

# ARTERIAL CATHETER MANAGEMENT IN NEONATES - GCNC CHW

## PRACTICE GUIDELINE<sup>®</sup>

### DOCUMENT SUMMARY/KEY POINTS

- A guideline for clinicians in the Grace Centre for Newborn Intensive Care on inserting peripheral and umbilical arterial catheters, their management, sampling and removal.
- Invasive arterial monitoring is indicated when you are considering treating hypotension or frequent (ie less than -8 hourly) blood sampling is required.
- Arterial lines are inserted by a nurse practitioner or medical officer.
- Patency is maintained with heparinised saline infusion. No other substance should be infused or injected. The transducer needs to be calibrated 8/24.
- The fluid in the line needs to be contiguous with no air present.
- Arterial blood sampling is performed by accredited staff only.
- Distal perfusion should be checked and documented hourly whilst the line is in situ.
- Insertion sites need to be observed for 4 hours post removal of an arterial line.

This document reflects what is currently regarded as safe practice. However, as in any clinical situation, there may be factors which cannot be covered by a single set of guidelines. This document does not replace the need for the application of clinical judgement to each individual presentation.

<b>Approved by:</b>	Director of Clinical Governance	
<b>Date Effective:</b>	1 <sup>st</sup> March 2017	<b>Review Period:</b> 3 years
<b>Team Leader:</b>	Staff Specialist	<b>Area/Dept:</b> GCNC

## CHANGE SUMMARY

- Details on the insertion and monitoring of arterial catheters in neonates
- The updated sampling technique for both umbilical and peripheral artery catheters.
- Inclusion of additional pictures to help guide practice.
- Referencing has been updated.

## READ ACKNOWLEDGEMENT

- Medical and nursing staff receives education and supervision in the management of arterial lines.
- Nursing staff are required to complete a biannual accreditation and eLearning program.
- Clinical staff caring for neonates with arterial lines should read and acknowledge this document.

This document reflects what is currently regarded as safe practice. However, as in any clinical situation, there may be factors which cannot be covered by a single set of guidelines. This document does not replace the need for the application of clinical judgement to each individual presentation.

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## Management of arterial lines

### **Defining Statement**

Invasive blood pressure measurement provides beat to beat assessment of the heart rate and blood pressure<sup>1,2</sup>. In infants with normal blood pressure non-invasive blood pressure measurement is considered an accurate means of measurement. For infants with fluctuating blood pressure (hypo or hypertension) or when delivering chronotropic medication intra-arterial monitoring is more accurate and recommended to support clinical management. Additionally indwelling arterial lines allow painless and free flowing blood sampling for infants.

## Terminology

### **Systolic Blood pressure**

Systolic pressure represents the peak pressure in the arteries during systole. Changes in the stroke volume can be reflected in the systolic pressure<sup>1</sup>.

### **Diastolic Pressure**

Diastolic pressure is the sustained pressure within the cannulated artery when the heart is relaxed allowing filling in diastole. It is a combination of the pressure exerted by the blood flow with in the artery and the vascular compliance of the arterial wall. In the newborn the heart rate influences diastolic ventricular filling time and the bradycardic or 'diving' reflex actually initially increases the blood pressure.<sup>1</sup>

### **Mean arterial Pressure (MAP)**

The mean arterial pressure is a calculated by the following:

$$\text{MAP} = [(2 \times \text{diastolic}) + \text{systolic}] / 3$$

In neonatology it is used as a guide to the overall perfusion of the infant. Mean BP is calculated using the 10<sup>th</sup> Centile in the first 24hours according to birth weight:

Birth Weight	10th centile for MAP
500-750 grams	26 mmHg
750-1000 grams	28 mmHg
1000-1250 grams	29 mmHg
1250-1500 grams	30 mmHg

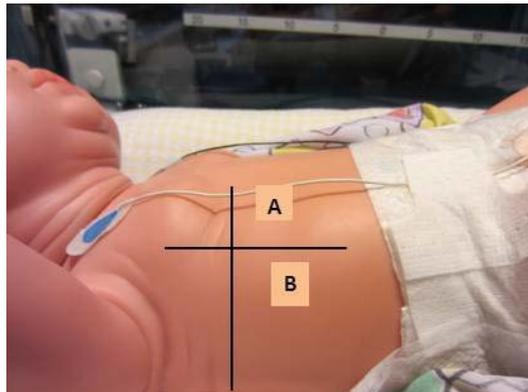
From these calculations it can be derived that MAP should be maintained above the gestation in weeks. There is some evidence that babies who mean arterial pressure is  $\geq$  33mmHg have better developmental outcome and less brain injury.

### **Pulse Pressure**

Pulse pressure is the difference between systolic and diastolic pressure. It is a reflection of the filling or intravascular volume during diastole. A widened pulse pressure is seen where there is run off into the pulmonary circulation via a widely patent ductus arteriosus or where there is inadequate filling in hypovolemia or sepsis. A narrow pulse pressure may indicate a failing line or reflect increased vascular resistance.

