

Title:	Umbilical Catheter Insertion		
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This guideline is applicable to all medical staff, ANNPs or extended role practitioners placing umbilical catheters in neonates.

Indications for Umbilical Arterial Catheter

- Direct blood pressure measurement
- Frequent acid-base and oxygen monitoring
- Frequent blood sampling
- Exchange transfusion

Indications for Umbilical Venous Catheter

- During resuscitation for administration of emergency drugs/fluids
- Difficult peripheral IV access
- Extreme prematurity in advance of long line insertion
- Infusion of hypertonic solutions (eg >12.5% dextrose)
- Administration of vaso-active drugs
- Exchange transfusion

The umbilical vessels can be catheterised up to 7-10 days after delivery although it is easiest just after birth. If the cord is dry, application of saline-soaked gauze around the cord for at least one hour prior to the procedure may be helpful.

Relative Contraindications

- Anterior abdominal wall defects
 - Exomphalos, Gastroschisis, Umbilical fistula
- Infection
 - NEC, Peritonitis, Omphalitis
- Evidence of local vascular compromise in lower limbs
- Abdominal surgery requiring an incision above the umbilicus

Considerations

There are three key considerations when siting umbilical catheters:

- protecting the infant's safety by maintaining warmth, comfort and humidity and avoiding exposure to harm e.g. chemical burns from cleaning solution, accidental extubation of an infant hidden under a towel
- infection control through correct aseptic technique
- siting of the catheters in the correct vessels at the ideal location

Ideal Equipment

- 1 umbilical artery catheter
 - French 3.5 <1.2kg
 - 5.0 for >1.2kg
- 1 umbilical venous catheter single or double lumen may be chosen depending on individual patient requirements
 - French 3.5 <1.5kg
 - French 5.0 >1.5kg
- scalpel blade
- arterial probe/dilator
- forceps
- scissors
- needle holder
- pots to hold cleaning solutions
- Gauze swabs
- Tape measure
- Sterile gown and gloves
- 1 sterile plastic drape
- 1 arterial transducer
- 2 disposable Luer lock 3-way tap
- 2 x 5ml syringe and drawing up needle
- Arterial blood sampling syringe
- Heparinised saline
- 2 x 10ml ampoule 0.9% saline
- 1 non-absorbable suture 2/0 or 3/0
- Skin preparation solution: 0.05% aqueous chlorhexidine
- Infusion pump
- Elastoplast / steri-strips/ tegaderms for taping of catheter

Insertion Length

Should be calculated prior to insertion using NeoMate or validated calculation

Eg. Shukla and Ferrara:

- UVC: $1.5 \times \text{Birth Weight (kg)} + 5\text{cm} + \text{stump length}$

- UAC: $3 \times \text{Birth Weight (kg)} + 9\text{cm} + \text{stump length}$

Or direct measurement of the shoulder-umbilical length: measure the perpendicular distance from an imaginary line drawn between the shoulders to the level of the umbilicus and calculate the catheter lengths – see appendix A)

Method

1. Estimate the position of catheter length and write it down where you can see it later
2. Optimise and maintain the infant's environment: in preterm babies, ideally, the procedure should be done through the porthole doors to maintain temperature.
3. Use full aseptic technique wearing sterile gown and 2 pairs of gloves.
4. Prepare your equipment, including:
 - a. Flush the catheters via the 3-way tap with normal saline, leave the syringe of saline attached to 3 way tap throughout the procedure. Never leave catheters open to atmospheric pressure. The abdominal venous system is under negative pressure so on deep inspiration air can enter the catheter and cause an air embolism.
 - b. Cut a hole in the centre of the sterile towel if not pre-cut.



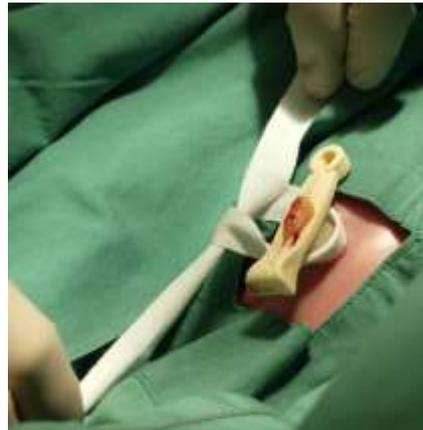
5. With a pair of straight forceps grasp the end of the cord clamp and clean the umbilical cord, cord clamp and surrounding 3-4cm of abdomen with a non-alcohol based solution. Allow time to dry. Preparation of the skin at the insertion site is regarded as one of the most important measures for preventing catheter related infection.

