PROCEDURE

59 Arterial Catheter Insertion (Assist), Care, and Removal

Hillary Crumlett and Alex Johnson

PURPOSE: Arterial catheters are used for continuous monitoring of blood pressure, assessment of cardiovascular effects of vasoactive drugs, and frequent arterial blood gas and laboratory sampling. In addition, arterial catheters provide access to blood samples that support the diagnostics related to oxygen, carbon dioxide, and bicarbonate levels (oxygenation, ventilation, and acid-base status).

PREREQUISITE NURSING KNOWLEDGE

- Knowledge of the anatomy and physiology of the vasculature and adjacent structures is needed.
- Knowledge of the principles of hemodynamic monitoring is necessary.
- Understanding of the principles of aseptic technique is needed.
- Conditions that warrant the use of arterial pressure monitoring include patients with the following:
  - Frequent blood sampling:
    - Respiratory conditions requiring arterial blood gas monitoring (oxygenation, ventilation, acid-base status)
    - Bleeding, actual or potential
    - Electrolyte or glycemic abnormalities, actual or potential
    - Metabolic abnormalities (acid-base, tissue perfusion), actual or potential
    - Monitoring serum levels related to therapeutic interventions (renal replacement therapy, chemotherapy, biotherapy, apheresis therapy, etc.)
  - Continuous blood pressure monitoring:
    - Hypotension or hypertension
    - Shock: cardiogenic, septic, hypovolemic, neurogenic
    - Mechanical cardiovascular support
    - Vasoactive medication administration
- Arterial pressure represents the forcible ejection of blood from the left ventricle into the aorta and out into the arterial system. During ventricular systole, blood is ejected into the aorta, generating a pressure wave. Because of the intermittent pumping action of the heart, this arterial pressure wave is generated in a pulsatile manner (Fig. 59-1). The ascending limb of the aortic pressure wave (anacrotic limb) represents an increase in pressure because of left-ventricular ejection. The peak of this ejection is the peak systolic pressure, which should be less than 120 mm Hg in adults.[21] After reaching this peak, the ventricular pressure declines to a level below aortic pressure and the aortic valve closes, marking the end of ventricular systole. The closure of the aortic valve produces a small rebound wave that creates a notch known as the dicrotic notch. The descending limb of the curve (diastolic downslope) represents diastole and is characterized by a long declining pressure wave, during which the aortic wall recoils and propels blood into the arterial network. The diastolic pressure is measured as the lowest point of the diastolic downslope, which should be less than 80 mm Hg in adults.[21]
- The difference between the systolic and diastolic pressures is the pulse pressure, with a normal value of about 40 mm Hg.
- Arterial pressure is determined by the relationship between blood flow through the vessels (cardiac output) and the resistance of the vessel walls (systemic vascular resistance). The arterial pressure is therefore affected by any factors that change either cardiac output or systemic vascular resistance.
- The average arterial pressure during a cardiac cycle is called the mean arterial pressure (MAP). MAP is not the average of the systolic plus the diastolic pressures because, during the cardiac cycle, the pressure remains closer to diastole than to systole for a longer period (at normal heart rates). The MAP is calculated automatically by most patient monitoring systems; however, it can be calculated with the following formula:

$$\text{MAP} = \frac{(\text{systolic pressure}) + (\text{diastolic pressure} \times 2)}{3}$$

- MAP represents the driving force (perfusion pressure) for blood flow through the cardiovascular system. MAP is at its highest point in the aorta. As blood travels through the arterial system away from the aorta, systolic pressure increases and diastolic pressure decreases, with an overall decline in the MAP (Fig. 59-2).
- The location of arterial catheter placement depends on the condition of the arterial vessels and the presence of other catheters (i.e., the presence of a dialysis shunt is a contraindication for placement of an arterial catheter in the same extremity). Once inserted, the arterial catheter causes little

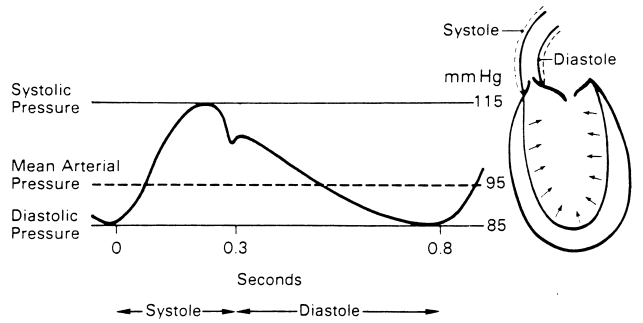


Figure 59-1 The generation of a pulsatile waveform. This is an aortic pressure curve. During systole, the ejected volume distends the aorta and aortic pressure rises. The peak pressure is known as the aortic systolic pressure. After the peak ejection, the ventricular pressure falls; when it drops below the aortic pressure, the aortic valve closes, which is marked by the dicrotic notch, the end of the systole. During diastole, the pressure continues to decline and the aortic wall recoils, pushing blood toward the periphery. The trough of the pressure wave is the diastolic pressure. The difference between the systolic and diastolic pressure is the pulse pressure. *(From Smith JJ, Kampine JP:* Circulating physiology. *Baltimore, 1980, Williams & Wilkins, 55.)*

