

Peripheral arterial access in the neonate

Guideline Responsibilities and Authorisation

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Guideline Review History

Version	Updated by	Date Updated	Summary of Changes
3	David Bouchier	7/9/2016	Updating only. No changes
4	Miranda Bailey-Wild	14/09/2021	Updating including change in format, change to procedure of sampling, consolidation of guidelines 5494 & 1650 (peripheral arterial catheterisation and puncture)

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1 Overview

1.1 Purpose

To describe the technique of peripheral artery puncture, cannulation and sampling from a peripherally inserted arterial catheter.

1.2 Scope

Puncture and cannulation: Medical Staff

Sampling: NICU Medical and Nursing staff

1.3 Patient / client group

Newborn infants under the care of Waikato Neonatal Intensive Care.

1.4 Exceptions / contraindications

- Relative contraindication: Coagulation defects
- Circulatory insufficiency to the hand or foot of that particular artery
- Local skin infection over the intended site for puncture/cannulation

1.5 Definitions & abbreviations

Allen's Test	Allen's test or the Allen test is a medical sign used in physical examination of arterial blood flow to the hands.
Medical staff	Neonatal Nurse Practitioners, Clinical Nurse Specialists, Registrars, Fellows, SMOs
NICU	Neonatal Intensive Care Unit
NNP	Neonatal Nurse Practitioner
PAL	Peripheral arterial line
PIV	Peripheral intravenous line
SMO	Senior Medical Officer

2 Clinical Management

2.1 Indications

Peripheral arterial puncture is primarily intended to obtain a bubble-free sample of heparinised arterial blood for gas analysis. The procedure can also be used for obtaining other critical blood samples, if repeated venous access has failed.

Peripheral arterial lines (PAL) are inserted to allow a route for:

- Blood sampling (blood gases in particular) when frequently needed

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- Continuous blood pressure monitoring
- Pre-ductal pO₂ measurement (rarely).

2.2 Roles and Responsibilities

Medical staff – to collect and set up equipment required, perform arterial puncture or cannulation

Nursing staff – to assist with positioning of infant for procedure and collect samples as directed by medical staff

2.3 Competency required

Nurse Practitioners, Clinical Nurse Specialists, Registrars, Fellows and Senior Medical Officers competent at PAL insertion or under supervision of senior practitioner.

2.4 Equipment

2.4.1 For Peripheral Arterial Puncture

- Appropriate antiseptic (skin cleaning) solution (chlorhexidine 2%/alcohol wipes)
- Heparinised (gas) syringe – 1 ml with 26G needle attached
- Gauze squares
- Consider infra-red, cold light transilluminator or ultrasound
- Sterile gloves recommended

2.4.2 For Percutaneous Cannulation Technique:

- Appropriate antiseptic (skin cleaning) solution (chlorhexidine 2%/alcohol wipes)
- Cannula (usually 24 gauge, 19mm)
- Heparinised (gas) syringe – 1 ml
- 1ml syringe with 0.9% Sodium Chloride
- Dressing Pack
- Short extension tube (primed with fluid – Sodium chloride 0.9%)
- 3-way tap
- Arrow Guidewire (do not open, but have available)
- SmartSite
- Tapes, Tegaderm and a long splint for securing line
- Consider infra-red, cold light transilluminator or ultrasound
- Sterile Gloves recommended

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2.4.3 For Cut Down Technique: - need in addition to the above (which should be sterile)

- Cut down tray – containing instruments, needle holder, forceps, sterile scissors
 - scalpel blade
 - suture material
 - sterile drapes
- Local anaesthetic – lignocaine 1% ([link to guideline Lidocaine here](#))
- Mask, gloves and gown
- Antiseptic solution - chlorhexidine 2% swab sticks (or sterile water if ELBW).

An arterial pressure line (including a pressure transducer) should be set up with a reliable infusion pump and appropriate fluids – usually heparinised (1unit/ml) Sodium chloride 0.45%. (refer [heparin sodium for neonates](#) drug guideline)

Flow rate usually 0.8 or 1 ml/hour (occasionally may run at lower rates, i.e. 0.5 mL/hour, although at this rate the line is more likely to block).

2.5 Analgesia/Sedation

This is a painful procedure. In most instances a neonate requiring an arterial line is unwell and will usually have an opioid and/or midazolam infusion prescribed. A bolus may be required prior to commencement of the procedure. Oral sucrose ([link sucrose guideline](#)) can be given if no contraindications apply. Neonate may be swaddled (with affected limb exposed for access) during procedure and offered non-nutritive sucking for comfort if appropriate.

