **not** recommended.
If skin is dirty, clean the skin with soap and water prior to inserting the CVC/PICC.

Skin Preparation Guidelines

- cleanse the area around the catheter including the hub(s)
- cleansing should be performed using a circular motion moving in concentric circles from the site outwards (see diagram) - gentle pressure on the skin should be used.



- Prepare an area the size greater than that of the final dressing (approx 12cm x 12cm).
- Use the antiseptic of choice **properly** to achieve the **maximum** benefits.
- An alcoholic chlorhexidine solution will dry slightly quicker, depending how much solution is used, but wait until solution is almost dry before starting procedure.

Dressings

The placement of a dressing over the catheter insertion site serves a number of purposes.

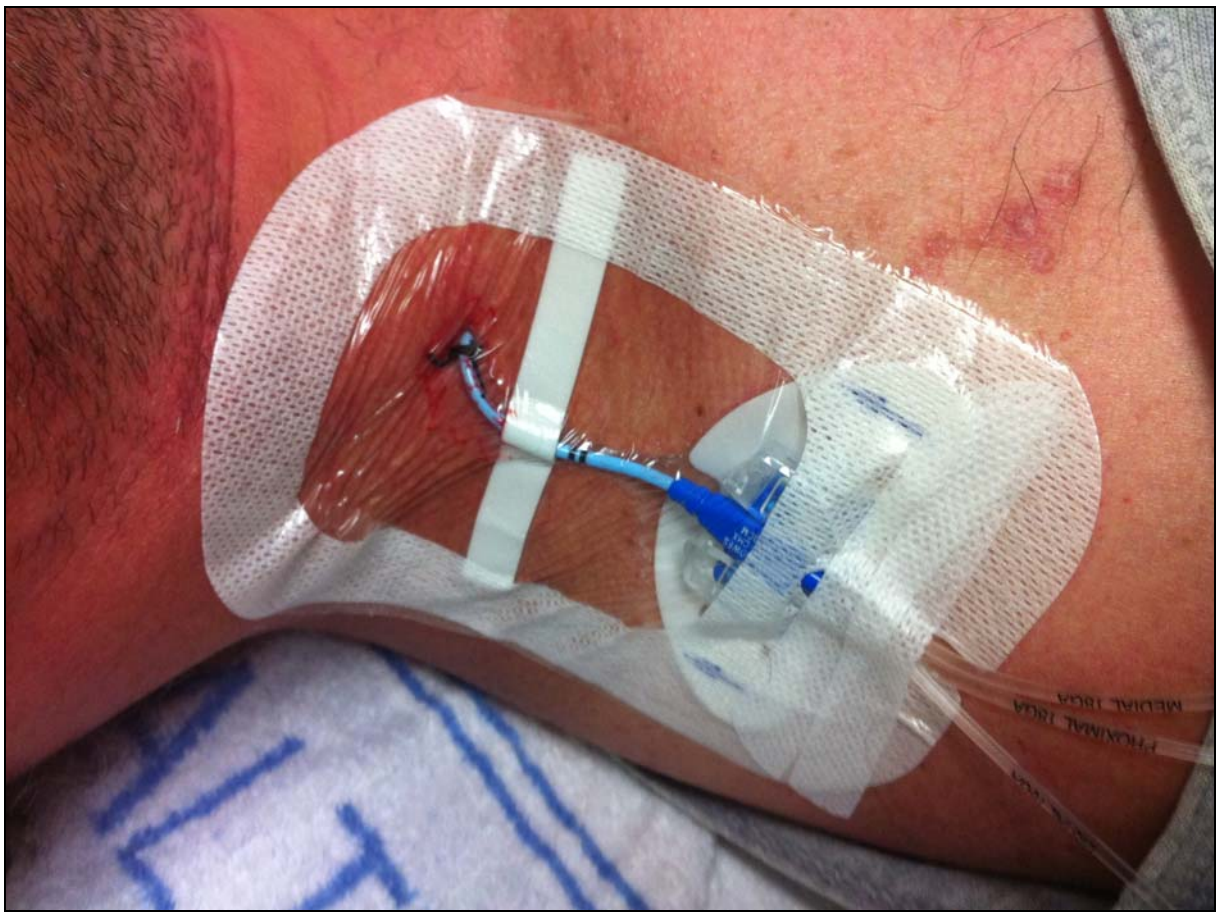
- It must be occlusive and water-repellent to protect the area from extrinsic contamination and to keep the site clean of any secretions or drainage from surrounding of anatomical sites.