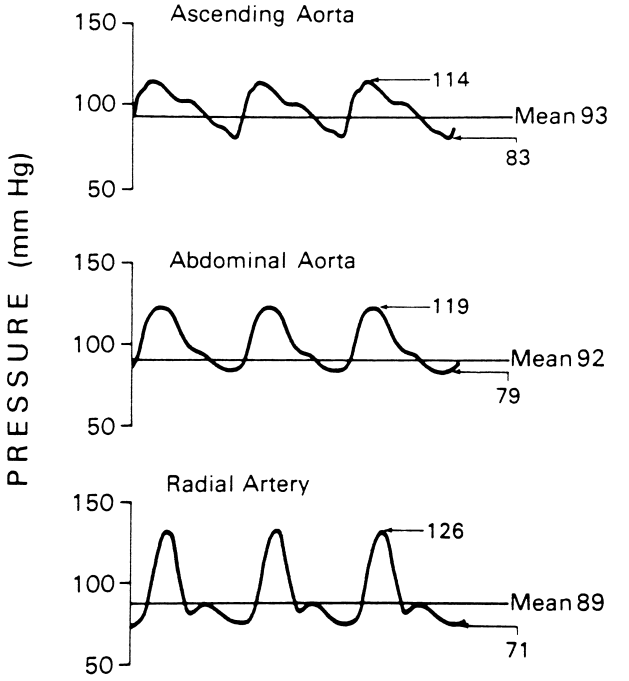


Figure 59-2 Arterial pressure from different sites in the arterial tree. The arterial pressure waveform varies in configuration, depending on the location of the catheter. With transmission of the pressure wave into the distal aorta and large arteries, the systolic pressure increases and the diastolic pressure decreases; with a resulting heightening of the pulse, pressure declines steadily. *(From Smith JJ, Kampine JP:* Circulating physiology. *Baltimore, 1980, Williams & Wilkins, 57.)*

or no discomfort to the patient and allows continuous blood pressure assessment and intermittent blood sampling. If intraaortic balloon pump therapy is necessary, arterial pressure may be directly monitored from the tip of the balloon catheter in the aorta.

- The radial artery is the most common site for arterial pressure monitoring. When arterial pulse waveforms are recorded from a peripheral site (compared with a central site), the waveform morphology changes. The anacrotic limb becomes more peaked and narrowed, with increased amplitude; therefore, the systolic pressure in peripheral sites is higher than the systolic pressure recorded from a more central site (see Fig. 59-2). In addition, the diastolic pressure decreases, the diastolic downslope may show a secondary wave, and the dicrotic notch becomes less prominent from distal sites.
- Vasodilators and vasoconstrictors may change the appearance of the waveforms from distal sites. Vasodilators may cause the waveform to take on a more central appearance. Vasoconstrictors may cause the systolic pressure to become more exaggerated because of enhanced resistance in the peripheral arteries.
- Several potential complications are associated with arterial pressure monitoring. Infection at the insertion site can develop and cause sepsis. Clot formation in the catheter can lead to arterial embolization. The catheter can cause a pseudoaneurysm or vessel perforation with extravasation of blood and flush solution into the surrounding tissue. Finally, the distal extremity can develop circulatory or neurovascular impairment.
- Ultrasound guidance is recommended to place arterial catheters if the technology is available.[8]

EQUIPMENT

- 2-inch, 20-gauge, nontapered Teflon cannula-over-needle or prepackaged kit that includes a 6-inch, 18-gauge Teflon catheter with appropriate introducer and guidewire (or the specific catheter for the intended insertion site)
- Pressure module and cable for interface with the monitor
- Pressure transducer system, including flush solution recommended according to institutional standards, a pressure bag or device, pressure tubing with transducer, and flush device (see Procedure 75)
- Dual-channel recorder
- Nonsterile gloves, head covering, goggles, and mask
- Sterile gloves and large sterile fenestrated drape
- Skin antiseptic solution (e.g., 2% chlorhexidine-based preparation)
- Sterile 4 × 4 gauze pads
- Transparent occlusive dressing
- 1% lidocaine without epinephrine, 1 to 2 mL
- Sterile sodium chloride 0.9%
- 3-mL syringe with 25-gauge needle
- Sheet protector
- Bedside ultrasound machine with vascular probe
- Sterile ultrasound probe cover
- Sterile ultrasound gel

Additional equipment, to have available as needed, includes the following:

- Sterile gown and full drape
- Bath towel
- Small wrist board
- Sutureless securement device
- Suture material

- Chlorhexidine-impregnated sponge
- Additional transparent adhesive dressing with tapes (if dressing has no tape, consider the use of ½-inch Steri-Strips)
- Transducer holder, intravenous (IV) pole, and laser lever for pole-mounted arterial catheter transducers

