ΟΜΙΛΟΣ ΥΓΕΙΑ

ΜΗΤΕΡΑ
ΓΕΝΙΚΗ, ΜΑΙΕΥΤΙΚΗ / ΓΥΝΑΙΚΟΛΟΓΙΚΗ & ΠΑΙΔΙΑΤΡΙΚΗ ΚΛΙΝΙΚΗ

MITERA CHILDREN'S HOSPITAL

# Hemodynamic Assessment basics, shunts and resistance calculations

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*No conflicts of interest to declare*

# DIAGNOSTIC CATHETERISATION

- Pressure measurement
- Obtain Sats

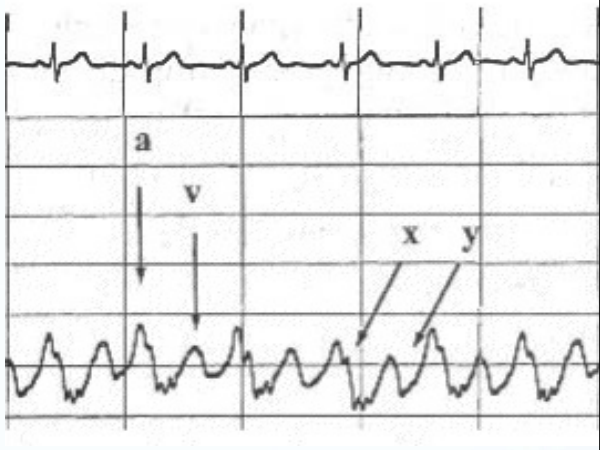
  FOR:

- Cardiac output measurement
  - Fick method
  - Thermodilution
- Vascular resistance
- Shunt detection
- Gradients and valve stenoses

# Right Heart Catheterisation

## Right Atrial Pressure

- "a" wave
  - Atrial systole
- "c" wave
  - Small upwards deflection in early systole
- "x" descent
  - Relaxation of RA
  - Downward pulling of tricuspid annulus by RV contraction




- "v" wave
  - End of systole. Corresponds with atrial filling against a closed TV
  - Smaller than a wave
- "y" descent
  - TV opening and RA emptying into RV

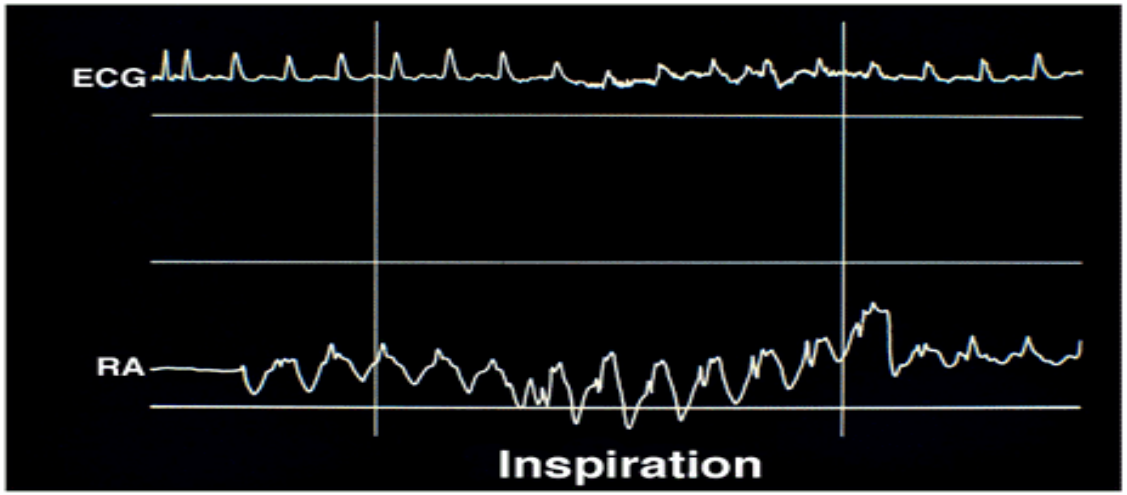
# Right Heart Catheterisation
## Abnormalities in RA Tracing

