

**PARKLAND HEALTH & HOSPITAL SYSTEM**  
**Nursing Service**

Section: Cardiovascular  
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Distribution: Nursing Procedure Manual

**INSERTION OF PULMONARY ARTERY CATHETER AND  
CARE OF THE PATIENT**

**PRACTICE**

**STATEMENT:** The catheter is inserted and discontinued by the provider. Prior to insertion the provider will obtain an informed consent.

**PURPOSE:**

1. Measure right atrial, pulmonary artery, and pulmonary capillary wedge pressures
2. Sample mixed venous blood
3. Measure cardiac output
4. Monitor right ventricular volumes and ejection fraction
5. Monitor SVO<sub>2</sub> values

**EQUIPMENT:** Pulmonary artery catheter (type specified by provider)  
Percutaneous sheath introducer kit (French size must be 1-1.5 larger than the catheter)  
Triple transducer Kit  
Pressure bag (1000 ml)  
NS (1000 ml) or premixed heparinized NS for flush and monitoring system  
30 ml bottle of Normal Saline  
Needleless injection caps  
Bedside monitor with pressure module and cables  
Edwards Vigilance monitor with cardiac output cable, SvO<sub>2</sub> cable, and ECG slave cable  
IV bag and tubing labels  
Lidocaine 2% without epinephrine  
Antiseptic solution  
4X4's (10 pkg)  
Mask, goggles/face shield, cap, nonsterile gloves, sterile gloves and sterile gown, sterile drapes (2-3), sterile towels (2-3)  
EKG monitor, defibrillator, cardiac arrest cart & pulse oximetry  
Central line dressing kit  
Analgesia & Sedation, as ordered  
Transducer holder  
IV Pole  
Carpenter's Level

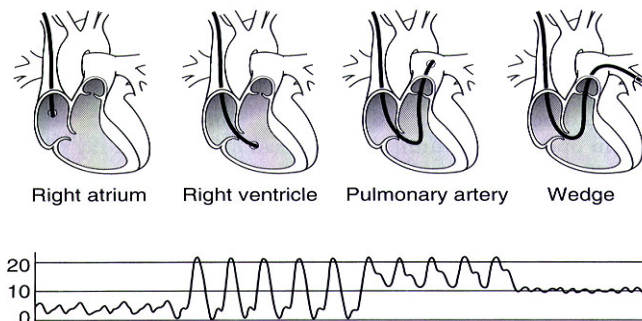
**Pediatrics:** 500 ml 1/2 NS or NS with 1u/ml heparin

**PROCEDURE:**

1. Verify Provider order and consent.
2. Wash hands and gather equipment.
3. Identify the patient using two patient identifiers (name and medical record number or no armband, name and date of birth).
4. Perform Time Out. Refer to Admin 6-30 Time Out Procedure in Administrative Manual <http://intranet.pmh.org/home/PP-Index/Admin/admin6-30.pdf>
5. Patient will be connected to the cardiac monitor and the ECG tracing should be clear.
6. \*Connect patient to Life-Pak defibrillator, unit specific.
7. Verify that patient is attached to pulse oximeter and a blood pressure monitoring device.
8. Verify that emergency equipment is present and functioning. (If patient has a pre-existing left bundle branch block, a pacemaker may be needed. The catheter may induce complete heart block by causing a right bundle branch block.)
9. Obtain baseline vital signs and check IV access for patency.
10. Prepare, level, and zero the pressure transducer system. (Refer to Nursing Policy 28-12 Setting up Transducers for Monitoring Arterial/PA and/or CVP Pressures <http://intranet.pmh.org/home/PP-Index/Nursing/28-12.pdf>)
  - a. Label waveform on bedside monitor as "PA" before zeroing.
  - b. Pull up the wedge screen and place waveform on appropriate scale to view CVP/RV/PA waveforms. (usually 60)
  - c. Shake pressure tubing to evaluate adequacy of pressure monitoring system. (Should see rapid, sharp, spiky waves.)
11. Position the portable monitor or bedside cardiac monitor close to the bedside and turn it on.
12. Provider performing procedure washes hands, don mask, goggles/face shields, caps, sterile gowns and gloves. Assisting/observing personnel must wear mask and cap when at bedside.

**Note:** If fluoroscopy is used, all personnel will wear lead aprons.
13. Consider sedation & analgesia per provider's orders.
14. Assist the provider with preparation of patient, sterile drapes and opening supplies. Open onto the sterile field the following sterile supplies:
  - a. PA catheter
  - b. Percutaneous sheath introducer kit

- c. Triple Transducer Kit
  - d. 4x4's (10 pkg)
15. The provider will:
- a. Prep site with antiseptic solution (chlorhexidine)
  - b. Drape patient with sterile sheets/towels/drape
  - c. Anesthetize the site with Lidocaine
  - d. Prepare catheter:
    - 1) Check balloon by injecting recommended volume of air. (Maximum 1.5 ml of air).  
**Pedi:** Check package insert for the precise inflation volume.
    - 2) Place a sterile plastic sheath over the catheter
    - 3) Prime the VIP lumen hub and attach a needleless injection cap to the VIP lumen.
    - 4) Flush all lumens of the PA catheter with NS or heparinized NS
  - e. The provider will first obtain central venous access by inserting the introducer. Provider will advance PA catheter through introducer.
16. Observe monitor for waveforms that indicate the catheter position (*See Figure 1*); when RA tracing is seen, provider inflates balloon with 1.5 ml of air (or recommended volume).



*Figure 1. PA catheter as it passes through right atrium, right Ventricle, pulmonary artery, and into wedge position.*

17. The PA catheter is advanced through right ventricle (RV) and into the PA. Monitor for dysrhythmias as the catheter is advanced and keep provider informed. Assess for ventricular ectopy when catheter tip is in the RV.
18. Catheter is advanced until a pulmonary capillary wedge pressure (PCWP) waveform is noted on monitor.
19. Allow the balloon to passively deflate air into the syringe. Detach the syringe from the

balloon port, expel all air, reconnect empty syringe to balloon port and lock gate valve of balloon port.

20. Check for return of PA waveform. Maintain PA waveform on constant monitor display to verify correct catheter position. (The catheter can sometimes spontaneously migrate forward to the wedge position or backward to the RV).
21. Upon catheter placement, maintain as saline-lock until correct placement is verified by chest x-ray. Once cleared for use, maintain **Keep Open** IV infusions to the proximal injectate (CVP) port, proximal infusion (VIP) port, and introducer port or flush with saline per unit standard.

**NOTE: Infusion of viscous solutions (e.g. PRBC or albumin) is not recommended because the lumens of the catheter are small.**

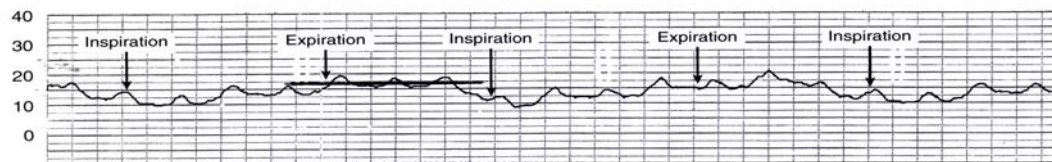
22. The provider will suture in place. Clean the site and apply sterile dressing. If introducer and sheath are left in place, secure area where PA catheter emerges from the introducer sheath
23. Record initial systolic and diastolic PA pressures, CVP and PCWP pressure readings as ordered. Report values to provider.
24. Initiate continuous cardiac output and SVO2 monitoring. (See below)
25. Document on the Nurses Notes, or Flow Sheet, the name of provider performing procedure, catheter type and size, insertion site, insertion depth of the catheter, amount of air required to wedge catheter, vital signs, administration of drugs (if any), IV infusions and locations, readings and quality of waveforms, and the patient's tolerance of the procedure (*e.g. presence of ventricular ectopy during insertion*).
26. The pulmonary artery port should be connected to the heparinized or NS flush pressure monitoring system at all times. Under no circumstances should it be used to infuse other fluids or drugs.

Potential Complications of PA catheter	
Pneumothorax/Hemothorax/Hydrothorax	Right bundle branch block
Pulmonary artery rupture	Complete heart block
Pulmonary infarction	Heparin –induced thrombocytopenia
Thrombosis	Thrombophlebitis
Catheter malposition	Air embolism
Cardiac <i>Arrhythmias</i>	
<i>Knotting of catheter</i>	
<i>Infection</i>	
<i>Primary bacteremia</i>	