Note. Do not allow the solution to pool under the infant as it may burn the skin of very low birth weight infant. Change any damp or wet linen under the infant immediately following the procedure and wipe any excess solution from the skin using sterile water.

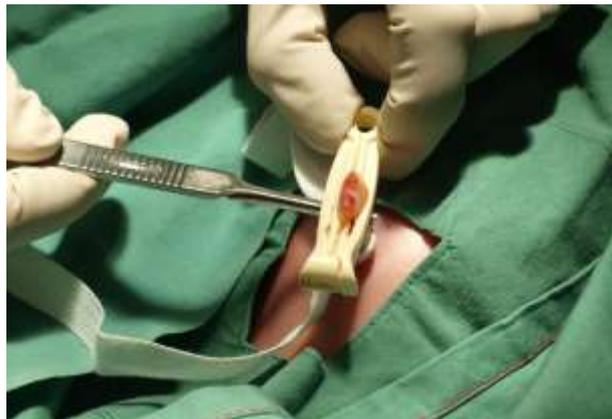
6. Pass the umbilicus through the hole in the sterile towel. The entire baby and all surfaces from the baby's neck to the foot of the incubator should be draped to create a sterile field. Only the cord should be visible or exposed. Ensure ET can be seen if applicable. Remove 'dirty' pair of gloves at this point.



7. Tie umbilical tape (or a short piece of rolled gauze) around the base of the cord – tightly enough to minimise blood loss but loosely enough that the catheter can pass.



8. Using scalpel cut cord cleanly 1-1.5cm from skin. Place the edge of the scalpel patient side of the forceps and cut away in one direction. Try not to make a sawing action. Remove the section of cord with clamp that is cut off and dispose of it. Take care that this does not touch the sterile field.



9. Identify the umbilical vessels:
- Vein: single, large, thin walled
 - Artery: two, smaller, thick wall, generally constricted so that the lumen may appear pinpoint

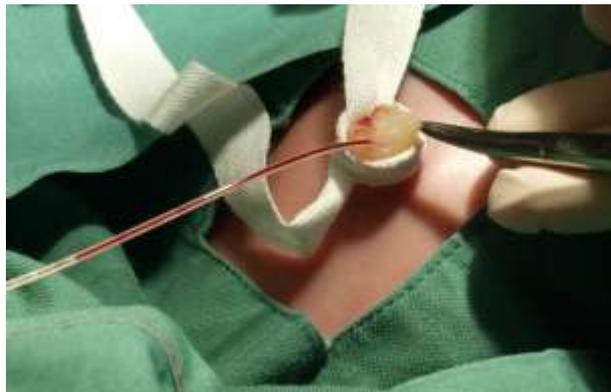


10. To insert the UAC. stabilise the umbilical cord and if needed gently open it using either the fine forceps or fine probe. Gradually dilate the artery, advancing either to the curve of the forceps or to half of the probe length.

Cannulate the artery and gently advance the catheter. Obstruction may be encountered at the anterior abdominal wall. Gentle steady pressure with slight rotation may help overcome this. Repeat probing or excessive pressure must be avoided to prevent pushing the catheter outside the vessel lumen causing a false passage.



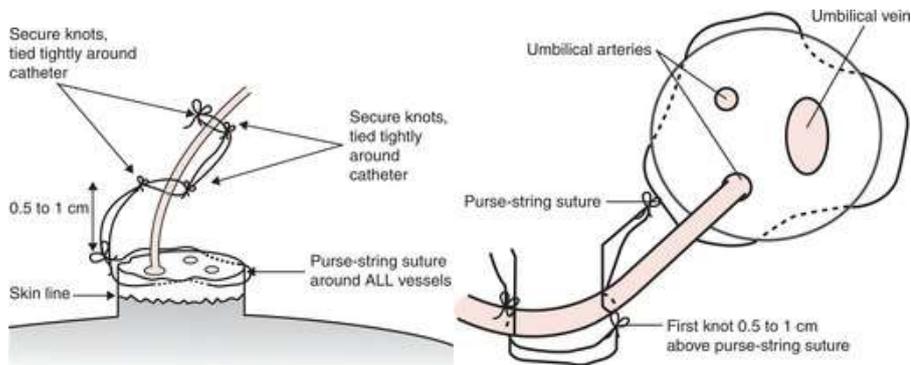
11. Ensure patency of catheter by checking for easy withdrawal of blood and “pulsation” of blood/saline in the catheter. A blood sample may be taken for immediate arterial blood gas prior to flushing the catheter with saline.