### **Phlebostatic axis**

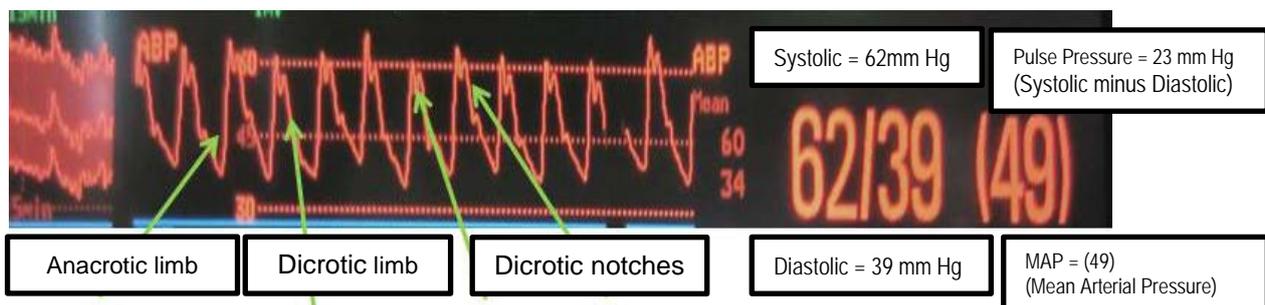
The phlebostatic axis provides an external reference point that approximates the anatomic level of the left and right atria and the pulmonary artery (**Figure 1**).



For a newborn in the supine position, locate the insertion of two imaginary lines, one drawn from the fourth intercostal space at the sternum toward the axilla and one drawn horizontally down the anterior axillary line. An imaginary vertical line from the fourth intercostal space at the sternal border to the right side of the chest (A)

A second imaginary line is drawn horizontally at the level of the midpoint between the anterior and posterior surfaces of the chest (B). The phlebostatic axis is located at the intersection of points A and B.

Figure 2. Normal arterial line waveforms in Neonates



### **Technique for calibrating “zeroing” the system**

The arterial monitoring transducer must be zeroed on insertion, once per shift and if there is major position change of the infant in relation to transducer.

The right atrium is used as a reference point for arterial and central venous pressure measurements. The position of the right atrium is estimated at the phlebostatic axis. The site

of the phlebostatic axis is at the intersection of the fourth intercostal space and mid axillary line.

“Zeroing” is the method of calibrating the system to atmospheric and hydrostatic pressure.

- The transducer is levelled with the phlebostatic axis.
- The stopcock on the transducer is opened to air and the cap removed.
- Zero is pressed on the module.
- Once the module indicates that zeroing has occurred the cap can be replaced on the transducer and the stopcock closest to the infant can be repositioned to neutral position.

## Insertion of a peripheral artery cannula

### Preferred sites

In the newborn, the radial, dorsalis pedis and posterior tibial sites are preferred over the brachial, femoral or axillary sites of insertion<sup>6</sup>. Brachial or femoral arteries are avoided where possible as these are prone to thrombosis and may not have adequate collateral circulation to compensate. In the critically ill patient however brachial or femoral access may be necessary at the discretion of the Neonatologist.

### Patient Safety

An artery with collateral circulation should only be cannulated. An Allen test should be performed when the line is planned for the radial or ulna artery to ensure adequate collateral perfusion of the hand.

### Allen's test

Accessing collateral circulation can be achieved by performing the Allen's test if using an upper limb. The Allen's Test is a measurement of radial or ulnar patency. Performing the Allen's test in a neonate involves elevating the arm and simultaneously occluding the radial and ulnar arteries at the wrist, then rubbing the palm to cause blanching. Release the pressure on the ulnar artery (see Figure 3). If normal colour returns to the palm in <10 seconds adequate ulnar circulation is present. Performing and reporting the results of the Allen's Test must be documented in the medical record.

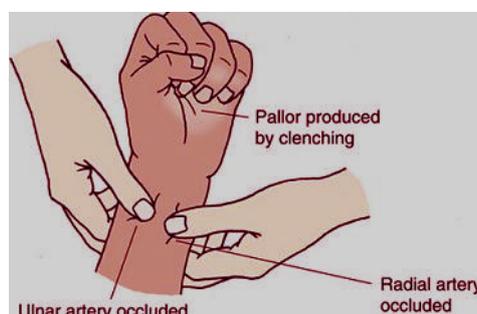


Figure 3. Allen's test

- If placing a line in the foot the perfusion must remain adequate post insertion.

- Arterial cannula should not be inserted in sites where there may be vascular compromise or thrombosis.
- Aqueous chlorhexidine is the preferred solution for skin preparation prior to insertion.
- The arterial line set-up must be connected to the cannula with extension tubing with red hub. This ensures;
  - The safety of a double Luer lock
  - Ease of identification that the catheter is arterial rather than venous
- Label the line with a sticker stating that it is Arterial.
- When priming the arterial line ensure that all air is removed from the system as the smallest amount of air can distort waveforms and arterial pressure readings<sup>2</sup>.

## Developmental and family support

- Explain the purpose and procedure to the parent(s).
- Administer sucrose to the infant two minutes prior to the procedure.
- Ensure the limbs are supported to prevent damage to joints and underlying nerves.
- Provide containment and support to the infant during the procedure

## Technique

The allocated patient nurse assists the medical officer or nurse practitioner with the insertion of the arterial cannula. This assistance not only involves the actual technical aspects of cannula insertion but ensures the infant is positioned appropriately, contained and supported.

Prepare the heparinised saline flush solution and prime the arterial line prior to cannulation to ensure efficiency of attachment and line maintenance post insertion.

