- pulmonary artery occlusion pressure closely approximates left atrial pressure which approximates left ventricular end diastolic pressure (wedge creates a static column of blood)

- conditions where PaOP may misrepresent LVEDP:
  1. aortic pressure > pulmonary venous pressure (i.e. catheter outside West's zone)
  2. pulmonary venous obstruction (arterial myxoma, pulmonary fibrosis, vasculitis)
  3. valvar heart disease:
     MS (PaOP > LVEDP)
     MR (PaOP > LVEDP)
     AR (PaOP < LVEDP)
  4. markedly reduced pulmonary vascular bed
  5. LV dysfunction (PaOP < LVEDP)

- general

  1. to characterise haemodynamic perturbation
  2. to differentiate cardiogenic from non-cardiogenic pulmonary oedema
  3. to guide the use of vasoactive drugs, fluids & diuretics (especially when haemodynamic disturbances are coupled with increased lung water, RV or LV dysfunction, pulmonary hypertension and organ dysfunction)

- indications

  1. tricuspid or pulmonary valve mechanical prosthesis
  2. right heart mass (thrombus / tumour)
  3. tricuspid or pulmonary valve endocarditis

- contraindications

  1. tricuspid or pulmonary valve mechanical prosthesis
  2. right heart mass (thrombus / tumour)
  3. tricuspid or pulmonary valve endocarditis

- waveform analysis:

  - MR may cause a large v wave which may be confused with Pa wave form
  - MS, CHF and VSD may also cause large v waves

- insertions

  - a 7.5F 15cm introduced sheath is first inserted by Seldinger technique
  - balloon volume is 1.5ml & balloon should be inflated with air before passage through the heart to assist flow guidance & to protect myocardium against injury & dysrhythmias

- complications

  1. complications of catheter insertion:
     - dysrhythmia
     - knotting / kinking
     - valve damage
     - perforation of pulmonary artery
     - RBBB
     - complete heart block

  2. complications post-insertion:
     - thrombosis
     - PA rupture (0.2%)
     - sepsis
     - endocarditis
     - pulmonary infarction
     - arrhythmia (37%)
     - air embolus (due to multiple attempts to fill ruptured balloon)

  3. risk factors for major morbidity (esp PaOP rupture)
     - pulmonary hypertension
     - anticoagulants
     - in situ > 3 days

- CVP:

  - a wave is ventricular diastole
  - C wave is tricuspid closure
  - V wave is ventricular filling
  - peak of the a wave coincides with the point of maximal ventricular filling of the right ventricle and is used for RVEDP measurement

- pulmonary artery pressure:

  - characterised by dichrotic notch
  - elevated diastolic pressure

- pulmonary artery occlusion pressure:

  - characterised by respiratory variation
  - peak of the a wave reflects the left ventricular end diastole

- references during insertion are as follows:

  - right atrium (15-20cm from internal jugular; 10-15cm from the subclavian vein, 30-40cm from the femoral vein, 40 & 50 cm from the right and left basilic veins respectively)
  - the right ventricle and pulmonary artery are then entered at 10cm intervals with a further 10cm to pulmonary artery occlusion (looping is likely and knotting can occur if continued insertion is attempted without passing these landmarks)

- CVP:

  - A wave is ventricular diastole
  - C wave is tricuspid closure
  - V wave is ventricular filling
  - peak of the a wave coincides with the point of maximal ventricular filling of the right ventricle and is used for RVEDP measurement

- right ventricular pressure:

  - characterised by dichrotic notch
  - elevated diastolic pressure

- pulmonary artery occlusion pressure:

  - characterised by respiratory variation
  - peak of the a wave reflects the left ventricular end diastole

- measurements of the PaOP should be performed by slow injection of air into the balloon while watching the pulmonary artery wave form. Overwedging can lead to falsely high occlusion pressures or pulmonary artery rupture

- deflation after PaOP measurement should re-establish the normal pulmonary artery waveform. If not, distal migration has occurred and the catheter should be withdrawn until the waveform is re-established.

- pulmonary artery occlusion pressure closely approximates left atrial pressure which approximates left ventricular end diastolic pressure (wedge creates a static column of blood)

- the normal PADP-PaOP gradient is <5mmHg so that PADP may be used as a direct approximation for PaOP

- this gradient is variably increased by:

  1. tachycardia
  2. increased pulmonary vascular resistance (eg ARDs, COPD, and PE)

- a bolus injected into the right atrium of cold injectate transiently decreases blood temperature in the pulmonary artery (monitored by a thermistor proximal to the balloon)

- the mean decrease in temperature is inversely proportional to the cardiac output

- margin of error with the technique is +/- 15%

- Causes of inaccurate cold thermodilution cardiac output measures:

  1. catheter malposition (wedge or vessel wall)
  2. abnormal respiratory pattern (respiration causes fluctuations)
  3. intracardiac shunt
  4. tricuspid regurg
  5. cardiac arrhythmias
  6. injectate port close to or within introducer sheath
  7. abnormal haematocrit affecting blood density
  8. extremes of cardiac output
  9. poor technique (slow injection, incorrect injectate volume)

- Site

  - Right atrium mean: 1-7
  - Right ventricle: systolic: 15-25
  - Diastolic: 0-8
  - Pulmonary arterial systolic: 15-25
  - Pulmonary arterial mean: 8-15
  - Pulmonary arterial occlusion: 6-15

- RVEF calculation:

  - Right ventricular stroke work index = (BP - PaO2) x CI x RVEF

- Technical terms:

  - PAOP: Right atrial pressure
  - CVP: Central venous pressure
  - PaO2: Oxygen saturation
  - CI: Cardiac index
  - RVEF: Right ventricular ejection fraction
  - BP: Blood pressure

- Limitations:

  - PAOP is influenced by the wedge pressure
  - RVEF may not be a reliable indicator of RV function in the presence of RV dysfunction
  - PAOP may not accurately reflect RV end diastolic pressure in the presence of RV dysfunction

- Complications:

  - air embolus (due to multiple attempts to fill ruptured balloon)

- Risk factors for major morbidity (esp PaOP rupture):

  - pulmonary hypertension
  - anticoagulants
  - in situ > 3 days

- Factors confounding a direct relationship between LVEDP and LVEDV: