Neonatal PICC Resource

Improving outcomes

VYGON

Value Life

Contents

What is a PICC?

PICCs - Peripherally Inserted Central Catheters

PICCs have become successful and common place within the NICU environment since Shaw first described the novel technique in 1973. They offer clinicians a reliable and safe means of vascular access as they can be used for an extended period of time.

Definition: A peripherally inserted central catheter is one which is inserted into the vein in a peripheral vessel and then threaded so the tip of the catheter sits in the central circulation. They might also be referred to as Longlines, perc lines or percutaneous central venous catheters.

PICC catheters are available with or without stylets. A stylet is a thin and flexible preloaded wire that provides stiffness, facilitating insertion. They are then removed once the catheter is placed. Stylets have been used successfully for more than 20 years without increased risk of morbidity or mortality.

Early vascular access assessment aids us in identifying the most appropriate vascular access device (VAD) and ensuring vein preservation. Choosing the best VAD, as early as possible for the neonate is vital in achieving best outcomes and reducing complications. PICCs can offer infants numerous advantages but require a skilled insertion and appropriate monitoring and care.

Indications:

- When vascular access therapy is expected to exceed 6 days
- Low birth weight infants that require TPN
- Infusions of fluids or medications >600mOsm/kg
- Infusions of fluid or medications <5 pH or >9 pH
- Infusions of fluids or medications with irritating properties
- Infants with limited peripheral venous access
- Medical preference for a PICC over other VAD

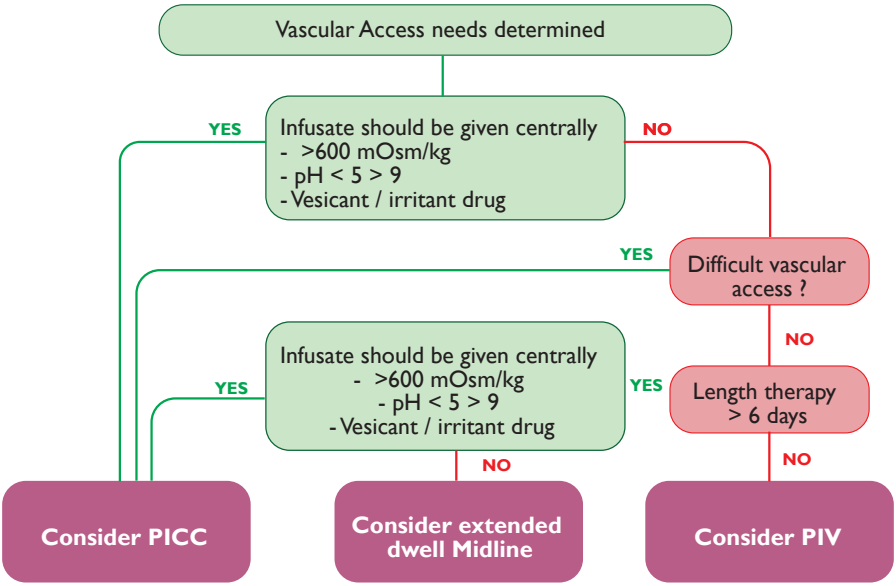
Contraindications:

There are no absolute contraindications, however, infants should be assessed for a PICC taking into account the risks and benefits. The following warrant additional consideration for the placement:

- No suitable veins
- Injury or infection of the extremity
- Broken clavicle or arm
- Dislocated shoulder
- Previous infiltration
- Edema and hematomas

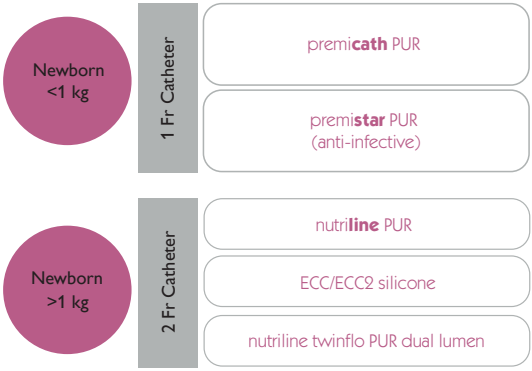
Neonatal early vascular access assessment

