Procedural Guideline

Arterial Line Management Using the Safeset™

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Functional Sub-Group: Clinical Governance
Summary: Insertion and management of the arterial line

Approved by: Clinical Policy Committee

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Replaces Existing Document: Management of Arterial lines 2010

Previous Review Dates: 2010

Note:
Sydney Local Health District (SLHD) was established on 1 July 2011 following amendments to the Health Services Act 1997 which included renaming the former Sydney Local Health Network (SLHN). The former SLHN was established 1 January 2011, with the dissolution of the former Sydney South West Area Health Service (SSWAHS).
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Appendix 1:
Arterial Line Management Using the Safeset™

1. Introduction

Arterial pressure monitoring is common in critically ill patients. This invasive monitoring is used for direct measurement of blood pressure and assists in obtaining arterial blood for laboratory testing.

The risks addressed by this guideline:

Unsafe insertion and management of the arterial line.
Inaccurate blood pressure monitoring.

The aims / expected outcome of this Guideline

To facilitate the safe and effective insertion and management of radial, femoral, pedal or brachial arterial line in the Intensive care unit.

2. Procedural Guideline Statement

Direct monitoring of the arterial blood pressure is the gold standard of measuring blood pressure. Cannulation of a systemic artery allows the ability to directly and continuously monitor the arterial blood pressure, the blood pressure waveform, heart rate and provides the ability for ongoing sampling of blood for blood analysis.

An arterial catheter can be inserted into the radial, femoral, dorsalis pedis, brachial or axillary arteries. The radial artery is the preferred site due to accessibility. The catheter is attached to a transducer system with pressure tubing and a pressure monitoring cable to the bedside cardiac monitor. This link allows the mechanical signal received by the transducer to be converted to a waveform on the monitor. It is this waveform and the numerics generated, that is used to guide clinical assessment and treatment of the critically ill patient.

3. Principles / Standards / Practices

Indications for an arterial line:

- Continuous haemodynamic monitoring and monitoring of vasopressors and inotropes
- Access for blood sampling and arterial blood gas (ABG) analysis

Complications:

- Thrombosis
- Air embolism from the air bubbles in the flush solution of an arterial catheter can embolise antegrade or retrograde and cause ischemic damage to organs (Unusual in adults)
- Embolism due to dislodgement of thrombus or atheromatous debris by the catheter and cause extremity ischaemia
- Acute blood loss, anemia
- Infection

MEDICATION IS NEVER TO BE INJECTED INTO THE ARTERIAL LINE
The arterial line is **ONLY FOR MONITORING BLOOD PRESSURE** and for **BLOOD SAMPLING**

### 3.1 Insertion of the Arterial line

#### 3.1.1 Line insertion

**Medical Staff**

- All arterial catheters are inserted using aseptic technique. Whilst still scrubbed the operator must transduce the line to confirm arterial placement
- Arterial catheters must be sutured
- Document insertion and confirmation of line placement in medical records
- Medical staff must review arterial catheter insertion site during ward rounds
- Arterial catheter must be changed if any indication of infection
- Maintain aseptic technique when accessing sampling port

#### 3.1.2 Set-up and priming

It is imperative that the transducer system of invasive devices be set up correctly to ensure accuracy of the monitoring system. Transducer lines are to be changed **every 96 hours** and should be clearly marked with the date of next change written on a NSW health approved red adhesive label. This change includes the transducer, associated lines and the flush solution bag.

**Equipment:**

1. Hand hygiene must be performed prior to donning Personal Protective Equipment (PPE)
2. 500 ml bag 0.9% Sodium Chloride
3. Pressure bag
4. Transducer giving set
5. Pressure monitoring cable
**Priming the set**

1. Check all connections are tight  
2. Place fluid bag on flat surface, spike and place in a pressure bag- do not inflate yet, hang on IV pole  
3. Compress drip chamber to fill 1/3 chamber  
4. **Prime under gravity only**  
5. Prime to the zeroing stopcock, flush the vented port, remove vented cap and replace with non vented cap  
6. Unlock inline reservoir wings and pull back to 3mls, hold reservoir syringe upright (wings at bottom), prime up to & including the syringe  
7. Check reservoir syringe for air- tap out any air bubbles. When air removed, close reservoir syringe, lock wings back into position  
8. Turn the sample port stopcock to the open position- **OFF handle** opposite to sample port as below

10. Then prime last part of line using the flush device  
11. Close sampling port, ensure **OFF handle** back at sample port

12. Using flush port perform a final flush before connecting  
13. Check entire line for air, connect to the arterial line  
14. Label the distal end of the arterial line with the Intra-ARTERIAL label (below) and the flush line with the orange ARTERIAL LINE Flag

(see right)

**3.2 Monitoring of arterial line**

**3.2.1 Arterial waveform**

\[ \text{120mmHg} \]

\[ \text{80mmHg} \]

Dicrotic notch

Systolic Phase

Diastolic Phase

Normal arterial pulsation wave form.
The arterial waveform corresponds with the cardiac cycle. Arterial pressure is measured at its peak, which is the systolic blood pressure (SBP), and at its trough, which is the diastolic blood pressure (DBP).

