Pulmonary Artery Wedge Pressure and Wedging

OVERVIEW

- Pulmonary Artery Wedge Pressure (PAWP) is also known as Pulmonary Artery Occlusion Pressure (PAOP)

PULMONARY ARTERY WEDGE PRESSURE

- PAOP or PAWP is pressure within the pulmonary arterial system when catheter tip 'wedged' in the tapering branch of one of the pulmonary arteries
- in most patients this estimates LVEDP thus is an indicator of LVEDV (preload of the left ventricle)
- normally 6-12mmHg (1-5mmHg less than the pulmonary artery diastolic pressure)
- PCWP >18 mmHg in the context of normal oncotic pressure suggests left heart failure

WEDGING

"Wedging" is measurement of PAOP (pulmonary artery occlusion measurement)

- PA catheter tip advanced into a small pulmonary artery (usually in RML or RLL)
- PAWP measured by convention at end-expiration at end-diastole (ECG p wave)
- phasic blood flow and pressure ceases
- static column of blood between catheter tip in pulmonary artery and the left atrium
- must be in West Zone III otherwise trace will show respiratory swing (reflects alveolar pressure in West Zones I and II)

5 indicators that PAC tip is in West Zone III:

- PAWP < PADP by 1-5 mmHg
- PAWP alters < than 50% of increase in PEEP
- PAWP increases by < 50% of changes in alveolar pressure (Pplat)
- O2 saturation in wedged position greater than unwedged position (sucking back of oxygenated blood)
- CXR: below level of LA

SITUATIONS WHEN PAWP IS NOT EQUIVALENT TO LVEDP

Situations when PAWP > LVEDP

- mitral stenosis
- atrial myxoma
- pulmonary venous obstruction (e.g. fibrosis, vasculitis)
- MR
- non-zone III placement
- L to R shunt
- COPD
- IPPV +/- PEEP

Situations when PAWP < LVEDP

- left ventricular failure
- raised intra-thoracic pressure (high PEEP)
- non-compliant left ventricle (e.g. hypertensive cardiomyopathy)
- aortic regurgitation

About Chris Nickson
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Pulmonary wedge pressure

The **pulmonary wedge pressure** or **PWP**, or cross-sectional pressure (also called the pulmonary arterial wedge pressure or PAWP, pulmonary capillary wedge pressure or PCWP, or pulmonary artery occlusion pressure or PAOP), is the pressure measured by wedging a pulmonary catheter with an inflated balloon into a small pulmonary arterial branch.[1] It estimates the left atrial pressure.

[Pulmonary venous wedge pressure (PVWP) is not synonymous with the above; PVWP has been shown to correlate with pulmonary artery pressures in studies, albeit unreliably].

Physiologically, distinctions can be drawn among pulmonary artery pressure, pulmonary capillary wedge pressure, pulmonary venous pressure and left atrial pressure, but not all of these can be measured in a clinical context.[2]

Noninvasive estimation techniques have been proposed.[3]

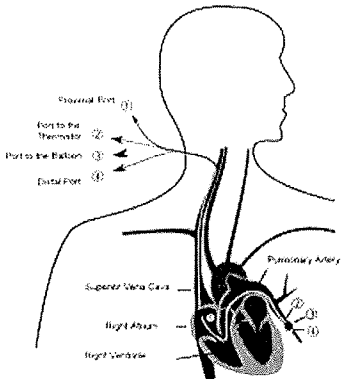

Diagram of Pulmonary artery catheter

Clinical significance

Because of the large compliance of pulmonary circulation, it provides an indirect measure of the left atrial pressure.[5]

For example, it is considered the gold standard for determining the cause of acute pulmonary edema; this is likely to be present at a PWP of >20mmHg. It has also been used to diagnose severity of left ventricular failure and mitral stenosis,[6] given that elevated pulmonary capillary wedge pressure strongly suggests failure of left ventricular output.[7]

Site		Normal pressure range (in mmHg)[4]
Central venous pressure		3–8
Right ventricular pressure	systolic	15–30
	diastolic	3–8
Pulmonary artery pressure	systolic	15–30
	diastolic	4–12
Pulmonary vein/ Pulmonary capillary wedge pressure		2–15
Left ventricular pressure	systolic	100–140
	diastolic	3-12

Traditionally, it was believed that pulmonary edema with normal PWP suggested a diagnosis of acute respiratory distress syndrome (ARDS) or non cardiogenic pulmonary edema (as in opiate poisoning). However, since capillary hydrostatic pressure exceeds wedge pressure once the balloon is deflated (to promote a gradient for forward flow), a normal wedge pressure *cannot* conclusively differentiate between hydrostatic pulmonary edema and ARDS.