12. Careful observation peri-umbilically and distally in the lower limbs and buttocks, if visible, for blanching, cyanosis or mottling throughout the procedure. If persistent the catheter should be removed.
13. Temporarily secure the catheter using a suture, steri-strips or Elastoplast. Great care should be taken to ensure that the catheter cannot move whilst awaiting X-rays.
14. To insert the UVC, stabilise cord and insert catheter into vein to required length. Some resistance may be felt at the umbilical ring just below the level of the skin; apply gentle pressure until the catheter passes through.
15. It should be possible to aspirate blood easily if the catheter is in the correct position - If blood is not drawn back easily insert the catheter a little further or withdraw it back slightly and try again. Flush the catheter with saline to avoid clotting and secure as for the UAC.
16. Check position of catheters by x-ray (see below). A malpositioned catheter should either be replaced or pulled back to a suitable position. A catheter should not normally be advanced, rather removed and resited under sterile conditions.

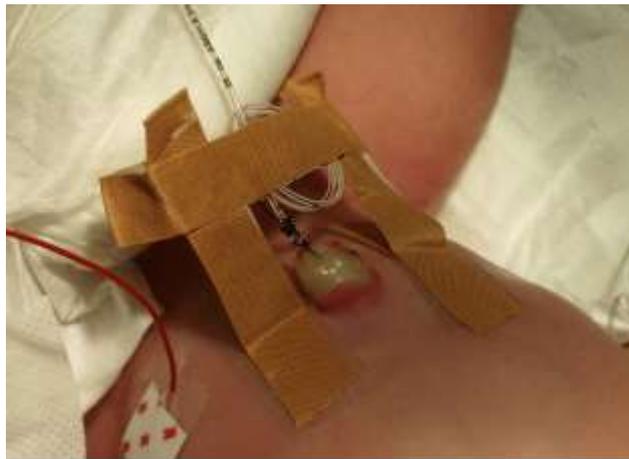
17. Secure the catheters –this can be done in whatever way you are familiar with providing it is secure.

One suggested approach to do is to tie a base suture by suturing through a large chunk of cord (avoiding puncturing the skin or catheter) or a purse-string suture using 3 bites of umbilicus around its circumference Tie a knot around the umbilical catheter close to the insertion point. Pass the suture around the catheter again, 1-2mm higher up, and tie another knot in identical fashion. This step can be repeated a number of times with steri-strips or Elastoplast placed on top for additional security if required.



18. further security for transport, a loop made from the catheters above the Elastoplast or steri-strip portion can be taped down to the abdomen using tegaderm or a “bridge”.

Note. Preterm babies should not have adhesive materials applied directly to their skin due to its fragility.



19. Connect UAC to heparinized saline infusion 0.5-1.0 ml/hr (1unit/ml) and check for arterial waveform on arterial transducer after it is connected and calibrated.
20. Connect UVC to infusion solutions, taking care to ensure that there will be at least a minimal infusion (0.1mL/hr) if drug infusion rates are reduced.
21. Fully document the procedure including the insertion depth of the catheters and x-ray appearance. The insertion depth should be documented at the start and end of transfer to ensure the lines have not moved.

Failure to Insert Catheter

If unsuccessful, ask for help. For UACs, the most common error arises after cannulating the layer between the vascular intima and the muscle and forming a “false passage”. This usually occurs if dilatation of the artery in the cord has been inadequate. Do not attempt the 2nd artery unless very experienced.

For very friable arteries, an alternative technique is to grasp the end of the vessel with forceps and gently ‘stroke’ transversely across the vessel with the scalpel blade below the forceps to make a small cut which should then gape and expose the lumen for cannulation. This approach carries a greater risk of false passage between the intima and muscle.

A UVC should be easy to insert. If the vessel has been identified, the most likely reason for failure to advance more than 4-5cm is a false passage within the visible cord stump or entering the portal or hepatic venous circulation. "Railroading" a second catheter is no longer advised⁴. A catheter that is stopping more deeply may be failing to advance through the ductus venosus. This may be overcome by pulling the catheter back to about 4-5cm, then advancing the catheter whilst rotating the catheter clockwise.

In the context of transport, the benefits of further attempts at siting lines should be weighed up against further delay in transfer.

Emergency UVC Insertion

In a true emergency, a UVC may be inserted and secured with tape. Full aseptic technique may not be possible but should be followed as closely as possible. A non-aseptically sited catheter should be removed or replaced as soon as it is clinically safe to do so.

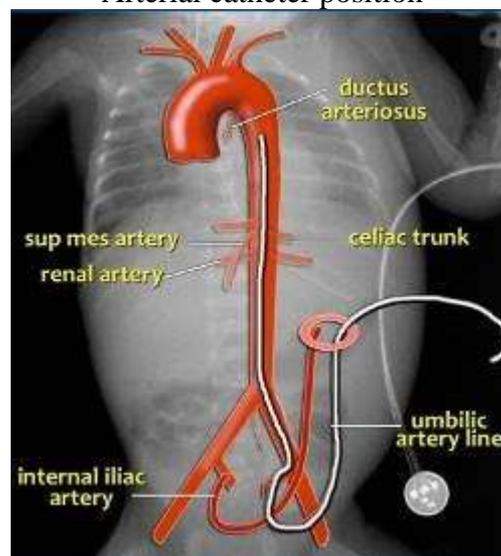
X-ray positions

The arterial catheter is identified by its 'looping' passage down to the internal iliac arteries and up through the abdominal aorta. Its tip must be sited away from the origins of the mesenteric and renal arteries. There are two suitable positions for the arterial catheter:

1. **HIGH POSITION:** Tip between T6 –T10 This is in the descending aorta above the origin of the mesenteric and renal arteries and below the ductus arteriosus.
2. **LOW POSITION:** Between L3 – L5 This coincides with the aortic bifurcation at the upper end of L4 and is below the major aortic branches.

High UAC position is associated with significantly lesser risks of clinical vascular compromise as it avoids the origins of the major arteries. **This position should be the ideal position** unless a low position is the only position that can be obtained and a UAC is deemed necessary for optimum patient care.

Arterial catheter position

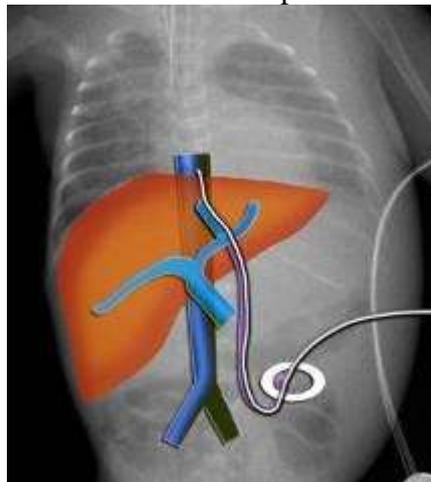


The UVC should be sited at approximately the level of diaphragm at the junction of ductus venosus and IVC, but outside the cardiac silhouette. Placement of the catheter tip in the portal or hepatic venous circulation is not recommended due to an increased risk of venous thrombosis.

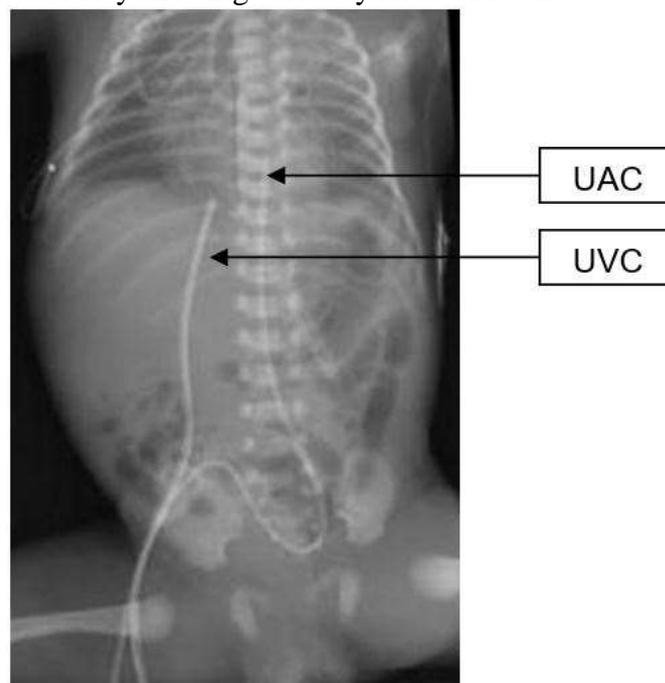
If the need for non-isotonic fluids (e.g. high concentration dextrose) is thought to outweigh the clinical risk, a UVC sited in the portal/hepatic system may be measured radiographically and pulled back into the umbilical vein for short-term use. A UVC tip sited below T10 carries a significantly higher risk of extravasation. It may be necessary to use these catheters in the short term, but they should be replaced at the earliest opportunity.