- The dressing also helps to stabilise the catheter and aids in the protection of the catheter body close to the insertion site. Sterile supplies must be used to prevent the introduction of pathogenic microorganisms at the time the dressing is applied.

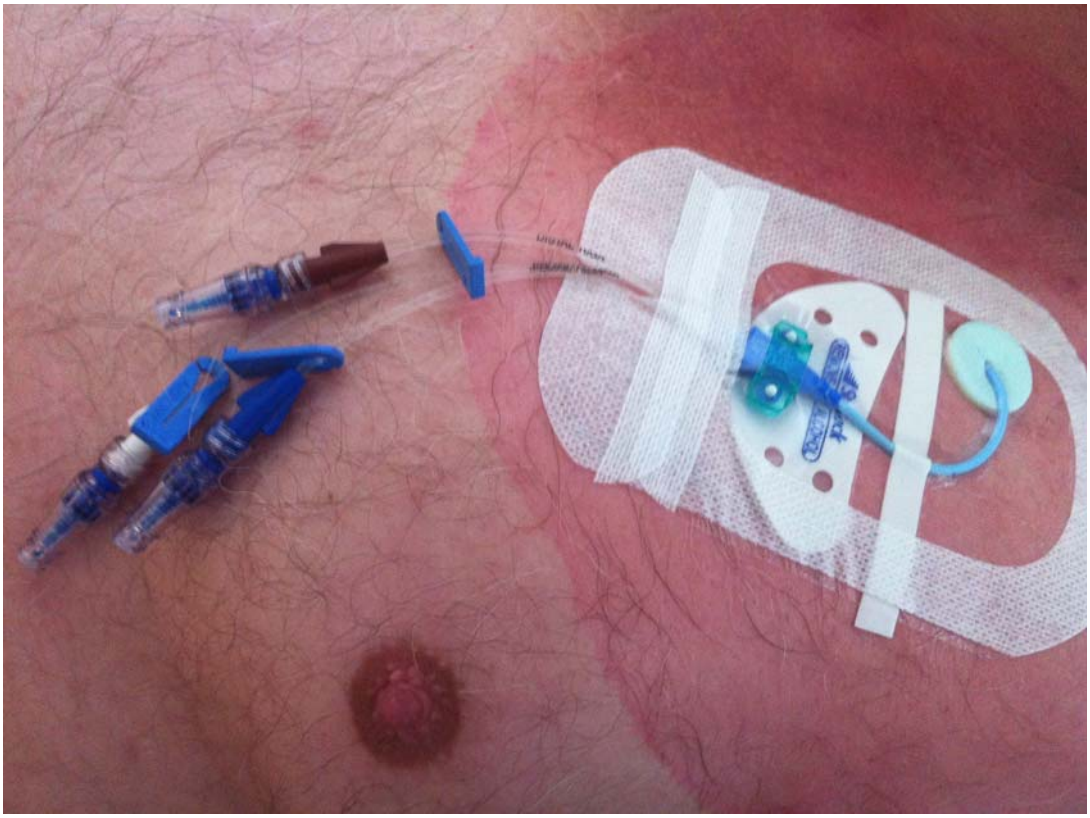
Catheter Securement

CVCs can be secured with a small stitch close to the insertion site to prevent pistoning at the site (movement of catheter body back and forth through the insertion site). This can often lead to site-related inflammation/infection. Se picture below.