The infusion solution is ordered on the fluid chart by the medical officer and checked by two registered nurses, or a doctor and a registered nurse.

### ***Equipment required for setting up system***

- Pressure module and transducer
- Transducer holder
- Normal Saline (50mL IV pack) or
- Pre-packed heparinised saline syringe 50IU/ml if available
- Heparinised Saline (50unit/5mL)
- 50 mL syringe
- 5mL syringe
- 19 gauge needle x 2
- Label for infusing fluid

### ***Equipment for cannula insertion***

- 24 gauge cannula (unless other gauge specified)
- Dressing pack
- Aqueous chlorhexidine solution
- Lignocaine 1%
- Pre-cut tape for securing cannula
- Appropriately sized arm board
- Cold light for visualising the artery to be cannulated

### ***Insertion Technique***

1. Hands are washed for one minute prior to donning clean gloves.
2. The site is cleaned with aqueous chlorhexidine solution.
3. The area to be cannulated is infiltrated with Lignocaine 1% (maximum 0.5mL/kg).
4. The artery is cannulated with an appropriate size cannula and the cannula is flushed and circulation to limb observed
5. One tape is applied to secure the cannula.
6. The primed arterial safe set is then attached to the cannula.
7. The line is then secured with further taping as per unit's protocol
8. The arterial line transducer is connected to the module cable
9. The arterial line is 'zeroed'
10. The procedure is documented in the Critical Care Information System (electronic medical record) by the proceduralist.

### **Securing the Arterial Cannula**

- The arterial cannula must be securely strapped. The suggested method is to place two 1cm tapes underneath the cannula and cross them over the top. A further piece of tape is placed lengthways across the cannula.
- The limb must be supported by an arm board that is placed on the back of the arm and taped securely in place allowing slight extension of the wrist.
- Skin area at cannula tip should be visible.

### **Priming the Safeset™**

1. Clean hands
2. Prepare Heparinised saline syringe by adding 50 International Units(IU) of Heparinised Saline (50International Units/5mL concentration) to 50mL of 0.9% sodium chloride or use pre-filled heparinised saline syringes of 50International Units/5mL concentration if available.

3. Label syringes in accordance with current practice/policy. (i.e. Final Concentration = 1IU/mL)
4. Add extension tubing with **no** pressure disc to the end of the syringe.

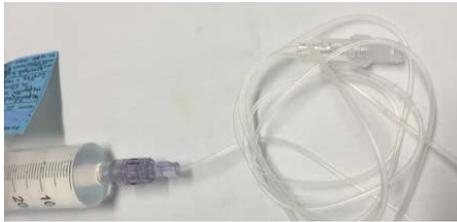


Figure 4. Syringe attached to tubing

5. Open arterial safe set kit and luer lock the 50mL Heparinised Saline syringe to the syringe driver tubing
6. Prime transducer and Safeset reservoir with heparinised saline
7. To Prime Transducers:
  - o Turn 3-way tap off to "patient" line.
  - o Squeeze the wings on the transducer while simultaneously pushing the plunger on the syringe till heparinised saline exits the side port.
  - o Place a red cap on the end.
8. To Prime the Safeset™ Reservoir:

<p><b>Step one:</b> Unlock the wings, pull back on the plunger to 2 -3mL.</p>	
<p><b>Step two:</b> Turn the reservoir upright, squeeze wings of the transducer whilst simultaneously pushing the plunger on the syringe and allow the reservoir to fill with heparinised saline until the fluid exits the end of patient line.</p>	

<p><b>Step Three:</b> Tap to ensure all bubbles are removed by purging the line</p>	
<p><b>Step Four:</b> Return the reservoir to the locked position.</p>	
<p><b>Step Five:</b> Place Arterial sticker 10 cm above the Black Demarcation line.</p>	

9. Place syringes in alaris pumps and program each to run at 0.6mL/hr.

10. Check the entire system to ensure there are NO air bubbles before connecting to baby and zero the transducer before starting the infusion

## Umbilical Artery Catheterisation

### Equipment required setting up system

- As listed for peripheral arterial line

### Equipment for catheter insertion

- Dressing Trolley
- Sterile gown and gloves

- Dressing pack
- Umbilical Artery Catheterisation Tray
- Umbilical arterial catheter appropriate to infants size( usually 3.5Fg< 1500g 5fg for larger infants)
- Dressing trolley
- Plastic drape to provide sterile field
- Minor procedure drape
- 2mL syringes
- Heparinised saline 50units/5mL

## Insertion Technique

1. If placing UAC and UVC then it is technically easier to put UAC in first – it is more stable and will not come out and it is slightly more challenging to place.
2. The caveat to this is if the vein is bleeding or the baby is hypoglycaemic – insert UVC first and correct hypoglycaemia, stem bleeding with catheter insitu.
3. Ensure infant is stable in a thermoneutral environment and with adequate oxygenation and monitoring insitu. It is desirable for some part of the baby to be visible (to monitor skin colour). In infants under 1.2kg it is best practice to do this procedure in a double walled isolette to maintain thermal control and humidity.
4. Set up trolley with equipment
5. Direct all monitoring leads away from the abdomen and ensure they are secure.
6. Measure umbilicus to shoulder tip as a guide to estimate the length the catheter is to be inserted.
7. Wipe trolley down with hospital antiseptic.
8. Doctor scrubs and double gloves – sets up trolley with assistance from nursing staff and primes lines
9. A nurse must be available continuously at the bedside during this procedure to support the newborn during the procedure.
10. Sterilise umbilical area and stump including clamp with sterile solution – do not allow solution to pool under baby as may cause burns to the skin in the ELBW infant.
11. Apply clear plastic drape over infant and then fenestrated drape over and around umbilicus (see Figure 11).



