Care and Maintenance of Central Venous Catheter Devices

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## CONTENTS PAGE

Introduction and Rationale for Guideline Development .................................................. 3

### CHAPTER 1: OVERVIEW OF VASCULAR ACCESS DEVICES

1.1 Peripheral Catheters ...................................................................................................... 5
1.2 Peripherally Inserted Central Catheters ...................................................................... 8
1.3 Central Venous Catheters ............................................................................................ 12
1.4 Tunnelled CVC’s ........................................................................................................ 15
1.5 Dialysis CVC’s ........................................................................................................... 21
1.6 Totally Implantable Ports ......................................................................................... 23

### CHAPTER 2: SELECTION OF CATHETER INSERTION SITE ........................................ 27

### CHAPTER 3: EDUCATION AND TRAINING ................................................................. 28

### CHAPTER 4: DEVICE SELECTION ............................................................................ 29

### CHAPTER 5: INFECTION PREVENTION IN CVC’S .................................................... 31

### CHAPTER 6: CUTANEOUS ANTISEPSIS .................................................................. 36

### CHAPTER 7: CATHETER OBSTRUCTION .................................................................... 38

### CHAPTER 8: DRESSING SELECTION ....................................................................... 47

### CHAPTER 9: BLOOD SAMPLING ............................................................................. 52

### CHAPTER 10: REPLACEMENT OF IV ADMINISTRATION SETS / HUB ................. 53

### CHAPTER 11: ASEPTIC TECHNIQUE ......................................................................... 55

### CHAPTER 12: POWER INJECTION (CONTRAST ADMINISTRATION) .................. 56

### REFERENCES .................................................................................................................. 57
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This document has been reviewed by senior nurses across NHS GG&C and various groups and forums across Scotland for an extensive peer review. These groups included the Scottish Intravenous Access Network (SIVAN) and the West of Scotland Cancer Nurses Group (WOSCAN).

The final document incorporates the comments of the reviewers.
INTRODUCTION AND RATIONALE FOR GUIDELINE DEVELOPMENT

CVAD’s are inserted directly or in directly into the superior vena cava or right atrium. Indications for the use of CVAD’s include drug and fluid administration, nutrition, antibiotic therapy, chemotherapy, bone marrow transplantation and renal dialysis. CVAD’s are inserted by medical or nursing staff, in theatre areas, radiology departments, designated clinical areas or at the bedside (Woodrow, 2002).

According to Elliott et al. (1994) there are approximately 200,000 catheters inserted annually in the UK. Infections are the most serious complication that can result from the presence and use of a CVAD. The rates for central venous catheter related bacteraemia (also referred to as catheter – related blood stream infection, or CRBSI) are 2.1 – 30.2 cases per 1000 catheter – days (Humar et al. 2000). Twenty – five percent of all hospitalised patients who have standard, non coated central venous catheters in place for eight days or more will develop colonization at the catheter site, and 5% of those patients will develop a CRBSI (Saint, 2001). Of the estimated 250,000 children and adults who will develop a CRBSI each year, approximately 12% to 25% of these patients will die. An additional cost per infection will be lost due to the extensive treatment and health – care management required (Raad & Hanna 2002). There are therefore, substantial costs associated with the morbidity, mortality, extended length of hospital stay, and treatment required secondary to central venous catheter related bacteraemia. Freeman (1990) and Cicalini et al. (2004) agree that CRBSI’s result in significant morbidity, increased duration of hospitalisation and increased medical costs.
Intravenous therapy is a major component in health care, and appropriate research-based knowledge is essential to ensure positive patient outcomes. Many changes in intravenous care have occurred in the last decade and due to these changes current practice has been affected. To ensure best practice within NHSGG&C this literature review and subsequent guideline was developed to meet the professional responsibility of educating healthcare workers about the changes in care. The aim of these guidelines is to minimise the risk of CRBSI’s and other complications, and to standardise practice across NHSGG&C. By applying best practice, the rate of CVAD complications might be reduced with benefits to patients.

A section relating to peripheral catheters has also been included to complete the range of VAD’s (Vascular Access Devices) available.

**Nutrition, renal and paediatric medicine**

*These specialities have specific guidelines that should be referred to and used in conjunction with this document.
Peripheral catheters are the most commonly inserted catheters with the numbers being inserted annually in the United Kingdom being too great to quantify. Waghorn (1994) estimated that in a 500 bedded district general hospital, 18,000 peripheral catheters were inserted in a single year.

1.1.2 Indications
Peripheral catheters are used for treatments including IV administration, administration of antibiotics and administration of certain cytotoxic drugs.

1.1.3 Contraindications
They are contraindicated for long-term treatment, certain cytotoxic drugs, total parenteral nutrition (TPN) and medications with a PH of less than 5 or greater than 9.
1.1.4 Insertion
Peripheral cannulation is a procedure that many nurses are now performing regularly and routinely as part of their role. Training and competences must be kept up to date.

- Collect all necessary equipment include correct catheter size for purpose
- Confirm patients identity and explain the procedure
- Perform hand washing technique
- Cleanse skin for at least 30 seconds with an alcohol impregnated wipe and allow to dry
- Wear clean gloves
- Position patient and select most appropriate site
- Facilitate accurate insertion

(ICNA, 2001)

1.1.5 Potential complications
Potential complications of peripheral IV therapy include disconnection, dislodgement, infiltration, extravasation and phlebitis. Inadequate fixation of peripheral cannula contributes to the occurrence of these complications (Wood, 1997). Optimal securement of the device is therefore a key nursing consideration (Callaghan et al, 2002). In the past cannulas, were often secured with non-sterile tape and gauze, this practice is no longer satisfactory as peripheral cannulae provide a direct route into the patients blood stream breaching the body’s defences and is therefore a potential route of contamination. In a study performed by Oldman (1991) it was found that the use of non-sterile adhesive tape resulted in bacterial contamination.

1.1.6 Implications for practice

- The selection of a peripheral catheter should be dependent on the length of therapy, type of medication, the patients’ condition and preference (Hamilton and Ferno 1998; Dolan and Doughery 2000; Hamilton 2000; ICNA 2000). If treatment is required for more than 3 weeks, consider alternative device selection.
- Use a transparent dressing to allow continual visualisation of site (Kiernan, 1997, Fuller and Winn, 1999).
- Change dressing if moist or no longer intact (ICNA 2001; RCN 2006)
- Cannula should be replaced every 72 – 96 hours, or sooner if complications are suspected (Bregenzer 1999; Holmer and Holmes 1998; Carlson 2001; Frey 2001; CDC 2002)
- A peripheral catheter inserted in an emergency situation where aseptic technique has been compromised should be replaced within 24 hours (RCN, 2006).
- Remove as soon as possible if no longer required.
1.2.1 PERIPHERALLY INSERTED CENTRAL CATHETER - PICC

PICC’s are frequently used to obtain central venous access for patients in secondary and primary care. PICC’s are a reliable alternative to short-term central venous catheters, with a lower risk of complications. They first gained popularity in the 1980’s, and their use has continued to grow steadily since then. The reason they have grown in popularity is because of their reduction in potential complications and cost compared to short-term central venous catheters, and because PICC’s can be inserted by registered nurses who have been trained in the procedure.

A vein in the arm is the most common point of insertion with the distal tip of the catheter terminating in the superior vena cava or proximal right atrium. These catheters can be inserted for treatment that is required for 3 weeks to 6 months.

1.2.2 Indications for use
As well as the delivery of antibiotic therapy, IV fluids, TPN, Blood sampling and the administration of irritants / vesicants, PICC’s have become an important venous access device for patients receiving chemotherapy (Bunting, Slaughter, Masel et al. 2000). This is largely due to the fact that inpatient stays are greatly reduced if treatment is delivered in the community instead of peripherally in the ward area.

1.2.3 Advantages of PICC’s
- Preserves venous access
- One cannula only
- Easy to insert
- Less skin flora (than Hickman line site)
- Fewer complications on insertion
∞ Allows rapid haemodilution of thrombophlebogenic agents reducing the risk of venous intimal damage, and thus reducing the potential for thrombosis formation and thrombophlebitis.

1.2.4 Disadvantages
∞ Not always suitable for blood transfusion / sampling
∞ Migration possible if not adequately secured.

1.2.5 Insertion technique
A clear understanding of vascular anatomy and certain principles of physiology are important, as these catheters are threaded many inches into the veins. The ability to apply this knowledge to a patient is important in successful placement.

