Peripherally inserted central catheters (PICC Lines)

This guideline is applicable to all neonatal staff who care for babies requiring Peripherally Inserted Central Catheters (PICC Lines). This edition is in response to a critical incident. It is imperative that all practitioners inserting these lines should be aware of correct insertion techniques and that all staff involved in the care of these lines are aware of the hazards associated with their use.

Use of PICC lines

- PICC lines should be reserved for use with TPN or other 24h infusions.
- Bolus drugs and those given by intermittent infusion should be given via a peripheral cannula whenever possible.
- An aseptic non-touch technique should be used for insertion site care and for accessing the system. (Pratt et al)
- An appropriate antiseptic solution should be applied (see antisepsis guideline) and allowed to dry before and after accessing the PICC line. (Pratt)
- The maximum infusion pressures vary for each line. Infusion pressures should not exceed 300mmHg.
- Where possible the larger line (Nutriline) or Premicath with stylet should be used as these are easier to identify on X-ray. Premicaths should be avoided where expected flow rates exceed 10-12 ml/hour.

Before placing a PICC line

- It is good practice, where possible, to inform parents prior to placing a PICC line
- Formal consent is not required
- Examine the infant to identify a suitable vein (See Fig.1)
- Measure the maximum insertion distance:
  - Upper limbs/ head & neck: Measure from the likely entry point to the supra-sternal notch
  - Lower limbs: Measure from the entry site to the umbilicus (reducing the likelihood of entering the cardiac silhouette in small infants)
- If perfusion is poor it may be necessary to correct this prior to line insertion.
- It is appropriate to correct any significant coagulopathy before commencing the procedure however there is no requirement to routinely check FBC and coagulation profile if there is no evidence of a bleeding tendency.
- Consider platelet transfusion before the line is placed, particularly if the Platelet count is <50 or there is evidence of excess bleeding from venepuncture sites
- If the infant is known, or strongly suspected to be septic, it may be wise to delay the placement of a PICC line until the sepsis is under control. PICC lines may easily become colonised with micro-organisms which may then prove difficult to eradicate whilst the line remains in situ.

* Where possible veins suitable for PICC lines (e.g. saphenous vein) should not be used for peripheral cannulation and venesection in the first few days to leave them available for this purpose.
### Choice of catheters

The available neonatal PICC lines are listed below with the manufacturer’s product characteristics quoted.

<table>
<thead>
<tr>
<th></th>
<th>Nutriline</th>
<th>Nutriline Twin-Flo</th>
<th>Premicath</th>
<th>Premicath with Stylet</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ref No.</strong></td>
<td>1352.152</td>
<td>1252.235</td>
<td>1261.21</td>
<td>1261.208</td>
</tr>
<tr>
<td><strong>Catheter Gauge</strong></td>
<td>24 G</td>
<td>24 G</td>
<td>27 G</td>
<td>28 G</td>
</tr>
<tr>
<td><strong>Catheter Length</strong></td>
<td>15cm</td>
<td>30cm</td>
<td>20cm</td>
<td>20cm</td>
</tr>
<tr>
<td><strong>Introducer Needle</strong></td>
<td>20G Microflash</td>
<td>20G Microflash</td>
<td>24G Breakaway needle</td>
<td>20G Microflash</td>
</tr>
<tr>
<td><strong>Gauge</strong></td>
<td>20G</td>
<td>20G Microflash</td>
<td>24G</td>
<td>20G Microflash</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>0.18 ml</td>
<td>0.2 ml (each lumen)</td>
<td>0.07 ml</td>
<td>0.07 ml</td>
</tr>
<tr>
<td><strong>Max Flow Rate</strong></td>
<td>240 ml/h</td>
<td>87 ml/h (each lumen)</td>
<td>30 ml/h *</td>
<td>30 ml/h *</td>
</tr>
</tbody>
</table>

*NB - Premicaths were designed for babies <1kg, who require the smallest catheters.