Figure11. Example of draping with green sterile drapes please use clear plastic drapes

12. Cotton umbilical tie is tied loosely around base of stump to temper bleeding (see figure 12).

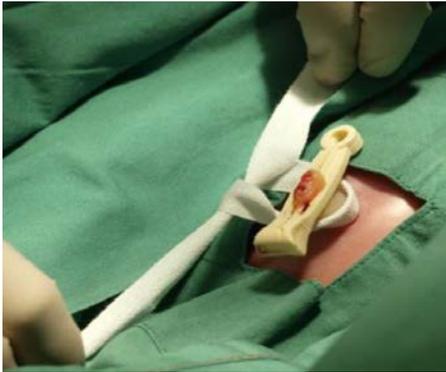


Figure12. Example of Umbilical tie.

13. If under 1.2kgs then fenestrated drape can be stuck to plastic wrapping of baby – do not adhere to premature skin.
14. Hold clamp with gloved hand and gauze and cut stump under clamp at least 1cm from skin
15. Discard clamp and excess cord (some parents may want to keep this)
16. Discard scalpel into sharps bin
17. Blanch stump with gauze
18. Reapply sterile fluid
19. Remove outer gloves and move lines and instruments to sterile field on baby
20. Grasp cord stump also known as 'Wharton's jelly', using tissue forceps and identify vessels – usually one large vein and two smaller arteries. Arteries often protrude up and out of Wharton's Jelly.

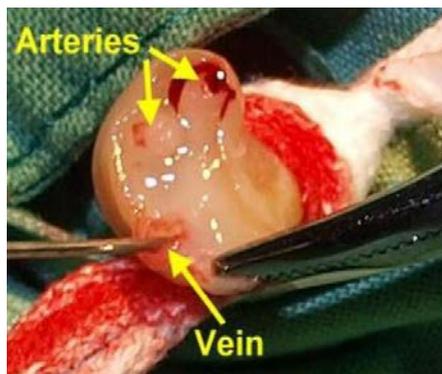


Figure13. Example of Vein and arteries in umbilical cord.

21. The curved mosquito forceps can be used at three points around the Wharton's Jelly – grab a portion and then turn the forceps over and lay on drapes – this stabilises the stump for insertion of lines.
22. Again using the tissue forceps grasp the Wharton's Jelly at point close to (but not on) the identified artery to be catheterised.

23. Introduce one of the points of the ophthalmic forceps into lumen of artery and probe gently to depth of 0.5cm.
24. Once the lumen is a little open, you can introduce both points together and then gently prise the lumen apart. Allow points to spring apart and maintain forceps in this position for 5-10 seconds to dilate the vessel. This may result in spurting blood and you will need to quickly insert the catheter to stem the flow.



Figure14. Example of opening the lumen

Although dilatation may take some time, it ensures a clear path into the vessel prior to catheter insertion, which in turn increases likelihood of success.

25. With the ophthalmic forceps lift catheter 1cm from tip and insert catheter into lumen of artery.
  - Do not hold catheter with gloved hands to prevent contamination of the line
  - Avoid holding the catheter with toothed forceps they may lacerate the catheter and cause extravasation of fluids



Figure15 Demonstrating hands off technique.

26. After passing the catheter approximately 5cm into vessel with a firm, steady motion, aspirate blood to verify intraluminal position. Withdraw ABG/ FBC/Culture and BSL.
27. Clear blood by injecting 0.5mL of flush solution.
28. Advance the catheter to the desired length taking into account the umbilical stump length.
29. Check measured length of catheter before taping. This allows displacement of the catheter to be readily recognised.

**Do not use the scalpel to further cut down or “trim” the umbilical stump whilst any catheter is located in any umbilical vessel. Accidental cutting of an indwelling catheter may result in the distal portion of the catheter immediately disappearing into a large vessel.**

## Trouble shooting complications associated with *UAC insertion*

Resistance before tip reaches abdominal wall (less than 3cm from surface of abdominal stump).	<ul style="list-style-type: none"> <li>Loosen umbilical tie</li> <li>Re-dilate artery</li> </ul>
Popping" sensation rather than "relaxation"	<ul style="list-style-type: none"> <li>Catheter may have exited lumen and created false channel.</li> <li>Remove and use second artery. Observe for intra-abdominal haemorrhage.</li> </ul>
Backflow of blood, particularly around vessel	<ul style="list-style-type: none"> <li>Tighten umbilical tape.</li> <li>Catheter may be in false channel with extravascular bleeding.</li> <li>Remove and use second artery.</li> </ul>
Resistance encountered at anterior abdominal wall or sharp turn in vessel as it angles around bladder toward internal iliac artery (approximately 6-8cm from surface of umbilical stump in 2- 4kg neonate).	<ul style="list-style-type: none"> <li>Apply gentle but steady pressure for 30-60 seconds.</li> <li>Position infant on side with same side elevated as artery being catheterized. Flex hip.</li> </ul>
Easy insertion, but no blood return	<ul style="list-style-type: none"> <li>This is rare and may indicated that the catheter is outside vessel and in a false channel.</li> <li>Remove and observe infant carefully for evidence of complications/internal haemorrhage.</li> </ul>