The arterial waveform is separated into the systolic and the diastolic phases. In the systolic phase, the aortic valve opens and blood enters the aorta at great force, this produces a steep upstroke on the arterial waveform. Followed by a rounded appearance and downward turn with blood continuing to be ejected, the arterial walls begin to distend. The dicrotic notch can then be seen on the waveform, signalling the closure of the aortic valve and beginning of diastole. The final phase, the diastolic phase, represents late systole and diastole, blood flow slows, the slope of waveform begins to decline as pressure decreases.

**Mean arterial pressure** (MAP) is the most frequently used parameter to assess perfusion pressure throughout the cardiac cycle and is a calculation of the average pressure within an artery over a complete cycle of one beat. Systemic arterial pressure measurements vary according to the site of measurement, with SBP and DBP pressure potentially changing with catheter location, MAP however tends not to vary. Additionally MAP is the least altered measurement by damping (see wafers dampening below). MAP is often used to define treatment goals as it represents the driving perfusion pressure to the tissues.

$$\text{MAP} = \text{DBP} + \frac{1}{3} \text{PP} \quad (\text{PP} = \text{SBP} - \text{DBP})$$

**Inaccurate monitoring**

If you suspect the values displayed on the bedside monitor are inaccurate, or if the arterial tracings are not clear, it is important to test your device to ensure that your waveform is appropriately dampened, providing accurate haemodynamic information.

**Waveform damping**

Damping refers the reduction in the amplitude of the waveform. Under-dampened waveform have increases oscillation, this can be a result of increase tubing length, incorrect tubing diameter. Under-dampened waveforms overestimate blood pressure.

Over dampened waveforms can also be present, here the waveform oscillations are reduced with the waveform looking more smooth in appearance. Such appearance can be a result of clots, air bubbles and loose connections. Over dampened waveforms underestimate the blood pressure.
Accuracy of the waveform can be tested using the square test/dynamic response test.

To perform the test:
- Squeeze the pull or snap tab on the flush device rapidly then quickly release it.
- The monitor should show a waveform that rises suddenly and sharply, tops off, then declines sharply.
- As you release, one or two oscillations appear above and below the baseline after release, indicating optimal dynamic response.
- The dicroitic notch should be clear.

Pulse Pressure (SBP – DBP)
Wide Pulse Pressure, a pressure > 40 mm Hg, is associated with:
- Thyrotoxicosis
- Arteriovenous fistula
- Aortic insufficiency
Narrow Pulse Pressure, pressure that is < 25 mm Hg, is associated with:
- Significant tachycardia
- Early hypovolemic shock
- Pericarditis
- Pericardial effusion or tamponade
- Ascites
- Aortic stenosis

Paradoxical Pulse:
Is a fall in cardiac output due to increased intrathoracic pressure. SBP of >10 mm Hg the patient is said to have a paradoxical pulse. Associated conditions include:
- Pericardial tamponade
- Asthma and COPD
- Ruptured diaphragm
- Pneumothorax
- Under filled patient who are mechanically ventilated

http://a248.e.akamai.net/7/248/432/20101213115642/www.msdlatinamerica.com/ebooks/5MinutePediatricConsult/files/3cd8a96f40346dc484d3873cc0c1820c.gif

3.2.2 Zeroing the arterial line
Invasive pressures such as the arterial pressure are displayed by the monitor in millimetres of mercury (mmHg). These pressures represent the pressure above atmospheric pressure, which is 760 mmHg at sea level. In order to tell the monitor what atmospheric pressure is, it is necessary to zero the transducer.

The arterial line should be zeroed on commencement of the shift, post line change or may be required when trouble shooting the device.

Once zeroed the arterial transducer should be at the level of the phlebostatic axis, which is the mid-axillary line at the fourth intercostal space.
- Placement of the transducer below this reference point can cause pressure overestimation
- Placement of the transducer above this reference point will underestimate the blood pressure

Compliance with this Procedural Guideline is highly recommended. This Guideline may contain mandatory components
Procedure:

1. Adjust the height of the three way port to align with phlebostatic axis and adjust the monitor to display the arterial waveform zero soft key.

