# RIGHT HEART CATHETERIZATION

## *BASICS OF PRESSURES, GRADIENTS AND INDICES*

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*Scan code for references*

### PULMONARY VASCULAR RESISTANCE
= (meanPAP – PCWP)/CO

- **PVR is the recommended parameter for differentiating subtypes of PH (preferred over Trans-Pulmonary Gradient, TPG*, and Diastolic Pulmonary Gradient, DPG**).**
- **PH (mean PAP>20) subtypes are identified based on PVR & PCWP† :**

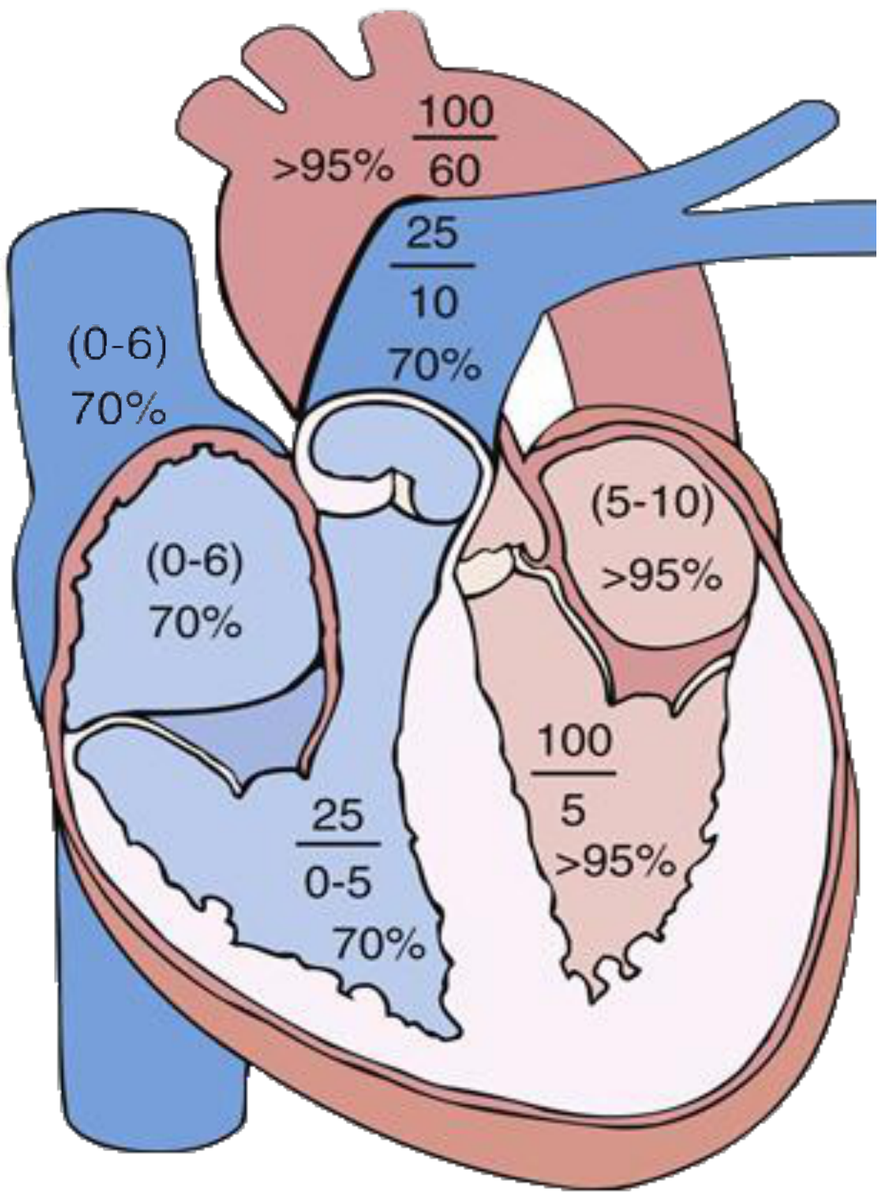
| | PCWP ≥ 15 | PCWP < 15 |
|---|---|---|
| PVR ≥ 3 WU‡ | *Combined Post- & Pre-capillary PH (CpcPH)* | *Isolated Pre-capillary PH* |
| PVR < 3 WU | *Isolated Postcapillary PH (IpcPH)* | *Consider high flow state* |