PATIENT AND FAMILY EDUCATION

- Explain the procedure and the purpose of the arterial catheter. ***Rationale:*** This explanation decreases patient and family anxiety.
- Explain the standard of care to the patient and family, including insertion procedure, alarms, dressings, and length of time the catheter is expected to be in place. ***Rationale:*** This explanation encourages the patient and family to ask questions and voice concerns about the procedure and decreases patient and family anxiety.
- Explain the patient's expected participation during the procedure. ***Rationale:*** Patient cooperation during insertion is encouraged.
- Explain the importance of keeping the affected extremity immobile. ***Rationale:*** This explanation encourages patient cooperation to prevent catheter dislodgment and maintains catheter patency and function.
- Instruct the patient to report any warmth, redness, pain, or wet feeling at the insertion site at any time. ***Rationale:*** These symptoms may indicate infection, bleeding, or disconnection of the tubing or catheter.

PATIENT ASSESSMENT AND PREPARATION

Patient Assessment

- Obtain the patient's medical history, including history of diabetes, hypertension, peripheral vascular disease, vascular grafts, arterial vasospasm, thrombosis, or embolism. Obtain the patient's history of coronary artery bypass graft surgery in which radial arteries were removed for use as conduits or presence of arteriovenous fistulas or shunts. ***Rationale:*** Extremities with any of these problems should be avoided as sites for cannulation because of the potential for complications. Patients with diabetes mellitus or hypertension are at higher risk for arterial or venous insufficiency. Previously removed radial arteries are a contraindication for ulnar artery cannulation.
- Review the patient's current anticoagulation therapy, history of blood dyscrasias, and pertinent laboratory values (prothrombin time [PT], international normalized ratio [INR], partial thromboplastin time [PTT], and platelets) before the procedure. ***Rationale:*** Anticoagulation therapy, blood dyscrasias, or alterations in coagulation studies could increase the risk of hematoma formation or hemorrhage.
- Review the patient's allergy history (e.g., allergy to heparin, lidocaine, antiseptic solutions, or adhesive tape). ***Rationale:*** This assessment decreases the risk for allergic reactions. Patients with heparin-induced thrombocytopenia should not receive heparin in the flush solution.
- Assess the neurovascular and peripheral vascular status of the extremity to be used for the arterial cannulation, including color, temperature, presence and fullness of pulses, capillary refill, presence of bruit (in larger arteries such as the femoral artery), and motor and sensory function (compared with the opposite extremity). Note: A modified Allen's test should be performed before cannulation of the radial artery (see Fig. 81-3). ***Rationale:*** This assessment may help identify any neurovascular or circulatory impairment before cannulation to avoid potential complications.[2,3,20]

Patient Preparation

- Verify that the patient is the correct patient using two identifiers. ***Rationale:*** Before performing a procedure, the nurse should ensure the correct identification of the patient for the intended intervention.
- Ensure that the patient and family understand preprocedural teaching. Answer questions as they arise, and reinforce information as needed. ***Rationale:*** Understanding of previously taught information is evaluated and reinforced.
- Ensure that informed consent is obtained. ***Rationale:*** Informed consent protects the rights of the patient and allows a competent decision to be made by the patient; however, in emergency circumstances, time may not allow the form to be signed.
- Perform a preprocedure verification and time out, if nonemergent. ***Rationale:*** Ensures patient safety.
- Place the patient supine with the head of the bed at a comfortable position. The limb into which the arterial catheter will be inserted should be resting comfortably on the bed. ***Rationale:*** This placement provides patient comfort and facilitates insertion.
- If the radial artery is selected, position the hand to allow for palpation of the artery (a pillow or towel may be used to support the wrist). ***Rationale:*** This placement positions the arm and brings the artery closer to the surface.
- If the brachial artery is selected, elevate and hyperextend the patient's arm and palpate the artery (a pillow or towel may be used to support the arm). ***Rationale:*** This action increases accessibility of the artery.
- If the femoral artery is selected, position the patient supine with the head of the bed at a comfortable angle. The patient's leg should be straight with the femoral area easily accessible and palpate the artery (a small towel may be needed to support the hip in some cases). ***Rationale:*** This position is the best for localizing the femoral artery pulse.