The PICC line is inserted using a strict aseptic technique. Topical or local anaesthesia is used at insertion site. The patient then lies in the supine position with the arm positioned at a right angle to the trunk.

The skin is cleaned using a single patient use application of alcoholic chlorhexidine 2% gluconate in 70% alcohol, and the area draped with sterile towels. The operator dons a sterile gown and gloves. When the prepared area is dry, venous access is obtained using an introducer needle. Once the vein is cannulated and good blood flow obtained, the catheter is advanced through the cannula to the desired point using depth markings on the catheter guide. Catheter placement within a vein is confirmed by aspirating blood and irrigating with normal saline before the guidewire is removed. The PICC is secured using a securing device and a transparent dressing. A chest x-ray is then performed to confirm the position of the catheter tip.

1.2.6. Mid line catheter
A soft flexible tube made from silicone or polyurethane that is inserted using the same technique as the PICC. They provide venous access in a large peripheral vein extending up to 20 cms. Midline catheters do not enter the central venous system. Midline catheters are used for therapy of moderate duration. They are neither cuffed nor sutured and are held in place by a transparent dressing.
1.2.7 Ultrasound guidance (USG) for PICC placement

Ultrasound imaging has been found to greatly assist vascular access, in particular the insertion of peripherally inserted central catheters. USG has been shown to increase success rates and avoid associated complications such as thrombosis and stenosis (Moureau, 2003). Real-time ultrasound studies have reported a greater percentage of successful cannulations, fewer venepuncture attempts and a decreased time required for cannulation (Slama, Novara, Safavian et al. 1996 and Rothschild, 2001).

Several studies have now been carried out to determine the need for USG in placing PICC’s. A recent study by Bunting et al. (2000) concluded that the success rate of USG PICC insertion is extremely high, in particular with patients who have very poor peripheral venous access. In this study there was a 100% success rate with the use of ultrasound guidance. A further study by Moureau (2003) found that successful PICC insertion increased to over 90% with the use of USG in comparison to 80% with traditional non-ultrasound PICC insertion.

Therefore, as concluded from the research, PICC insertion is greatly aided by the use of ultrasound guidance. The National Institute for Clinical Excellence (2002) further reiterates this by stating, “The use of two-dimensional (2-D) imaging ultrasound guidance should be considered in most clinical circumstances where CVC insertion is necessary either electively or in an emergency situation”.

As the use of ultrasound guidance to place central venous catheters requires a competent and experienced operator (Bunting et al, 2000), training for all nurse specialists is paramount. Current guidelines state “It is recommended that all those involved in placing CVC’s using two-dimensional (2-D) imaging ultrasound guidance should undertake appropriate training to achieve competence” (National Institute for Clinical Excellence, 2002).

1.2.8 PiCC line removal

Universal precautions must be maintained to avoid contamination of the health care worker through exposure of blood bourne pathogens.
PiCC lines can be removed by registered nursing staff who have undergone training and are competent in the procedure.

**Procedure**

Don sterile gloves  
Remove dressing from bottom upward  
Clean site using 2 % chlorhexidine gluconate in 70% isopropyl alcohol  
Place swab at exit site  
Gently withdraw catheter  
Apply pressure to exit site for 5 minutes  
Tip may be sent for sensitivity and culture if infection is suspected  
Apply mepore dressing
1.3. CENTRAL VENOUS CATHETERS

A central venous line is a catheter which is placed directly via of one of the large veins of the body (jugular, subclavian or femoral) and whose tip lies in one of the central veins (superior vena cava or inferior vena cava). These lines can have up to five lumens and are held in place by a suture or catheter securement device. They are commonly used for the measurement of central venous pressure, the administration of fluids and/or toxic drugs, in patients who have limited peripheral access and for short-term haemodialysis (Hocking, 2000).

1.3.1 Advantages
The advantages of central venous lines are that they can be inserted relatively easily and quickly and used immediately once tip position has been ascertained. As they can also be used for several therapies at the same time and can be used for critically ill patients this makes them highly advantageous. These lines can be placed in a variety of settings and can be placed by most senior medics making their use relatively common (Dougherty, 2006). Another advantage of the central venous line is their use for blood sampling, thus decreasing venepuncture cannulations.

1.3.2 Disadvantages
There are many disadvantages in the use of the central venous line. There are many complications associated with their insertion including, pneumothorax/haemothorax, arterial injury and haemorrhage, infection, air embolism and thrombosis. The use of central venous lines in emergency situations for the treatment of critically unwell patients further exposes patients to these complications (Dougherty, 2006).
Central venous lines should only be used as a temporary measure due to the high rates of infection associated with these devices (Centers for Disease, Control and Prevention, 2002). Some research suggests the routine replacement of these catheters should take place in order to reduce incidence of infection (Centers for Disease, Control and Prevention, 2002). However, statistics show that routine replacement of central venous lines does not significantly reduce the incidence of infection (Centers for Disease, Control and Prevention, 2002). Therefore, these lines should only be used as a temporary measure for a short duration.

1.3.3 Insertion of Central Venous Lines
Insertion of central venous lines is commonly undertaken by medical practitioners, although specialist nurse-led units are now developing key roles in the insertion of these devices (Dougherty, 2006). Research shows, however, that these catheters should be placed by experienced operators who have been appropriately trained in the procedure (British Committee for Standards in Haematology (BCSH), 2006).

There are several different methods of central venous line placement, however, in all cases the vein of choice is directly punctured and the skin entry site dilated to allow easy insertion of the device. Research shows that in all cases of insertion, the use of ultrasound is beneficial, decreasing the risk of complications on insertion (BCSH, 2006).

Following insertion of the central venous line the catheter should be anchored using a skin suture or securement device (Dougherty, 2006). The patient should then have a check chest x-ray prior to use to ensure that the catheter tip is in satisfactory position (Dougherty, 2006).
1.3.4 Care of Central Venous Lines
The care of central venous lines should always be carried out using a strict aseptic technique. In order to maintain patency of the catheters lumens should be flushed before and after use (Moureau, 2004). There is still some debate as to whether central venous line lumens should be locked with heparin. The research is inconclusive; therefore, we would recommend adhering to your local policy regarding this matter.

In order to prevent infection dressings should also be changed every seven days or sooner if no longer intact or soiled. A transparent dressing should be used to allow visual inspection of insertion site (Scales, 1999).

1.3.5 Removal of Central Venous Lines
Although removal of central venous lines is fairly straightforward, complications can still occur. The main risk is that of air embolus. Once the sutures or securement device has been removed, the patient should be placed in a 30% head down tilt while and after the catheter is removed, thus decreasing the risk of air embolus. A bioocclusive dressing should then cover the site for at least 24 hours (Scales, 1999).

Removal should be performed using strict aseptic technique as the risk of contamination is present until the site is fully healed.

1.3.6 Recommendations for Practice
- Central Venous Lines should be for short-term use only
- Central Venous Lines should be placed and cared for using an aseptic technique
- Central Venous Lines should never be used without confirming line tip on a chest x-ray
- Central Venous Lines should be flushed before and after each use
1.4 TUNNELL ED CENTRAL VENOUS CATHETERS

Hickman type catheter

1.4.1 Description

A soft, flexible tube made from various materials including silicone and polyurethane. It is inserted via the large veins of the neck or chest (jugular and subclavian using a guide wire Seldinger technique). The femoral vein should be avoided. The tip rests in the lower third of the superior vena cava or the upper right atrium. It is tunneled subcutaneously and many are equipped with a fibrous (Dacron) cuff, which sits in the skin tunnel. This enables the patient's tissue to bond with the line, to create a secure fix, and will act as a mechanical barrier to prevent infection traversing the line. They are usually sutured or secured in place for three to six weeks until the bonding process is complete. These lines may be open-ended or valved and are available in single, dual or triple lumen. They are available in various gauges the most commonly used being 6.6 French to 14 French.

1.4.2 Indications

There are many indications for tunneled central venous access including:

- Poor venous access - this may have a variety of causes, including drug abuse and obesity.
- Irritating agents - many drugs are caustic and can irritate veins, which may lead to clotting and inflammation. Infusates with an osmolarity greater than 280-300 mOsm require dilution within a central vein.
- Prolonged intravenous therapy, such as chemotherapy and antibiotics.
- Dialysis, either for acute renal failure or while awaiting permanent access.
Plasmapheresis.

Conditions requiring multiple punctures, such as daily blood withdrawals in patients with coagulopathy.