- Low mean atrial pressure
  - Hypovolemia
  - Improper zeroing of the transducer
- Elevated mean atrial pressure (pulsatility in FV trace)
  - Right ventricular failure
    - Valvular disease (TS, TR, PS, PR)
    - Left heart failure (MS, MR, cardiomyopathy)
  - Increased pulmonary vascular resistance
  - Pericardial effusion with tamponade physiology

Davidson CJ, et al. Cardiac Catheterization. In: Heart Disease: A Textbook of Cardiovascular Medicine, Edited by E. Braunwald, 5th ed. Philadelphia: WB Saunders Company, 1997

# Inspiratory Effect on Right Atrial Pressure

- Normal physiology
  - Inhalation: Intrathoracic pressure falls → RA pressure falls
  - Exhalation: Intrathoracic pressure increases → RA pressure increases




Kern MJ. Right Heart Catheterization. CATHSAP II CD-ROM. Bethesda, American College of Cardiology, 2001.

# RV Tracing

- Rapid upstroke representing isovolume contraction
- Downslope presents isovolumetric relaxation

# Abnormalities in RV Tracing

- Systolic pressure overload
  - PHT
  - Pulmonary valve stenosis
  - Right ventricular outflow obstruction
  - Supravalvular obstruction
  - Increased pulmonary vascular resistance

  - High diastolic pressure (tamponade, restrictive cardiomyopathy, diastolic dysfunction – ToF)

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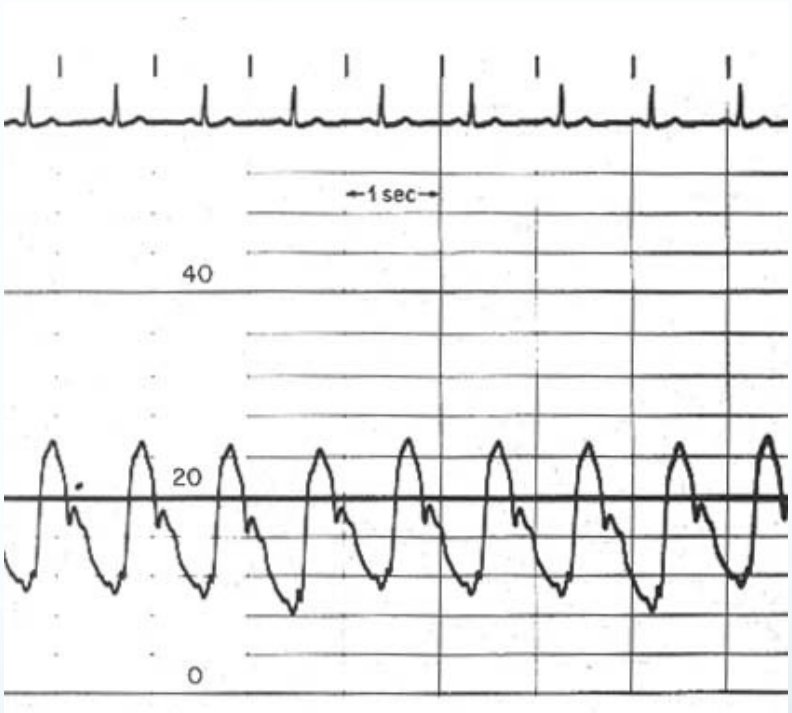
# PA Tracing

- Biphasic
- Dichrotic notch often well seen
- PAd = PCW = LA = LVEDp



# Right Heart Catheterisation
## Abnormalities in PA Tracing

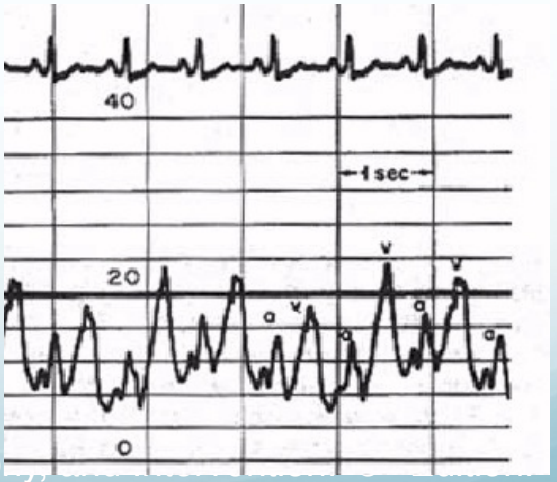
- Elevated systolic pressure when mean PAp:

> 25mmHg (Mild), > 35mmHg (Moderate), >45mmHg (Severe)

- PHT
- MS
- MR
- CHF
- Restrictive cardiomyopathy
- Left-to-right shunt
- Pulmonary disease

# Pressure Measurement
## Wedge Pressure

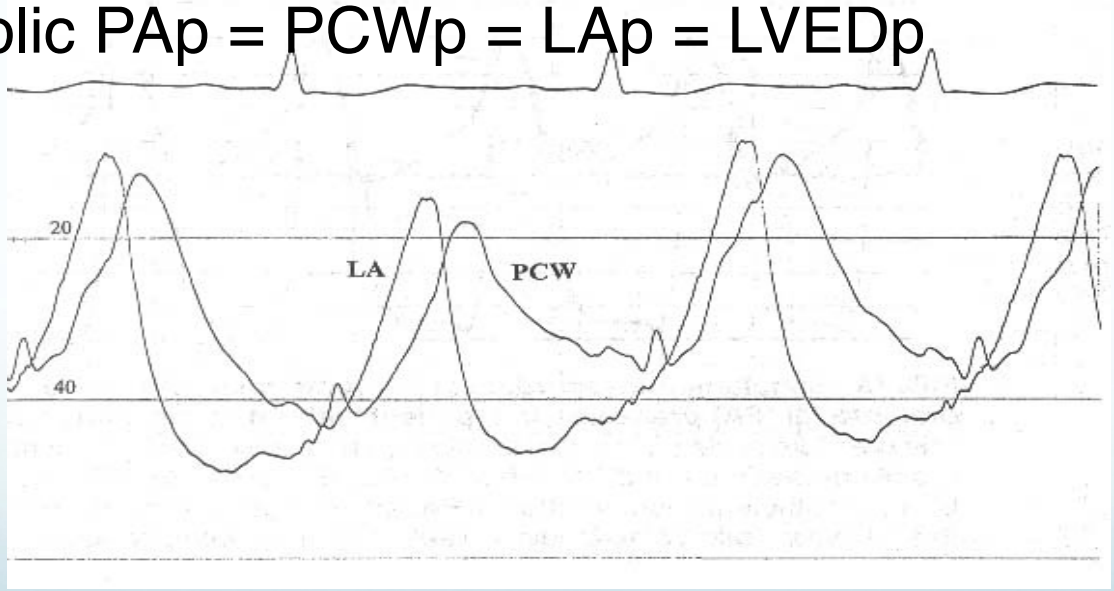
- Wedge Pressure
  - Pressure obtained when an end-hole catheter is positioned in a “designated” blood vessel with its open end-hole facing a capillary bed, with no connecting vessels conducting flow into or away from the “designated” blood vessel between the catheter’s tip and the capillary bed
  - True wedge pressure can be measured only in the absence of flow, allowing pressure to equilibrate across the capillary bed




Baim DS and Grossman W. Cardiac Catheterization, Angiography, [illegible] Baltimore: Williams and Wilkins, 1996.