2. Turn the three way off to the patient and open to air (see above)

3. Select zero soft key, ensure the pressure waveform equals zero on the scales

4. When zeroing is completed, turn the three way tap back, ensure the wave form is present, place a new sterile white cap onto the three way tap.
3.3 Care of the arterial line

3.3.1 General care of the arterial line

- Staff managing and accessing arterial lines must be accredited (Once off accreditation)

- Document systolic, diastolic and mean arterial pressure hourly on 24 hour flow chart and as applicable for any significant fluctuations. Escalate interventions and care in the presence of deterioration to both Nursing Team leader and ICU medical team.

- Observe monitor for an adequate waveform. Perform the dynamic response test to assess accuracy of the waveform

- Ensure waveform scale is set appropriately, that is, a scale above the systolic pressure.

- Arterial lines are to be zeroed at the commencement of the shift, post line change and when trouble shooting

- Ensure the position of the transducer so that it is level with the heart or phlebostatic axis (4th intercostal space mid axillary line)

- Observe the arterial line site for infection, the presence of distal perfusion and to ensure the line and sample port is free of air and blood

- Ensure the dressing is intact, replace dressing weekly minimum and when required

- The arterial line insertion site must be in view in case of accidental disconnection

- Check pressure bag is inflated to 300mmHg and sufficient fluid remains in flush bag

- Arterial alarms and waveform scale should be reviewed and set appropriately to the patient and their clinical condition. **Alarms must never be turned off** (except in instances where the arterial line is no longer accurate)

- Insertion date of arterial line must be documented on the 24 hour flow chart

- All sets must be labelled with the appropriate identifying label and the date and time of attachment
• When an arterial waveform is inaccurate, **use Non-invasive blood pressure (NIBP)** until a new arterial line is sited

• **Do not** document blood pressure from an inaccurate arterial line, however, continue to monitor the limb and the waveform

• Culture arterial catheter tip on removal

### 3.3.2 Dressing

Arterial catheter dressing must be changed at least every 7 days (Tegaderm CHG dressing) or when dressing becomes soiled or detached. If Tegaderm CHG not available, replace with a semi permeable transparent dressing till stock returns.

**Equipment:**
- Dressing pack
- Skin prep Cavilon™ skin protectant
- Chlorhexidine 2% Isopropyl 70% stick (Check allergies below)
- Tegaderm CHG dressing
- Sterile gloves
- PPE

**Chlorhexidine allergy**

Ensure Chlorhexidine allergy has been checked. If allergy suspected/confirmed an alternative is required.

**Skin is to be cleaned:**
- 5% alcohol based povidone-iodine swab
- ≥70% alcohol swab
- 10% aqueous povidone-iodine if alcohol based antiseptics are contraindicated

**Dressings utilised:**
- transparent adhesive films and tape

See appendix 1 *Decision Matrix: Dressings For Percutaneous Devices – Specifically Central Venous Access Devices*
Procedure:
1. Explain procedure to the patient.
2. Wash hands, don PPE
3. Remove old dressing from arterial line insertion site and check for erythema, tenderness, suture integrity, skin integrity and catheter position.
4. Wash hands and don sterile gloves
5. Cleaning site:
   First clean site with sterile 0.9% saline if dried blood or other fluid present to remove debris from around the catheter and under the securement hub, then disinfect with Chlorhexidine 2% Isopropyl 70% stick
6. Allow skin to dry, apply skin protectant e.g. Cavilon™ before applying occlusive dressing.
   Ensure Arterial insertion site is in the centre of the dressing
7. Secure the transducer so it is easily accessible, mindful of pressure areas and is comfortable for the patient.
8. Ensure Arterial line is visible at all times where possible.
9. Label dressing with date and time of change
10. Record date and time of next dressing change on 24 hour flow chart
11. Document in clinical notes condition of insertion site and inform medical officer of signs of infection

3.3.3 Fluid and line changes

Check date and time when flush bag/lines were changed on 24 hour flow chart.

0.9% Sodium Chloride (500mls) flush bag to be changed every 24 hours. Ensure flush bag inflated to a pressure of 300mmHg to maintain patency by preventing clotting and back flow.

3.3.4 Change of transducer line

The arterial transducer and line are to be changed every 96 hours. The Red intra-ARTERIAL label (see below) is to be attached to line just above transducer with date line/transducer due for change written on it and higher up on the flush bag line as a flag identifying the arterial line.