### Alternative introducer devices

<table>
<thead>
<tr>
<th></th>
<th>Ref No</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vygon Microflash</strong></td>
<td>7370.19</td>
<td>20 G</td>
</tr>
<tr>
<td><strong>N.B.</strong></td>
<td></td>
<td>Microflash cannulae may be available in some PICC sets but are available separately on the above code should an additional or alternative introducer cannula be required.</td>
</tr>
<tr>
<td><strong>Vygon Microsite</strong></td>
<td>1147.02</td>
<td>24G needle (or use 24G IV cannula) Guide wire &amp; 20G dilator</td>
</tr>
</tbody>
</table>

The Vygon Microsite uses a Seldinger technique to insert any of the above PICC lines starting with a 24G needle or 24G IV cannula. Note that the PICC line is not included in this set.
PICC line placement

There are multiple potential sites for PICC line insertion. (See Fig.1)

The most commonly used are the antecubital and basilic veins in the upper limbs and the long saphenous veins in the lower limbs.

Axillary and scalp veins are also used.

Documentation

Documentation is essential when placing, manipulating or removing any invasive line.

The operator should record in the notes the following information:

- Any discussion with parents regarding PICC line insertion
- Name & designation of the operator & anyone assisting/ supervising
- The measured maximum insertion distance
- The no. of lumens, type and size of catheter inserted e.g. Premicath with stylet 28G
- The batch number
- Site of insertion
- The length of catheter inserted (do not exceed the maximum insertion distance)
- The position of the line on X-ray and whether this is satisfactory
- Details of any subsequent manipulation or re-imaging of the line.

Fig.1 Common sites of PICC line insertion
There are multiple potential sites for PICC line insertion. (See Fig.1)

The operator should take time to identify the most suitable point for venous cannulation.
Placing a PICC line

- PICC line placement should be performed or directly supervised by an operator experienced in their insertion.
- Full aseptic precautions must be observed. A gown and sterile gloves must be worn and a surgical (hernia) towel used.
- Use the drapes to cover the infant from head to toe.
- The line should be flushed with 0.9% sodium chloride for injection prior to placement and the clamp closed. This will help prevent occlusion whilst awaiting an X-ray. Use a 10ml syringe.
- Sterilise the skin around the insertion site according to standard sterile technique. Allow the sterilising solution to dry completely before commencing insertion. *Contact with antiseptic solutions may weaken the lines and cause premature failure. If there is any residual antiseptic solution pooling around the limb this should be cleaned off with a saline soaked swab before the procedure.*
- Insert the introducer until flashback is noted or free-flowing blood is obtained.
- Insert the long line and use non-toothed forceps to gently advance the line.
- Do not insert the line further than the maximum insertion distance measured before the procedure.
- If the line will not advance to the measured distance, the tip may have entered the start of an adjoining vessel. Attempts can be made to bypass this by withdrawing the line and then attempting further advancement. Do not leave the tip sitting against such an obstruction.
- Once successfully inserted, remove the introducer and apply gentle pressure to the insertion site until all oozing of blood around the PICC line has stopped.
- Secure the line in place with a steristrip close to the entry site then cover the line with a Tegaderm dressing (or similar semi-permeable clear dressing) ensuring that all of the polyurethane part of the catheter is covered. This will involve looping the redundant portion around the entry site. *NB Ensure the junction between the polyurethane part of the catheter and the wider bore section is covered by the dressing as this is a site which is prone to snapping if not supported.*
- The position of the line should be determined before TPN or drugs are infused through it. A 10% glucose infusion may be commenced prior to confirmation of line position if hypoglycaemia is a significant risk.
- For upper limb PICC lines the x-ray should be taken with the limb in a neutral position.
### Using the Vygon Microsite introducer kit using the Seldinger technique