Total parenteral nutrition.

1.4.3 Advantages
- More comfortable and discreet than the non-tunnelled catheters.
- Can remain insitu for over 2 years.
- Patients can be nursed at home with these devices in place.

1.4.4 Disadvantages
- Requires a minimally invasive surgical procedure for placement.
- Potential complications on insertion.

1.4.5 Insertion Technique

The procedure of tunnelled central venous catheter insertion is a minimally invasive surgical procedure that carries risks of complication. These complications can be serious or potentially fatal (Hamilton, 2006; McGee and Gould, 2003; Polderman and Girbe, 2002). Complications include; pneumothorax, haemothorax, haemorrhage, carotid puncture, air embolism and infection (Maklin and Chernecky, 2004)

- The procedure should take place in a clean environment (Theatre, radiology suite or dedicated treatment room). Bedside placements should only be performed in emergencies.
- Experienced operators should perform catheter insertions and supervision and assessment programs should be in place.
- Ultrasound guidance is recommended for all central venous access insertions (NICE, 2002)
- Imaging facilities (fluoroscopy) should be available for tunnelled catheter insertion (BCSH guidelines, 2006).
Maximum sterile barrier precautions should be used for catheter insertion including: gown, sterile gloves, hat and mask (Mermel et al, 1991)

Clean site using 2 % chlorhexidine gluconate in 70% isopropyl alcohol and allow to dry.

A large sterile drape should be used to completely cover the patient.

Procedure should be performed using a strict aseptic technique and following the local standard operating procedure.

The patient should be monitored throughout (blood pressure, pulse, oxygen saturation).

Tip placement should be checked by performing a chest x-ray.

The procedure should be documented in the patients’ notes.

Paediatric specialists should insert catheters in children.

Sedation or general anaesthesia should be used where appropriate.

1.4.6 Post procedure care

Do not use the catheter until x-ray checked and deemed satisfactory

Change dressing after 24 hours – weekly thereafter (INCA, 2001; RCN, 2006).

Check for signs of pneumothorax

Follow local protocol for post procedure care

1.4.7 Removal of tunnelled central venous catheters

Tunnelled lines are removed for the following reasons:

Systemic infection.

Thrombosis.

Obstruction

Fistula maturity

End of treatment

Although this is a relatively straightforward procedure, it is essential this should only be carried out by appropriately trained personnel, as inappropriate removal technique could result in catheter damage, fracture or both. (Macklin & Chernecky 2004). Potential Complications include: infection, line dissection, air embolus and bleeding. If catheter removal is required urgently
and the vascular access service is not available the procedure detailed below should be followed.

1.4.7 Local procedure for removal of cuffed tunnelled catheter

Check the patients’ anticoagulation status. If the patient has been receiving anticoagulants it should be ensured the INR is 1.5 or below.

Set trolley using a sterile technique

Explain procedure to patient and obtain consent

Remove heparin lock by aspirating all lumens.

Prepare patient, and expose area

Don sterile gloves

Clean skin using chlorhexidine 2%

Drape patient with sterile covers

Infiltrate lidocaine 1% (approx. 10mls) locally at entry site, along the line tract and beyond the cuff, care being taken not to puncture catheter.

Using forceps carefully separate tissue from around the line to expose the cuff. Care must be taken to avoid line dissection, therefore the use of blades or scissors is not advised.

If the line accidentally gets cut, grab the line beyond it with forceps and contact a member of medical staff/ Vascular Access Service immediately.

When the cuff is free, put the trolley or bed on a head down tilt (If this is not possible place a pillow or other type of support under the knees).

Place a swab over the entry site, and ask the patient to breathe in, then out, and then to hold their breath (this will prevent air entry) Again if this is not possible wait until the patient is breathing on inspiration and using one quick movement pull the line out.

Apply digital pressure until bleeding stops.

If necessary the site should be stitched by medical staff or competent registered nurse. Remove the stitches after 7 to 10 days.

The site should be covered with a transparent dressing, which can remain in place until the site has healed.

The patient is advised to take mild analgesia for localised pain, and advised that they may experience bruising at the site.
If the patient is being discharged, they should be given extra dressings to take home, and advised to speak to their district nurse or practice nurse if they are worried about the site.

1.4.6 Implications for practice

- Only staff competent in CVC care and maintenance should carry out care and treatment in CVC’s (RCN, 2006)
- Use a dedicated lumen for TPN
- Use a tunneled catheter for patients whose anticipated duration of treatment is more than 3 – 4 weeks.
- Dress catheter with a transparent dressing that should be changed every 7 days or sooner if loosened or moist. A gauze dressing should be replaced by a transparent dressing as soon as possible.
- Use a single patient application of alcoholic chlorhexidine gluconate solution (preferably 2% chlorhexidine gluconate in 70% isopropyl alcohol) to cleanse area during dressing change. The area should be left to dry.
- Do not apply antimicrobial ointment to catheter insertion sites as part of routine catheter site care.
- Antibiotic locks should not be routinely used.
- In-line filters should not be routinely used for infection prevention purposes.
- Preferably, sterile 0.9% sodium chloride for injection should be used to flush and lock catheter lumens that are in frequent use.
- When recommended implanted ports or open-ended catheters should be flushed and locked with heparin (See section on flushing and locking)
- Change needle free devices every 7 days or as per manufacturer’s instructions.
- Administrations sets in continuous use need not be replaced more frequently than at 72 hours unless they become disconnected or a central access device is replaced.
∞ Administration sets for blood and blood components should be changed when transfusion complete or every 12 hours (Whichever is sooner)

∞ TPN administration sets should be changed every 24 hours.

(Pratt, 2007)

1.4.7 Statlock catheter securing device

Advantages

1. Studies have proved that to reduce the incidence of CRBSI (1, 2)
2. Reduces the risk of accidental needle stick injuries (3)

The centre for Disease Control and Prevention Guidelines for the prevention of intravascular catheter – related infections (2002), state that these devices can be advantageous over sutures in the prevention of catheter related blood stream infections. BCSH guidelines on the insertion and management of central venous access device’s (2006) also recommend that securing devices, for example, statlock are preferable to stitches.

Two recent studies document a 2% needle stick rate among clinicians who secure catheters with sutures. Using a securing device drops this risk to zero (Sheppard, LeDesma, O’Connor, 1999; Yamamoto, Solomon, Soulen, 2002).

Most securing devices require changing once a week.

1.5 TUNNELLED DIALYSIS CATHETER (PERMCATHS)
Tunneled dialysis catheters are used as a bridge to a more permanent form of access or in patients with no remaining access sites.

Cuffed venous catheters are the chosen method for temporary access lasting longer than three weeks, and are also acceptable for shorter durations. They may also be used in patients who have exhausted all other means of access, or in those patients waiting for a fistula to mature.

1.5.1 Advantages

∞ No maturity time.
∞ Possibility to insert into multiple sites.
∞ Venepuncture not required for dialysis.
∞ Long-term access to allow maturity of A V fistulae.
∞ Applicable universally
∞ Venepuncture not required for dialysis
∞ No haemodynamic consequences
∞ Ease of catheter placement and replacement
∞ Ease of correcting thrombotic complications.

1.5.2 Disadvantages

∞ Thrombosis
∞ Infection
∞ Risk of permanent central venous stenosis or occlusion
∞ Discomfort and cosmetic problems associated with external placement
∞ Shorter expected use life than other types of access
∞ Lower blood flow rates which require longer dialysis times

1.5.3 Insertion Technique

As per Hickman type catheter insertion, although requires the use of large dilators to aid placement. X-ray screening is recommended for placing these catheter unless twin catheters with small dilators are used.
1.6 TOTALLY IMPLANTABLE PORTS (TIPS)

An implantable port or port-a-cath is a venous access device comprised of a portal body and attaching catheter which are implanted under the skin (Dougherty, 2006). The port, made of stainless steel, titanium or plastic is a hollow reservoir with a latex septum and a side outlet which connects to a silicone or polyurethane catheter. It is this catheter which lies directly into one of the central veins (Schwarz, Groeger and Coit, 1997).

To administer treatment the skin overlying the reservoir is punctured with a Huber needle and it is through this needle that treatment is given (Goodman, 2000).

Ports and Huber needles are available in many different types and sizes, allowing device choice to be tailored to each individual’s need (Dougherty, 2006).