Equipment:
- Transducer set
- Sterile luer lock cap (white cap)
- Alcohol wipe Chlorhexidine 2% Isopropyl 70%
- Normal Saline 0.9% 500mls
- Pressure bag
• Intra-ARTERIAL line label x2
• PPE, gloves

Procedure:
1. Explain procedure to the patient
2. Wash hands, don PPE
3. Place 0.9% Sodium Chloride 500mls on the bedside trolley
4. Open arterial line pack, tighten connectors, prepare equipment in the pack
5. Spike fluid bag, place in the pressure bag and hang from an IV pole. DO NOT inflate the pressure bag at this point
6. Prime line ensure no air bubbles whilst set still in packaging. Remember prime under gravity only
7. Once completely primed and free of air, inflate the pressure bag to 300mmHg
8. Wash hands, don gloves
9. Scrub arterial line connection with Chlorhexidine 2% Isopropyl 70% swab for 30 seconds, Allow to dry for 15 seconds
10. Once dry, clamp arterial line and disconnect old line, reconnect with new primed line
11. Connect transducer to pressure cable and Zero the transducer
12. Replace the red venting cap with a sterile luer lock cap (white cap)
13. Clearly label the transducer set with a red intra-ARTERIAL sticker label complete with date and time clearly indicating when line change was performed
14. Record date and time of next line change on 24 hour flow chart

3.4 Blood sampling

• All staff must be deemed competent in arterial blood gas sampling
• Only those who are accredited in the procedure of performing arterial blood gas analysis can use the ABG machine
• Maintain aseptic technique when accessing sampling port
• Observe standard precautions and ensure PPE is used at all times
• Document ABG results on 24 hour flow chart
• Notify medical officer of arterial blood gas results

Equipment:
• PPE, non-sterile gloves
• Arterial Blood Gas (ABG) syringe
• 2 x 2% Chlorhexidine 70% isopropyl x2 Alcohol wipes
• Vacutainer™ + blood collection tubes (if bloods additional to ABG being taken)

Procedure
1. Inform patient that a blood sample is about to be taken
2. Perform hand hygiene and don PPE

Compliance with this Procedural Guideline is highly recommended. This Guideline may contain mandatory components.
3. Clean sample port with the first alcohol wipe, allow to dry

4. Ensure stopcock OFF handle is in the correct position (open to all sites) to allow blood flow into the sample port. Draw back on inline reservoir syringe 1ml per second—ensure blood is filling syringe to 3ml

5. Turn Sample stopcock off to reservoir syringe. Take sample—attach the ABG syringe, push syringe into port and ¼ turn to right

6. Allow sample volume to fill automatically, once finished, turn stopcock off to sample port and remove—twist ABG syringe anticlockwise—DO NOT PULL
7. Cap ABG syringe with venting stopper, hold sample upright, expel air into the vent stopper. Mix the ABG sample with the anticoagulant by rolling the syringe between the palms of both hands.

8. Clean the sample port hub free of any debris using the second alcohol wipe, allow to dry.

9. Flush the sample port free of remaining blood, -> turn sample port stopcock to the open all position (facing opposite to sample port), once complete, return stopcock to the original position.

10. Return blood slowly to the patient from inline reservoir syringe at 1ml per second till wings have locked back into closed position.

11. Flush remainder of the line free of blood from the flush port using a slow constant (laminar) flow and twisting the inline reservoir syringe to create turbulence in line.

ENSURE LINE AND SAMPLING PORT ARE FREE OF BLOOD at the end of the procedure.

If difficulty is experienced in aspirating blood using the reservoir syringe, default to:

1. Follow steps 1 & 2 above.
2. Attach a 3ml syringe to sampling port, push syringe into sampling port and ¼ turn to right, turn sampling port stopcock OFF handle to reservoir syringe.
3. Withdraw 3ml blood, remove syringe- twist slowly anticlockwise to remove and discard-do not pull off.
4. Attach ABG syringe, ¼ turn to the right, and allow sample volume to fill passively.
5. Once complete, turn sampling port stopcock off the sample port and remove syringe slowly, twist anticlockwise to remove- do not pull off.
6. Cap ABG syringe with venting stopper, expel air.
7. Hold sample upright, expel air into the vent stopper. Mix the ABG sample fully with anticoagulant by rolling the syringe between the palms of both hands.
8. Flush the sample port free of remaining blood, - turn sample port stopcock to the open all position (facing opposite to sample port) and flush. Once complete, return stopcock to the original position.
9. Flush remainder of the line free of blood from the flush port.
10. Clean sample port with alcohol swab, allow to dry.
Processing the ABG sample
1. Remove gown and gloves and wash hands
2. Once sample collected and mixed, there is 10 minutes to process sample
3. Prior to processing the sample at the ABG machine mix again, rolling the syringe in the palm of both hands
4. Enter user ID, follow prompts on the device
5. ABG analysis complete discard sample with dirty hand in the contaminated waste bin
6. Attend to hand hygiene
7. Document results on 24 hour flow chart
8. Inform medical offer of result