Physiological pressure: 6–12 mm Hg.[8]

References

1. Peacock, Andrew J.; Lewis J. Rubin (2004). *Pulmonary Circulation: Diseases and their treatment*. Arnold Publisher. ISBN 0-340-80782-2
2. Chaliki HP, Hurrell DG, Nishimura RA, Reinke RA, Appleton CP (July 2002). "Pulmonary venous pressure: relationship to pulmonary artery, pulmonary wedge, and left atrial pressure in normal, lightly sedated dogs". *Catheter Cardiovasc Interv*. 56 (3): 432–8. doi:10.1002/ccd.10203 (https://doi.org/10.1002%2Fccd.10203). PMID 12112902 (https://www.ncbi.nlm.nih.gov/pubmed/12112902).
3. Uzun M, Erinc K, Kirilmaz A, et al. (November 2004). "A novel method to estimate pulmonary artery wedge pressure using the downslope of the Doppler mitral regurgitant velocity profile" (http://www3.interscience.wiley.com/resolve/openurl?genre=article&sid=nlm:pubmed&issn=0742-2822&date=2004&volume=21&issue=8&spage=673). *Echocardiography*. 21 (8): 673–9. doi:10.1111/j.0742-2822.2004.03174.x (https://doi.org/10.1111%2Fj.0742-2822.2004.03174.x). PMID 15546367 (https://www.ncbi.nlm.nih.gov/pubmed/15546367).
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5. "Gun Shot Wound Case Study Discussion" (http://classes.kumc.edu/cahe/respcared/ptcs/ptcsdis.html). Retrieved 2009-03-02.
6. "CV Physiology" (http://www.cvphysiology.com/Heart%20Failure/HF008.htm).
7. Harrison's Principles of Internal Medicine. 14th edition. Chapter 38. page 243.
8. "Pulmonary Capillary Wedge Pressure" (http://www.wheelessonline.com/ortho/pulmonary_capillary_wedge_pressure).

External links

- Overview at cvphysiology.com (http://www.cvphysiology.com/Heart%20Failure/HF008.htm)
- Pulmonary wedge pressure (https://www.nlm.nih.gov/cgi/mesh/2011/MB_cgi?mode=&term=Pulmonary+wedge+pressure) at the US National Library of Medicine Medical Subject Headings (MeSH)