(From Massachusetts General Hospital, America)

1.6.2 History

Totally implantable ports are accepted as a safe and effective method of facilitating long-term intravenous therapy (Deerojanawong, Sawyer, Fink, Stokes and Robertson, 1998). These devices were first introduced in the early 1980’s and used as a form of venous access in oncology patients (Dougherty, 2006). Ports are now also commonly used in patients with cystic fibrosis requiring long-term intravenous antibiotics because of their low complication rates (Deerojanawong et al. 1998).

1.6.3 Uses

Implantable ports are used for the same reasons as any other central venous access device but are viewed as a long-term device for use in hospital and the community as they are easy to maintain and have few associated complications (Dougherty, 2004). Many recent studies have evaluated the suitability and safety of venous port implantation and considered the advantages and disadvantages of using this device.
1.6.3 Advantages
The main advantage of ports over other venous access devices is that they are implanted and therefore, not external to the body (Dougherty, 2006). Consequently, there is less of an impact on patient’s body image as the port is not seen, less risk of infection as the port is not exposed to life’s daily bacteria, the ability to swim and bathe and allow more patient activity, an external dressing to the device is not required and there is no risk of accidental pulling/cutting of the device (Dougherty, 2006; Lamont, McCarty, Stephens et al. 2003). The design of the device also means that maintenance flushing is only required monthly (Eastridge and Lefor, 1995). The other great advantage is that these devices are long lasting and can be punctured up to 2000 times before a device change is required. There has been some documented evidence of ports remaining in situ for up to five years (Burdon, Conway, Murchan et al. 1998).

1.6.4 Disadvantages
Initial and long-term complications and disadvantages of implantable ports have been documented in many studies. As with any surgical procedure, pre, intra and post-operative complications are always a risk (Ahmadi, Izadyar, Ashjaei, et al. 2006). Biffi, de Braud, Orsi et al. (1998) recorded incidence of catheter/port malfunction, catheter rupture and embolisation, venous thrombosis and infection. A further recorded complication is extravasation (Ahmadi et al. 2006). Meanwhile, disadvantages include mainly that of having to access the port with a Huber needle which in itself leads to a further drawback of needle stick injury (Dougherty, 2006).

1.6.5 Insertion of Implantable Ports
Insertion and removal of implantable ports is very similar to insertion and removal of tunnelled central venous catheters (Dougherty, 2006). However, insertion and removal of implantable ports should only be carried out by experienced and competent professionals.

Implantable port insertion is a surgical technique which must be carried out within strict aseptic guidelines. The port is placed through an incision into subcutaneous
tissue commonly in the forearm or upper chest wall (Goodman, 2000). Following cannulation of the desired vein the catheter is attached to the port and tunneled subcutaneously. The catheter tip can then be threaded into the desired vein ensuring that the tip is positioned within the SVC or right atrium (Baranowski, 1993). The port can then be anchored to the deeper tissues using sutures and the subcutaneous incision can then be sutured and dressed. The practitioner should ensure that the port is placed below the intended suture line in order to prevent port cannulation through scar tissue (Dougherty, 2006).

The patient should then have a check chest x-ray prior to use to ensure that the catheter tip is in satisfactory position (Dougherty, 2006).

1.6.6 Care of Implantable Ports
Accessing implantable ports should also always be carried out using strict aseptic techniques. Huber needles, once in situ, should be secured to prevent trauma and dislodgement with the use of a transparent dressing (Dougherty, 2006). TIP’s sites with no needle insitu require no dressing.

There is still some debate among researchers on how frequently these needles should be changed. Vescia, Baumgärtnner, Jacobs, et al. (2007) advice that Huber needles should be changed after every 2000 punctures, while most other literature including Dougherty (2006) and Masoorli and Angeles (2002) suggest Huber needles should be changed weekly.

To maintain patency of the port research suggests that ports should be flushed every four weeks with heparinised saline (McPhee, 1999).

1.6.7 Removal of Implantable Ports
Removal of implantable ports is also a surgical procedure which should be carried out using strict aseptic technique. An incision should be made into the fibrous tissue which forms around the port. The anchoring sutures should then be cut and the port can be removed ensuring that the entire catheter length is pulled from the venous system (Galloway and Bodenham, 2004). The subcutaneous incision can then be sutured and dressings applied.
1.6.8 Recommendations for Practice
In conclusion, totally implantable ports are a safe, versatile and adequate method of administering long-term intravenous therapy (Deerojanawong, Sawyer, Fink, Stokes and Robertson, 1998).

- Implantable ports should be inserted, accessed and removed using strict aseptic techniques and by practitioners who are competent and experienced in doing so
- Huber needles should be changed after every 2000 punctures or weekly, whichever is more frequently
- Implantable ports should be flushed every four weeks with heparinised saline

1.6.9 Conclusion
In conclusion, totally implantable ports are a safe, versatile and adequate method of administering long-term intravenous therapy (Deerojanawong, Sawyer, Fink, et al. 1998). Research shows that they have a low incidence of complication rates, up to 85% of insertions have no associated complications related to implantation and management of these devices (Ahmadi et al. 2006). Although the advantages and disadvantages of implantable ports have been described, the implications of these i.e. reduction in infection and service-life are the real advantages to both the patient and health care organisation.
CHAPTER 2: SELECTION OF CATHETER INSERTION SITES

The selection of the best insertion site for the patient can minimise the risk of infection (Pratt, 2007).

There are a number of factors that have to be assessed when determining the site of a central venous access device (CVAD) including:

**Patient - specific factors**

- Pre-existing CVAD’s (Anatomic deformity, Bleeding diathesis, Some types of positive pressure ventilation)
- Relative risk of mechanical complications (e.g., bleeding, pneumothorax, thrombosis);
- The risk of infection.

CVAD’s are generally inserted in the subclavian, internal or external jugular, femoral veins or peripherally inserted into the superior vena cava via the cephalic, or basilar vein.

Following a systematic review, EPIC state that unless medically contraindicated, the subclavian vein should be used in preference to the jugular or femoral sites for non-tunnelled catheter placement. The femoral vein should be avoided.

EPIC further suggest the use of implantable access devices for patients who require long-term, intermittent vascular access. For patients requiring regular or continuous access, a tunnelled central venous access device is preferable.

CHAPTER 3: EDUCATION AND TRAINING

All Health Care Workers who deal with central venous catheters must have undergone training, and deem themselves confident and competent. It is the responsibility of the health care worker to ensure this prior to working with central venous catheters (UKCC, 1992).
Training in care and maintenance of central venous catheters is available for healthcare staff across NHSGG&C:

The Vascular Access Service / WOSCC run a ½ day workshop which can be booked through the Training and Development Department, 34 Shelley Court, Gartnavel General Hospital (Tel: 50148). This is run on a bimonthly basis.

3.1 Competency
Each health care worker should complete a competency pack when competency has been obtained. This will be updated annually.

3.1.2 Link nurses for central venous catheter care
Training for link nurses is available at the training and development department 34 Shelley Court on a three monthly basis. The remit of these nurses is to act as mentors to others within their department, and work with them through competencies thus ensuring high standards of care within their department.

Contact: Training and Education department, Gartnavel General Hospital 50148

CHAPTER 4: DEVICE SELECTION
There is a range of catheters available for intravenous therapy. It is important to ensure an optimal match between patient and catheter choice.

4.1 Peripheral and central venous vascular assessment
Consider the diagnosis and prognosis especially taking into account conditions that may prevent vascular access e.g. radiotherapy skin reactions or previous multiple peripheral cannulation. Finally consider patient lifestyle.

If peripheral cannulation is possible consider the treatment duration and the likelihood of treatment extension or additional treatments, as prolonged and repeated intravenous cannulation is time-consuming and unpleasant for the patient.

4.2 Consideration of the infusate
Peripheral cannulas should only be used for infusates that:
∞ Have a final osmolarity < 500mOsm/L
∞ PH between 5 & 8
∞ Not an irritant or vesicant for continuous infusion

Select the insertion site and catheter size that allows rapid dilution of the infusate to reduce the risk of chemical phlebitis.

Select a single-lumen catheter unless multiple ports are essential for the management of the patient. This will decrease the chance of catheter infection (Terotola, 2000, Sansivero, 1998).
### 4.3 Length of treatment

The type of device will usually depend on the length of time the treatment will last.