# Right Heart Catheterisation
## Left Atrial and PCW Pressure

- PCW tracing "approximates" actual LA tracing but is slightly delayed since pressure wave is transmitted retrograde through pulmonary veins
- Diastolic PAp = PCWp = LAp = LVEDp

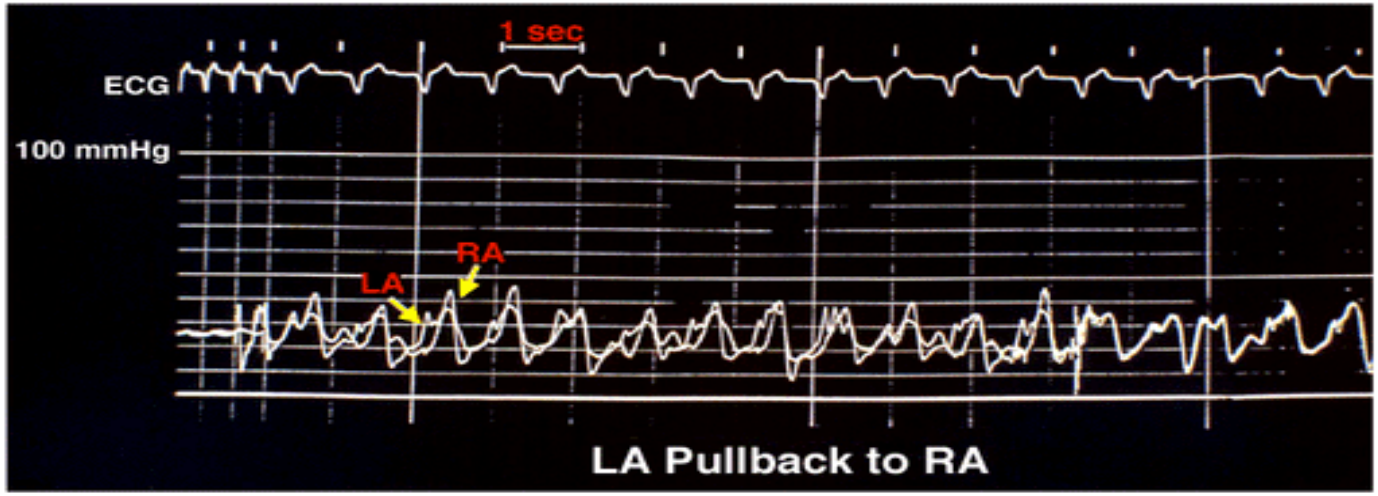



Baim DS and Grossman W. Cardiac Catheterization, Angiography, and Intervention. 5th Edition. Baltimore: Williams and Wilkins, 1996.

# Right Heart Catheterisation

## Right vs Left Atrial Pressure

- Normal LA pressure slightly higher than RA pressure

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# Right Heart Catheterisation
## Abnormalities in PCWP Tracing

- PCWP not equal to LV end diastolic pressure
  - Mitral stenosis
  - Cor triatriatum
  - Pulmonary venous obstruction
  - Decreased ventricular compliance