## Securing the UAC

This component often occurs in combination with the UVC:

- A purse-string suture (3.0 silk suture) is inserted into the umbilical stump (not surrounding skin area) and then looped around catheter to secure line. Make sure suture loops are not too tight to cause occlusion to catheters.
- Suture each line separately to facilitate adjustment of lines post check X-ray
- Apply leucoplast in goal post formation maintaining UVC and UAC separate again to facilitate adjustment post check Xray (see Figures six, seven and eight)
- Two pieces of protective dressing - DuoDERM<sup>®</sup> should be cut and positioned to fit under the leucoplast. The DuoDERM<sup>®</sup> is used to protect the skin and provide a barrier against epidermal stripping should the tape be removed in the first days following birth.

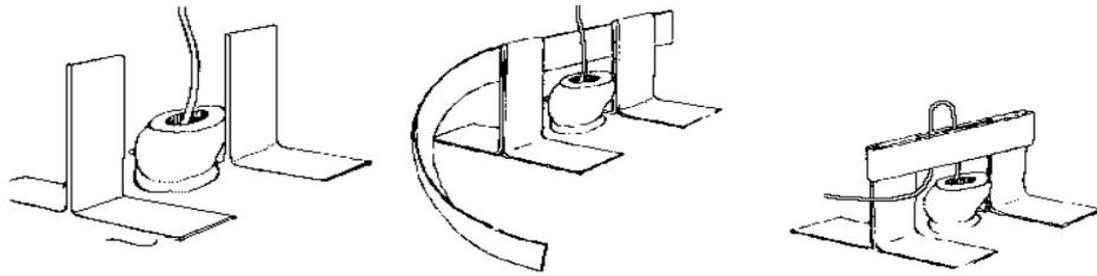


Figure 16. Demonstrates securing method

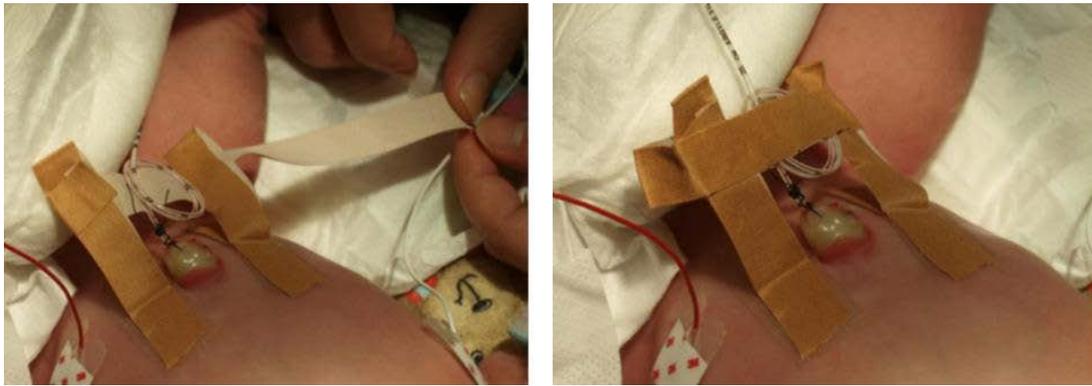


Figure 17. Ensure tape is secure and catheter is looped so that accidental tension to line will not displace catheter

## X-ray confirmation of line position

There are two potential tip positions for the UAC. These are described as “high” or “low”.

- The high position is tip “above the diaphragm” at the level of thoracic vertebral bodies T6-T10. This position is above the coeliac axis (T12), the superior mesenteric artery (T12-L1), and the renal arteries (L1). Figure 9.
- The low position is tip at the level of lumbar vertebral bodies L3-L4. The inferior mesenteric artery (IMA) arises from L3-L4. This position is essentially between the bifurcation and IMA origin. Lying below the major aortic branches. In most infants this position coincides with aortic bifurcation at upper end of the 4th lumbar vertebra.

A Cochrane Systematic Review suggests that a high position is preferred as it is associated with fewer obvious vascular complications, a probable reduction in the incidence of aortic thrombus and longer catheter life. All catheters should be checked radiographically for correct placement.

- Correctly placed UVC/UAC lines: UAC and UVC should be located on the left and right paramedian respectively.
- Ideally, both should be above the diaphragm with the UAC between T6 and T9.

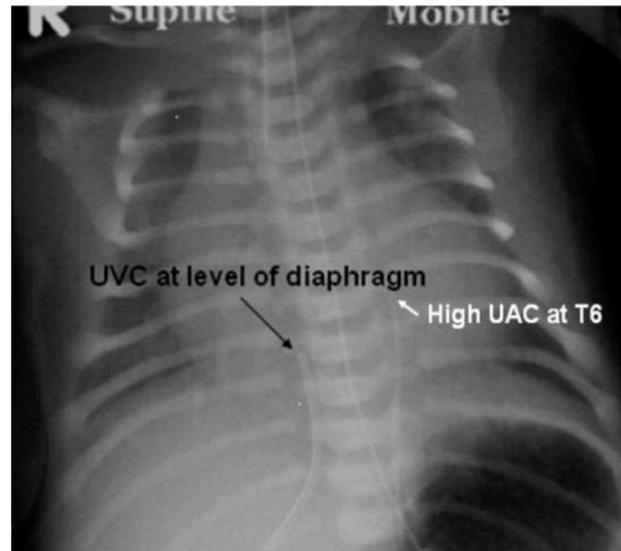


Figure 18. Demonstrating UVC position on x-ray.