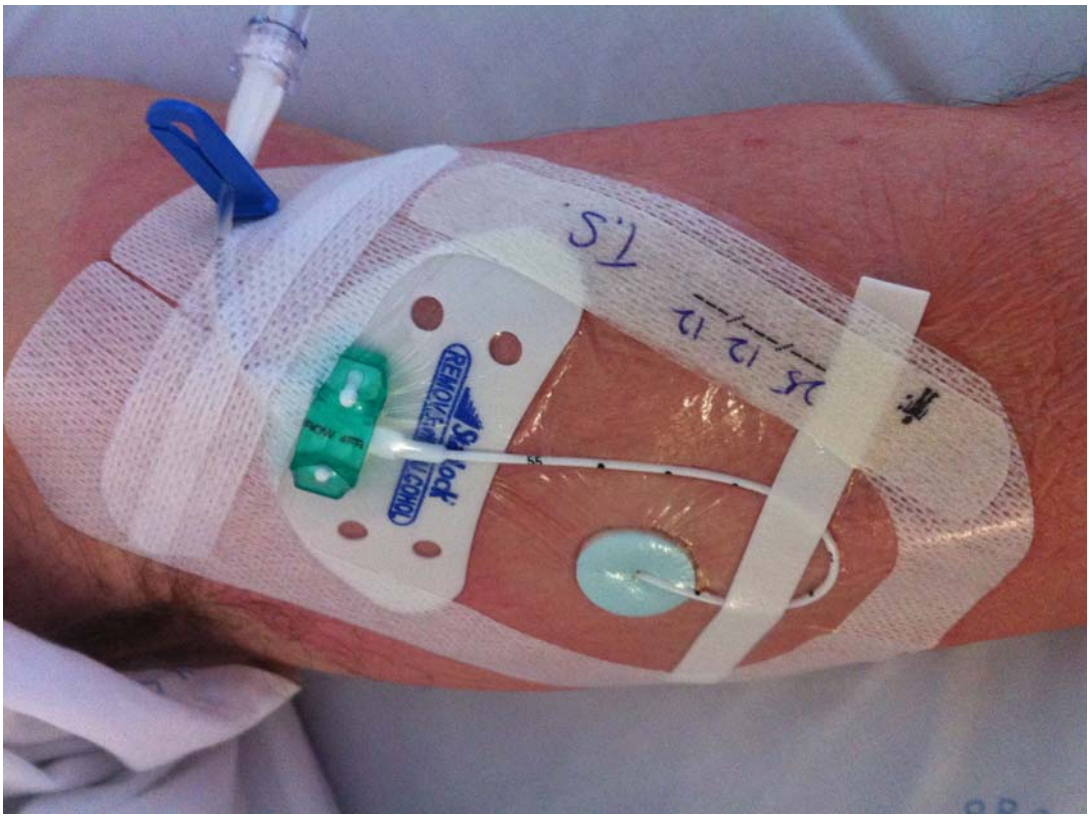
A Statlok is also placed on the suture/securement wing of the catheter. As shown below, it is placed away from the insertion site but still covered by the dressing (which helps stabilise the catheter also). Place a slight curve in the catheter body to reduce any tension that may cause movement at insertion site. The Steristrip must also be used to help secure the catheter (see images below)



R) IJV with low approach



L) Axillary CVC with large Biopatch



L) Basilic PICC with Biopatch

Maintaining Patency

When a catheter lumen is no longer used for continuous infusion, it can be capped and “locked” in preparation for intermittent or future use. To “lock” a catheter lumen a solution must be instilled to fill the entire space of the lumen and the injection cap. Theoretically, this prevents a backflow of blood that would cause clotting within the catheter.
A controversy still exists concerning which solution is appropriate; heparinised-saline or saline alone.
Heparinised saline has been primarily used due to the anti-thrombolytic properties of heparin. Heparin inhibits clot formation by inactivating thrombin and other coagulation factors. HITTS is mostly associated with continuous IV heparin infusion, but has also occurred with intermittent subcutaneous and lushing/locking administration. HITTS occurs in approximately 5-30% of persons receiving heparin.

Two clinical types of HITTS have been identified. One is a mild form characterised by a transient decrease in platelets that usually occurs around the second or third day of therapy. This is the most frequent presentation. The other type is believed to be an immune response to heparin and occurs 6 to 12 days after therapy is started. It is characterised by a severe decrease in platelets that may be accompanied by thrombosis, the result of platelet aggregation. The clots may form in arteries or veins and affect any portion of the body including organs. The clotting phase of the disease has also been called “white clot syndrome” due to the colour of the clots, which consist of platelets and fibrin.

Another aspect of the procedure that is not standardised is the frequency with which the IV device is flushed. A regime used frequently is to flush at the time of medication administration using the SASH method and at least every 8 hours or once per shift. The SASH method consists of a flush of saline, followed by the medication, another saline flush and finally, heparin to lock the device.
This prevents the interaction of heparin with other medications. Without heparin an SAS regime is used.

SASH Method

Saline
Administer medication
Saline
Heparin lock

SAS Method

Saline
Administer medication
Saline

Infection Control

Due to the threat of exposure to blood to health care workers during central venous catheterisation and certain aspects of catheter care, all involved personnel must comply with the safety measures provided by using Standard Precautions. Protective garb and needlestick prevention measures should be utilised based on the task and amount of blood exposure that is anticipated. Needle free systems and needle containment devices have been developed the further reduce personnel exposure to needles during the admixture and administration of injectable medications.
Routine measures can be taken to reduce the risk of local and systemic catheter-related infections. They include;

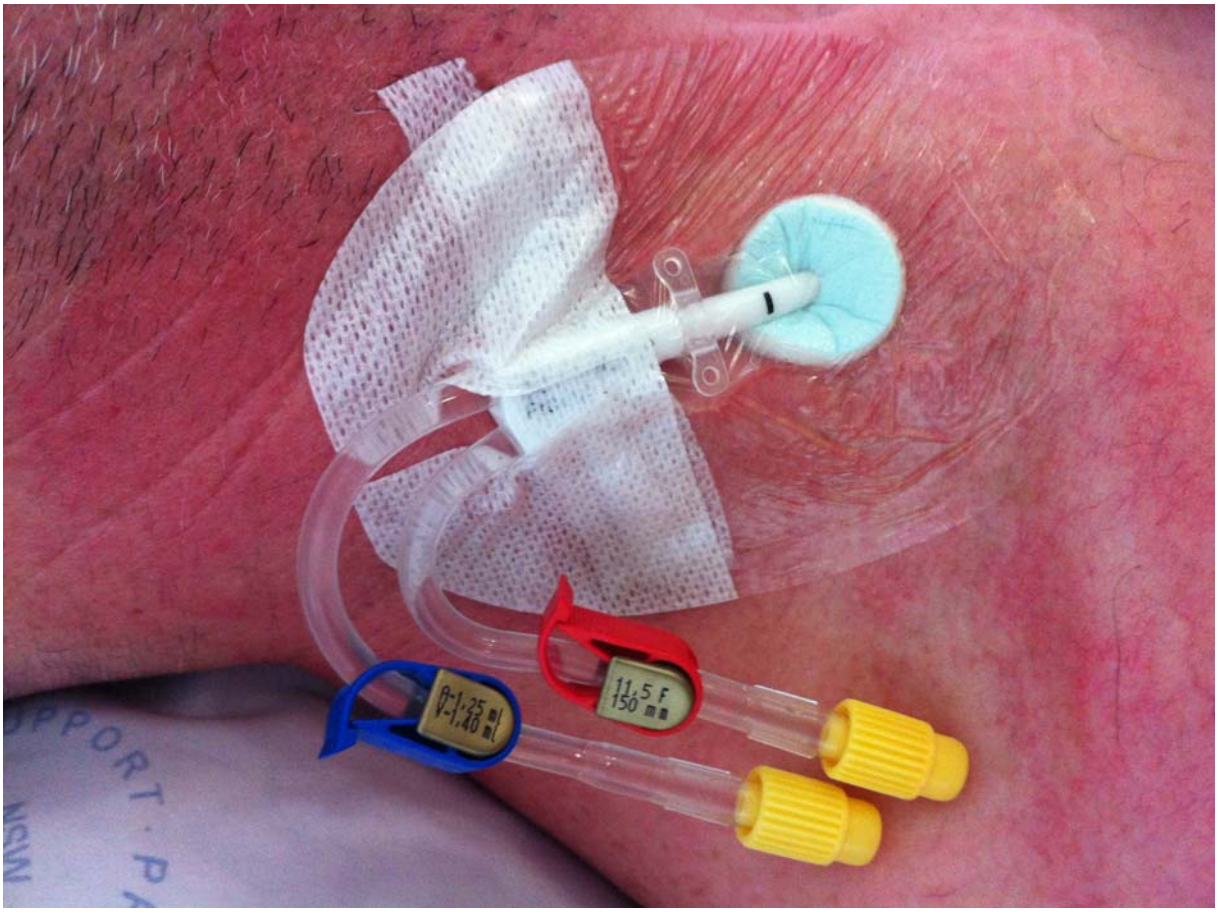
- **Hand washing**
- **Site preparation**
- **Catheter stabilisation**
- **Inserter expertise**
- **Site evaluation**
- **Minimal handling**
- **Occlusive dressings**