If the ABG machine is not available, place labelled ABG syringe with time of sample and accompanying Blood Gas request form. The ABG is to be double bagged in ice slurry, the sample is to be sent and received at Diagnostic Pathology Unit (DPU) within 30 minutes.

3.5 Removal of arterial line
Removal of the arterial line occurs when the arterial line is no longer required for close blood pressure monitoring and/or frequent blood sampling, there are any signs of infection, the device is not functioning or there is compromise to the limb. Ensure a clear order exists for the removal of the line. Prior to removal, check coagulation status and if cessation of anticoagulation therapy is required. All arterial catheter tips are sent for culture

Equipment:
- Dressing pack
- Chlorhexidine 2% Isopropyl 70% stick
- Stitch cutter x2
- Gauze squares
- Tegaderm
- Sterile gloves
- Specimen container
- PPE

Procedure:
1. Correctly identify the patient using the 3 core identifiers i.e. name, date of Birth and MRN
2. Monitor blood pressure by non-invasive blood pressure cuff (NIBP), ensure appropriate alarm settings are set
3. Prepare equipment needed
4. Cease arterial monitoring, suspend BP alarms
5. Explain procedure to the patient
6. Wash hands, apply PPE
7. Remove dressing
8. Wash hands apply new gloves
9. Adhere to aseptic technique
10. Cut suture and remove cannula while pressing firmly over the insertion site with gauze for at least 5 minutes or for femoral sites press for firmly for 10 minutes until

Compliance with this Procedural Guideline is highly recommended. This Guideline may contain mandatory components
haemostasis is achieved. Avoid contamination of the tip, place catheter on sterile dressing pack field
11. Immediately apply occlusive dressing, observe site for further bleeding
12. **Tip culture** - Cut tip with 2nd sterile suture cutter and place in labelled specimen container and send to pathology with catheter tip order
13. Document in the patient’s medical record

3.6 Occupational Health and Safety:
- Ensure correct wearing of PPE as per standard precautions and in accordance with hospital policy
- Observe universal precautions
- Containment of body fluids in accordance with hospital policy
- Discard all disposable equipment and sharps in accordance with hospital policy
- Containment of body fluids in accordance with standard precautions.

4. Use of the guide
This guideline is intended to be used for all Nursing staff in Concord hospital taking care of patients with Arterial pressure monitoring with safenet.

5. Definitions
**Mean arterial Pressure (MAP):** Map is a calculated value. The following calculations may be used \((\text{SBP} + 2\times \text{DBP})/3\) OR \(\text{MAP} = \text{DBP} + \frac{1}{3} \times \text{PP} (\text{PP} = \text{SBP} – \text{DBP})\)

**Transducer** An electronic device to measure pressures by converting mechanical energy into an electrical signal that is then displayed on a monitor as a waveform.

6. References and links


Critical Care London (2004) Procedure for dressing change for Central lines and peripheral Arterial lines Critical Care Nursing Procedures [www.lhsc.on.ca/critcare/icu/procedures/drsgart.htm](http://www.lhsc.on.ca/critcare/icu/procedures/drsgart.htm).


Liverpool Intensive Care Unit, 2011. **Arterial blood pressure and arterial line management in the ICU.**

Orange Base ICU 2013 **Safeset Arterial Line Equipment Policy**


7. **Custodian**
Intensive Care Unit CNC

8. **Associated Procedures**

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APPENDIX 1:
Decision Matrix: Dressings For Percutaneous Devices – Specifically Central Venous Access Devices

Chlorhexidine (CHG) Dressing

The CHG Dressing eliminates the need for a StatLock & a BioPatch

All CVADS:
Short Term CVDS:
I/J Veins
Subclavians
Femoral
Peripherally Inserted Central Catheters (PICC’s)
Tunneled Catheters - Hickman’s
Dialysis Catheters
P/IVC (Cannula)
Arterial Catheters

Decison Matrix for Dressing & Securement of Central Venous Access Devices

IV Advanced Dressing

The IV Advanced Dressing eliminates the need for a StatLock

For patients with sensitive skin and/or an Allergy to CHG

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