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Insert the cannula into the chosen vein. A 24ga yellow cannula may be used if preferred</td>
</tr>
<tr>
<td>2</td>
<td>Insert the guidewire through the needle or cannula. Either end may be used. A mark on the wire indicates when the wire starts to enter the vein</td>
</tr>
<tr>
<td>3</td>
<td>Withdraw the needle / cannula ensuring that the wire remains in place</td>
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<tr>
<td>4</td>
<td>Insert the Microsite cannula over the wire. Use a little rotation of the cannula to ease the tip through the skin. Ensure the outer part of the cannula is well into the vein</td>
</tr>
<tr>
<td>5</td>
<td>Remove the inner part of the cannula and the guidewire</td>
</tr>
<tr>
<td>6</td>
<td>Pass the PICC line (Nutriline) through the Microsite catheter to the measured length</td>
</tr>
<tr>
<td>7</td>
<td>Withdraw the Microsite catheter until the tip is outside the skin and then split the catheter off the PICC line. Secure the PICC line</td>
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</table>
PICC line tip position

The optimal position of the placement of long line tips is debated. The aim is to have the tip of the line in a large central vein (ideally the superior or inferior vena cava) but outwith the heart.

For lines in inserted via the lower limbs, this is more easily achieved as the IVC runs for a longer distance before joining the heart. The line tip should be clearly outside the cardiac shadow- below T9 and well into the abdominal area.

For lines inserted via the upper limbs this is more difficult as there is a shorter run of SVC between the heart and the subclavian vein. Differentiating the mediastinum and cardiac shadow is also a challenge. From a safety point of view it is still vital that the tip should be outside the left atrium- the landmarks on X ray are less clear however, and if the line is too proximal (outside the SVC) there may be issues with an increased risk of thrombosis and extravasation. In practice precise placement is not always possible, in which case safety must be the primary consideration and a more proximal position than is ideal from the thrombosis/extravasation point of view may be necessary. The position of the long line tip should be borne in mind when considering the composition of infusions going through that line (e.g. concentrated TPN). In summary:

The tip of all PICC lines placed in WoS MCN neonatal units should be clearly visible outwith the cardiac silhouette.

- Lines in the upper limbs, scalp or neck veins should lie in the SVC, proximal to the pericardial reflection (i.e. not below T4)
- Lines inserted in the lower limbs should lie in the IVC

If the line tip lies beyond these landmarks it should be withdrawn and reimaged.
Following insertion of a PICC line, the operator must satisfy themselves that the line is in an appropriate position. Small calibre PICC lines e.g. Premicath can be difficult to identify in up to 50% of cases. (Reece et al) This difficulty may be overcome by using the Premicath with a wire stylet, which remains in place until the x-ray has been taken, on which it will be clearly visible. This guideline therefore recommends these styletted lines as the preferred device when a fine bore catheter is required.

If a 27g Premicath without stylet is used then radio opaque contrast must be used to identify accurately the position of the line tip. When using contrast only 0.2ml of Omnipaque (240mg/ml) is required. Prior to using the contrast, flush the line with 0.9% Sodium Chloride for injection to ensure patency. The X-ray should be taken a few seconds after the Omnipaque has been injected. (This should allow contrast in the vein to disperse but ensure that pooled, extravasated contrast, in a non-vascular space, does not have time to disperse). The line should then be flushed with 0.9% sodium chloride for injection again and the gate clamp closed until the X-ray has been reviewed. There has been a historical reluctance to use iodine containing contrast media in the preterm population due to concerns about potential impact on thyroid function. Recent data from the I2S2 study has provided reassurance around this (personal communication) however, so given the clear dangers associated with intracardiac line placement contrast is recommended by the West of Scotland neonatal MCN guideline group for “premicath” style lines without a wire stylet.