<table>
<thead>
<tr>
<th>Treatment required for:</th>
<th>Device choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to one week</td>
<td>Cannula</td>
</tr>
<tr>
<td>One week to 6 months</td>
<td>PiCC line / Tunneled catheter</td>
</tr>
<tr>
<td>One month to 2 years</td>
<td>Tunneled catheter / Implantable port</td>
</tr>
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(Vygon, 2001)
CHAPTER 5: INFECTION PREVENTION IN CENTRAL VENOUS CATHETERS

Infection is one of the greatest complications associated with a central venous catheter (CVC). Although CVC’s provide necessary vascular access, their invasive nature puts patients at risk for local and systemic infectious complications. CVC’s disrupt skin integrity and this direct opening into the vascular system creates a portal for pathogens to enter the bloodstream (Earsing et al. 2005) During prolonged catheterisation CVC’s can be manipulated multiple times per day and can also have multiple lumina therefore increasing the risk of complications. For this reason it is advised that the lumina diameter and number of lumina is kept to a minimum. (Bishop et al. 2007; Pratt et al. 2007).

Infective complications can occur in several ways, including contamination of the CVC by: skin flora at the point of insertion, skin bacteria migration down the tunnel tract, bacteria transfer during manipulation and seeding from another site of infection.(Rosenthal, 2006) Infective complications include: local site infection, catheter-related bloodstream infection (CRBSI), septic thrombophelbitis and other systemic infections.

5.1 Catheter-Related Bloodstream Infection

Defined by the following:
BSI is considered to be associated with a central line if the line was in use during the 48 hour period before the development of the BSI. If the time interval between onset of infection and device use is greater than 48 hours, there should be compelling evidence that the infection is related to the central line.

Or: At least two positive blood cultures with the same organism, obtained from at least two separate sites at different times, in association with evidence of colonisation of the catheter with the same organism. The later can only be strictly be fulfilled by removing the catheter.

5.2 Clinical Sepsis

Should meet the following criteria:
Criteria 1: Patient has at least one of the following clinical signs with no other recognised cause: Fever (>38 degrees centigrade), hypotension (systolic pressure <90mm Hg), or oliguria (<20mL/hr), and blood culture not done or no organism or antigen detected in blood and no apparent infection at another site, and physician institutes treatment for sepsis.

Secondary BSI: A culture-confirmed BSI associated with nosocomial infection at another site. Secondary BSI must yield culture of the same organism and exhibit same antibiogram as the primary nosocomial infection site.

(Taken from NHS Scotland HAI prevalence survey protocol)

5.3.3 Prophylactic Antibiotics

Prophylactic administration of systemic antibiotics has previously been used to reduce the incidence of catheter related infection. McKee et al (1985) stated that contamination of the catheter might occur at the time of insertion despite the use of aseptic techniques. They set out to determine whether the administration of a single dose of prophylactic vancomycin at the time of insertion would decrease the incidence of catheter- related sepsis. However, they failed to demonstrate a reduction in the incidence of clinical or bacteriological proven catheter-related sepsis in patients receiving vancomycin, which suggests that colonization of the catheter at the time of insertion is not the predominant cause of catheter-related sepsis. They also suggested that bacteria are more likely to be introduced during manipulation of a system, such as changing the hubs or giving sets, thus further reason why single dose vancomycin at the time of catheter insertion does not affect rates of catheter sepsis. Department of Health, Epic Project (2001) and recently updated in February 2007, have developed guidelines for preventing health care associated infection. Pratt et al, from the Epic Project, advise not administering prophylactic antibiotics routinely for central venous access, as many of the scientific studies examined were not conclusive.

Edmond et al. (1995) confirmed this thought and caused many to rethink the use of vancomycin due to the spread of vancomycin resistant enreococci. The Centre for Disease Control and Prevention (2002) have issued guidelines for limiting vancomycin use, stating that the agent should not be used for routine prophylaxis.
The management of catheter infections remains controversial. Various studies have produced conflicting results as to the benefits of antibiotic prophylaxis. Because of the spread of vancomycin-resistant enterococci, as highlighted by Edmond et al (1995), we need to rethink the use of routine antibiotic administration, especially in non-neutropenic patients.

5.3.4 Definitions

**Exit site infection:** Local infection of the skin and soft tissue around the exit site. Erythema and purulent discharge with tenderness are typically present. Usually the subcutaneous tissue is not involved, although in some cases it may be affected. (Oncu and Sakarya, 1992).

**Tunnel Infection:** Invasive soft tissue infection that extends along the subcutaneous tunnel towards the vein. The cuff is typically involved. Tenderness and erythema along the catheter tract is present with copious purulent discharge from the exit site. Tunnel infections require immediate line removal. (Ward et al.1999).

**Catheter-related Bacteraemia:** This presents with signs and symptoms of systemic infection ranging in severity from minimal to life-threatening. Fever, shakes, nausea and vomiting, back pain and changes in mental state. In any patient with a central venous catheter, symptoms and signs of infection without another confirmed source should raise the concern that the catheter may be the source of the infection. (Oncu and Sakarya, 1992).

5.3.6 If site infection suspected

- Send swab to microbiology for culture and sensitivity.
- Start patient on broad spectrum antibiotics.
- Continue using the catheter.

5.3.7 If line infection is suspected

- Stop using the catheter.
- Take cultures from the line and peripherally.
- Check – does the temperature drop (after 3 -4 hours) when the catheter is not in use. If yes, remove the catheter or discuss with the microbiologist. If no,
await the culture results and is positive, remove the line or discuss with the microbiologist. If negative, continue use of the catheter.

5.3.8 Recommendations for Practice.

It is believed that the overall balance of care can prevent most catheter related infections, rather than the administration of single dose antibiotics. We must be aware of the following to reduce the risk of catheter infections.

- Selection of catheter type
- Selection of catheter site
- Optimum aseptic technique during catheter insertion
- Skin antisepsis with 2% Chlorhexadine solution
- Catheter and catheter site care

5.3.9 Catheter replacement

- Do not routinely replace catheters as a method of infection prevention
- If there is no evidence of infection at the catheter site or CRBSI guidewire can be used to replace malfunctioning catheter.
- If CRI is suspected but no evidence of infection at site, new catheter can be inserted at a different site (do not use guidewire exchange).

(Pratt, 2007)
Hand washing
Cross-transmission, the transfer of micro organisms between humans, which occurs directly via an environmental source, occurs at all time in hospitals. It is the antecedent factor to cross infection that can result in negative clinical outcomes. Overviews of epidemiological evidence conclude that hand cross contamination is a major contributing factor in the current infection episodes in hospital in – patients (Pratt et al. 2001) Therefore all health care workers must be aware of their responsibility in prevention of infection. An effective hand washing technique is essential and is demonstrated below

HAND HYGIENE
Six stages of hand washing
CHAPTER 6: CUTANEOUS ANTISEPSIS

The cause of most catheter-related blood stream infections are those micro organisms that colonise catheter hubs and the skin surrounding the catheter insertion site. (Mermal, 2000). Skin antisepsis is regarded as one of the most important measures for preventing catheter-related infection and appropriate preparation of the insertion site will reduce this risk.

Maki et al. (1991) conducted a trial to compare the effectiveness of 2% chlorhexidine compared to either 10% povidone iodine or 70% alcohol. They found that 2% chlorhexidine was superior and an additional study by Miroz et al (1996) has since confirmed the superior efficacy of chlorhexidine 2%.

The Centre for Disease Control and Infection (O’Grady et al, 2002) have stated in their guidelines for prevention of intra-vascular catheter-related infection that although povidone iodine has been the most widely used antiseptic for cleaning central venous catheter sites, that following these studies chlorhexidine is the optimal cleaning solution.

6.1 Recommendations for Practice

Most central venous access devices and other catheter materials are generally alcohol resistant. However, it is recommended that manufacturers’ guidance is adhered to before using a solution of chlorhexidine containing alcohol.

Cloroprep stick

The following recommendations are taken from the Epic Guidelines updated in February 2007.
An alcoholic chlorhexidine gluconate solution (preferably 2% chlorhexidine gluconate in 70% isopropyl alcohol) should be used to clean the catheter insertion site and allowed to air dry. An aqueous solution of chlorhexidine gluconate should be used if the manufacturer’s recommendations prohibit the use of alcohol with their product.

Individual single use sachets of antiseptic solution or individual packages of single use antiseptic impregnated swabs or wipes should be used to disinfect the insertion site.

Do not apply antimicrobial ointment to catheter insertion site as part of routine care.

Health care workers should ensure that the catheter site care is compatible with catheter materials i.e. tubing, hubs, injection ports, leur connectors and extensions. They should also check compatibility with the manufacturers’ recommendations.

Chlorhexidine impregnated disc (eg. Biopatch)

With the break in the patient’s skin being a common pathway for microbes to enter the bloodstream (Mermel, 2000), it can be deemed beneficial to protect this site further. Several studies have shown that the use of a chlorhexidine 2% impregnated disc e.g. bio patch can reduce the incidence of catheter related bloodstream infection when placed around the catheter at the point it exits the patient’s skin (Mann et al. 2001, Garland et al. 2001, Maki et al. 2000). This type of dressing has resulted in a 60% reduction in catheter related bloodstream infections and a 44% reduction in the incidence of local infection. (Maki et al. 2000)
CHAPTER 7: CATHETER OBSTRUCTION

Central venous catheter occlusions are a common problem, especially with small –
gauge catheters.

7.1 Types of occlusion

7.1.1 Mechanical Occlusions
Mechanical occlusions are caused by improper function of some part of the
administration set up, the dressing, or the catheter that prevents flow. Some
occlusions are easy to identify, such as kinks or closed clamps, others are less obvious
and are caused internally through positioning of the catheter.

7.1.2 Blood occlusions
A blood occlusion occurs when a clot completely occludes the lumen of the catheter.
Blood occlusions can occur suddenly, as when the IV solution runs dry and the blood
backs up into the tubing, or over time as blood residue builds up in the catheter lumen,
causing a sluggish flow. Failure to correctly flush is a common cause of blood
occlusions.

7.1.3 Fibrin sheath formation
The human body reacts to any irritant in the vascular system by depositing fibrin
around the irritant. In central lines, the body sees the catheter as a foreign object, and
deposits fibrin and thrombus around it (Santilli, 2002) Fibrin sheath formation has
been reported as early as 24 hours after insertion. According to Xiang (1998) after
catheterisation, 42% to 100% of central venous catheters are surrounded by a fibrin
sheath
The first sign of a fibrin sheath is the inability to withdraw blood. The vacuum created
by negative pressure of withdrawal pulls back a flap, which is formed by the fibrin
sheath, against the catheter opening and prevents blood from entering the lumen. IV
fluids may flow between the outside of the catheter and the sheath and leak out into
the insertion site causing extravasation if the fibrin continues to form along the length
of the catheter (Andris, 2000). It has been suggested that fibrin sheath may influence
catheter related sepsis (Lloyd, 1993, Mehall, 2002)

Central venous catheters that will not flush or allow flow, are considered to be
occluded. Occlusions can be caused by mechanical, drug, or blood obstructions.
Mechanical obstruction can be ruled out by checking the following:

- IV tubing not clamped or kinked
- All connections are tight and there are no air leaks
- Sutures are not too tight at the exit site
- The catheter is not kinked, twisted or misplaced
- Ask patient to change position, cough, deep breathe, stand up or lie down with the foot of the bed tipped up
- If aspiration is possible following position change, consider chest x-ray to check catheter position or possible kinking of catheter.
- If aspiration is still not possible following the above, consider thrombolytic treatment.

7.2 Thrombolytic treatment

Savader et al. (2001) and Svoboda et al. (2004) have both demonstrated that catheter occlusions can be treated with thrombolytic agents such as urokinase and alteplase. These have both been shown to be effective in re-establishing patency in catheters. Urokinase is a direct plasminogen activator and was first introduced in 1978. It has been used therapeutically in millions of patients for a variety of indications. In low doses, it is highly effective in re-establishing patency to occluded lumens of indwelling CVC’s (Svoboda et al. 2004). Urokinase has traditionally been used as thrombolytic agent for catheter de clotting, and success rates have been between 55% to 85% (Haire et al. 1994 and Meers 1998). In December 1998, however, the United States Food and Drug administration released a warning regarding potential infectious disease risks from current supplies of urokinase (UK Food and Drug Adminstration, 1999). Since this time other thrombolytic agents have been used for catheter clearance. One of these drugs was alteplase. Recombinant tissue plasminogen activator (alteplase) has a low adverse reaction rate but is expensive and only stable for 8 hours after reconstruction. Wiernikowski et al. (1999), however, provides evidence that alteplase can safely be frozen at –30oC for up to 22 weeks.

7.3 Evidence to support the use of alteplase
There have been many clinical trials to assess the effectiveness of alteplase for catheter clearance. In one trial by Genetech, inc. (2001) 2mg/2ml alteplase dose restored the function to 150 patients with catheter occlusion up to 24 hours in duration. Patients were randomised to receive either alteplase or a placebo instilled into the lumen of the catheter; catheter function was assessed at 120 minutes. Restoration of function was assessed by successfully withdrawing 3mls of blood and infusion of 5mls of saline through the catheter. All patients whose catheters did not meet these criteria where then re administered alteplase, until function was restored or each patient had received up to two active doses. After the initial dose of study agent, 51 (67%) of 76 patients randomised to alteplase and 12 (16%) of 74 patients randomised to placebo had catheter function restored. A total of 88% of alteplase – treated patients had restored function after up to two doses.

The 2nd study was an open-label single arm trial in 995 patients with catheter dysfunction. Patients were treated with up to two doses of alteplase 2mg / 2mls instilled into the lumen of the catheter. Assessment for restoration was made at 30 minutes post instillation. 30 minutes after the first dose, 516 (52%) of 995 patients had restored catheter function. If function was not restored after the first dose, a second does was administered. 209 patients received a second dose. Thirty minutes after instillation of the second dose, 70 (33%) of 209 patients had restored catheter function. 120 minutes after the instillation of the second does, 97 (46%) of 209 patients had restored catheter function. A total of 844 (85%) of 995 patients had function restored after up to 2 doses. Across both trials, 796 (68%) of 1043 patients with occlusions present for less than 14 days had function restored after one dose, and 902 (88%) had function restored after up to two doses. Of 53 patients with occlusions present for longer than 14 days, 30 (57%) of patients had function restored after a single dose, and a total of 38 patients (72%) had restored function after up to two doses.

346 patients who had successful treatment outcome were evaluated at 30 days after treatment. The incidence of recurrent catheter dysfunction within this period was 26%). Although this study was carried out by the company supplying the product the numbers were large, and the results very impressive.
A smaller study was carried out in the radiology department of the Royal Preston Hospital (Donnelly et al. 2004). 21 patients presented with clinical features of fibrin sheath formation. 1.5mgs / 2mls of alteplase was instilled into each catheter lumen, and a repeat alteplase lock was instilled, if required. After one lock of 24 hours the patency rate was 47.6%. A second dose was administered if necessary. The overall patency rate was 100%. The result of this very small study is conclusive and proves that alteplase could be considered as an alternative to urokinase.

There have been studies performed to evaluate the efficacy of urokinase versus alteplase for the treatment of catheter occlusion. In a study by Aitkinson et al. (1990) occlusions were initially treated with urokinase. Six out of 25 occlusions failed to clear after a dose of urokinase. These six occlusions were treated with a 2 mg dose of alteplase. Alteplase restored catheter function in five out of the six catheters. This success was echoed in a double – blind, randomised clinical trial conducted by Haire et al (1994) comparing urokinase and alteplase. A total of 50 occluded catheters were treated with urokinase or alteplase, and a second dose instilled if catheter function was not restored after the initial dose. The result of this study demonstrated that catheters treated with alteplase had restored function for 89% compared with 59% of those treated with urokinase. As well as this only 18% of catheters treated with urokinase had restored function after one dose compared with those treated with alteplase, which was 46%. Both of these studies suggest that alteplase has a more successful rate of success than urokinase. There remain concerns however over using alteplase, as the most common adverse event associated with its use is bleeding. If alteplase is installed properly into the lumen of the catheter, this should result in minimal systemic drug exposure (ResouceNurse.Com). Evidence from studies by Deitcher et al (2002), Aitkinson et al (1990) and Shea et al (2001) all suggest that alteplase was safe during use in trials, and produced no changes in prothrombin time, and no adverse effects were seen.