Procedure for Assisting With Insertion of an Arterial Catheter

Steps	Rationale	Special Considerations
1. HH		
2. Prepare the flush solution (see Procedure 75). A. Use an IV solution of normal saline. B. Follow institutional standards for adding heparin to the IV solution, if heparin is not contraindicated. **(Level B*)**	Heparinized flush solutions are commonly used to minimize thrombi and fibrin deposits on catheters that might lead to thrombosis or bacterial colonization of the catheter.	Although heparin may prevent thombosis,[9,14,17] it has been associated with thrombocytopenia and other hematologic complications.[6] Other factors that promote patency of the arterial line besides heparinized saline solution include male gender, longer arterial catheters, larger vessels cannulated, patients receiving other anticoagulants or thrombolytics, and short-term use of the catheter.[1]
3. Consider the use of a blood-conservation arterial line system. **(Level B*)**	Reduces the risk of nosocomial anemia.[5,11,16,18,19]	
4. Prime or flush the entire single-pressure transducer system (see Procedure 75).	Removes air bubbles. Air bubbles introduced into the patient's circulation can cause air embolism. Air bubbles within the tubing dampen the waveform.	Air is more easily removed from the hemodynamic tubing when the system is not under pressure.
5. Apply and inflate the pressure bag or device to 300 mm Hg.	Each flush device delivers 1–3 mL/hr to maintain patency of the hemodynamic system.	
6. Connect the pressure cable to the bedside monitor.	Connects the pressure transducer system to the bedside monitoring system.	
7. Set the scale on the bedside monitor for the anticipated pressure waveform.	Prepares the bedside monitor.	
8. Level the air-fluid interface (zeroing stopcock) to the phlebostatic axis (see Figs. 75-7 and 75-9).	Leveling ensures that the air-fluid interface of the monitoring system is level with a reference point on the body. The phlebostatic axis reflects central arterial pressure.[13]	Use a pole mount or patient mount according to institutional protocol (see Procedure 75). The tip of the arterial catheter is not used as the reference point because it measures transmural pressure of a specific area in the arterial tree, which may be increased by hydrostatic pressure.[13]
9. Zero the system by turning the stopcock off to the patient, opening it to air, and zeroing the monitoring system (see Procedure 75).	Prepares the monitoring system.	
10. HH		
11. PE		
12. Assist as needed with skin preparation.	Provides help to the provider inserting the catheter.	

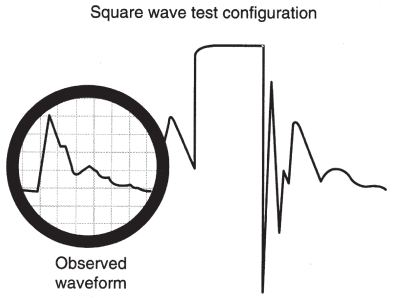
*Level B: Well-designed, controlled studies with results that consistently support a specific action, intervention, or treatment.

Procedure continues on following page

Procedure **for Assisting With Insertion of an Arterial Catheter—*Continued***

Steps	Rationale	Special Considerations
13. Assist as needed with immobilizing the extremity during catheter insertion.	Facilitates insertion.	Personal protective equipment (e.g., head cover, mask, goggles) is needed, as well as sterile equipment. Maximal sterile barrier precautions should be used for femoral artery catheter insertion.[8,14]
14. Connect the pressure cable from the arterial transducer to the bedside monitor.	Connects the arterial catheter to the bedside monitoring system.	
15. Reassess accurate leveling, and secure the transducer (see Procedure 75).	Ensures that the air-filled interface (zeroing stopcock) is maintained at the level of the phlebostatic axis. If the air-fluid interface is above the phlebostatic axis, arterial pressures are falsely low. If the air-fluid interface is below the phlebostatic axis, arterial pressures are falsely high.	Leveling ensures accuracy. The point of the phlebostatic axis should be marked with an indelible marker, especially when the transducer is secured in a pole-mount system.
16. Zero the system again (see Procedure 75).	Ensures accuracy of the system with the established reference point.	
17. Turn the stopcock off to the top port of the stopcock. Place a sterile cap or a needleless cap on the top port of the stopcock.	Prepares the system for monitoring and ensures a closed system.	
18. Observe the waveform and perform a dynamic response test (square wave test; Fig. 59-3).	Determines whether the system is damped. This will ensure that the pressure waveform components are clearly defined. This aids in accurate measurement.	The square wave test can be performed by activating and quickly releasing the fast flush. A sharp upstroke should terminate in a flat line at the maximal indicator on the monitor. This should be followed by an immediate rapid downstroke extending below the baseline with 1–2 oscillations within 0.12 second and a quick return to baseline (see Fig. 59-3).
19. Ensure that the provider inserting the catheter has secured the arterial catheter in place.	Maintains arterial catheter position; reduces the chance of accidental dislodgement.	A sutureless securement device can be used.
20. Ensure that the provider inserting the catheter has applied an occlusive, sterile dressing to the insertion site.	Reduces the risk of infection.	
21. Apply an arm board, if necessary.	Ensures the correct position of the extremity for an optimal waveform.	
22. Set the alarm parameters according to the patient's current blood pressure.	Activates the bedside and central alarm system.	
23. Remove PE and discard used supplies in appropriate receptacles; ensure that all needles and other sharp objects are disposed of in appropriate containers.	Reduces the transmission of microorganisms; Standard Precautions. Safely removes sharp objects.	
24. HH		

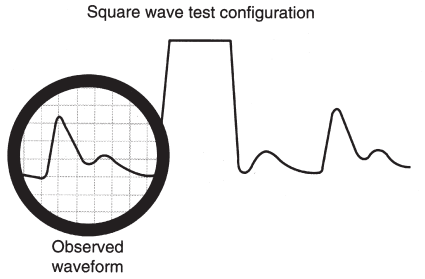
When the fast flush of the continuous flush system is activated and quickly released, a sharp upstroke terminates in a flat line at the maximal indicator on the monitor and hard copy. This is then followed by an immediate rapid downstroke extending below baseline with just 1 or 2 oscillations within 0.12 second (minimal ringing) and a quick return to baseline. The patient's pressure waveform is also clearly defined with all components of the waveform, such as the dicrotic notch on an arterial waveform, clearly visible.



Intervention

A There is no adjustment in the monitoring system required.

The upstroke of the square wave appears somewhat slurred, the waveform does not extend below the baseline after the fast flush and there is no ringing after the flush. The patient's waveform displays a falsely decreased systolic pressure and false high diastolic pressure as well as poorly defined components of the pressure tracing such as a diminished or absent dicrotic notch on arterial waveforms.



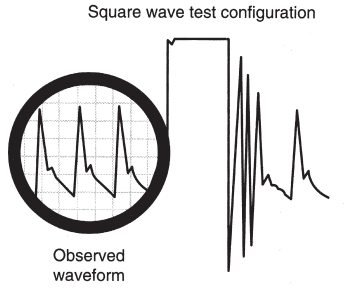
Intervention

To correct for the problem:

1. Check for the presence of blood clots, blood left in the catheter following blood sampling, or air bubbles at any point from the catheter tip to the transducer diaphragm and eliminate these as necessary.
2. Use low compliance (rigid), short (less than 3 to 4 feet) monitoring tubing.
3. Connect all line components securely.

B 4. Check for kinks in the line.

The waveform is characterized by numerous amplified oscillations above and below the baseline following the fast flush. The monitored pressure wave displays false high systolic pressures (overshoot), possibly false low diastolic pressures, and "ringing" artifacts on the waveform.



Intervention

C To correct the problem, remove all air bubbles (particularly pinpoint air bubbles) in the fluid system, use large-bore, shorter tubing, or use a damping device.

Figure 59-3 Dynamic response test (square wave test) using the fast flush system. **A**, Optimally damped system. **B**, Overdamped system. **C**, Underdamped system. *(From Darovic GO, Zbilut JP: Fluid-filled monitoring systems. In* Hemodynamic monitoring*, ed 3. Philadelphia, 2002, Saunders, 122.)*

Procedure for Assisting With Insertion of an Arterial Catheter—*Continued*

Steps	Rationale	Special Considerations
25. Compare the manual (noninvasive) blood pressure with the arterial (invasive) blood pressure.	Obtains baseline data.	No direct relationship exists between noninvasive and invasive blood pressures because noninvasive techniques measure blood flow and invasive techniques measure pressure.[13]
26. Run a waveform strip and record the patient's baseline arterial pressures.	Obtains baseline data.	Digital values are not used because they are averaged calculations.

Procedure for Troubleshooting an Overdamped Waveform

Steps	Rationale	Special Considerations
1. HH		
2. PE		
3. Identify the overdamped waveform (Fig. 59-4).	Identifies the problem.	An overdamped waveform results in a falsely low systolic pressure and a falsely high diastolic pressure.

Figure 59-4 Overdamped arterial waveform (*1*, systole; *2*, diastole). *(From Daily EK, Schroeder JS:* Hemodynamic waveforms*. St Louis, 1990, Mosby, 110.)*

4. Check the patient.	A sudden hypotensive episode can look like an overdamped waveform (Fig. 59-5).	

Procedure for Troubleshooting an Overdamped Waveform—*Continued*

Steps	Rationale	Special Considerations

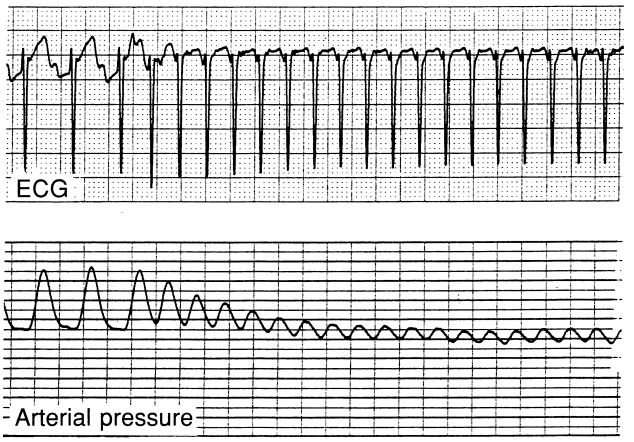


Figure 59-5 Patient developed supraventricular tachycardia (SVT) with a fall in arterial pressure. Note how the arterial waveform appears overdamped but is in fact reflecting a severe hypotensive episode associated with the tachycardia.

