

<b>Department:</b>	Neonatal Intensive Care Unit (NICU)		
<b>Document:</b>	Multidisciplinary Policy and Procedure		
<b>Title:</b>	Insertion of Umbilical Arterial Lines		
<b>Applies To:</b>	All NICU Staff and X-ray Technicians		
<b>Preparation Date:</b>	January 05, 2025	<b>Index No:</b>	NICU-MPP-007
<b>Approval Date:</b>	January 19, 2025	<b>Version :</b>	2
<b>Effective Date:</b>	February 19, 2025	<b>Replacement No.:</b>	NICU-DPP-007 (1)
<b>Review Date:</b>	February 19, 2028	<b>No. of Pages:</b>	6

## 1. PURPOSE:

- 1.1 Painless, frequent, blood sampling of infants, especially preterm infants who have fragile poorly keratinized skin susceptible to extensive damage from frequent heel sampling.
- 1.2 Accurate measurement of all components of blood gas analysis, particularly PO<sub>2</sub>.
- 1.3 Continual arterial blood pressure monitoring.

## 2. DEFINITIONS:

- 2.1 A catheter introduced into either one of the two umbilical arteries will usually pass into the aorta from the internal iliac artery (post-ductal). The catheter is pre-measured to ensure its placement in the correct area of the aorta.
- 2.2 Abbreviations:  
UAC: umbilical arterial catheter.  
PaO<sub>2</sub>: partial pressure of oxygen.

## 3. POLICY:

- 3.1 Indications:
  - 3.1.1 Critically ill neonates who need frequently repeated arterial blood gas monitoring e.g. Extreme prematurity, when risk of oxygen toxicity is significant.
  - 3.1.2 Severe or moderate but worsening respiratory failure.
  - 3.1.3 Persistent Pulmonary hypertension.
  - 3.1.4 When non-invasive measurements of PaO<sub>2</sub>: and PCO<sub>2</sub> or Oximetry saturation cannot be validated or are unreliable e.g. shock.
  - 3.1.5 Need for continuous monitoring of arterial blood pressure.
  - 3.1.6 Infants who have UAC inserted may get their routine blood tests withdrawn from the UAC.
- 3.2 Contraindications:
  - 3.2.1 Evidence of local vascular compromise in lower limbs or buttocks.
  - 3.2.2 Peritonitis.
  - 3.2.3 Necrotizing Enterocolitis.
  - 3.2.4 Presence of abdominal wall defect e.g. omphalocele, gastroschisis.
- 3.3 Inserting umbilical arterial catheter needs a written physician order.
- 3.4 It is performed by a neonatology physician trained in this procedure, assisted by another NICU physician or a qualified neonatology staff nurse. Infant is connected to vital signs monitor all through the procedure.
- 3.5 The UAC is inserted under complete aseptic technique.
- 3.6 The vessel can be catheterized during the first 4-5 days after delivery.
- 3.7 Indwelling time and monitoring:
  - 3.7.1 UAC can be left in situ up to 7 days provided that:
    - 3.7.1.1 The infant is closely monitored (at least every hour) for any complication (Table 1)
    - 3.7.1.2 The need for catheter and benefits versus risks are assessed daily, promptly remove once not needed.

3.7.1.3 Catheter is kept free of blood to prevent clot formation by continuously infusing a low dose of heparin: 0.5-1 Unit heparin/ml of IV half normal saline to run at 0.5-1ml/hour.

**Table 1: Signs & Symptoms of Some of the Complications of UAC**

Complication	Etiology	Signs and symptoms	Action
<b>Distal vascular compromise</b>	Arterial spasm or malposition of catheter e.g. into the femoral artery via the external iliac or into one of the gluteal arteries	Cyanosis, blotching of toes or buttocks or poor distal perfusion.	Warm opposite foot, (for reflexive response), if blanching does not resolve within 15 minutes, remove catheter
<b>Thrombus formation</b>	Improper flushing. To prevent; *Continuous heparin infusion, *when flushing after sample collection, take at least 5 seconds to infuse 0.5 ml to avoid retrograde embolism	Difficulty withdrawing blood samples.	* Do not flush clot forcibly, * Remove catheter. * Replace only if critical line.
<b>Thromboembolism</b>	* Catheter thrombosis migration *May be distributed throughout systemic circulation	Deposition site specific: -Pulmonary; tachypnea, respiratory distress Renal; hematuria, oliguria hypertension NEC: abdominal distension or discoloration, legs; poor perfusion	*Remove catheter and manage accordingly. *Doppler ultrasound studies for diagnosis & follow up. *If signs of emboli or loss of pulses or coagulopathy with no contraindication e.g. IVH, heparinization is considered.
<b>Vascular perforation</b>	*Traumatic insertion *Hypertonic solutions *Malposition of catheter	Potential for large blood loss hypovolemia	Investigate & manage accordingly.
<b>Hemorrhage</b>	*Arterial damage, *Accidental removal or disconnection, *Oozing around the catheter	Potential for large blood loss hypovolemia	Apply direct pressure to the site, Assess for removal of the line
<b>Air bubble in line Air embolism</b>	Empty IV bag * Improper flushing * Loose connections * Catheter open to atmosphere can cause air embolism.	Air embolism causes hypotension, tachycardia, weak pulses, cyanosis	-Check for loose connections in line, -Flush air bubbles out through an open stopcock port.

Complication	Etiology	Signs and symptoms	Action
<b>Catheter malposition in the heart and great vessels</b>	*Cardiac perforation *Catheter lodged in or perforated pulmonary vein	Cardiac tamponade Cardiac arrest Pericardial effusion Arrhythmias, hypotension, Respiratory distress	Manage accordingly Resuscitation
<b>Local infection</b>	Fault in aseptic technique, *Contaminated equipment /solution	Redness, soreness, positive purulent material at site	Remove catheter, Culture blood and tip of catheter

**3.8 Site of catheter tip:**

3.8.1 **High setting:** is preferable (catheters placed in the high position result in a lower incidence of vascular complications without an increase in adverse sequelae). UAC tip is placed between 6<sup>th</sup> & 9<sup>th</sup> thoracic vertebra.

For "higher" insertion, calculate the length of UAC using one of the following formulas:

- 3.8.1.1 Shukla's formula:  $3 \times \text{Birth Weight} + 9 + \text{umbilical stump}$ ,
- 3.8.1.2 Wright's formula:  $4 \times \text{Birth weight (kg)} + 7 + \text{umbilical stump}$ , or,
- 3.8.1.3  $\{ 2.5 \times \text{Birth weight (Kg)} \} + 9.7 + \text{umbilicus stump length}$ , or,
- 3.8.1.4 110% of the distance measured from above the lateral end of the clavicle to the umbilicus, or,
- 3.8.1.5 Use the attached standardized graph using birth weight.
- 3.8.1.6 Aim at the higher site, however, if on X-Ray t Never advance catheter once in situ, because this will introduce length of contaminated catheter into vessel if tip is below T 12, pull the UAC to L3.

3.8.2 **Low setting:** UAC tip between 3<sup>rd</sup> & 4<sup>th</sup> lumbar vertebra. This avoids accidental diversion of catheter into or spasm of the renal, superior or inferior mesenteric, celiac or hepatic arteries.

For measuring length of UAC "in cm" for low insertion.

- 3.8.2.1  $3 \times \text{Birth Weight (kg)} + 9 + \text{umbilical stump length} / \text{divided by 2}$ ,
- 3.8.2.2 60% of the shoulder to umbilicus length.

**3.9 What cannot be given via an umbilical arterial catheter:**

- 3.9.1 Hypertonic solutions
- 3.9.2 Calcium Gluconate boluses
- 3.9.3 Vasoactive medications
- 3.9.4 Blood or blood products, except in emergencies with no alternative access

**3.10 Size of catheter:**

- 3.10.1 Infants < 1500 gm; use 3.5 French umbilical catheter
- 3.10.2 Infants > 1500 gm; use 5 French umbilical catheter
- 3.10.3 Using a small catheter in a large infant increases the incidence, during insertion, of the catheter looping down to the contralateral iliac artery, into one of the arteries to the buttocks or looping on itself in the aorta.

**4. PROCEDURE:**

- 4.1 This policy is followed in accordance with the neonatology policy "Prevention of Catheter Associated Blood Stream Infection" and hospital infection control policies.
- 4.2 The assigned nurse stabilizes the patient by wrapping a diaper around both legs and taping it. Leave feet, head and upper chest exposed.
- 4.3 Connect infant to vital signs monitor and ensure proper temperature maintenance of the body.