7.4 Urokinase administration (Hickman type catheters)

∞ After discussion with the medical staff, obtain a prescription for the
- 2mls (5000ui/ml) urokinase should be administered into each catheter lumen.
- If the catheter is completely blocked the use of a three way tap to suction the medication through the catheter is advised
- The urokinase should remain in situ for up to one hour.
- Aspiration and flushing should be then attempted.
- Repeat administration if required.
- If unsuccessful a chest x-ray should be requested to check the tip position of the catheter if this has not already been performed.
- If aspiration is still not possible consider catheter removal and re insertion.
7.5 FLUSHING / LOCKING

At the time a CVC is inserted in the vascular system, fibrin deposition begins on the exterior and intraluminal catheter surfaces. Other proteins associated with both maturation of the fibrin clot and extracellular matrix formation (fibronectin) also accumulate. As these deposits continue to develop they can rapidly result in several different types of thrombolic events. (Bagnall-Reeb et al. 1992). One such thrombolic event is intraluminal thrombosis, which occurs when blood remaining in the catheter forms a clot after inadequate flushing or from retrograde blood flow. Obstruction of a CVC presents as the inability to either flush fluids through or withdraw blood from the catheter. (Baranowski, 1993). Heparin has historically been used to routinely flush CVC’s to prevent the formation of thrombosis. (Hickman et al. 1979). However the volume and concentration of heparin as well as frequency of flushing required maintaining patency, continuing to be areas of controversy and inconsistent practice. The RCN (2006) guidelines suggest that CVC’s should be flushed and locked weekly. The flushing solution (normal saline 0.9%) should be at least twice the volume of length of catheter lumen.

When flushing a catheter a push pause technique should be used, as this creates turbulence within the catheter which removes any debris from the internal catheter wall. The clamp should be closed in the last second when flushing to ensure positive pressure which prevents a backflow of blood into the line (Todd, 1998; INS, 2000; EPIC, 2007)
7.5.1 Heparin locks

There is very little up to date research on flushing protocols for CVC’s. The most recent article was by Weatherhill (1999), in which the author discussed the development of a local policy for maintaining or increasing the patency of CVC’s. In the article Weatherhill (1999) notes that the problems of using heparin may depend on the concentration of heparin solution. Hanson (1976) found that heparin solutions containing 10 units per ml did not affect clotting time, prothombin time or activated partial thromboplastin time and this solution prevented the formation of clots within the catheter. This strength of heparin solution is also advocated by Weber (1991) who states, “The lowest effective concentration of heparin should be used” 10 units/ml has been shown to be effective. The RCN (2003) and INS (2000) also recommend that the concentration of heparin should be the lowest possible that will maintain patency – usually 10 units of heparin in 1 ml of 0.9% sodium chloride.

The literature on the volume of heparin which should be used is also variable, in a quasi-experimental/descriptive study conducted by Brown-Smith, et al. (1990) comparing the incidence of thrombus in two cohorts of patients using different flushing regimes, results indicated that 5mls of a 1:10 solution of heparin is a sufficient volume and concentration to flush CVC. The RCN (2003) recommend the volume of the flush solution should be equal to at least twice the volume of the catheter and add on devices – usually 5-10 ml’s. Vygon manufactures state that the priming volume for a 6.6fr single lumen catheter is 1.10ml and for a 9.5fr double lumen catheter is 1.65ml and they recommend a lock of 2-3 ml’s of 500 units of heparin solution. However they also state that the CVC should be flushed with saline after each injection, perfusion or blood sampling and finally flushed with 2-3 ml’s of 500 units/ml of heparin. Barabowski (1993) also states that when heparin is used to assess patency of the catheter and to eliminate potential incompatibilities with medications being administered, the catheter should be flushed with 0.9% sodium chloride before and after intermittent medication administration. After blood withdrawal the catheter should also
be flushed with 0.9% sodium chloride to remove residual red blood cells and thus prevent possible occlusion before flushing with the heparinized saline solution.

Within NHS GG&C the recommendation is a 2ml lock of heparin 10units as this extends the catheter lumen length.

7.5.2 Frequency of flushing
The RCN (2006) recommend frequency of flushing should be weekly unless occlusive problems indicate otherwise. A study carried out by Kelly et al. (1992) support the use of weekly flushing protocols, concluding that flushing a CVC with 2mls of heparin 10units /ml was a safe and effective method of cvc management. This study found that weekly flushing did not increase incidents of dysfunction and the infection rate remained acceptable when compared with the literature.

7.5.3 Flushing techniques
Todd (1998) advocates that the patency of the catheter should be maintained by using a pulsated push-pause and positive pressure flush thus creating turbulence within the catheter lumen – removing debris from the internal catheter wall. Positive pressure with the lumen of the catheter should be maintained to prevent reflux of blood (INS 2000). Consideration must be given to syringe size used for flushing since the smaller the syringe size, the greater the pressure generated. Catheters are designed to withstand venous infusion pressures, but typically infusion pressures should never exceed 25-40 pounds per square inch (PSI). Smaller sized syringes will generate pressures in excess.

The flushing regimes and practices in maintaining CVC patency vary widely. Recommendations for flushing catheters are abundant in the literature but few are research based. It is therefore very clear that further research is necessary focusing on the volume and concentration of heparin as well as frequency of flush.
Non–tunnelled central line
In between usage, flush with 10mls of 0.9% saline. Non tunnelled catheters do not require heparin lock if used frequently. Consider line removal if line not being used regularly.

Tunnelled central line (Hickman) and PICC lines
Non-valved catheters (catheters with clamps), require flushing with 10mls 0.9% saline per lumen, using push/pause technique. They require to be locked with 2mls of 10 units/ml heparin per lumen. This requires to be done on a weekly basis and following each use of the lumens of the catheter.

Valved catheters (catheters with no clamps), require flushing with 10mls 0.9% saline, using push/pause technique but do not require a heparin lock.

Tunnelled Dialysis Lines
Dialysis catheters required to be flushed with 20mls 0.9% saline, using push/pause technique and locked with heparin 5,000 units/ml, to lumen volume. This requires to be done following dialysis and after each catheter usage. Heparin must be aspirated from the catheter prior to use and prior to catheter removal.
CHAPTER 8: DRESSING SELECTION

Consider before dressing Exit Site

- Sterility
- Stability
- Inspection
- Versatility
- Duration

The safe maintenance of a central venous catheter and relevant care of the catheter site are essential components of a strategy for preventing catheter related (CR) infections in patients. This includes good practice in all aspects of catheter care, and the use of an appropriate catheter site dressing regimens.

The type of dressing used on the Vascular Access Device (VAD) has been recognized as one of the variables which affect complication rates associated with these devices (Larwood, 2000). In addition, dressings offer securement of the VAD. Most studies support and recommend the use of dressings (Larwood, 2000) however; the type of dressing remains controversial (CDC, 2002).
8.1 Review of the literature (Dressing choice)

A series of evidence based guidelines have been devised aimed at reducing healthcare associated infections associated with vascular access devices (VAD’s).

As bloodstream infections associated with central venous catheters are a significant cause of morbidity in 2001 the Department of Health commissioned the EPIC team at Thames Valley University to produce a set of guidelines for the prevention of health care associated infections (HCAI) in particular catheter related blood stream infections (CR-BSI) It has been estimated that up to 6000 patients per year in England acquire a CR-BSI and 1 in 2000, the national Audit Office estimated the additional cost of a bloodstream infection to be £6209 per patient. National evidence - based guidelines for preventing healthcare - associated infections (HCAI) in National Health Service (NHS) hospitals in England were updated in 2007 and provide comprehensive recommendations (Pratt et al. 2007) for preventing HCAI. Following multiple systematic reviews of experimental and non experimental research and expert opinion they recommend a sterile, transparent, semi- permeable dressing to cover the catheter insertion site, they suggest that this dressing should be changed every 7 days or sooner if they are no longer intact or moisture collects under the dressing. If a patient has profuse perspiration or if the insertion site is bleeding or oozing, a sterile gauze dressing is preferable to a transparent, semi - permeable dressing. If a gauze dressing is used this will required to be assessed daily and changed when inspection of the dressing becomes damp, loose or soiled. A gauze dressing should be changed to a transparent dressing as soon as possible. Dressings that are used on tunnelled or implanted catheter insertion sites should be replaced every 7 days until the site has healed, unless there is an indication to change them sooner. The ‘Winning Ways guidelines also state that a dedicated occlusive dressing should be used to dress central venous catheters.