Early assessment of the infant is essential when choosing the best vascular access device for meeting ongoing needs. The device should allow for uninterrupted therapy and preserving the vasculature to improve outcomes for the infant.
Infusates requiring central delivery need special considerations. When they are delivered through a PICC and the tip is in a non-central position there is a 28% higher risk of complications. However, when drugs can be delivered into the peripheral vessels a Midline catheter may offer a suitable option as a vascular access device. Whilst the tip of a PICC sits in the central circulation a Midline catheter placed in the arm should have its tip in the peripheral vessel below the axillary line and those placed in the legs should remain below the inguinal crease.



Catheter choice

Catheter matrix



Catheter material

Polyurethane (PUR) and silicone materials have both been used successfully for many years and the choice of material is mainly personal preference:
- PUR is thermosensitive which means it will be stiffer on insertion and will soften in the blood. PUR also has a higher tensile strength than silicone which allows for thinner walled catheter design, providing higher flow rates for the same external diameter.
- Silicone is a soft material prior to insertion which can potentially make it more difficult to thread the catheter to the required tip position. However it is also the most biocompatible and chemically inert material, which allows a dwell time of more than 30 days, whereas traditionally PUR neonatal PICCs are licensed for a dwell time of less than 30 days.

Catheter size

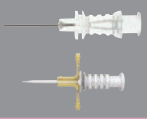
To reduce rates of thrombosis and phlebitis catheters should take up no more than 1/3 of the internal diameter of the vessel. There are 2 strategies to achieve this:

- Using ultrasound measure the diameter and choose the catheter accordingly

Vein diameter	Max catheter size
1mm	1Fr
2mm	2Fr
3mm	3Fr

- Choose the smallest catheter to deliver the required therapy

Introducer matrix

	Breakaway needle		Short IV cannula	microflash	Butterfly needle	microsite	
							
Gauge	24	20	24	20	19	24 (puncture needle)	20 (peelable sheath)
Ø ext (mm)	0.7 mm	0.95mm	0.7 mm	1.1 mm	1 mm	0.55mm	1,1 mm
Ø int(mm)	0.4 mm	0.66 mm	0.5 mm	0.7 mm	0.86 mm	0.4 mm	0.7 mm
Catheter insertion	1 Fr	2 Fr	1 Fr	(1 Fr &) 2 Fr	2 Fr with easy**lock**	1 Fr & 2 Fr for difficult access	
Compatible with	premi**cath** premi**star**	epicuta**neo**2 nutri**line** nutri**line** twin**flo**	premi**cath**	premi**cath**/ premi**star** epicuta**neo**2 nutri**line** nutri**line** twin**flo**	epicuta**neo** cava	premi**star** premi**cath** epicuta**neo**2 nutri**line** nutri**line** twin**flo**	

Breakaway needle:
- The needle is inserted into the vein
- The catheter is threaded through the needle
- The needle is then retracted and split

Short IV cannula: Not recommended unless a last resort as the device can't be removed from the line and poses an infection risk as well as mechanical damage.

Microflash:
- The cannula is inserted into the vein
- The needle is removed
- The catheter is threaded through the cannula into the vein
- The cannula is retracted and then peeled apart

Butterfly needle:
- The needle is inserted into the vein
- The catheter is threaded through the needle
- The catheter is detached from the extension and the needle removed
- The extension is then reattached to the catheter

Microsite:
Microsite is a modified seldinger technique, also known as micropuncture. Modified seldinger technique kits, MST kits, have been shown to increase the success rate, of venipuncture and catheter insertion, when traditional methods are too challenging.
With appropriate training and use, MST can be cost effective and reduce complications.

- The needle is inserted into the vein
- A wire is passed to maintain venous access
- The needle is removed
- A dilator and peelable sheeth are passed into the vein over the wire
- The wire and dilator are removed
- The catheter is passed through the peelable sheath
- The peelable sheath is retracted and split off the catheter

Common site choices

- Basilic

Often preferred choice due to being the largest vein in the upper arm and the straightest and most direct route to the Superior Vena Cava (SVC). Due to this, a lower incidence of phlebitis is recorded compared to the cephalic vein and the catheter is easily advanced. A high incidence of internal jugular malposition is possible from the basilic vein. To minimise this, ensure the head is positioned towards the insertion site during catheter advancement.

- Cephalic

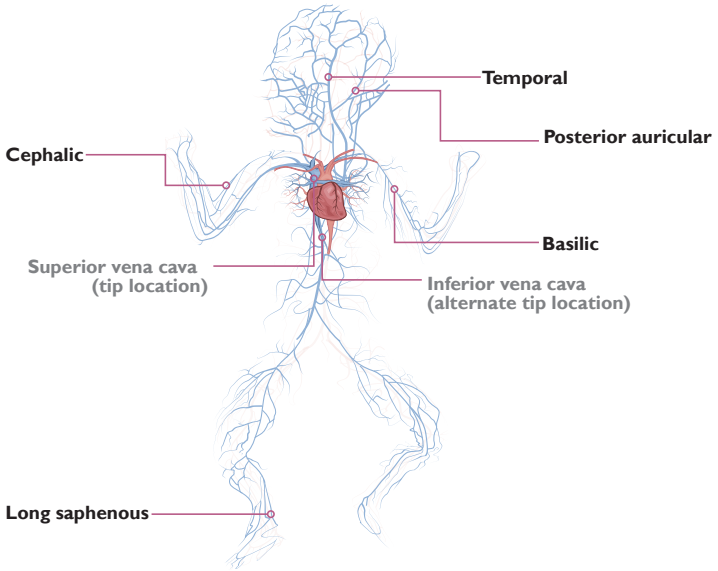
Smaller than the basilic vein, it makes a sharp turn in the shoulder where it joins the axillary vein. At this point slow insertion movements can aid the blood in carrying the catheter in a direction of the heart.

- Saphenous

The longest vein in the body with the largest amount of valves. The tip of the PICC should terminate in the Inferior Vena Cava (IVC). Lower extremity vessels are associated with lower overall complication rates and the right saphenous with lower malposition rates. These veins should be considered unless gastroschisis is present.

- Scalp veins

Scalp veins are difficult to dress and can be negatively perceived which is why they often remain as a last resort. However they can be successfully utilised for PICC insertion. The temporal vein is less tortuous and more visible than the post auricular vein with the right side offering the most direct route.



Tip positioning

Tip position guidelines:

- Lower 1/3 of the SVC - National Association Neonatal Nurses (NANN)
- Outside the cardiac silhouette - British Association of Perinatal Medicine (BAPM)
- IVC above level of diaphragm (NANN)

Confirming tip position

The X-Ray should be taken with the insertion site also within the image. The infant should be positioned to place the catheter in its deepest position, or a position most likely to be maintained in the day. The catheter material itself is radiopaque, but due to the nature of these tiny catheters and the pathology of the infant, it can sometimes be difficult to visualise them. The following points can help:

- Using a water-based, isotonic, non-ionic contrast solution
- Take a lateral oblique view with the right side elevated 10-15° angle

If using a digital X-ray machine:

- Use the invert feature
- Use the zoom feature
- Check if there is a setting for line placement on the X-ray machine

Infant positioning for deepest tip location

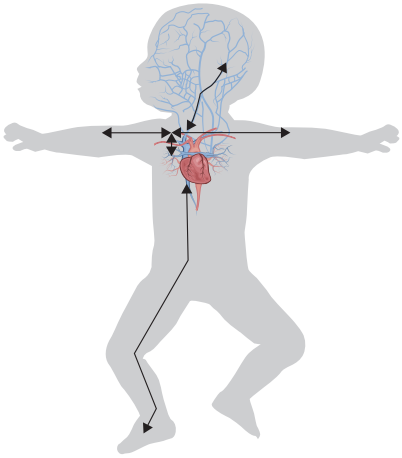
Catheter Insertion Site	Infant position
Cephalic Vein	Abduction of arm
Basilic & Axillary Veins	Adduction of arm
Pre-antecubital Insertion	Flexion of arm
Scalp Veins	Flexion of neck
Leg Veins	Flexion of leg

PICC measurements

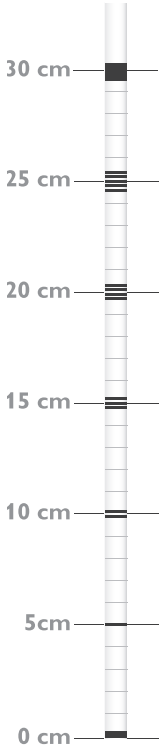
External measurements

Although external measurements offer a guide, the tip position must be confirmed by X-ray before treatment is commenced and adjustments made accordingly to your hospital protocol.

Arm Insertion	Scalp and Neck Insertion	Leg Insertion
1. Insertion site with arm at 90 degree angle from body	1. Insertion site along the vein to the external jugular vein	1. Insertion site along the vein to the groin
2. To the head of the right clavicle	2. To the head of the right clavicle	2. To the right of the umbilicus
3. Down the right side of the sternum	3. Down the right side of the sternum	3. To the xiphoid process
4. To the 3rd intercostal space	4. To the 3rd intercostal space	



Catheter markings



- All Vygon neonatal catheters have the same depth markings to aid recognition during catheter insertion.

- The precise length of the catheter is measured at the midpoint of the centimeter markings.

- The tip of the catheter has a solid black mark to allow quick visualisation of complete catheter removal.

Insertion tips

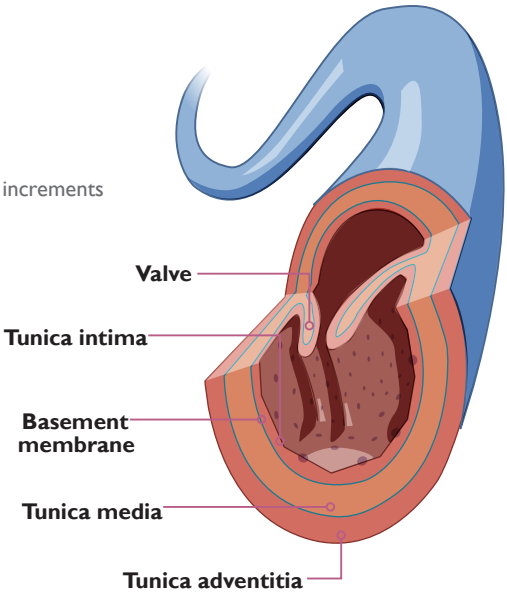
Causes of difficulty in advancement:

- Not in vessel
- Vasospasm
- Valve or bifurcation interference

Potential solutions:

- Stabilise introducer in the vein
- Insert the catheter slowly at 1/4 - 1/2cm increments
- Check the arm is positioned at 90°
- Flush to dilate and open valves
- Reposition the arm or leg
- Apply heat to dilate the vessel
- Massage the vein towards the heart
- Elevate the shoulder or pelvis

Always aim to minimise the trauma caused during the insertion. Damage and irritation to the inside of the vessel can result in phlebitis and lead to thrombotic clots.
Inserting the catheter slowly will aid the catheter to be carried by the flow of the blood and therefore reducing the chances of catheter tip malposition.



Managing malposition

A malposition is when the catheter tip does not terminate in the SVC/IVC as desired, but in another location. The risks and benefits between repositioning and having a suboptimal tip location should always be assessed. In the case of repositioning, the following patient positions can help to facilitate successful repositioning with gentle flushing.

Catheter malposition	Position	Intervention
Internal Jugular Vein	Head of bed 45-90 degrees if tolerated	Flush
Contralateral Subclavian vein	Ipsilateral position, head of bed elevated Example catheter placement on R, tip in L subclavian, position patient on side	Flush
Axillary Vein	Contralateral positional head of bed elevated	Flush
Azygous Vein	Position of comfort with head of bed elevated	Flush
Right Atrium	Position of comfort; arm in position aseptic technique for retraction	Retraction

Care & Maintenance

Effective care of the catheter is integral to prolonging the life of the catheter and minimising complications. Having an expert team perform dressing changes and care has been shown to enhance success with PICC catheters.

Hand hygiene

- Appropriate hand hygiene procedures should always be used
- Hand hygiene should be performed:
    * Before and after palpating catheter insertion sites
    * Before and after inserting the catheter
    * Before and after accessing the catheter
    * Before and after dressing the catheter

Infusion

- Infusion tubing should be configured under aseptic technique
- Infusion equipment should be Luer-lock
- The use of stopcocks should be replaced with needleless connectors which should be scrubbed according to the IFU before access
- Catheter lumen smaller than 2Fr can be difficult to maintain patency. Consider running a continuous infusion at 0.5-1ml/h

Flushing

- Positive pressure flushing technique should be performed as per hospital protocol to maintain catheter patency.
- Double lumen catheters should be treated independently for care and maintenance
- Push-pause technique should be employed to create a turbulent flush
- Syringes 10ml and above should be used for flushing. Syringes smaller than 10ml create excessive pressure and pose a risk of catheter fracture - critical for silicone catheters but also applies to PUR.

Dressing changes:

Secure dressings are intended to provide a barrier to infection and also prevent the catheter from migration and dislodgement. When using dressings, refer to the manufactuers Instructions for use and use sterile technique

- Dressings should be transparent and without gauze and tape covering the insertion site
- Transparent dressings should be changed when the integrity is compromised or they become soiled.
- Dressings with gauze over the insertion site should be changed at 24-48 hours
- If there is bleeding at the insertion site consider the use of a hemostatic agent
- Avoid tape and steristrips directly on the catheter tubing material. If using position over the wings or external integral extension of the catheter only
- Ensure there is no tape or gauze protruding from the dressing

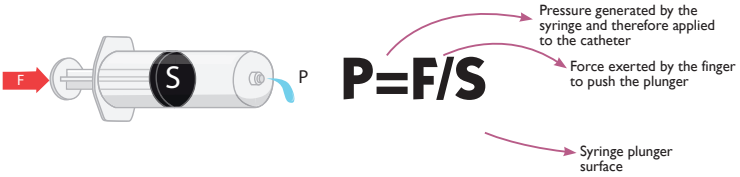
Catheter removal:

PICC catheters should be removed as soon as they are no longer required. Removal should be an educated procedure with the correct techniques for minimising complications.

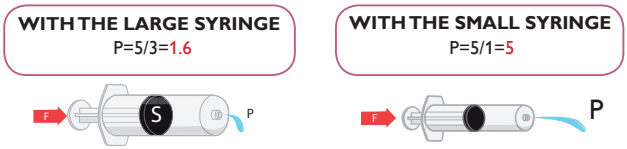
- Removal should be a slow and steady motion to prevent vein spasm
- The removed catheter should be checked for length against the documented length of catheter at insertion or the black distal mark identified
- Do not attempt to remove a catheter by applying tension or excessive force
- Removed with an aseptic technique

Understanding syringe pressure

It is a fact: small syringes are those that generate the most pressure. To understand why, let's consider the following formula:



Let's assume that the force applied on the plunger is always the same, F=5 for example. We want to compare exit pressures from two separate syringes (random measurements):
- One whose plunger has a diameter of 3 cm S=3
- One whose plunger has a diameter of 1 cm S=1



Catheters of size <3 Fr have a resistance of 900 mmHg (1.2 bar); with small syringes, this pressure is easily exceeded (shown in bold)

Force applied to the plunger (mmHg)	Syringe exit pressure (mmHg)		
	3 ml syringe	10 ml syringe	20 ml syringe
50	490	155	70
150	**1425**	510	270
250	**2425**	915	485

(Denise Macklin, BSN, RNC, CRNI-Journal of Vascular Access Devices- 1999)

This is why in order to avoid the risk of breaking neonatal PICCs, Vygon recommends the following:
1. Always use 10 ml syringes when priming and flushing the catheter.
2. Always use 10 ml syringes to infuse boluses of medication which can be diluted.
3. If medication cannot be diluted, smaller syringes should be ideally pumped.
4. If the medication cannot be diluted or pumped, administer the bolus very slowly (over 30 seconds to 1 minute).

Managing complications

The complication rate of PICCs is similar to that of the short IV cannula, the incident of major complications is low. The success rate of placing and maintaining PICCs is greatly increased when standardised practice is implemented, and when the insertion and care is routinely completed by experienced practitioners. It is well documented that having a dedicated team improves the success and performance whilst reducing complication rates, and maintaining cost effectiveness.
A list of the most common problems are found below.

	Possible causes	Prevention	Management
Bleeding	- Accidental arterial cannulation - Coagulopathy issues - Large access device	- Use smallest size introducer available - Excessive bleeding could be from an arterial puncture. Ensure careful assessment of vessel - Investigate persistent bleeding for signs of arterial puncture, infant activity, vessel shearing and coagulopathy	- Apply pressure for 5 minutes following insertion - A sterile piece of gauze can be applied under the dressing. However, this should be changed within 48 hours - A haemostatic agent can be applied if bleeding is persistent
Air embolism	- Catheter fracture - Tubing disconnection - Deep inspiration during catheter insertion or removal - Inadvertent infusion of air through infusion set	- Position the infant in supine position - Use only Luer-lock devices - Monitor IV connections to ensure they are secure - Clamp the catheter during tubing and connector changes - Do not clean the catheter in cleaning solutions containing alcohol (this can weaken the material and progress to fracture)	- Place infant in left lateral trendelenburg position - Administer 100% oxygen to decrease air embolism
CRBSI (Catheter Related Bloodstream Infection)	- Premature infants especially those below 1Kg and under 28 weeks - PICC insertion or care by inexperienced clinicians - Multiple insertion attempts - Contamination of catheter hub - Long catheter dwell time - Multi lumen catheter - Poor hand hygiene and clean technique	- Use a CVC strategy bundle to ensure compliance to key components - Ensure staff competencies Standardise the procedure and limit the staff who insert - Use maximum barrier techniques for insertion and sterile technique for dressing changes - Disinfect per hospital protocol and consider using PI or CHG where indicated upon catheter insertion and dressing changes - Perform dressing changes when the integrity of the dressing is lost - Use needleless connectors and ensure they are vigorously scrubbed with alcohol prior to access and allowed to dry - Exercise care to prevent contamination when changing administration sets - Remove the PICC catheter when it is no longer required - Consider using an antimicrobial catheter such as premistar	- Discuss treatment with risk vs benefits for infants dependant on their PICC - Follow local policies and guidelines for CRBSI treatment