A repeat x-ray should be performed following major positional change of a catheter to confirm correct tip position. Deferral of repeat X-rays to the receiving unit for minor positional adjustments can be considered.

Venous catheter position



X-Ray showing correctly sited UAC and UVC



(Image from: <https://www.clinicalguidelines.scot.nhs.uk/ggc-paediatric-guidelines/ggc-guidelines/neonatology/umbilical-catheters/>)

Ongoing Management

- Observe skin colour and note any skin blanching or bruising of limbs, toes or buttocks prior to, during and following the procedure and at any time that catheter is in situ. Report any concerns immediately.
- Low threshold to remove if any concerns +/- apply GTN patches if clinically indicated.

Complications

1. Malposition

- Vascular perforation of the umbilical arteries, haematoma formation and retrograde arterial bleeding
- Refractory hypoglycaemia with catheter tip opposite coeliac axis
- Peritoneal perforation
- False aneurysm
- Movement of catheter tip position due to changes in abdominal circumference
- Sciatic nerve palsy
- Misdirection of UAC into internal or external iliac artery or curving back on itself due to catching on the intima
- In heart and great vessels:
 - Pericardial effusion/cardiac Tamponade (cardiac perforation)
 - Cardiac arrhythmias – Withdraw line
 - Thrombotic endocarditis
 - Haemorrhagic infarction of the lungs
 - Hydrothorax (UVC lodged in perforated pulmonary vein)
- UVC In portal system:
 - Necrotizing enterocolitis
 - Perforation of colon
 - Hepatic necrosis:
 - Thrombosis of hepatic veins
 - Infusion of hypertonic or vasospastic solution into liver tissues

2. Vascular accident

- Vasospasm of the femoral artery causing blanching of toes or feet
- Embolisation from blood clot or air in the infusion system
- Thrombosis involving:
 - Femoral artery resulting in limb ischaemia, gangrene and loss of extremity or paraplegia
 - Renal artery resulting in hypertension, haematuria, renal failure
 - Mesenteric artery resulting in gut ischaemia, NEC
 - Aorta resulting in congestive heart failure
- Pseudocoarctation of the aorta

3. Equipment-related

- Bleeding due to accidental disconnection or from open connections
- Breaks in catheter and transection of catheter
- Intravascular knot in the catheter

4. Infection

- Cellulitis
- Line associated infection
- Necrotising enterocolitis

Appendix A: Umbilical line position graphs

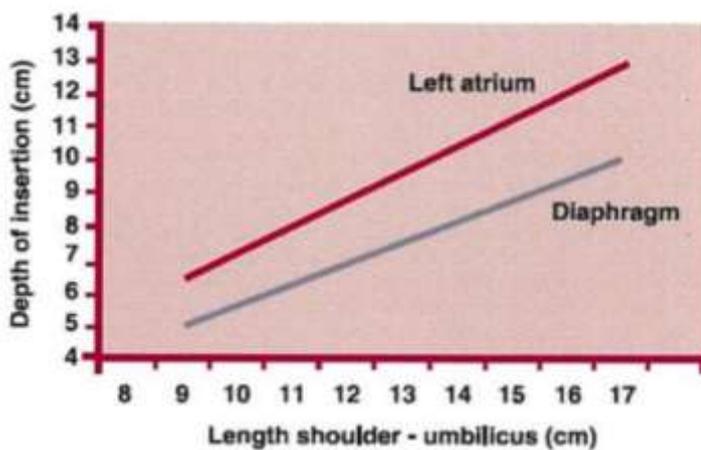


Figure 3 Relationship between shoulder-umbilicus length measurement and the depth of insertion needed to achieve an umbilical venous catheter tip placement between the diaphragm and the right atrium. Adapted from Dunn PM. Localization of the umbilical catheter by post-mortem measurement. Arch Dis Child 1966;41:69-75.