## PROTOCOL

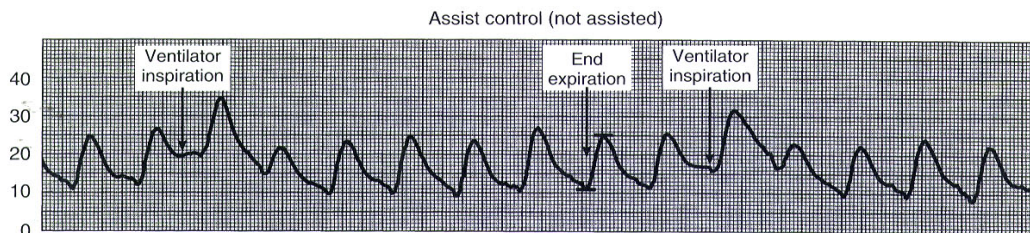
### Obtaining Pressure Readings

1. Position patient supine with the head of bed (HOB) flat or no greater than 45 degrees elevation. Neuro patients will have readings at the ordered HOB elevation. Refer to Nursing Procedure 28-12 Setting Up Transducers for Monitoring Arterial/PA and/or CVP Pressures. <http://intranet.pmh.org/home/PP-Index/Nursing/28-12.pdf>
2. Level and zero the pressure transducer system at the phlebostatic axis.
3. Observe the patient's respiratory pattern and pressure waveform. Note the changes in the waveform display during inspiration and expiration. Readings should be obtained at end-expiration. Measure the pressures using the cursor bar on the bedside monitor or using a paper printout of the tracing. The freeze mode may be used to obtain readings on the bedside monitor.
  - a. With a spontaneous (i.e. patient initiated) breath, the pressure waveform dips down during inspiration and comes back up during expiration. Read the pressure waveform complexes just before the dip (i.e. end-expiration) (See figure 2)



*Figure 2. PAWP tracing in a patient on face mask, thus all breaths are patient initiated. Note negative deflection with inspiration. Solid line indicates mean PCWP during expiration.*

- b. With ventilator initiated breath, the pressure waveforms rise during the ventilator breath and comes back down during expiration. Read the pressure waveform complexes just before the rise. (See figure 3)



*Figure 3. Patient being mechanical ventilated, assist-control mode. Patient not assisting ventilator, all breaths ventilator initiated. Upward deflection with ventilator inspiration. End-expiration systolic and diastolic pressure marked with a line.*

4. Obtain the PA systolic (peak of the waveform complex) and the PA diastolic (trough of the waveform complex) pressures.
5. Measure the mean CVP (midway between the top and bottom of the waveform at end exhalation).
6. Measure the PCWP.

*Note: Precautions when wedging the catheter include the following:*

- *Do not inflate the balloon above the recommended volume*
  - *Limit the time that the catheter is wedged to 10-15 seconds*
  - *Do not flush the catheter when it is wedged*
  - *Never inject fluid into the balloon port*
  - *Avoid numerous repetitive attempts to wedge the catheter*
- a. Unlock gate valve, disconnect the volume-limited syringe from the balloon port and fill syringe with recommended volume of air (usually 1.5 ml).
  - b. Connect the syringe to the balloon port. Unlock, slowly inflate the balloon with air until the PA waveform changes to a PCWP waveform. Note the amount of air needed to wedge the catheter. It should be close to the maximum volume (e.g. 1.25-1.5ml). (If less, catheter may have migrated forward, and may need to be repositioned by the provider.)
  - c. Read the mean of the PCWP waveform (midway between the top and bottom of the waveform at end exhalation (See Figure 2 or 3). Limit balloon inflation time to a maximum of 10-15 seconds.
  - d. Allow the balloon to passively deflate air into the syringe. Disconnect syringe, expel all air, reconnect empty syringe, and lock gate valve.
  - e. \*\*\*Confirm that the PCWP waveform has changed back to the PAP waveform\*\*\*\*

### **Continuous Cardiac Output Monitoring**

1. Confirm that the thermal filament and thermistor port connections on the catheter are securely connected to the cardiac output connecting cable from the Vigilance Edwards monitor.
2. Verify proper catheter position.
  - a. PA waveform is displayed from the distal lumen.
  - b. Right atrial waveform is displayed from the proximal injectate lumen.
  - c. If a right ventricular waveform is displayed from the proximal injectate lumen instead of a right atrial waveform, consult the provider about repositioning the catheter.
3. If CCO monitoring is not already in progress, enter patient's height and weight from the PATIENT DATA screen, then press the CCO key on the Vigilance monitor to begin. The

monitor will begin collecting data. After approximately 3-6 minutes, when enough data has been obtained for an averaged cardiac output, a CCO value will appear on the left of the Vigilance monitor screen.

4. Note the CCO value. The cardiac output displayed is an average of the CO measurements from the preceding 3-6 minutes. The displayed average is updated every 30-60 seconds. Press the STAT key to view the latest CO measurement from the preceding 30-60 seconds.
5. Connect the slave cable from the Vigilance monitor to the bedside monitor for continuous end-diastolic volume monitoring (EDV).
6. Whenever pressure readings are obtained, enter the data on the Vigilance monitor by pressing the PATIENT DATA key, then EDIT to enter the value. Press CURSOR to move the cursor to the next value to be entered.
7. Press the CALC key to obtain updated calculated hemodynamic parameters and record on flowsheet.