### PULMONARY ARTERY PULSATILITY INDEX (PAPI)
= (sPAP – dPAP)/RAP

- **PAPi ≤ 0.9 predicts RV failure and in-hospital mortality in inferior MI.**
- **PAPi < 1.85 predicts RV failure in patients with LVADs.**

### RAP/PCWP RATIO

- **A ↑ RA/PCWP correlates with RV dysfunction. e.g., RA/PCWP > 0.8 indicates RV dysfunction in patients with cardiogenic shock.**
- **RA/PCWP > 0.54 (EUROMACS) / >0.63 (Kormos et al.) predicted RV dysfunction in patients with LVADs.**




* TPG = mPAP – PCWP
** DPG = dPAP – PCWP
† Differentiation of subtypes may also require provocative testing
‡ 1 WU = 80 dynes-sec/cm$^5$

### SYSTEMIC VASCULAR RESISTANCE
(SVR, N: 800-1200 dynes-sec/cm$^5$) ‡
= [(MAP – RAP)/CO] x 80

- **In cardiogenic or hypovolemic shock, SVR ↑ as a compensatory response.**
- **Advanced cardiogenic shock may have a low or normal SVR.**

| SHOCK | SVR | PCWP | CO | $MVO_2$ |
|---|---|---|---|---|
| *Cardiogenic* | ↑ | ↑ | ↓ | ↓ |
| *Hypovolemic* | ↑ | ↓ | ↓ | ↓ |
| *Distributive* | ↓ | ↓ | ↑ | ↑ |

### CARDIAC POWER OUTPUT (CPO)
= (MAP x CO)/451

- **Reflects hydraulic energy delivered by the LV.**
- **CPO of <0.6 was the strongest independent hemodynamic correlate in the SHOCK trial registry for in-hospital mortality in patients with cardiogenic shock.**

### LV TRANSMURAL FILLING PRESSURE
= PCWP – RAP

- **Reflects the pressure difference between the LV and its external forces, and influences LV filling.**
- **Increases in RAP or pericardial pressure can reduce LV filling, stroke volume, and forward flow. e.g., PE, right heart failure.**

### CARDIAC OUTPUT (CO, N: 4 – 8 l/min)
### &
### CARDIAC INDEX (CI, N: 2.5 – 4 l/min/m²) = CO/BSA

- **Shock + CI <2.2 usually indicates a "COLD" profile.**
- **Bedside clue to a low CI: The proportional pulse pressure ((SBP-DBP)/SBP) of less than 25% suggests a cardiac index of less than 2.2 L/min/m$^2$.**

**THERMODILUTION (TD)**

**Principle: washout of a temperature change induced by injection of a defined fluid volume cooler than the body temperature. The faster the circulation or flow (↑ cardiac output), the quicker the neutralization of the temperature change.**

**FICK**

**Principle: blood flow is proportional to the difference in the concentration of oxygen between arterial and venous blood and the rate of oxygen uptake in the lungs.**

$$CO = \frac{\text{Oxygen consumption}}{(\text{Arterial } O_2 \text{ content} - \text{Venous } O_2 \text{ content})}$$

***Both methods are based on the assumption that pulmonary blood flow (PBF) is equal to systemic blood flow (SBF) in the absence of an intracardiac shunt.***

- **TD is EASY to perform (compared to Direct Fick) but technique-dependent**
- **Less accurate in patients with irregular rhythms.**
- **Was previously thought to be less accurate in severe TR and extremes of CO. However, studies have shown good correlation between TD and Direct Fick in severe TR and extremes of CO.**

- **Direct Fick is the GOLD STANDARD for measuring CO.**
- **Direct Fick requires specialized equipment to measure oxygen consumption, which is generally not available in most catheterization laboratories.**
- **Indirect Fick (using nomogram-based estimates of oxygen consumption) can lead to large errors, as much as 40% in cardiac output estimates, compared with the Direct Fick.**

***DO NOT FORGET: the measured pressures also provide valuable clinical information. e.g., Central Venous Pressure (CVP) was shown as one of the predictors of SCAI profile and mortality in the Cardiogenic Shock Working Group registry.***