	Possible causes	Prevention	Management
Catheter migration	- Increased thoracic pressure - High-frequency ventilation - Frequent vomiting - Coughing - Rapid infusion of forceful flushing	- Maintain security of dressing and consider using a securement device such as griplok - Verify tip position on insertion and whenever a chest X-Ray is taken for another clinical reason subsequently - Check the position of the limb where the catheter has been inserted on X-ray	- Obtain radiograph and verify tip position - Consider repositioning strategies - Consider leaving the catheter in current position or pulling back into a midline position - Consider removing the catheter or performing a catheter exchange
Catheter dislodgement	- Security of dressing compromised - Tension on catheter or dressing	- Maintain security of catheter with intact dressing - Consider using securement device such as griplok - Follow dressing IFU's	- Obtain radiograph and verify tip position - Consider risks and benefits of leaving catheter in position - Consider removing catheter or performing a catheter exchange
Myocardial perforation, effusion or tamponade	- Catheter tip within the heart - Catheter contact with myocardium - Displacement of catheter into the heart with movement of limbs - Inadequate catheter security	- Check catheter tip position on every X-ray - Consider the position of the limb during X-ray and how it relates to the natural position of the limb - On X-ray be aware of the whole length of the catheter and check for angulation, knots or loops	- Stop the infusion of fluid and notify the medical care provider - Immediately obtain chest X-Ray or echocardiogram - Attempt to aspirate blood whilst waiting for the imaging study. If the aspirate is consistent with the infusion continue to aspirate and remove as much fluid as possible. If the fluid can not be removed, pericardiocentesis may be necessary. - Withdraw the catheter to correct position - Follow up with X-ray or ultrasound because effusion can occur
Thrombosis	- Traumatic insertion - Catheter size too large for the vessel - Inadequate catheter tip position (outside the SVC)	- Catheter tip should be maintained in the superior vena cava - Appropriate size catheter in the vessel to facilitate blood flow around the catheter and prevent irritation. Catheter <= 1/3 vessel diameter - Secure catheter to limit vessel damage due to migration	- Consider the use of thrombolytic agents in line with your hospital policy - Consider catheter removal

	Possible causes	Prevention	Management
Mechanical Phlebitis	- Rapid or traumatic insertion - Catheter too large for vessel - Catheter tip outside vena cava - Catheter inadequately secured - Cephalic and saphenous insertion	- Maintain catheter tip in vena cava - Monitor the vessel to ensure early detection - Slow and gentle insertion technique by trained personnel - Use smallest catheter to deliver therapy - Secure catheter - Carry out vein assessment prior to choosing insertion site	- Consider applying warm compress every 4. Hours until resolved - Consider elevating the extremity and administering a gentle range of motion exercise - If no improvement or the phlebitis advances after 24hours consider removing the catheter
Chemical phlebitis	- Infusate lacks adequate hemodilution - Catheter tip in location of inadequate hemodilution - Fibrin sheath development along length of catheter	- Ensure catheter tip is in appropriate location for required infusion - Deliver infusates with osmolarity >600osmols centrally - Delivery infusates with ph<5 and ph>9 centrally - Delivery infusates with irritant and vesicant qualities centrally	- Check chemical properties of infusate and required tip location - Check catheter tip position. If inadequate consider removing catheter - If fibrin sheath is causing the phlebitis remove catheter
Catheter occlusion	- Inadequate catheter flushing and locking - Fibrin sheath formation - Inadequate catheter tip position - Catheter kinking or looping - Incompatible infusates - Clamps - Blood reflux	- Use positive pressure flushing techniques Use a neutral NLC to prevent blood reflux upon disconnection such as bionector - Do not aspirate through 1Fr catheters due to small inner lumen size - Ensure good tip position in the vena cava - Consider the use of a double lumen catheter for incompatible infusions - Always run a continuous infusion through 1 and 2Fr catheters at 0.5ml/h-1ml/h	- Check catheter isn't clamped - Inspect catheter under dressing for knots, bends and migration - Consider repositioning if catheter is against vessel wall - Consider the use of thrombolytics and clearing agents as per hospital protocol - Consider catheter removal if catheter can not be rescued

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