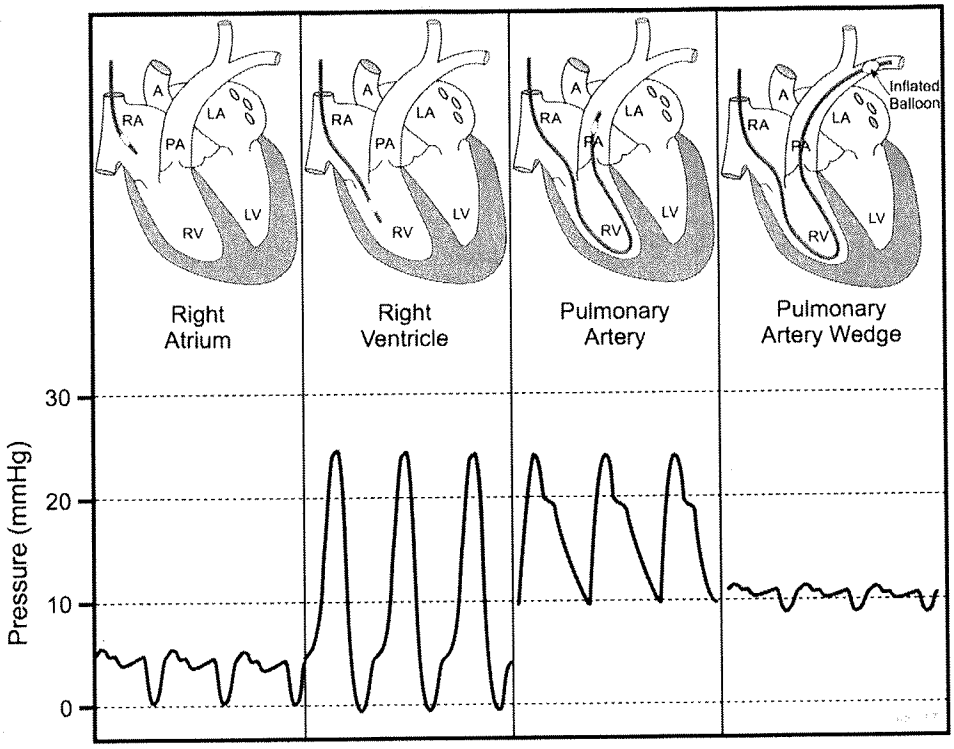
Pulmonary Capillary Wedge Pressure

What does it measure?

Pulmonary capillary wedge pressure (PCWP) provides an indirect estimate of left atrial pressure (LAP). Although left ventricular pressure can be directly measured by placing a catheter within the left ventricle, it is not feasible to advance this catheter back into the left atrium. LAP can be measured by placing a special catheter into the right atrium then punching through the interatrial septum; however, for obvious reasons, this is not usually performed because of damage to the septum and potential harm to the patient.

How is it measured?

PCWP is measured by inserting balloon-tipped, multi-lumen catheter (**Swan-Ganz catheter**) into a peripheral vein (e.g., jugular or femoral vein), then advancing the catheter into the right atrium, right ventricle, pulmonary artery, and then into a branch of the pulmonary artery. The catheter has a lumen (port) that opens at the tip of the catheter distal to the balloon. This port is connected to a pressure transducer. As illustrated below, the location of the catheter can be determined by viewing the pressure measured from the tip of the catheter. In the right atrium, the pressure usually averages <5 mmHg and fluctuates a few mmHg. When the catheter is advanced into the right ventricle, the systolic pressure increases to ~25 mmHg and the diastolic pressure remains similar to right atrial diastolic pressure. When the catheter enters the pulmonary artery, the systolic pressure normally is similar to the right ventricular systolic pressure, but the diastolic pressure increases to about 10 mmHg because of pulmonic valve closure at the beginning of diastole. Just behind the tip of the catheter is a small balloon that can be inflated with air (~1 cc). When properly positioned in a branch of the pulmonary artery, the distal port measures pulmonary artery pressure (~ 25/10 mmHg; systolic/diastolic pressure). The balloon is then inflated, which occludes the branch of the pulmonary artery. When this occurs, the pressure in the distal port rapidly falls, and after several seconds, reaches a stable lower value that is very similar to left atrial pressure (mean pressure normally 8-10 mmHg). The pressure flucuates during the cardiac cycle and normally shows a, c and v waves similar to the right atrial pressure tracing. The balloon is then deflated. The same catheter can be used to measure cardiac output by the thermodilution technique.



The pressure recorded during balloon inflation is similar to left atrial pressure because the occluded vessel and its distal branches that eventually form the pulmonary veins act as a long catheter that measures the blood pressures within the pulmonary veins and left atrium.

Why is it measured?

It is helpful to measure PCWP to diagnose the severity of left ventricular failure and to quantify the degree of mitral valve stenosis. Both of these conditions elevate LAP and therefore PCWP. Aortic valve stenosis and regurgitation, and mitral regurgitation also elevate LAP. When these pressures are above 20 mmHg, pulmonary edema is likely to occur, which is a life-threatening condition. Note that LAP is the outflow or venous pressure for the pulmonary circulation and therefore increases in LAP are transmitted almost fully back to the pulmonary capillaries thereby increasing their hydrostatic pressure and filtration of fluid. By measuring PCWP, the physician can titrate the dose of diuretic drugs and other drugs that are used to reduce pulmonary venous and capillary pressure, and thereby reduce pulmonary edema. Therefore, measurement of PCWP can help guide therapeutic efficacy.

PCWP is also important to measure when evaluating pulmonary hypertension. Pulmonary hypertension is often caused by increased pulmonary vascular resistance. To calculate this, pulmonary blood flow (usually measured by the thermodilution technique), pulmonary artery pressure and pulmonary venous pressure (PCWP) measurements are required. Pulmonary hypertension can also result from increases in pulmonary venous pressure and pulmonary blood volume secondary to left ventricular failure or mitral or aortic valve disease.

PCWP is also useful in evaluating blood volume status when fluids are administered during hypotensive shock. One practice is to administer fluids at a rate that maintains PCWP between 12-14 mmHg.

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