- The X-ray should include the entire anticipated course of the PICC line, to ensure there are no loops that could unwind and cause the tip to migrate.
- The line tip should be visualized in a large central vein outwith the cardiac silhouette.
- **If the catheter is in an inappropriate position** the line must be withdrawn and a further X-ray should be taken to ensure the line is now correctly sited.
- Ultrasonography can be utilised to identify line tip position (Madar/ Jain) though should only be performed by appropriately trained personnel
- If the line takes an unusual or tortuous route advice must be sought from a senior paediatrician or radiologist before the line is used.
- If the line cannot be advanced to the pre-measured length or the tip lies at the level of the hip or shoulder joints, the tip may be in a small tributary vein. These lines should be withdrawn slightly to ensure the tip is in a main vein.
- The position of the line should be reviewed on any subsequent X-ray to ensure migration has not occurred.
- Record a “sticky note” on PACS including position of the line tip and any amendments to the line position.
**Additional Precaution - Lines which cannot be advanced to the full insertion distance.**

The tip of a PICC line may “stick” during insertion and not be able to be advanced to the planned insertion length. Typically this may occur where the line enters a small anastamotic vessel. This is most likely to occur at the level of major joints including the **shoulder or hip** but the literature records instances of other vessels being entered including **vertebral vessels**. Clues to this may include the tip of the PICC sitting at the level of the shoulder or Hip joint as in figure 3. Alternatively the x-ray may show a sharp deviation of the line close to the tip. Extravasation at these sites may lead to serious complications and therefore the line should be withdrawn a short distance and reimaged.

**Fig 3 – PICC line at level of the hip joint**

**Removal of a PICC line**
- Care should be used to remove the occlusive dressing, particularly in ELBW babies with fragile skin.
- Remove the PICC by applying gentle traction to the line close to the point of entry.
- The tip of the removed line should be sent to microbiology for culture.
- Gentle pressure on the site may be required to stop bleeding.
- The entry site may be left open to the air.

A PICC line may become adherent to the tissues around the insertion site especially if it has been in situ for a prolonged period. If significant resistance is felt when removal is attempted then the operator should cease and seek senior advice as the line could snap leaving a portion within the vein, which may be very difficult to remove.
Precautions and Hazard warnings

Misplacement or Displacement: The tips of PICC lines can perforate a blood vessel or the wall of the right atrium, this can occur at line placement or by subsequent erosion after a period of normal usage. This has the potential to cause: extravasation injuries; therapy failure (e.g. hypoglycaemia if TPN or glucose is being infused or hypotension if inotropes are being infused); pericardial effusion or cardiac tamponade. Warning signs may include rising infusion pressures, inflammation and oedema confined to the entry limb, hypoglycaemia, falling blood pressure, cardiomegaly on CXR or pericardial fluid seen on ECHO. If misplacement or displacement is suspected the infusions should be transferred to another IV line whilst the situation is investigated. It is usually necessary to remove the line unless a correct position can be determined beyond doubt.

Perforation: The polyurethane tubing of a PICC line is very thin and the lines can burst if too much pressure is applied. To avoid this the following precautions should be taken:
- Avoid high pressures when flushing a PICC line - use a 10ml syringe
- When flushing do not use excessive force to overcome resistance within the tubing.
- Do not increase pressure limits on infusion pumps or syringe drivers to overcome resistance.

Gate clamps: The gate clamp on the PICC line's extension tubing may cause a fracture of this tubing if used too close to the catheter hub, if left closed for extended periods or if repeatedly used on the same portion of the tubing.

Bacterial / Fungal colonisation: If bacteraemia or fungaemia occur whilst a PICC line is in situ the lines may easily become colonised. This can also occur if inadequate aseptic precautions are observed when changing infusion fluids. Such colonisation is very difficult to eradicate whilst the line remains in situ. Failure to remove PICC lines in the face of bacterial or fungal sepsis is associated with failure of antimicrobial treatment and increased morbidity and mortality. If a PICC line is in situ when a neonate becomes septic then withdrawal of the line would be appropriate in most cases. If the line is vital because of very difficult vascular access, or where it is clear that long term central venous access will be required (e.g. babies with “intestinal failure”) the situation should be discussed with the NICU consultant as it may be more appropriate to initially treat to conserve the line. Where the decision is made to retain the line for such reasons it is prudent to remove the line at the point of discontinuation of antimicrobial therapy as there may be a significant risk of recurrent infection.