5. If the waveform is overdamped, follow these steps:		
A. Check the arterial line insertion site for catheter positioning.	Wrist movement in the radial site or leg flexion in the femoral site can cause catheter kinking or dislodgment, resulting in an overdamped waveform.	
B. Check the system for air bubbles and eliminate them if they are found.	Air bubbles can be a cause of an overdamped system; air bubbles can also cause emboli.	
C. Check the tubing system for leaks or disconnections, and correct the problem if it is found.	Ensures all connections are tight.	
D. Check the flush bag to ensure fluid is present in the bag and that pressure is maintained at 300 mm Hg.	An empty flush bag or a pressure of less than 300 mm Hg may result in an overdamped system.	
E. A catheter with an overdamped waveform should always be aspirated before flushing.	Use of the fast-flush device or flushing with a syringe first may force a clot at the catheter tip into the arterial circulation.	
Attempt to aspirate and flush the catheter as follows:	Assists with the withdrawal of air in the tubing or clots that may be at the catheter tip.	
• Using the stopcock closest to the patient, remove the nonvented cap from the blood sampling port or cleanse the needleless port and attach a 5- or 10-mL syringe to the top port of the stopcock (see Fig. 61-1).	A 5-mL syringe generates less pressure and may prevent arterial spasm in smaller arteries (e.g., radial artery).	A 10-mL syringe may be needed for larger arteries (e.g., the femoral artery). A needleless system can also be used.
• Turn the stopcock off to the flush solution (see Fig. 61-4B).	Opens the system from the patient to the syringe. Assesses catheter patency. Normally, blood should be aspirated into the syringe without difficulty.	
• Gently attempt to aspirate; if resistance is felt, reposition the extremity and reattempt aspiration.		
• If resistance is still felt, stop and notify the physician or advanced practice nurse.		

Procedure continues on following page

Procedure for Troubleshooting an Overdamped Waveform—*Continued*

Steps	Rationale	Special Considerations
• If blood is aspirated, remove 3 mL, turn the stopcock off to the patient, and discard the 3-mL sample.	Removes any clotted material within the catheter.	All blood wastes should be disposed using Standard Precautions.
• Fast-flush the remaining blood from the stopcock onto a sterile gauze pad or into another syringe and remove the syringe.	Removes blood residue from the stopcock, where it could be a reservoir for bacterial growth, and prevents clotting in the blood sampling port.	
• Turn the stopcock off to the blood sampling port (see Fig. 61-1) and place a new sterile nonvented cap (not needed if using a needleless port).	Maintains sterility and a closed system.	
• Use the fast-flush device to clear the line of blood.	Prevents the arterial line from clotting.	
6. Remove PE and discard used supplies in the appropriate receptacles.	Reduces the transmission of microorganisms; Standard Precautions.	
7. HH		

Procedure for Troubleshooting an Underdamped Waveform

Steps	Rationale	Special Considerations
1. HH		
2. PE		
3. Identify the underdamped waveform.	Identifies the problem.	An underdamped waveform results in a falsely high systolic pressure and a falsely low diastolic pressure.
4. Check the system for air bubbles and eliminate them if they are found.	Air bubbles can contribute to underdamping; air bubbles can also cause emboli.	
5. Check the length of the tubing of the pressure transducer system.	Ensures that the tubing length is minimized.	
6. Observe the waveform and perform a dynamic response test (square wave test; Fig. 59-3).	Determines whether the system is damped. This will ensure that the pressure waveform components are clearly defined. This aids in accurate measurement.	
7. Remove PE and discard used supplies in appropriate receptacles.	Reduces the transmission of microorganisms; Standard Precautions.	
8. HH		

Procedure for Arterial Catheter Dressing Change

Steps	Rationale	Special Considerations
1. HH		
2. PE		
3. Carefully remove and discard the arterial line dressing.	Removes the previous dressing without disrupting the integrity of the catheter.	If present, remove the securement device.
4. Inspect the catheter, insertion site, and surrounding skin.	Assesses for signs of infection, catheter dislodgement, or leakage.	
5. Remove nonsterile gloves, discard dressings, and perform hand hygiene.	Reduces the transmission of microorganisms	
6. Don sterile gloves	Maintains aseptic and sterile technique.	
7. Cleanse the skin and catheter with 2% chlorhexidine-based preparation.[14]	Reduces the rate of recolonization of skin flora. Decreases the risk for bacterial growth at the insertion site.	Allow time for the solution to air dry.
8. Apply a new stabilization device.	Secures the catheter.	
9. Apply a chlorhexidine-impregnated sponge to the site.[12,14] **(Level D*)**	Reduces the transmission of microorganisms.	Follow institutional standards. A chlorhexidine-impregnated sponge dressing is recommended if an institution's central line–associated bloodstream infection rate is not decreasing despite adherence to basic prevention measures, including education and training, appropriate use of chlorhexidine for skin antisepsis, and maximum sterile barrier.[8,12,14] Use with caution in patients predisposed to local skin necrosis, such as burn patients or patients with Stevens-Johnson syndrome.[22]
10. Apply a sterile air-occlusive dressing. Dressings may be a sterile gauze or a sterile, transparent, semipermeable dressing.[14]	Provides a sterile environment.	Write the date and time of the dressing change on a label and tape it to the dressing.
11. Remove gloves and discard used supplies in appropriate receptacles.	Reduces the transmission of microorganisms; Standard Precautions.	
12. HH		

*Level D: Peer-reviewed professional and organizational standards with the support of clinical study recommendations.

