

Title:	Umbilical Catheter Insertion		
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Indications for Umbilical Arterial Catheter

- Frequent arterial sampling
- Direct BP measurement
- Frequent acid-base and oxygen monitoring
- Exchange transfusion

Indications for Umbilical Venous Catheter

- During resuscitation for administration of emergency drugs/fluids
- Difficult peripheral IV access
- Extreme prematurity
- Infusion of hypertonic solutions (eg >12.5% dextrose)
- Administration of vaso-active drugs
- Can be used for measurement of central venous pressure

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.

Contraindications

- Evidence of local vascular compromise in lower extremities or buttocks
- Peritonitis
- Necrotizing enterocolitis
- Omphalitis
- Omphalocele

Considerations

There are three key aims 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

- scalpel blade
- 2 probes: fine and medium
- forceps
- scissors

- needle holder
- 2 bowls
- Gauze swabs
- Tape measure
- Sterile gown and gloves
- 1 sterile plastic drape
- 1 umbilical artery catheter (French 3.5 for preterm baby, 5.0 for full term baby)
- 1 umbilical venous catheter (single or double lumen may be chosen)
- 1 blood pressure monitoring kit
- 2 disposable luer lock 3-way tap
- 2 x 5ml syringe and 18G needle
- Arterial blood sampling syringe
- 1ml ampoule heparin 1000units/mL
- 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
- Drug additive label
- Elastoplast / steri-strips for taping of catheter

Method

1. Estimate the position of catheter length and write it down where you can see it later
 - 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 using the graphs at the end of the protocol
 - Formula for UAC: $(\text{Weight (kg)} \times 3) + 9 + \text{length of the stump cm}$
 - Formula for UVC: $(\text{Weight(kg)} \times 1.5) + 5 + \text{length of the stump cm}$
2. Decide how to maintain the infant's environment: in preterm babies, ideally, the procedure should be done through the porthole doors, which may need to be taped back to avoid touching them with sterile items.
3. Begin the procedure using full aseptic technique wearing sterile gown and gloves.
4. Flush the catheters via the 3-way tap with normal saline, leave the syringe of saline attached to 3 way tap throughout the procedure.
5. Cut a hole in the centre of the sterile towel.
6. 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. Preparation of the skin at the insertion site is regarded as one of the most important measures for preventing catheter related infection.
7. 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.
8. Pass the umbilicus through the hole in the sterile towel and drape the towel around the umbilicus over the baby then hand the forceps to the assistant or place on towel.
9. Tie a short piece of rolled gauze around the base of the cord. It should be secure enough to maintain haemostasis but not too tight to prevent passage of the catheter. Within 6-12 hours of delivery there is a risk of haemorrhage from the arteries when the cord is cut.
10. Whilst the assistant or you applies gentle upward traction on the cord with the forceps, slice the cord with the scalpel, 1.5 – 2.5 cm from the skin margin.

11. Dispose of the forceps and cord clamp. Do not use this forceps again during the procedure.
12. Blot the cut surface dry and identify the umbilical vessels:
 - a. the single thin walled umbilical vein
 - b. two smaller thick walled round arteries, generally constricted so that the lumen appear pinpointed
13. Use the other forceps to secure and stabilise the umbilical cord.
14. If you are inserting a UAC do so first. Pick one artery and 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.
15. Cannulate the artery and gently advance the catheter. Obstruction may be encountered at the anterior abdominal wall or bladder. This can usually be overcome by 30-60 seconds of gentle steady pressure and pulling the umbilical stump up towards the baby's head to straighten out the artery as it turns caudally in the anterior abdominal wall just below the umbilicus. Avoid excessive pressure or repeated probing.
16. 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.
17. Secure catheter by placing a suture into the base of the cord, avoiding puncturing the skin or catheter, then tie securely around the catheter at the insertion site. The catheter may need securing temporarily with steri-strips or Elastoplast, or crossing over and tying the suture multiple times ascending the catheter. In either case great care should be taken to ensure that the catheter cannot move whilst awaiting x-rays.
18. To insert the UVC, stabilise cord using an artery forceps and with the second forceps grasp the wall of the vein. Insert catheter into vein to required length. Some resistance will be felt at the umbilical ring just below the level of the skin; apply gentle pressure until the catheter passes through. If in, catheter will fill with blood.
19. 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 temporarily as for the UAC.
20. 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, it should be removed and resited under sterile conditions.
21. Secure the catheters, ideally by crossing-over and tying the suture multiple times ascending the catheter then putting Elastoplast or steri-strips along the length; alternatively pull the loose ends of the suture along the length of the catheter and apply Elastoplast or steri-strips along the length. Preterm babies should not have Elastoplast applied to the abdomen.
22. For an active term babies with intact abdominal skin, a loop made from the catheters above the Elastoplast or steri-strip portion can be taped down to the abdomen.
23. 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.
24. 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.
25. Fully document the procedure including the insertion depth of the catheters and x-ray appearance.

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. 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. Try leaving the 'stuck' catheter temporarily in place and inserting a second catheter just next to it. This should not be attempted with the UAC. 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. A normotensive, normoglycaemic, non-polycythaemic infant probably does not need their umbilical lines urgently.

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.