- Immediately check colour, perfusion and warmth of buttocks and lower limbs (UAC). Recheck at regular intervals.

## Documentation

1. Proceduralist is required to document insertion in electronic medical record including the type/size/length of catheter inserted in centimetres.
2. Position of catheter tip on x-ray in relation to landmarks.
3. Colour, perfusion and warmth of lower limbs and buttocks.

## Catheter care

- Unless the sterile field has been maintained you should not advance catheters following x-ray as this may introduce infection and potentially contaminate a line. In this instance the line should be removed and a new line placed.
- Do not leave catheter open to atmosphere due to the danger of air embolus.
- If removing the catheter for any reason, do so slowly over 30-60 seconds to allow spasm to assist control haemorrhage.
- Attach infusion as soon as appropriate tip position has been confirmed to reduce risk of blockage.
- There may be more bleeding from the umbilical vein than the artery as it is not a contractile vessel. If bleeding persists tighten the cotton tape slightly around stump ensuring not to occlude lines.
- If the site continues to ooze wrap Calдостat<sup>®</sup> or Hemostat<sup>®</sup> or similar haemostatic agent around stump and consider reviewing the coagulation profile of the infant.

### **Patient safety specific to management of UAC**

- Carefully label the arterial catheter, the associated tubing and infusion pump to avoid inadvertent administration of vasoactive substances or medication through the artery.
- Inspect the integrity of the catheter and infusion system every hour to avoid accidental haemorrhage<sup>5</sup>.
- Check that all connections are tight and secure to prevent air embolus and disconnection.
- Verify that the stopcocks are positioned appropriately (off to atmosphere) in particular after the system has been calibrated.
- Ensure the infusion pump setting is correct and the alarm is set to alert the nurse of any problems with backflow.
- When a UAC is in use, booties are not to be worn, including use of wrappings/blankets which cover legs or feet. The toes, feet and legs are checked for discolouration and signs of blanching. Any discolouration must be documented reported to the medical officer.
- If a nappy is worn it must be fastened in a manner so as not to obscure the umbilical stump, and to allow easy access to viewing buttocks.
- Check security of dressing and the catheter, remembering that with umbilical sloughing the suture securing the catheter will weaken.

### **Sampling from UAC**

- Blood sampling from the umbilical artery catheter should be carried out slowly to decrease the risk of cerebral hypoperfusion<sup>7</sup>.
- There is a direct relationship between the flow rate during flushing of the catheter and changes in cerebral blood flow velocity.
- The recommended rate of withdrawal and flush is 1mL per 30 seconds to reduce the effect on the cerebral blood flow<sup>8</sup>.

### **Assessment and management of UAC**

- Infants with an umbilical artery catheter must be closely observed to avoid potential complications- see below table<sup>5</sup>.
- Every 4 hours verify that the catheter is secure and still at the prescribed documented centimetre marking.
- Position and protect the tubing to avoid accidental removal by the infant through entrapment of a finger or toe.
- Use strict hand hygiene when handling the catheter, replacing the fluids or sampling from the catheter.
- Use a closed infusion system to avoid the risk of air embolus, tubing contamination and catheter related blood stream infections.

- Every 2-4 hours monitor for vascular compromise which include; thrombosis, arterial vasospasm, ischemia or infarction to an organ or an extremity.

## Complications of Umbilical Artery Catheters

Aortic thrombosis	Aortic vasospasm	Distal ischemia
<p>Narrow pulse pressure</p> <ul style="list-style-type: none"> <li>• Dampened arterial waveform</li> <li>• Hypertension</li> <li>• Then distal obstruction to perfusion:</li> <li>• Oliguria</li> <li>• Haematuria</li> <li>• Decreased perfusion lower limbs</li> <li>• Absent femoral pulses</li> <li>• Limb blanching and</li> <li>• Duskiness</li> <li>• paucity of lower limb movement</li> <li>• Hypoglycaemia</li> <li>• Metabolic acidosis</li> <li>• Requires removal of UAC and Doppler assessment urgently if symptoms do not resolve</li> </ul>	<ul style="list-style-type: none"> <li>• Evaluate distal sites for</li> <li>• Colour</li> <li>• Temperature</li> <li>• Perfusion (capillary refill)</li> <li>• Compare each leg, unilateral discolouration may occur within hours of insertion</li> <li>• Report any lack of lower extremity movement</li> </ul>	<ul style="list-style-type: none"> <li>• Palpate for femoral, pedal and tibial pulses</li> <li>• Clinical signs maybe in toes, feet, legs and buttocks</li> <li>• Compare</li> </ul>

- Discontinue the UAC as soon as frequent blood sampling or continuous blood pressure monitoring is no longer required.
- UAC are typically left in place from 3 -14 days, complications specifically thrombosis increase with longer indwelling catheters.
- Inadvertent dislodgement with or without blood loss.
- Necrotizing enterocolitis
- Sepsis
- Thromboembolic: Distal emboli into the brain or systemic arteries are a rare occurrence.