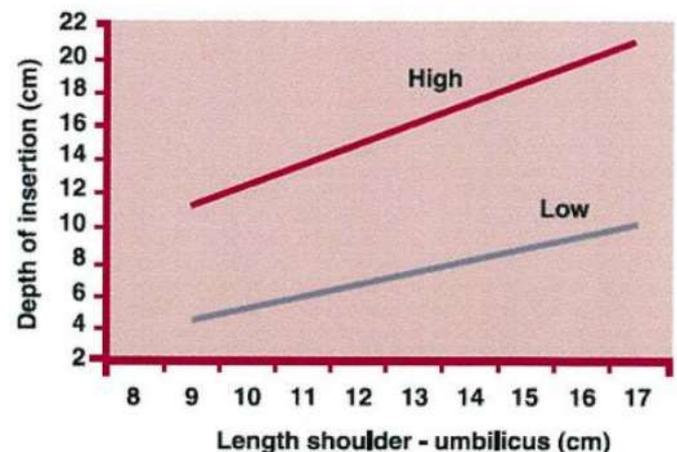


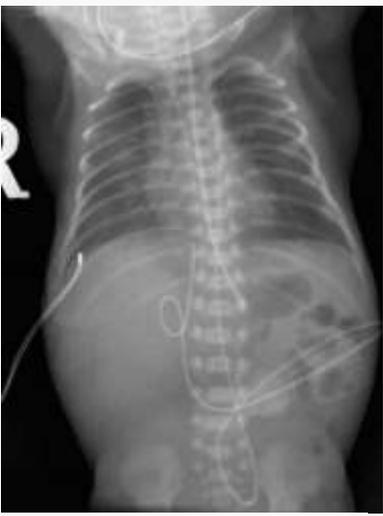
Figure 2 Relationship between shoulder-umbilicus length measurement and the depth of insertion needed to achieve an umbilical arterial catheter tip placement in the low or the high position. Adapted from Dunn PM. Localization of the umbilical catheter by post-mortem measurement. Arch Dis Child 1966;41:69-75.

UAC

UVC

(Graphs from: Central Access: Umbilical Artery & Vein Cannulation, College of Respiratory Therapists of Ontario, available from: http://www.crto.on.ca/pdf/PPG/Umbilical_CBPG.pdf accessed 1/3/2015)

Appendix B

COMMENT	IMAGE	COMMENT	IMAGE
<p>UAC is too high sitting in the left subclavian artery</p> <p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> - Withdraw - Re-image as major position change <p>UVC is too high</p> <p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> - Withdraw to sit outside the cardiac silhouette 		<p>Malposition of UVC in right portal vein</p> <p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> - Withdraw - Optimal to replace 	
<p>UAC is too high at T3</p> <p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> - Withdraw - Consider re-imaging <p>UVC is coiled in the liver and exits via the ductus venosus. The coil is probably within the capacious space where the umbilical vein and left portal vein join.</p> <p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> - Replace 		<p>Two UACs are in place:</p> <ul style="list-style-type: none"> - One in the right iliac artery - One in the lower aorta at the level of the upper border of L2. <p>Neither position is satisfactory</p> <p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> - Replace 	
<p>The UAC is at T9: satisfactory</p> <p>The UVC is in too far, passing through the foramen ovale and into left atrium</p>		<p>The UAC is looped upon itself and is probably tracking subcutaneously in the abdomen.</p>	

<p>then left ventricle.</p> <p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> - Withdraw - Re-image as major position change 		<p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> -Remove; replace if needed <p>UVC is in the right atrium</p> <p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> - Withdraw 	
<p>The UAC is in satisfactory position at the level of T6/7 UVC in too far (into jugular vein)</p> <p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> - Withdraw - Re-image as major position change 		<p>UVC lies over the liver outline but position satisfactory</p> <p>Note. the endotracheal tube is too low</p>	
<p>The UAC is high at T5</p> <p><u>Suggested Action:</u></p> <ul style="list-style-type: none"> - Withdraw <p>The UVC appears low but central</p> <p>May be ok to use - consider lateral X-ray or USS to confirm</p>			

References

1. NETS neonatal handbook 2003, www.wch.org.au/nets/handbook/
2. Teaching Files: Umbilical Artery Catheterization, Division of Neonatology, Cedars-Sinai Medical Centre, Los Angeles, California, Neonatology on the Web www.neonatology.org/syllabus/uac.html
3. Rennie & Robertson's Textbook of Neonatology, 5th Edition
4. BAPM Framework - [Use of Central Venous Catheters in Neonates - a Framework for Practice](#)