In addition, advances designed to provide additional protection against catheter-related infections have been made in IV technology e.g antiseptic-impregnated catheter materials, silver-impregnated collagen cuffs and antibiotic-coated catheters. The action of these products is directed toward preventing the migration of skin microorganisms down the catheter track.

The antiseptic surface consists of a combination of silver sulfadiazine and chlorhexidine that is impregnated into the polyurethane surface of the catheter. The agents act synergistically to prevent replication of microorganisms. The process

involves alteration of the cell wall of the organism by chlorhexidine, which then allows entry of the silver ions into the cell. The silver ions bind to the DNA helix and prevent the cell from replicating. Both agents are active against gram-positive and gram-negative bacteria as well as yeast. The agents are released slowly over a period of time, up to 15 days, after which the release is reduced significantly. By using a multiple lumen catheter made with an antiseptic surface, the benfits will include a longer catheter dwell time, decreased patient morbidity and mortality and cost effectiveness.

BIOPATCH – is a chlorhexidine-impregnated foam disc that is placed over the insertion site at catheter insertion, providing sustained CHG release for 7 days. The disk can hold up to 4 times its weight in fluid/blood and will continue to provide effective antiseptic action at the insertion site while insitu. There are 2 sizes.
Below shows an image of a R) IJ Vascath secured with a large Biopatch insitu.



Catheter Removal

When a catheter is removed, precautions must be taken to prevent associated complications. During removal Universal Precautions must be employed to protect the healthcare worker from potential exposure to bloodborne pathogens. Aseptic technique must be used at the insertion site. To increase intra-thoracic pressure, the patient should be placed in the Trendelenburg position, if tolerated, or flat in bed and should be instructed to hold their breath or perform the Valsava manoeuvre. If the patient cannot cooperate with these instructions, the catheter should be removed during expiration.

After the catheter is removed pressure must be maintained with sterile gauze at the site until haemostasis is achieved. A totally air occlusive dressing must be applied over the insertion site to prevent an air embolism caused by air entering the body through the residual subcutaneous catheter track. The dressing must remain in place for approximately 24-72 hours depending on the length of time the catheter was indwelling.

During the time following the catheter removal the patient should be observed closely for signs and symptoms of complications, especially bleeding, air embolism or infection at the insertion site.

Documentation

The following information should be included in the patients clinical progress notes;

- Date of insertion,
- Inserter - Name, designation
- Anatomical location of catheter
- Documentation of non-arterial waveform/ABG analysis
- Inserted catheter depth according to catheter reference markings
- X-Ray confirmation of catheter tip location
- Site assessment, patient condition
- Complications during insertion
- Ongoing assessment documentation whilst catheter insitu

CVC/PICC insertion competency assessment

To be completed by **all** Registrars during ICU training.

Retain one copy and give a copy to Dr Parr.

Name:

	Satisfactory assessment by:	Date:
Internal Jugular		
Subclavian		
Femoral		
PICC		
Other:		

References

Arrow Multi-Lumen Central Venous Catheter Nursing Care Guidelines, Arrow International, 1994.

Guidelines for Prevention of Intravascular Device-Related Infections, Pearson, M.L, 1996, Infection Control and Epidemiology, Vol. 17, No. 7, pp. 438-473.

Liverpool Health Service General Nursing Policy and Procedure Manual, 1996, Liverpool Health Service

Rosen, M Latto, P NG, S (1992) Handbook of Percutaneous Central Venous Catheterisation, 2nd Edition, WB Saunders, London

BIOPATCH – Johnson & Johnson Best Practice Publication

COMPETENCY ASSESSMENT CHECKLIST – Central Venous Cannulation

The following criteria must be successfully achieved during assessment on **5 separate occasions** (exception: staff granted RPL are to complete only **2** assessments).

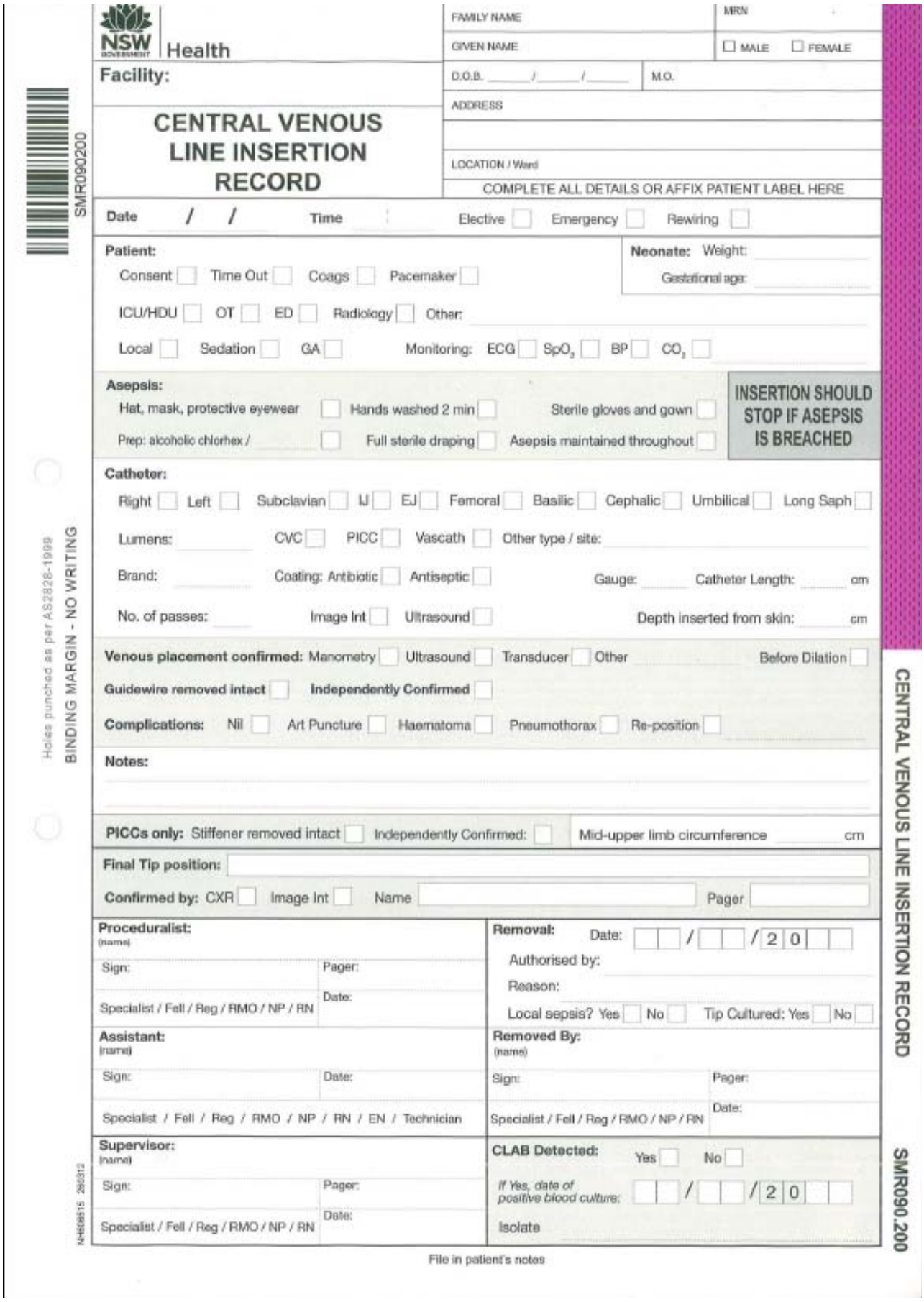
Unsuccessful attempts must also be recorded and assessed.