Procedure continues on following page

Procedure for Removal of the Arterial Catheter

Steps	Rationale	Special Considerations
1. Review the patient's coagulation profile (PT, INR, PTT, platelets) and anticoagulation medication profile before removal of the arterial catheter.	Elevated PT, INR, PTT, and decreased platelets affect time to hemostasis.	If laboratory values are abnormal, pressure needs to be applied for a longer period to achieve hemostasis.
2. HH		
3. PE		
4. Turn off the arterial monitoring alarms.	The alarm system is no longer needed.	
5. Remove the dressing.	Prepares for catheter removal.	
6. Remove the stabilizing device.	Prepares for catheter removal.	
7. Turn the stopcock off to the flush solution (see Fig. 61-4B).	Turns the monitoring system off to the flush solution.	
8. Apply pressure 1–2 finger widths above the insertion site.	The arterial puncture site is above the skin puncture site because the catheter enters the skin at an angle.	
9. Remove the arterial catheter and place a sterile 4 × 4 gauze pad over the catheter site.	Prevents splashing of blood.	
10. Continue to hold proximal pressure and immediately apply firm pressure over the insertion site as the catheter is removed.	Prevents bleeding.	
11. Continue to apply pressure for a minimum of 5 minutes for the radial artery.	Achieves hemostasis.	Follow institutional standards. Longer periods of direct pressure may be needed to achieve hemostasis (e.g., patients receiving systemic heparin or thrombolytics, patients with catheters in larger arteries such as the femoral artery, or patients with abnormal coagulation values).
12. Apply a pressure dressing to the insertion site.	A pressure dressing helps prevent rebleeding.	The dressing should not encircle the extremity (prevents ischemia of the extremity).
13. Remove PE and discard used supplies in appropriate receptacles.	Reduces the transmission of microorganisms; Standard Precautions.	
14. HH		

Expected Outcomes

- Successful cannulation of the artery
- Peripheral vascular and neurovascular systems intact
- Alterations in blood pressure identified and treated
- Able to continuously monitor blood pressure
- Maintenance of baseline hemoglobin and hematocrit levels
- Adequate circulation to the involved extremity
- Adequate sensory and motor function to the involved extremity
- Maintenance of catheter site without infection
- Removal of catheter when no longer needed

Unexpected Outcomes

- Pain
- Insertion complications
- Inability to cannulate the artery
- Change in color, temperature, sensation; movement of the extremity used for insertion
- Hematoma, hemorrhage, infection, or thrombosis at the insertion site
- Decreased hemoglobin and hematocrit values
- Catheter disconnection with significant blood loss
- Presence of a new bruit
- Impaired sensory or motor function of the extremity
- Elevated temperature or elevated white blood cell count
- Redness, warmth, edema, or drainage at or from the insertion site

Patient Monitoring and Care

Steps	Rationale	Reportable Conditions
		These conditions should be reported if they persist despite nursing interventions.
1. Assess the neurovascular and peripheral vascular status of the cannulated extremity immediately after catheter insertion and every 4 hours, or more often if warranted, according to institutional standards.	Validates adequate peripheral vascular and neurovascular integrity. Changes in sensation, motor function, pulses, color, temperature, or capillary refill may indicate ischemia, thrombosis, arterial spasm, or neurovascular compromise.	• Diminished or absent pulses • Pale, mottled, or cyanotic appearance of the distal extremity • Extremity that is cool or cold to the touch • Capillary refill time of greater than 2 seconds • Diminished or absent sensation or pain at the site or distal extremity • Diminished or absent motor function
2. Check the arterial line flush system every 4 hours to ensure the following: • Pressure bag or device is inflated to 300 mm Hg. • Fluid is present in the flush solution.	Ensures that approximately 1–3 mL/hr of flush solution is delivered through the catheter, thus maintaining patency and preventing backflow of blood into the catheter and tubing. The risk of catheter occlusion related to fibrin sheath or clot formation increases if the flush solution is not continuously infusing.	
3. Perform a dynamic response test (square wave test) at the start of each shift, with a change of the waveform, or after the system is opened to air (see Fig. 59-3).	An optimally damped system provides an accurate waveform.	• Overdamped or underdamped waveforms that cannot be corrected with troubleshooting procedures
4. Monitor for overdamped or underdamped waveforms. An overdamped waveform is characterized by a flattened waveform, a diminished or absent dicrotic notch, or a square wave that does not fall to baseline or below baseline (see Fig. 59-4). An underdamped waveform is characterized by catheter fling or artifacts on the waveform (see Fig. 59-3,C).	An optimally damped system provides an adequate waveform which facilitates accuracy of blood pressure monitoring. An overdamped waveform can result in inaccurate blood pressure measurement. The patient's blood pressure measure may be inaccurately low. An overdamped system can be caused by air bubbles in the system; use of compliant tubing versus stiff, loose tubing connections in the system; too many stopcocks in the system; a cracked tubing or stopcock; arterial catheter occlusion or a kink; the catheter tip being against the arterial wall; blood in the transducer; and insufficient pressure of the flush solution. An underdamped waveform can also result in inaccurate blood pressure measurement. The patient's blood pressure measure may be inaccurately high. Common causes of an underdamped waveform include excessive tubing length, movement of the catheter in the artery, patient movement, and air bubbles in the system.	• Overdamped or underdamped waveforms that cannot be corrected with troubleshooting procedures