Guidelines from both the ICNA (Infection Control Nurses Association), 2001 and RCN (Royal College of Nursing, 2003) recommend a sterile, transparent, self – adhesive, semi – permeable dressing and suggest the same dressing changes as above.
A recent Cochrane review aimed to discover if different types of dressing (transparent, polyurethane, gauze and tape) used to protect the VAD site reduced the chance of developing a catheter related infection found that although the dressings varied in their ease of use, ability to prevent infections and skin reactions, no risk difference among the dressings reviewed was found and it was recommended that dressings reflected patients preference (Gillies et al. 2003). A recent by Mermel (2000) echoed these findings and drew the following conclusion on the prevention of CR infections “on the basis of all available evidence, the choice of central venous catheter dressings may be a matter of preference and cost”

The two main types of dressing used for CVC sites are transparent, semi - permeable, polyurethane dressing and gauze and tape dressing.

### 8.2 Transparent dressings
These dressing prove popular as they reliably secure the device and permitted continuous inspection of the catheter site, permit the patient to bathe and shower and require less frequent changing than standard gauze and tape, thus saving time. They allow prevent the entry of air into the vascular system following insertion and removal of a VAD.

### 8.3 Colliod or Sterile gauze
Sterile gauze dressings are more appropriate than transparent dressings when insertion sites are bleeding, oozing or if the patient is diaphoretic (CDC, 2002; Hadaway, 2003b; Rosenthal, 2003)

The potential risk of infection associated with these dressings was controversial and studies examined by Healthcare Infection Control Practices Advisory Committee (HICPAC) were contradictory; some suggesting the use of transparent dressing for peripheral and CVC’s increased both microbial colonization of the catheter site and the risk of subsequent catheter related (CR) infections while others including the largest controlled trial of peripheral venous catheter dressing regimens available at the time (Maki, 1987) failed to demonstrate any difference in infection risk between transparent and gauze dressings. In one meta - analysis of catheter dressing regimes, CVC’s on which a transparent dressing was used had a
significantly higher incidence of catheter-tip colonization, but a non-significant increase in the incidence of CR-BSI (Hoffman, 1992) HICPAC also noted preliminary data that suggested that newer transparent dressing that permit the escape of moisture from underneath the dressing could reduce the incidence of colonization and CR infections (Maki et al. 1991)

The results of the meta-analysis are consistent with the favourable outcome of previous studies addressing the issue of local flora overgrowth under transparent dressings. A study with a 2 X 2 factorial design comparing transparent dressings versus no dressing and chlorhexidine disinfectant versus no disinfectant on the intact upper arm skin in 55 patients showed that transparent dressings significantly reduced aerobic skin flora growth versus no dressing and that the reduction was higher when the areas had been disinfected previously.

8.4 Functions of IV dressings

The functions of IV dressings are multiple and included:

- Providing a barrier impermeable to water and bacteria
- Protect the catheter site from extrinsic contamination
- Discourages bacterial production at the insertion site
- Secures the catheter thereby preventing dislodgement

VAD’s offers direct access to a patients’ vascular system and provides a potential route of entry of microorganisms into the system. These organisms can cause serious infection if they are allowed to enter and proliferate in the intravenous cannula, insertion site or intravenous fluid.
8.5 Size and shape of dressing
There are a range of shapes and sizes of dressings and the chose is determined by both the patient and the catheter type and location.

8.6 General guidelines
When choosing a dressing the factors that are essential are:
- Sterility on application
- Stability
- Allows continuous visual inspection of the catheter and insertion site
- Ability for the patient to shower and bathe with out the dressing becoming saturated
- Limited dressing changes

8.7 Therefore a dressing should be
- Transparent (Allows visual inspection)
- Self - adhesive (Ensures stability therefore reducing the risk of trauma, mechanical phlebitis and contamination)
- Semi - permeable (Protects the site from bacteria and liquid but allows the skin to “breathe”)

Post line removal – Bioclusive dressing – helps prevent air entry.
CHAPTER 9: BLOOD SAMPLING

If a patient has a CVC in situ it should be used for blood sampling, therefore minimizing undue stress to patients through multiple venepuncture.

Frequent unnecessary opening of the line has been shown to increase the risk of contamination, therefore, blood sampling should only be taken on a “required” basis and all samples should be taken at the one time if possible.

Using a strict aseptic technique, withdraw 5-10mls of blood and discard the syringe, using a fresh syringe for the samples thus ensuring that samples are not including “dead space” or contaminated with heparin (Cella and Watson, 1989). Only when sampling for blood cultures must this initial 5-10mls be used for the sample to ensure accurate diagnosis.

If the CVC is in use when blood sampling is required be aware that the infusate may affect the laboratory results, therefore, infusion should be stopped prior to blood sampling and lines should be flushed (RCN, 2003).
CHAPTER 10: REPLACEMENT OF INTRAVENOUS ADMINISTRATION SETS AND HUB CARE

10.1 Administration Set Changes

The routine replacement of intravenous administration sets has been well researched. Studies show that replacing intravenous administration sets and all attached tubing should take place no more frequently than every 72 hours for clear fluid infusions to ensure a cost-effective and safe practice, unless sets have been disconnected from the central venous device (Pratt et al. 2007). With fluids, such as total parenteral nutrition (TPN) and blood products, which enhance microbial growth, intravenous administration sets should be changed more frequently. Research suggests that administration sets which introduce blood products should be changed 12 hourly (Effective Use of Blood Group Scottish National Blood Transfusion Service, 2004) while those used for lipid based substances (i.e. TPN) should be changed 24 hourly (Reiter, 2004). Further recent research shows that statistically central venous devices with intravenous giving sets left in situ for up to 96 hours show no significant increases in infection rates (Gillies, O’Riordan, Wallen, et al. 2004).

Intravenous administration sets (including any tubing from the catheter to the fluid being administered) should be clearly labelled, indicating date and time of change, with a specific lumen designated for the administration of TPN (LTHT Infection Control Policies, 2003).
10.2 Hub Care

Hub care has also been hugely researched in recent years. The introduction of closed needle-free sampling systems can reduce port and administration fluid contamination (Leon et al. 2003), and the closed system ensures less risk of complications such as air embolism and haemorrhage. The devices should be considered to have highly contaminated external surfaces with some evidence suggesting that they may increase the risk of infection. However, studies have shown that when these devices are used in conjunction with manufacturer’s guidelines they do not significantly affect the incidence of associated infection (Pratt et al. 2007). In particular these devices should be cleaned with appropriate antiseptic cleaning solutions prior to and after every use in order to minimise the risk of contamination (Pratt et al. 2007).

Care should be taken to ensure that closed sampling systems are changed in accordance with manufacturer’s guidelines. These devices should be changed every 7 days.
CHAPTER 11: ASEPTIC TECHNIQUE

Aseptic technique is the methods taken to keep patients free from hospital-acquired micro-organisms as much as possible by preventing contamination (Crow, 1989). Procedure guidelines for aseptic technique include a full surgical scrub and the use of sterile surgical clothing and protective devices, i.e sterile gloves and gowns (Mangram, Horan, Pearson et al. 1999), or the use of the “no-touch” technique which ensures that hands, even though they have not been washed using a full surgical scrub, do not contaminate the sterile equipment or the patient by using sterile forceps, gloves (Department of Health, 2001a) or swabs.

There is still a lot of controversy surrounding the handling of CVCs and aseptic technique. The evidence is of a conflicting nature as there have been few statistically significant findings showing that the “no touch” technique is adequate in preventing infection when handling CVC’s (Larwood, Anstey and Dunn, 2000).

However, research does show that if a strict aseptic technique is not adhered during all catheter manipulations, sites can easily become contaminated and act as a potential source of infection due to contamination (Tebbs, Trend and Elliott, 1995).

Therefore, it would be our recommendation that a full aseptic technique is adhered to when handling central venous access devices (CVAD’s) as research has not statistically proven that the “no-touch” technique is satisfactory in the prevention of contamination and thus, infection.
CHAPTER 12: POWER INJECTION OF CONTRAST MEDIA VIA CVC’S

CVAD’s are frequently placed for patients who receive chemotherapy or in patients in whom long term IV therapy is necessary but do not have adequate venous access. When bolus administration of contrast material is indicated for example during CT examination there are few options for delivery of contrast media (Herts et al. 1996; Reynolds and Grosvenor, 2003)

∞ Peripheral catheter
∞ CVAD

The policy for delivery of contrast via CVAD varies among institutions. This may in part due to local policy and that there are no concrete recommendations by manufacturers of either CVAD’s or injectors.

Recently new catheters have been devised that, according to manufacturers’ guidelines, are suitable for power injection of contrast.

Recommendations for practice

∞ If not available local policies should be agreed.
∞ Radiologist should contact CVAD manufacturers for advice.
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