Criteria **Assessor's Name:** _____	**Achieved** ✔ or ✕ (or n/a)	***Re-assessment (if required) &/or Comments***
Procedure		
Explains procedure to patient and obtains consent – if applicable		
Organises equipment (ensure sharps container available)		
Identifies patient and performs timeout and safety checklist		
Checks for patient allergies – drugs, dressings, antiseptics		
Assesses and selects suitable vessel for cannulation with ultrasound		
Prepares equipment and accessories for catheter insertion		
Position's patient to maximise access to desired area of insertion i.e. Trendelenberg position if required		
Attaches monitoring (ECG or SpO^2) if available		
Applies personal protective equipment (PPE) (gloves, mask & eyewear or face shield) as per standard precautions policy		
Washes hands using sterile hand-wash technique (2 mins)		
Prepares skin area appropriately (with antiseptic solution)		
Drapes patient with full body sterile drapes to maximise sterile barrier		
Inspects catheter and equipment to ensure it is not damaged/remains intact & checks that the guidewire mechanism is working		
Flush/prime each lumen with 0.9% normal saline		
Palpates anatomical landmarks correctly/ positions ultrasound probe and visualises the correct vessel to be cannulated		
Correctly anaesthetises skin and deeper tissue with local anaesthetic under ultrasound guidance		
Inserts cannula/needle with bevel facing upwards, advancing slowly while maintaining slight negative pressure with syringe, ensuring visualisation of needle tip under ultrasound guidance at all times		
Once accessed the vessel, stabilise needle and check for aspirate and then advance guidewire through needle to desired length – do not pull wire back through needle while insitu in patient. Remove needle once guidewire in place		
Dilates skin and vessel with vessel dilator – do not cut the skin with scalpel		
Inserts catheter over guidewire to desired or measured length whilst maintaining grip on guidewire at all times		
Removes guidewire & connects transducer line. Checks & acknowledges for NON-ARTERIAL waveform on monitor.		
Secures catheter at insertion site appropriately and applies sterile transparent occlusive dressing to insertion site e.g. IV3000™ or Tegaderm. Date & time must be recorded on dressing at insertion		
Dispose of all sharps material in sharps container		
Removes drapes and accessories from patient/workspace		
Correctly dispose of general/contaminated waste materials		
Remove protective equipment and perform hand hygiene		
Document procedure in patients' health care record on SMR.090.200		

Date: / /

Assessor's Name:	Assessor's Signature:	
Assessment Decision (**Please Circle**):	Successful	Unsuccessful

This triplicate copy form must be completed at insertion and filed in the patient's clinical records as it is a mandatory Ministry of Health document.



NSW Health

Facility:

CENTRAL VENOUS LINE INSERTION RECORD

SMR090200

FAMILY NAME | MRN

GIVEN NAME | ☐ MALE ☐ FEMALE

D.O.B. ____/____/____ | M.O.

ADDRESS

LOCATION / Ward

COMPLETE ALL DETAILS OR AFFIX PATIENT LABEL HERE

Date / / Time : Elective ☐ Emergency ☐ Rewiring ☐

Patient:

Consent ☐ Time Out ☐ Coags ☐ Pacemaker ☐

ICU/HDU ☐ OT ☐ ED ☐ Radiology ☐ Other:

Local ☐ Sedation ☐ GA ☐ Monitoring: ECG ☐ SpO_2 ☐ BP ☐ CO_2 ☐

Neonate: Weight:

Gestational age:

Asepsis:

Hat, mask, protective eyewear ☐ Hands washed 2 min ☐ Sterile gloves and gown ☐

Prep: alcoholic chlorhex / ☐ Full sterile draping ☐ Asepsis maintained throughout ☐

INSERTION SHOULD STOP IF ASEPSIS IS BREACHED

Catheter:

Right ☐ Left ☐ Subclavian ☐ IJ ☐ EJ ☐ Femoral ☐ Basilic ☐ Cephalic ☐ Umbilical ☐ Long Saph ☐

Lumens: CVC ☐ PICC ☐ Vascath ☐ Other type / site:

Brand: Coating: Antibiotic ☐ Antiseptic ☐ Gauge: Catheter Length: cm

No. of passes: Image Int ☐ Ultrasound ☐ Depth inserted from skin: cm

Venous placement confirmed: Manometry ☐ Ultrasound ☐ Transducer ☐ Other Before Dilation ☐

Guidewire removed intact ☐ **Independently Confirmed** ☐

Complications: Nil ☐ Art Puncture ☐ Haematoma ☐ Pneumothorax ☐ Re-position ☐

Notes:

PICCs only: Stiffener removed intact ☐ Independently Confirmed: ☐ Mid-upper limb circumference cm

Final Tip position:

Confirmed by: CXR ☐ Image Int ☐ Name Pager

Proceduralist: (name)

Sign: Pager:

Specialist / Fell / Reg / RMO / NP / RN Date:

Assistant: (name)

Sign: Date:

Specialist / Fell / Reg / RMO / NP / RN / EN / Technician

Supervisor: (name)

Sign: Pager:

Specialist / Fell / Reg / RMO / NP / RN Date:

Removal: Date: / / 20

Authorised by:

Reason:

Local sepsis? Yes ☐ No ☐ Tip Cultured: Yes ☐ No ☐

Removed By: (name)

Sign: Pager:

Specialist / Fell / Reg / RMO / NP / RN Date:

CLAB Detected: Yes ☐ No ☐

If Yes, date of positive blood culture: / / 20

Isolate

Holes punched as per AS2828-1999 BINDING MARGIN - NO WRITING

CENTRAL VENOUS LINE INSERTION RECORD SMR090.200

NH6868 15 2803/2

File in patient's notes

clabicu PROJECT

PREVENTING CENTRAL LINE INFECTIONS

TRAINING FRAMEWORK **for clinicians new to inserting** CENTRAL LINES **in** NSW

ICCMU

NSW HEALTH

CLINICAL EXCELLENCE COMMISSION

BIOPATCH – How to apply

B.E.S.T. Practice
***means* BIOPATCH® Protective Disk Every Single Time†.**

How to apply BIOPATCH®:

1 Place BIOPATCH® around catheter with blue side up and white foam side next to the patient's skin.

2 To ensure easy removal, place BIOPATCH® so that the catheter rests on or near the radial slit. The edges of the slit must touch to assure efficacy.

3 Secure catheter and BIOPATCH® with transparent film dressing. Assure complete contact between skin and BIOPATCH®.

How to remove BIOPATCH®:

1 Lift corner of transparent film dressing and stretch away from catheter, holding catheter in place.

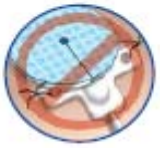
2 BIOPATCH® will remain attached to transparent film dressing, making removal simultaneous.

Common Considerations:

Apply BIOPATCH® so that the pre-cut slit is oriented ***near or under*** the catheter, as shown.

Don't apply BIOPATCH® with the slit straddling the catheter hub. The edges of the slit need to meet to maximize product performance.

Make sure the edges of the slit meet, so that BIOPATCH® has full contact with the skin. It needs 360° skin contact around the catheter for maximum efficacy.



Don't suture the catheter too close to the entry point—this will prevent proper placement of BIOPATCH®. Providing enough room for BIOPATCH® will allow for proper skin antisepsis at each dressing change

Be sure to apply BIOPATCH® with the ***blue side up***, and make sure slit is aligned with catheter line. If you notice that BIOPATCH has been applied with the white foam side up, change it **immediately**.

ORDERING BIOPATCH®

ORDER CODE	3150	3151	3152
SIZE	1" disk (2.5cm) w/4.0mm center hole	3/4" disk (1.9cm) w/1.5mm center hole	1" disk (2.5cm) w/7.0mm center hole

*For additional information or technical support, call **1-877-384-4266** or visit our website at **www.biopatch.com***

*To place an order, call **1-800-255-2500***

Johnson & Johnson Wound Management
A division of ETHICON, INC.
P.O. Box 151, Somerville, NJ 08876-0151

BIOPATCH®
Protective Disk with CHG

† Not for use on premature infants, patients with known sensitivity to CHG. Safety and effectiveness in children under 16 years of age has not been established.