2.6 Procedure – Peripheral arterial puncture

2.6.1 Identify site

- (a) Brachial artery
- (b) Radial artery or posterior tibial artery
- (c) Popliteal artery
- (d) Femoral artery
- (e) Ulnar artery or dorsalis pedis artery.

(a.1) Brachial artery is first choice. It lies near the median nerve, and in the antecubital fossa they are both bound down together under the biceps insertion. Swelling here is probably what leads to median nerve palsy. It is better to move the insertion site up to beside the middle of the lower third of biceps muscle. Here the nerve can easily move away from the needle and is not going to be compressed by swelling.

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- (b.1) The radial artery and posterior tibial artery are valuable for insertion of in-dwelling peripheral arterial lines. For this reason they should not be used for routine puncture unless the brachial artery region is indurated or infant is unlikely to require long-term blood gas monitoring.
- (c.1) Popliteal artery is close to the tibial nerve making this puncture an unsuitable choice and is technically difficult.
- (d.1) The femoral artery is a "dirty area", it is easy to get a venous sample in error and there is risk of producing transient ischaemia in the leg. Use only in exceptional circumstances.
- (e.1) Dorsalis pedis and ulnar artery must not be used because they will be the only supply to the foot and hand if a previous line has been in place in the radial or posterior tibial. If these are used ischaemia leading to gangrene is possible.

2.6.2 Technique

1. Take a 1 ml gas syringe with a 26 gauge needle.
2. Clean skin using an alcohol swab
3. Palpate the artery, insert the needle into the vessel. Transillumination may assist location if peripheral arteries being used.
4. Aspirate gently on the syringe. When the needle tip is in the lumen, blood should flow into the syringe.
5. Take 0.3 mL (if taking only for blood gas) and then cap syringe after removing any air bubbles and send for immediate measurement. Analysis should occur within 15 minutes.
6. Maintain pressure on artery for at least 3 minutes using a Gauze swab (not an alcohol swab) and then assess for haemostasis. If bleeding persists, continue to apply pressure until haemostasis is achieved.
7. Check distal circulation after procedure

2.7 Procedure – Peripheral arterial cannulation

General nursing preparations can be identified in the [Arterial Line – Sampling, Nursing Management and Removal in NICU](#) procedure.

2.7.1 Identify site

The following sites are recommended for peripheral artery catheters:

- (a) radial artery
- (b) posterior tibial artery
- (c) dorsalis pedis artery
- (d) ulnar artery (**ONLY** if radial artery on the same limb has not been previously accessed or is documented as patent).

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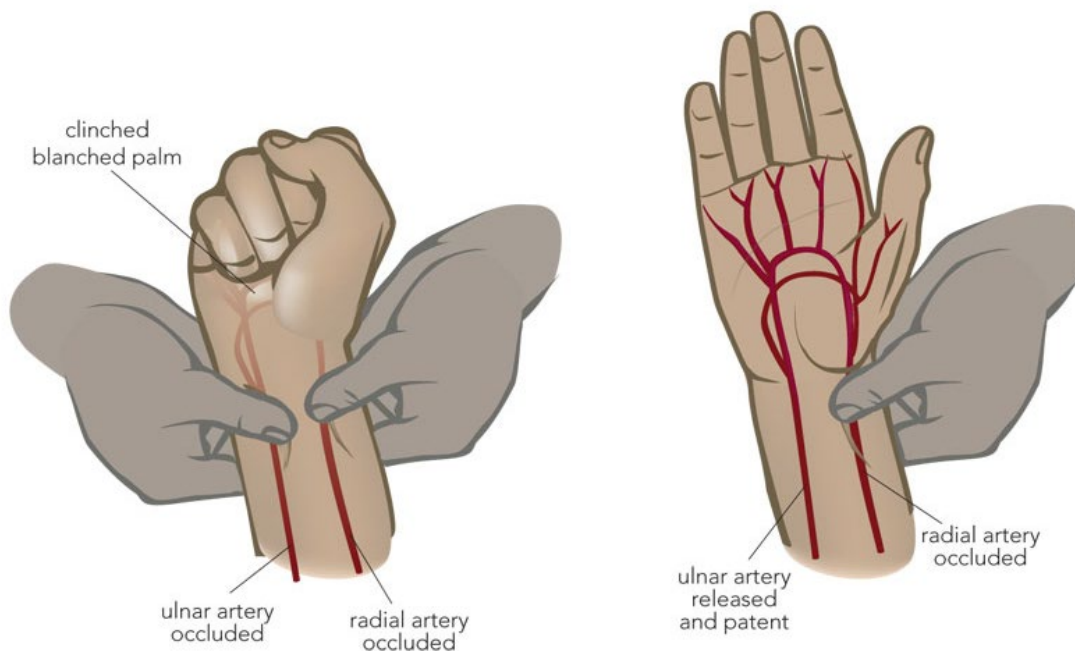
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The risk of ischaemia secondary to radial or ulnar arterial cannulation is approximately 5 per cent. The dorsalis pedis artery can be used if palpated (however it is absent in some infants). The brachial artery should not be used due to absence of collateral circulation.