Breakage of Premicath lines: These catheters are more prone to breakage (snapping or bursting) than wider bore catheters. This is due to a number of factors including their very thin walls. Antiseptic solutions may weaken the catheter material and should not come into direct contact with the catheters. Ensure antiseptic solutions used to clean the skin are allowed to dry thoroughly before starting the catheter insertion. The catheters may be prone to fracture at the junction of the thin polyurethane section and the wider microbore tubing. This junction should be secured under the dressing to support this vulnerable area.
Emergency Management of Cardiac Tamponade

Cardiac tamponade is a rare complication of PICC line use in neonatal units. It is a medical emergency, with associated morbidity and mortality. Literature suggests an incidence of 0.76% to 3% in infants with PICC lines. Retrospective data from the UK estimates an incidence of 0.2%, with a mortality of 0.7 per 1000 neonates. Initial resuscitation should be methodical and follow recognised life support guidelines. Siting catheter tips outwith the cardiac border does not completely abolish the risk of pericardial effusion, or cardiac tamponade.\textsuperscript{12}

Pericardiocentesis should only be performed by skilled operators, under ultrasound guidance, unless a delay in treatment would be life threatening. If it is not possible to await ultrasound-guided drainage, emergency pericardiocentesis should be attempted by the most experienced neonatal practitioner available.

In subacute cases, where infusate pericardial effusion is suspected, there may be a role for aspirating the PICC line in-situ. This should be discussed with the Consultant on-call.

**Clinical Signs**
- Tachycardia
- Bradycardia
- Hypotension
- Desaturation
- Quiet heart sounds
- Sudden collapse

**Investigations**
- Chest X-ray: Widened mediastinum +/- fluid level
- ECHO (if available/ time permits)

**Equipment**
- Sterile gloves & gown
- Sterile drapes
- Dressing pack
- 22/24G Cannula
- 10ml syringe x 2
- 3-way tap
- Suitable cleaning Solution - See antisepsis guidelines

**Procedure**
- **Ensure senior support available or en route to attend**
- Clean the skin around the xyphisternum and allow to dry
- Connect the cannula to one syringe
- Connect the 3-way tap and other syringe
- Insert the cannula below the xyphisternum at 30° to the skin, aiming towards the left shoulder

**Fig. 4 IV Cannula & 10ml syringe**
Fig.5 Approach for emergency pericardiocentesis

- Aspirate continuously as the needle is advanced until blood or infusate is aspirated
- Advance the plastic sheath of the cannula, ensure the needle does not advance further
- Connect the 3-way tap & use to aspirate the pericardial contents
- Send the aspirated fluid for microbiological and biochemical investigation
- Cover the injection site with an occlusive dressing e.g. Tegaderm
References

Arch Dis Child Fetal Neonatal Ed 2002;87:F155-F156 doi:10.1136/fn.87.2.F155-a Placement of neonatal central venous catheter tips: is the right atrium so dangerous? D W Cartwright


ToddT.Nowlen,MD;GeoffreyL.Rosenthal,MD,PhD;GregoryL.Johnson,MD; Deborah J. Tom, MD§; and Thomas A. Vargo, MD. Pericardial Effusion and Tamponade in Infants With Central Catheters. Pediatrics 2002; 110:137–142.

KBeardsall,DKWhite,EMPinto,AWRKelsal.Pericardialeffusionandcardiac tamponade as complications of neonatal long lines: are they really a problem? Arch Dis Child Fetal Neonatal Ed 2003;88:F292–F295


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