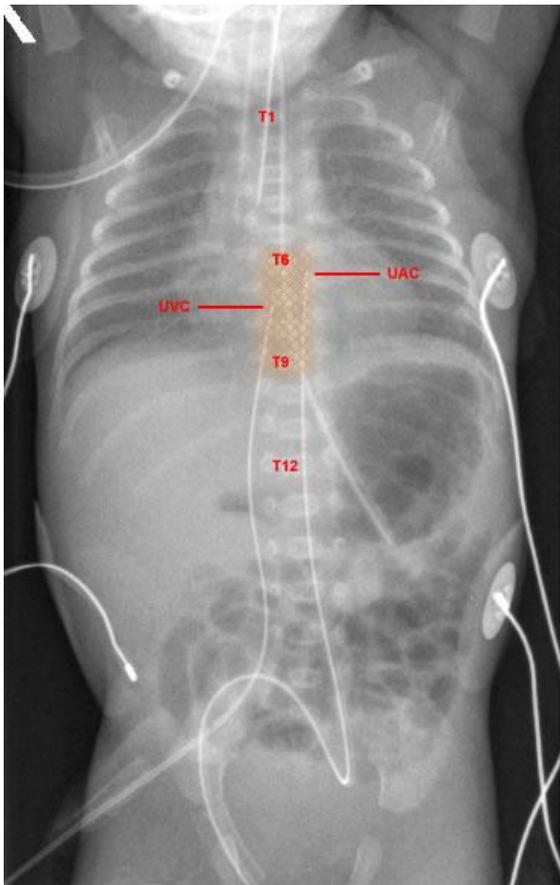
X-ray positions

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:** Between T6 –T10 This is in the descending aorta above the origin of the mesenteric and renal arteries and below the ductus arteriosus. The high position is associated with fewer episodes of blanching and cyanosis of the lower extremities. However hypertension may be more common and this position may also be associated with increased incidence of IVH.
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.

The UVC should be sited above the diaphragm at the junction of ductus venosus and IVC. Placement of the catheter tip in the portal circulation or liver is not acceptable.

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 system may be measured radiographically and pulled back into the umbilical vein for short-term use. It should be removed or resited at the earliest opportunity.



X-Ray showing correctly sited UAC and UVC

Unfortunately this film does demonstrate a malpositioned endotracheal tube, which should ideally be corrected before a potentially long procedure such as umbilical line siting.

(Image from: Auckland District Health Board
<http://www.adhb.govt.nz/newborn/TeachingResources/Radiology/UA-CUVCPlacement.htm>)

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 immediately.
- If one limb is involved, warm opposite limb to induce reflex vasodilatation of affected limb.
- If physical therapy fails, the catheter may be withdrawn 0.5 – 1.0cm and observe. Remove catheter if blanching persists. Small fragments of GTN patches (used for adult angina therapy) may be applied over distal arteries to treat suspected digit or limb ischaemia (unlicensed indication).
- Maintain infant supine or in lateral position for 24hours post procedure to observe for haemorrhage from umbilical stump.
- Keep catheter and infusion line clear of blood as blood clots may form. Remove all air bubbles in the infusion line and catheter. Interruption to infusion must be for as short a time as possible. Do not flush catheters quickly
- Filters are not used for arterial line. All connections must be luer lock.

Complications

1. Malposition
 - Vascular perforation of the umbilical arteries, haematoma formation and retrograde arterial bleeding
 - Refractory hypoglycemia 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

Umbilical line position graphs

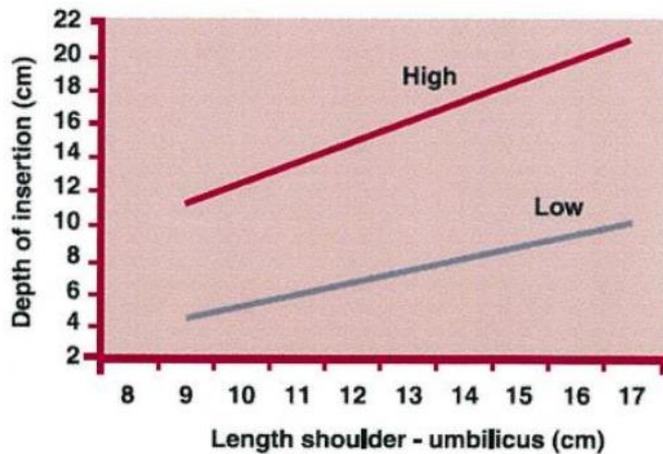


Figure 2 Relationship between shoulder-umbilicus length measurement and the depth of insertion needed to achieve an umbilical arterial catheter tip placement in the low or the high position. Adapted from Dunn PM. Localization of the umbilical catheter by post-mortem measurement. Arch Dis Child 1966;41:69-75.

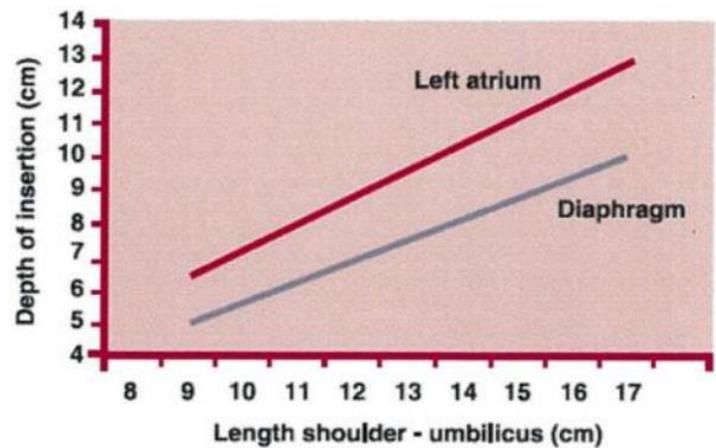


Figure 3 Relationship between shoulder-umbilicus length measurement and the depth of insertion needed to achieve an umbilical venous catheter tip placement between the diaphragm and the right atrium. Adapted from Dunn PM. Localization of the umbilical catheter by post-mortem measurement. Arch Dis Child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

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)

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