2.7.2 Modified Allen's Test

Perform a modified Allen's test to check for adequacy of collateral circulation 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 1). 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.



2.7.3 Technique (percutaneous)

1. Wash hands and prepare work surface and equipment.
2. Perform Allen's test to check for adequacy of collateral circulation.
3. Slightly extend the wrist/ankle to bring the artery closer to the surface. *NB Avoid hyperextension as this may occlude the artery.*
4. Identify the artery by palpation +/- trans-illumination.
5. Rewash hands and don sterile gloves.
6. Clean the skin with chlorhexidine 2%/alcohol wipes.
7. Insert the 24G cannula over the artery at an angle of 15-45 degrees.

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8. Puncture the artery and watch for blood in the hub of the cannula.
9. Withdraw the needle while advancing the cannula slowly. There may be spasm from the artery having been touched, hence blood return may be delayed. *(An Arrow guidewire may be considered at this stage if cannulation is difficult)*
10. Observe the cannula hub for pulsatile blood flow.
11. Attach the cannula to the arterial connector and three-way tap and slowly flush with heparinised (one unit of heparin per mL) sodium chloride 0.9%.
12. Turn off the three-way tap and secure the cannula with tape and a splint.
13. Connect the 10 cm luer-lock, transducer set up and heparinised (one unit of heparin per mL) sodium chloride 0.45% or 0.9% 50 mL syringe.
14. Identify the line as an arterial line by placing a red arterial line sticker on the infusion line.
15. Observe the fingers/toes for circulation and warmth post procedure.
16. Level and zero the pressure transducer if in use and set MEAN alarm limits as per medical preference.
17. Secure with splint and strapping. Ensure hub supported/fingers protected by gauze, and that all digits are visible for ongoing assessment. (Refer to nursing procedure: Arterial Line Catheterisation and set up (1638))
18. Dispose of sharps in sharps bin
19. Document blood pressure limits on neonatal fluid balance and treatment orders chart.
20. Document procedure in the medical record.

2.7.4 Technique (Cut Downs)

- Site of insertion should be infiltrated with local anaesthetic. (Allow time for this to take effect).
- Cut down on the radial artery is by means of a transverse incision (± 0.5 cm) at wrist and for the posterior tibial by means of a transverse incision medial (or behind) medial malleolus at ankle, followed by blunt longitudinal dissection with curved mosquito forceps.
- The artery is identified, stabilised with a suture passed around it (not ligated) and cannulated with 24 G cannula.
- The wound is sutured and the cannula securely strapped and connected the 10 cm luer-lock, transducer set up and heparinised (one unit of heparin per mL) sodium chloride 0.45% or 0.9% 50 mL syringe
- The arterial line should be identified as such by placing a red arterial line sticker on the infusion line.

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2.8 Sampling and use of lines

We suggest sampling from a PAL be a two person procedure (if available, 1st person to sample and return the dead space and 2nd person to put blood samples into relevant tubes).

1. Prepare 3 syringes (3 mL), fill one with 1mL of 1unit/ml heparinized saline solution
2. Don sterile gloves. Disinfect the access port of the arterial line (as close to the patient as possible) with chlorhexidine 2%/alcohol swab and allow to dry.
3. Turn 3-way tap off to infusion line and open to neonate and exit port.
4. Withdraw 1 mL blood (“dead space”) into an empty syringe over 20 seconds under aseptic conditions. *NB blood pressure will be interrupted during sampling, alarms may be paused for 2 mins.*
5. Turn 3-way tap connector to 45 degrees ensuring no port is open to air.
6. Remove syringe from three-way tap and connect blood gas syringe or syringe for blood sample collection.
7. Turn 3-way tap so that blood can be aspirated from neonate into the syringe.
8. Once sufficient blood is collected, turn three-way tap 45 degrees ensuring no port will be open to air.
9. Remove this syringe and give to assistant (if present).
 - a. If no PIV present, Replace with original syringe of aspirated blood (step 4, “dead space”). Open 3-way tap to exit port and aspirate gently to remove any air from the hub.
 - b. If PIV present, go to step 12.
10. Slowly administer blood from step 4 (“dead space”) through the arterial line over 30-60 seconds. Monitor closely for any signs of arterial spasm such as blanching.
11. Turn 3-way tap connector to 45 degrees ensuring no port is open to air.
12. Remove “dead space” syringe and attach pre-prepared syringe with 1mL of 1unit/ml heparinized saline solution. Open 3-way tap to exit port and aspirate gently to remove any air from the hub.
13. Flush the line carefully with 0.5-1.0 mL of heparinised saline, ensuring complete clearance of the catheter.
14. Reopen 3-way tap- infusion to baby and off to exit port and ensure correct, pulsatile blood pressure wave form is still present on monitor. Check the peripheral perfusion.
15. Observe digits and limb for colour, warmth and circulation and record on observation chart.

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2.9 Potential complications arising from insertion and use of Peripheral Arterial Lines

- Burns from cold light source used for transillumination at time of insertion.
- Haematoma formation.
- Damage to peripheral nerves on insertion, e.g. carpal tunnel syndrome.
- Thromboembolism, vasospasm, thrombosis leading to:
 - Blackening of fingers or toes, progressing to frank gangrene
 - Cerebral emboli
 - Skin ulcers.
 - Infiltration.
 - Infection.
- Accidental dislodgement – leading to haemorrhage.
- Air embolism.
- **IF IN DOUBT, TAKE IT OUT!**

2.10 After Care

Refer the [Arterial Line – Sampling, Nursing Management and Removal in NICU](#) procedure.

- Make sure all taps are turned on, the line is likely to block if turned off or not flushed continually.
- Heparinised saline (0.45% or 0.9%) at a rate of 0.5-1 mL/hr should be used for continuous infusion
- Care must be taken during sampling and flushing to avoid trauma and spasm. Blanching may be due to arteriospasm – stop flush briefly and consider running for a short period at a slower rate.
- If there is other than transient blanching when the arterial line is flushed, it should be reviewed for removal by medical staff. Over-vigorous flushing of the arterial line has a risk of the dispersal of emboli into the systemic circulation.
- Damp trace – possibly small clots in short extension tube – cannot be aspirated, disconnect and replace the short extension.
- Persistent duskiness of digits requires the line to be removed.

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2.11 Removal of Peripheral Arterial Line

Refer the [Arterial Line – Sampling, Nursing Management and Removal in NICU](#) procedure.

- Stop the infusion of heparinised sodium chloride.
- Wash hands and prepare work surface. Don gloves (non-sterile).
- Remove tapes carefully to ensure skin integrity.
- Withdraw the cannula and apply pressure to the site for 5 minutes with a piece of sterile gauze/cotton ball ensuring circulation to the hand/foot is maintained.
- Check to see if the bleeding has stopped. If it has not, apply pressure for a further 2–3 minutes before checking again. Repeat this step as needed.
- Once bleeding has stopped, cover the site with a small piece of gauze and tape/film dressing.
- Observe the digits and limb for adequate circulation and continue to monitor for the next four hours.
- Document procedure in the medical record.

3 Evidence base

3.1 Bibliography

- Government of Western Australia, Women and Newborn Health Service (2016) King Edward Memorial Hospital, [Clinical Practice Guidelines](#), Neonatology: Peripheral arterial catheter insertion and removal
- Safer Care Victoria: Peripheral arterial access in neonates requiring intensive care <https://www.bettersafecare.vic.gov.au/clinical-guidance/neonatal/peripheral-arterial-access-in-neonates-requiring-intensive-care>
- Lippincott Procedures – Arterial line blood gas sampling, pediatric.
- Imamura et al. Evaluation of arterial catheter management in very preterm neonates: peripheral artery vs umbilical artery. *Fukushima J med Sci.* 2012;58(1):
- Mense L et al. Peripheral Arterial Lines in extremely premature neonates: a potential alternative to umbilical arterial catheters. *Adv Neonatal Care* 2021;00:1-5

3.2 Associated Waikato DHB Documents

- NICU [Heparin sodium for neonates](#) drug guideline (Ref. 2925)
- NICU Nursing [Arterial Line – Sampling, Nursing Management and Removal in NICU](#) procedure (Ref. 1638).

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