- 4.4 Arterial line placement is an invasive procedure. MAXIMUM STERILE BARRIER precautions should be taken. Perform antiseptic scrub for hands, wrists and forearms before the procedure. Put on sterile gown, gloves, cap and mask.
- 4.5 Thoroughly disinfect the umbilical cord stump and surrounding skin using povidone-iodine. Let the antiseptics to dry for at least 30 seconds. After the procedure is finished, remove it from the patient's skin with sterile water or saline to prevent tissue damage, absorption, and thyroid suppression.
- 4.6 Never break the sterility of the field.
- 4.7 Place a sterile drape that covers the baby from upper chest to ankle with an opening around the umbilicus.
- 4.8 Attach stopcock to hub of catheter and fill catheter with heparinized saline solution. Place umbilical tie around umbilicus with single knot and tighten only enough to prevent bleeding.
- 4.9 Cut the cord horizontally about 0.5-1 cm away from abdominal skin.
- 4.10 Stabilize stump with artery forceps. Introduce one of the points of the curved iris forceps into lumen of artery and probe gently to depth 0.5 cm. Remove forceps and bring points together before introducing them once more into lumen and probe gently to 1 cm. Allow points to spring apart and maintain forceps in this position for 30-60 seconds to dilate vessel.
- 4.11 Insert catheter into lumen of artery to the pre calculated length. After passing the catheter about 5cm, aspirate to verify intraluminal position.
- 4.12 Take appropriate action if insertion is complicated .
  - 4.12.1 Resistance < 3cm from surface of abdominal stump; loosen umbilical tape and re-dilate the artery,
  - 4.12.2 Popping sensation rather than "relaxation" or easy insertion but no blood return; catheter may have exited the lumen and created a false channel, remove and use second artery.
  - 4.12.3 Backflow of blood particularly around vessel; catheter in false channel with extravascular bleeding. Tighten umbilical tape.
- 4.13 Place marker tape on catheter with base of tape flush with surface of cord, so that displacement of the catheter may be readily recognized.
- 4.14 Remove umbilical tie and place purse-string suture around base of cord, wrap ends of suture in opposite direction around catheter for about 3 cm and tie taking care not to kink the catheter. Add tape bridge for further stability.
- 4.15 Avoid covering the umbilicus with dressing. Dressing may delay recognition of bleeding or catheter displacement.
- 4.16 Confirm position of catheter by X-ray of chest and abdomen. If doubt about position, obtain lateral X-ray.
- 4.17 Precautions:
  - 4.17.1 Document the internal and external length of the catheter in the progress notes to aid in monitoring of catheter position
  - 4.17.2 Remove and do not replace umbilical artery catheters if any signs of catheter related blood stream infection, vascular insufficiency in the lower extremities, or thrombosis are present
  - 4.17.3 Do not use topical antibiotic ointment or creams on umbilical catheter insertion sites because of the potential to promote fungal infections and antimicrobial resistance.
  - 4.17.4 An umbilical catheter may be replaced if it is malfunctioning, and there is no other indication for catheter removal, and the total duration of catheterization has not exceeded 5 days.
  - 4.17.5 Minimize accessing the line.
- 4.18 Aseptic techniques are used for all access to the line:
  - 4.18.1 "Scrub the hub" before and after each use of the line. Disinfect port of entry "hub", needleless connectors or injection ports using 1% chlorhexidine in 70% alcohol. Rub for at least 15 seconds. Leave it to dry before accessing and scrub with 70% alcohol after use.
  - 4.18.2 Ensure covering open lumens (such as stopcocks) by injection ports, sterile end-caps or needleless connectors at all times. Using closed system is preferred.
  - 4.18.3 Change caps and needleless connectors according to the manufacturer's recommendations, and whenever the administration set is changed.
  - 4.18.4 Withdrawing blood from UAC must be done under complete aseptic conditions.
- 4.19 Removal of umbilical artery catheter:

4.19.1 Indications:

- 4.19.1.1 No further clinical need
- 4.19.1.2 Catheter-related vascular compromise
- 4.19.1.3 Hypertension, Hematuria not due to other recognized cause
- 4.19.1.4 Catheter related sepsis
- 4.19.1.5 Onset of platelet consumption coagulopathy
- 4.19.1.6 Peritonitis
- 4.19.1.7 Necrotizing Enterocolitis, Omphalitis

4.19.2 Technique of removing UAC:

- 4.19.2.1 Aseptic hand wash, sterile gloves and gown, disinfect site with povidone and then with 1% chlorhexidine or with sterile saline for extremely low birth weight and cover with sterile drape.
- 4.19.2.2 Use suture removal forceps and scissors to remove sutures. Cut suture at skin, not on catheter to avoid catheter transaction. Be careful not to cut through the line.
- 4.19.2.3 Reinsert purse string suture through dried Wharton Jelly (Artery may have lost ability to spasm).
- 4.19.2.4 Withdraw catheter slowly and evenly until approximately 5cm remains in vessel, tighten purse string suture.
- 4.19.2.5 Discontinue infusion.
- 4.19.2.6 Pull remainder of catheter at a rate of 1cm/minute to allow vasospasm. If there is bleeding apply lateral pressure to the cord by compressing between thumb and first finger.
- 4.19.2.7 If resistance is met when removing catheter, soak umbilical stump with normal saline for 5 minutes. Do not pull on catheter with excessive force as it may break off in patient's artery.

## 5. MATERIAL AND EQUIPMENT:

- 5.1 Sterile gown and gloves, masks and surgical caps
- 5.2 Sterile drapes with central aperture
- 5.3 Cup with antiseptic solution
- 5.4 Umbilical artery catheter (3.5 F for infant weighing < 1.5kg and 5 Fr weighing > 1.5 kg),
- 5.5 Tape measure
- 5.6 Scissors
- 5.7 Hemostat
- 5.8 Fine forceps,
- 5.9 Scalpel blade and holder,
- 5.10 3-way stopcock with luer-lock,
- 5.11 Umbilical tie
- 5.12 3.0 silk suture on small curved needle
- 5.13 Needle holder
- 5.14 Gauze pads
- 5.15 Tape
- 5.16 10 ml syringe
- 5.17 Heparinized saline

## 6. RESPONSIBILITIES:

- 6.1 Physician
- 6.2 Nurse
- 6.3 X-ray Technician

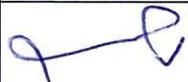
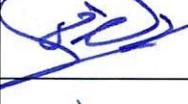
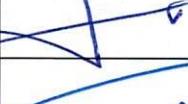
## 7. APPENDICES:

N/A

## 8. REFERENCES:

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