## Removal of UAC

1. Procedure should be performed by a medical officer or an accredited senior nurse. If there is an umbilical venous line taped with the arterial line it is preferable for a medical officer to remove the arterial line.
2. Turn off the infusion and remove the catheter slowly retracting the catheter 1cm at a time over a period of 60 seconds.
3. Slow removal allows the artery to spasm and constrict and may minimise bleeding.
4. If bleeding occurs firmly grasp the abdomen below the umbilical stump (along the pathway of the umbilical artery) with a gloved hand. Apply firm pressure for 3-5 minutes until bleeding stops.
5. Monitor closely for any ooze or bleeding. Do not cover area with a nappy.
6. Avoid prone position for 1-2 hours until bleeding risk is low.
7. Monitor for vascular compromise after removal as complications related to the UAC and thrombosis may still occur.
8. Continue to monitor for hypertension using a non-invasive monitor<sup>6</sup>.

## Management of Arterial Lines

### *Patient safety*

- Only heparinised saline 1 unit/mL is infused.
- Only inject normal or heparinised saline into the arterial line – no other medications or infusates are recommended.
- The level of the transducer should be assessed at the commencement of each shift with a spirit level to ensure accurate calibration to the infant's phlebostatic axis.
- Zero the transducer at the commencement of arterial pressure monitoring and the beginning of each shift; and with the infants' change of position above or below the transducer.
- Arterial pressure monitor alarms should not be turned off and alarm parameters should be checked each shift.
- Alarms are set within 5 mmHg above and below the target MAP, and switched on at all times
- Monitor the insertion site for bleeding and signs of infection and record findings hourly.
- The site must remain visible at all times. Site checks of the extremity for perfusion and possible digital embolism are attended hourly and documented on the flow chart in

electronic medical record. Note any colour changes to limb periphery and inform the Medical Officer /Nurse Practitioner (NP) immediately.

- The limb must be secured to a splint and placed in a secure position to avoid the risk of accidental disconnection.
- Sampling from the line is attended by accredited nurses or doctors.
- Universal precautions should be observed when accessing the line. This should include the application of gloves and protective eye wear.
- All connections in the system must be Luer locked.
- Ensure there are no air bubbles in the line, in flush solution, in bolus flush including returned blood.
- No attempt should be made to flush a blocked arterial line.

## Nursing Care

- Any marked changes to the blood pressure and/or pressure waveform requires review of the patient to determine the cause and if necessary notification to the medical officer/ NP and the nurse in charge of shift.
- The flushing solution is changed every 48 hours.
- The arterial line giving set with transducer is replaced every Monday, Wednesday and Friday.
- The transducer is calibrated to the infant's phlebostatic axis.
- All re-tapings of the peripheral artery cannula are attended by a Medical Officer/ NP or under supervision of an experienced nurse.
- Two nurses assist for all arterial line tubing changes, one to support the infant's limb.
- Check the arterial site when flushing to determine if there is any compromise, such as severe blanching, in circulation.
- Blood pressure is observed regularly for changes both in pressure reading and waveform.
- Blood pressure results are documented hourly in the electronic medical record vital signs section.

Samples of blood are taken according to the infant's clinical condition or as ordered by medical or senior nursing staff.

## Sampling from arterial cannula

### **Equipment required**

- 1 x 1mL pre - heparinised syringe (Rapidlyte syringe with safety cap)
- 1 x blunt drawing up cannula

- Appropriate pathology collection tubes ( if blood specimens for pathology required)
- 3mL syringe and 1 x blunt cannula (depending on the requested tests and volumes required)
- Clean gloves
- Protective eye wear
- 2 x alcohol swabs
- Patient labels

## Technique

1. Use universal precaution to reduce the risk of introducing contaminants. It is recommended to wear gloves and protective eye wear when obtaining blood samples from arterial lines.
2. Check patient identification (ID) against the armbands and ensure a patient label with MRN is taken with you to the blood gas room to enter identifying data.
3. All staff using the blood gas analyser require accreditation.
4. If using the on-site blood gas machine for EUC/ABG check analyser is available for use. It is preferable not to interrupt a calibration cycle as this can take longer than waiting. In an emergency the PICU analyser may be used.
5. Provide a clean field and place a new sterile blunt cannula, blood gas syringe, extra blunt cannula and syringes if required for other blood specimens that may be needed.
6. Pause syringe driver and disinfect sample port for 30 seconds with alcohol & Chlorhexidine swab and allow it to dry.
7. Attach shielded blunt cannula to ABG syringe (push and twist for luer slip).
8. Release locking mechanism on reservoir and pull back slowly, no faster than 0.5ml/sec. Pull back blood up to the demarcation line to ensure that there is no residual heparin in the line. If the blood specimen is diluted with heparin a false low reading of PaCO<sub>2</sub> and base excess may result.
9. Turn one way stopcock at the tip of the reservoir "off".
10. Withdraw required amount of blood for specimen using the ABG syringe. Note TcO<sub>2</sub> and/or SpO<sub>2</sub> readings while withdrawing sample. An ABG requires a minimum of 0.3mL. The other volume of blood required is listed on the pathology collection chart on ward. Any unknown sample volumes can be determined by looking up the pathology handbook on the intranet.
11. The sample should be slowly withdrawn to ensure the blood does not haemolyse and the artery does not go into spasm.
12. Disconnect ABG syringe and shielded blunt cannula device together from the sampling port and seal the sample with the safety cap. Any air bubble in the sample needs to

be expelled. Remove air bubbles using safety cap and mix to prevent clotting of sample. Air bubble can increase the PaO<sub>2</sub> of the sample<sup>9</sup>.