Procedure continues on following page

Patient Monitoring and Care —*Continued*

Steps	Rationale	Reportable Conditions
5. Zero the transducer during the initial setup, after insertion, if disconnection occurs between the transducer and the monitoring cable, if disconnection occurs between the monitoring cable and the monitor, and when the values obtained do not fit the clinical picture. Follow manufacturer recommendations for disposable systems.	Ensures accuracy of the hemodynamic monitoring system.	
6. Recheck the level of the air-fluid interface (zeroing stopcock) to the phlebostatic axis whenever patient position changes (see Procedure 75).	Ensures accurate reference point for the left atrium and accuracy of blood pressure measurements.	
7. Place sterile injectable or noninjectable caps on all stopcocks. Replace with new sterile caps whenever the caps are removed.	Stopcocks can be a source of contamination. Stopcocks that are part of the initial setup are packaged with vented caps. Vented caps need to be replaced with sterile injectable or noninjectable caps to maintain a closed system and reduce risk of contamination and infection.	
8. Continuously monitor the arterial catheter values and waveform.	Provides for continuous waveform analysis and assessment of patient status.	
9. Observe the insertion site for signs and symptoms of infection.	Infected catheters must be removed as soon as possible to prevent bacteremia. The CDC does not recommend routinely replacing peripheral arterial catheters to prevent catheter-related infections.[14]	• Redness at the site • Purulent drainage • Tenderness or pain at the insertion site • Elevated temperature • Elevated white blood cell count
10. Change the pressure transducer system (flush solution, pressure tubing, transducers, and stopcocks) every 96 hours. **(Level B*)** The flush solution may need to be changed more frequently.	The CDC[14] and the Infusion Nurses Society[8] and research findings[10,15] recommend that the hemodynamic flush system can be used safely for 96 hours. This recommendation is based on research conducted with disposable pressure monitoring systems used for peripheral and central lines.	
11. Label the tubing: A. Arterial B. Date and time prepared	Identifies that the catheter is arterial and when the system needs to be changed.	
12. Maintain the pressure bag or device at 300 mm Hg.	Maintains catheter patency.	

*Level B: Well-designed, controlled studies with results that consistently support a specific action, intervention, or treatment.

Patient Monitoring and Care —*Continued*

Steps	Rationale	Reportable Conditions
13. Print a strip of the arterial pressure waveform and obtain measurement of the arterial pressures. Note if there are respiratory variations.	Ensures accurate blood pressure measurement.	
14. Obtain an arterial pressure waveform strip to place on the patient's chart at the start of each shift and whenever a change is found in the waveform.	The printed waveform allows assessment of the adequacy of the waveform, damping, or respiratory variation.	
15. Monitor hemoglobin or hematocrit values daily or as prescribed.	Allows assessment of nosocomial anemia.	• Abnormal hemoglobin values • Abnormal hematocrit values
16. Replace gauze dressings every 2 days and transparent dressings at least every 5–7 days and more frequently as needed.[7,8,14,22] **(Level D*)**	Decreases the risk for infection at the catheter site. The CDC[14] and the Infusion Nurses Society[7,8] recommends replacing the dressing when it becomes damp, loosened, or soiled or when inspection of the site is necessary.	
17. Print a strip of the arterial waveform to place on the patient's chart at the start of each shift and whenever a change in the waveform occurs.	The printed waveform allows assessment of the adequacy of the waveform and the presence of damping.	
18. Assess the need for the arterial catheter daily. **(Level D*)**	The CDC[14] does not recommend routine replacement of arterial catheters. Catheters should be removed when no longer needed and should be replaced when there is a clinical indication.	• Signs and symptoms of infection at the arterial catheter insertion site
19. Follow institutional standards for assessing pain. Administer analgesia as prescribed.	Identifies need for pain interventions.	• Pain at the catheter site.

*Level D: Peer-reviewed professional and organizational standards with the support of clinical study recommendations.

Documentation

Documentation should include the following:

- Patient and family education
- Completion of informed consent
- Preprocedure verifications and time out
- Performance of the modified Allen's test before insertion and its results (when using the radial artery)
- Insertion of the arterial catheter
- Size of the arterial catheter inserted
- Number of insertion attempts
- Date and time of arterial catheter site care and dressing change
- Pain assessment, interventions, and effectiveness
- Site assessment
- Arterial site dressing change
- Intake of flush solution volume
- Printed strip of the arterial pressure waveform
- Appearance of the limb, color, pulse, sensation, movement, capillary refill time, and temperature of the extremity after insertion is complete
- Arterial pressures
- Waveforms
- Occurrence of unexpected outcomes and interventions

References and Additional Readings

For a complete list of references and additional readings for this procedure, scan this QR code with any freely available smartphone code reader app, or visit http://booksite.elsevier.com/9780323376624.