



PULMONARY ARTERY PRESSURE MEASUREMENT

Expected Practice:

- ☑ Verify the accuracy of the transducer-patient interface by performing a square waveform test at the beginning of each shift.
- ☑ Position the patient supine prior to PAP/RAP (CVP) measurements. Head of the bed (HOB) elevation can be at any angle from 0° (flat) to 60°.
- ☑ Level the transducer air-fluid interface to the phlebostatic axis (4th ICS/½ AP diameter of the chest) with the patient in a supine position prior to PAP/RAP measurements.
- ☑ Obtain PAP/RAP measurements from a graphic (analog) tracing at end-expiration.
- ☑ Use a simultaneous ECG tracing to assist with proper PAP/RAP waveform identification.
- ☑ PA catheters can be safely withdrawn and removed by competent registered nurses.

Supporting Evidence:

- The square waveform test, or dynamic response test, determines the ability of the transducer system to correctly reflect pressures in the pulmonary artery.¹⁻⁵ This test can identify system problems, such as air bubbles in the tubing, excessive tubing length, loose fitting equipment, and/or patient problems, such as catheter patency. Any of these problems may affect accuracy of PAP/RAP measurements and should be corrected prior to pressure measurement. Experts recommend the following situations as appropriate to perform the square waveform test: on the initial system setup, at least once each shift, after opening the catheter system (e.g. for zeroing, drawing blood, or changing tubing), and whenever the PAP waveform appears to be damped or distorted.^{1-4,6}
- Consider the following changes in PA pressures as clinically significant (i.e., not reflective of the normal variability in PA pressures): Δ PAS > 4-7 mm Hg; Δ PAEDP > 4-7 mm Hg; Δ PAWP > 4 mm HG.^{7,8}
- Studies in a variety of patient populations have found that PAP/RAP measurements are accurate when the head of the bed is elevated to any angle between 0° and 60°, as long as the patient is in the supine position.⁹⁻¹¹ Two studies have also shown that PAP/RAP readings are accurate with the patient in a lateral position if the angle of rotation is exactly 30° or 90° with the head of the bed flat, and the location of the transducer air-fluid interface changed to the appropriate external landmarks for lateral positioning (30° lateral: ½ distance from surface of bed to the left sternal border; 90° right lateral: 4th ICS/midsternum; 90° left parasternal border).^{1,12-14} When utilizing a 30° side lying angle a method of ensuring an accurate angle is needed and should be readily available to the bedside practitioner.¹³
- Leveling the transducer air-fluid interface to the left atrium corrects for changes in hydrostatic pressure in vessels above and below the heart.^{1,3} In the supine position, the external landmark for the left atrium is the phlebostatic axis (4th ICS/½ AP diameter of the chest).^{15,16} Studies have found that improper positioning of the air-fluid interface can lead to significantly different PAP/RAP reading.^{17,18} Once the correct location for the phlebostatic axis is identified, a mark should be placed on the chest wall and a laser pointer level or a carpenter's level should be used to properly level the transducer air-fluid interface anytime the patient is repositioned.^{1,2,18} Changes in patient position, even slight HOB ↑ or ↓, require releveling of the transducer air-fluid interface before obtaining PAP/RAP measurements.
- Changes in intrathoracic pressure during respiration significantly alter hemodynamic pressures. Obtaining accurate PAP/RAP measurements requires reading pressure waveforms during end expiration only.^{1-4,9,19} Digital readouts on pressure monitors reflect pressures obtained throughout respiration and are significantly different from end expiratory pressures, requiring pressure to be read from graphic waveform tracings.^{6,20,21}
- Levels of evidence supporting validation of PAP/RAP waveform measurement with simultaneous ECG tracings include clinical literature, expert opinion and sound theoretical principles of hemodynamic measurement.¹⁻⁴
- Studies and surveys show that after education and clinical monitoring to assess competency, registered nurses can safely withdraw and/or remove PA catheters.^{22,23,24} Before incorporating withdrawing and/or removing PA catheters into nursing practice, verify that it is within your state's scope of practice for registered nurses.

What You Should Do:

- Always identify and mark the phlebostatic axis, obtain PAP/RAP with the patient in the supine position and the head of the bed elevated between 0 and 60 degrees, read pressures from a graphic (analog) recording at end expiration, and periodically perform a square waveform test.
- Assure that your critical care unit has written practice documents such as a policy, procedure or standard of care, that include these expected practice alert standards.
- Determine your unit's rate of compliance with these Practice Alert standards.
- If compliance is < 90%, develop a plan to improve compliance¹³:
 - ⇒ Consider forming a unit task force to address the need for changes in PAP/RAP measurement practices.
 - ⇒ Educate staff about the inaccuracies which can occur in PAP/RAP measurements with improper techniques (Education Toolbox)
 - ⇒ Incorporate content into orientation programs, initial and annual competency verifications.
 - ⇒ Develop a variety of communication strategies to alert and remind staff of the importance of these PAP/RAP practices.
 - ⇒ Create an audit tool for measuring compliance with PAP/RAP expected practice standards

Need More Information or Help?

- A web based educational program on pulmonary artery pressure measurement is available at www.pacep.org
- PAP/RAP Practice Alert information at www.aacn.org
 - ⇒ Test of PA catheter knowledge
 - ⇒ Square waveform test information
 - ⇒ Identifying correct PAP/RAP waveforms from simultaneous pressure and ECG tracings
 - ⇒ Identifying correct phlebostatic axis location for leveling transducers in the supine position
 - ⇒ Power Point slide program for PAP/RAP measurement education sessions
- Talk with a clinical practice specialist for additional information / assistance (www.aacn.org) then select PRN.

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