13. Purge the fluid in the reservoir to return to the locked position. Monitor for air bubbles tracking down the line during this process.
14. Flush the line by using the bolus button on the syringe driver and flush until line is clear. Use approximately 1- 1.5ml of saline and observe limb.
15. Disinfect the sample port for 30 seconds with alcohol & Chlorhexidine swab as per hospital policy
16. Ensure syringe driver is on and arterial line waveform and readings visible on the Philips monitor
17. If using the ward blood analyser, enter relevant data on screen after sample has been inserted for analysis.
18. Check results have entered on electronic medical record. If results have not entered electronic medical record print out blood gas result and manually enter data in electronic medical record.
19. Inform the senior clinical staff of the results.
20. Blood gases need to be analysed promptly unless placed on ice. After blood is withdrawn from an artery it continues to consume oxygen and produce carbon dioxide, therefore results may be inaccurate.
21. Notify nurse in charge of any problems with the blood gas analyser so that Biomedical Engineering Department can be contacted if necessary.

## Complications and management of arterial lines

Complication	Signs	Causes	Intervention
Arterial Spasm	<ul style="list-style-type: none"> <li>• Irregular or dampened waveform on the monitor</li> <li>• Reduced pulse below the arterial line</li> </ul>	<ul style="list-style-type: none"> <li>• Trauma or irritation to the artery by the catheter</li> <li>• Hypovolemia</li> </ul>	<ul style="list-style-type: none"> <li>• When taping- the catheter properly to prevent excessive movement of the catheter</li> <li>• Splint to immobilise limb</li> <li>• Ensure adequate blood volume</li> </ul>
Thrombosis	<ul style="list-style-type: none"> <li>• Weakened or lost pulse below the site</li> <li>• Loss of warmth and perfusion to</li> </ul>	<ul style="list-style-type: none"> <li>• Failure to flush catheter</li> <li>• Damage to artery on insertion</li> </ul>	<ul style="list-style-type: none"> <li>• Ensure pump running and heparinised saline is used for continuous and intermittent flushes</li> <li>• Proper insertion, positioning</li> </ul>

	<p>area distal to catheter</p> <ul style="list-style-type: none"> <li>No waveform</li> </ul>	<ul style="list-style-type: none"> <li>Trauma to artery by a mobile catheter</li> </ul>	<p>and support of the line.</p>
Air in line	<ul style="list-style-type: none"> <li>Dampened wave form</li> <li>If there is air embolus change in infants vital signs – tachycardia, bradycardia, cyanosis, death</li> </ul>	<ul style="list-style-type: none"> <li>Air in tubing from loose connections</li> <li>Air in tubing from inadequate priming of line</li> <li>Air in tubing from bolus flushing of line containing air bubbles</li> </ul>	<ul style="list-style-type: none"> <li>Ensure connections are secure</li> <li>Ensure line is primed properly before use</li> <li>Ensure no air bubbles in flush solution both continuous and bolus or in blood being returned to infant post collection of ABG</li> <li>If embolus is suspected place infant on L side and seek immediate medical assistance</li> </ul>
Infection	<ul style="list-style-type: none"> <li>Inflammation of site</li> <li>Temperature instability and tachycardia, bradycardia</li> </ul>	<ul style="list-style-type: none"> <li>Poor aseptic technique and contamination of line</li> <li>Immature immune function and severity of illness</li> </ul>	<ul style="list-style-type: none"> <li>Care of line to prevent contamination</li> </ul>
Bleeding from site or line. Haematoma	<ul style="list-style-type: none"> <li>Bleeding evident</li> <li>Alarm audible if disconnection</li> <li>Swelling of limb or site</li> </ul>	<ul style="list-style-type: none"> <li>Disconnected line or catheter that has dislodged</li> <li>Coagulopathy</li> </ul>	<ul style="list-style-type: none"> <li>Check all connections on initial set up and then at least once per shift</li> <li>Ensure proper positioning and support of the line and taping of cannula</li> </ul>

## Removal of peripheral arterial lines

1. Turn off infusion
2. Remove cannula as direct pressure is applied to site.
3. Keep pressure on site until bleeding stops, this may take up to five minutes.

## Post Removal

- Document the procedure in electronic medical record
- Continue to observe for bleeding for at least 4 hours post line removal.

### **Educational notes**

- The umbilical vessels allow easy central vascular access to the newborn infant in need of intensive care therapy.
- In general, extremely premature babies (<28 weeks gestation) or neonates with a weight of less than 1000g will have an umbilical venous catheter (UVC) inserted on Day 1.
- An umbilical arterial catheter (UAC) may also be indicated for babies with significant respiratory disease (ventilated or >60% oxygen) or is likely to require frequent sampling of blood.
- Term or near term infants with significant respiratory distress or other illness that warrant intensive care therapy may also require UVC/UAC placement.
- Typically, UAC are single lumen whereas a multi-lumen UVC is used.

### **Contradictions**

- Omphalitis
- Omphalocele
- Necrotising enterocolitis
- Peritonitis

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