### **Continuous SvO2 Monitoring**

1. Confirm that the SvO2 connecting cable is connected to the SvO2 connector on the PA catheter.
2. Perform an in vivo calibration to initiate SvO2 monitoring, and then every 24 hours. An in vivo calibration is performed using a mixed venous blood gas sample drawn from the PA distal port.
  - a. Check the signal quality indicator (SQI) on left side of screen to verify a numeric score of < 3.
  - b. Press SvO2, then IN VIVO CALIBRATION, then DRAW.
  - c. Insert a 10 ml syringe onto the PA distal port and gently withdraw 3 times the deadspace volume for discard. Insert ABG syringe into the port and slowly withdraw approximately 2 ml. Place the sample on ice, label per unit standard and send to the lab. Intermittently flush system using the in-line flush device.
  - d. To enter the mixed venous Oxygen saturation laboratory value, press CURSOR to select SvO2, enter the value.
  - e. Enter patient's hemoglobin or hematocrit from the mixed venous result.
  - f. Press CAL to begin SvO2 monitoring.
3. Continue to monitor the SQI to confirm adequate signal. If the SQI is 3 or greater, the signal quality is poor. Possible causes include poor catheter position, catheter clotted, kinked or damaged, change in Hgb/Hct values.
4. Update Hgb/Hct when there is a change of 6% or greater in the Hct or 1.8 g/dL in the Hgb by pressing HGB UPDATE and entering new values.
5. Monitor the SvO2 value and record on the flowsheet as ordered. (Normal range is 60-80%.)

6. If the patient must be transported, unplug the SvO<sub>2</sub> cable from the Vigilance monitor and transport it with the patient to avoid the need to recalibrate. To restart SvO<sub>2</sub> monitoring when the patient returns, press SvO<sub>2</sub>, then TRANSPORT, then RECALL.

### Care of the Patient with a Pulmonary Artery Catheter

1. Monitor the PA waveform continuously to detect any changes in catheter position.
  - a. If PCWP is observed, the catheter may have migrated forward spontaneously. Confirm balloon is deflated, have patient cough or suction patient. Reposition patient side to side. If wedge waveform persists, notify the provider immediately to reposition the catheter due to potential complications of pulmonary artery infarction or rupture.
  - b. If a right ventricular waveform is observed, the catheter may have slipped back into the right ventricle. This may cause ventricular dysrhythmias. Inflate the balloon to cushion the catheter tip and to promote floatation to the PA. Call the provider to reposition the catheter if waveform persists.
2. The PA pressure alarm should be on and set so that a disconnection or significant change in pressure can be detected.
3. Assess the pressure monitoring system to help prevent damping of waveform.
  - a. Keep pressure bag inflated to 300 mmHg. Verify adequate amount of flush solution is in the bag.
  - b. Make sure all tubing connections are tight and secure. Limit the length of the pressure tubing to 3-4 feet.
  - c. Examine the system for presence of air bubbles, blood in the tubing, or kinks.
  - d. Keep sterile yellow, non-occlusive caps on all open stopcock ports.
4. Relevel and zero every 4 hours and/or when the accuracy of the pressure measurement is in question.
5. Obtain and document pressure readings and updated hemodynamic calculations every 4 hours or as ordered. (See techniques discussed previously.) Notify provider for abnormal readings or changes from baseline values.
6. Place a recording of the pressure waveforms in the chart at least every shift.
7. The PA distal port should always be connected to a pressure monitoring/flush system with the waveform continuously displayed. **Never infuse any IV fluids, medications, or blood products through the PA port.**
8. Maintain patency of the RA/proximal injectate, VIP/proximal infusion, and introducer ports with IV fluid as ordered. Avoid infusing vasoactive medications through the RA/proximal injectate port, as they are stopped during CVP measurement. Avoid infusing blood or viscous solutions through any of the lumens of the PA catheter as they are small, making it difficult to maintain an adequate flow rate and lumen patency. The introducer port should be used for blood or large volumes of fluids.

9. Avoid routine withdrawal of blood from the PA catheter. Fibrin may build up in the lumen and dampen pressure waveforms.
10. Keep the volume-limited syringe empty, connected to the balloon port with gate valve locked to prevent inadvertent air or fluid injection into the balloon port catheter.
11. Assess the condition of the site and dressing. Apply a new sterile dressing prn if dressing is wet, soiled, or loosened. Otherwise, change transparent dressing every 72 hours or if biopatch is present change every 7 days.
12. Change the pressure tubing, injection caps, and flush solution every 72 hours. Quickly disconnect the old tubing and connect the new tubing during exhalation. Label with date, time, and initials.
13. Removal of the PA catheter must be performed by the provider.
14. Daily documentation includes the following:
  - a. Insertion site, catheter type, and size, insertion depth
  - b. Pressure measurements, CO, calculated hemodynamic parameters listed on flowsheet (e.g. SVR), SvO<sub>2</sub>, and EDV as ordered
  - c. Amount of air required to obtain the PCWP waveform
  - d. Type and rate of solution infusing through RA, VIP, and introducer ports
  - e. Waveform quality and blood return
  - f. Appearance of insertion site
  - g. IV fluid and tubing changes every 72 hours
  - h. Dressing changes prn or every 72 hours (every 7 days and PRN if biopatch in place)