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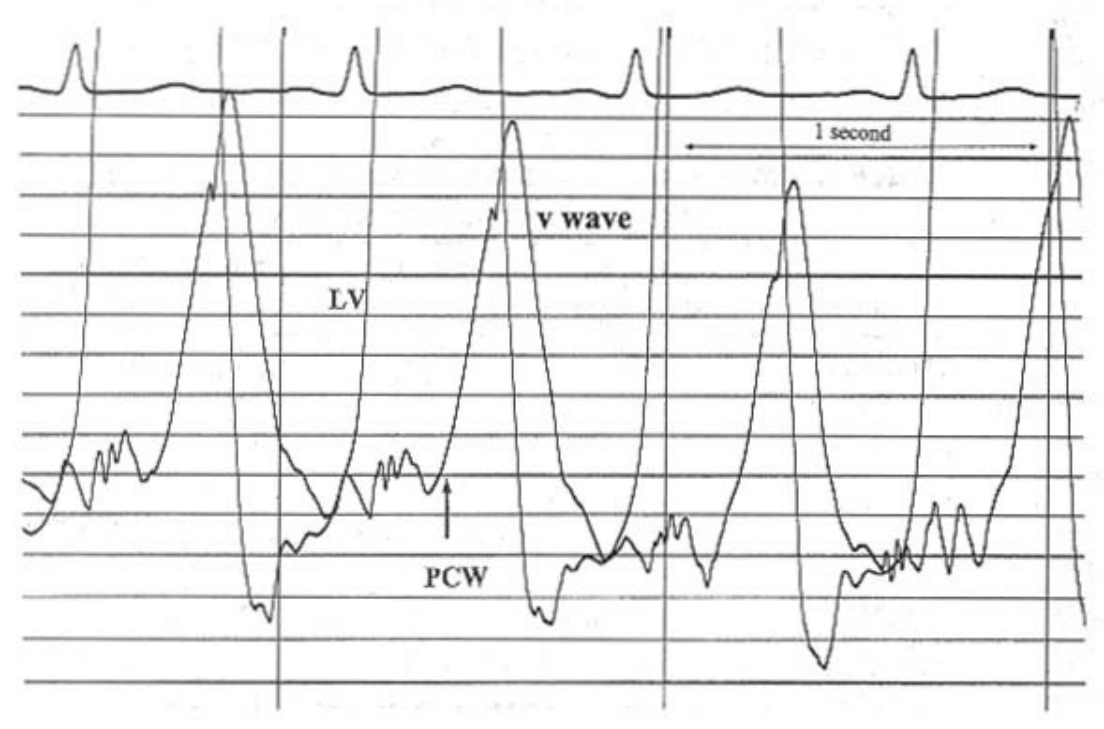
# Right Heart Catheterisation
## Abnormalities in PCWP Tracing

- Severe Mitral Regurgitation

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# Left Heart Catheterisation

## Left Atrial Pressure

- wave

"V" wave more pronounced than "a" partly because of pulmonary vein contraction

Dominant a wave: Either LA outlet obstruction or TAPVC

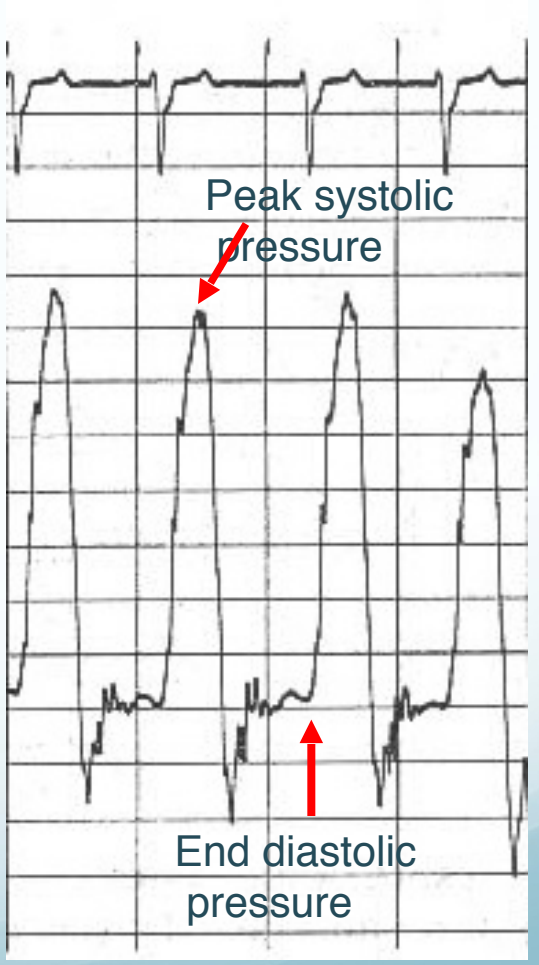
In MR, "v" wave becomes enlarged, representing increased atrial filling via an incompetent LAVV.

Protrusion of TV into RA

# Left Heart Catheterisation

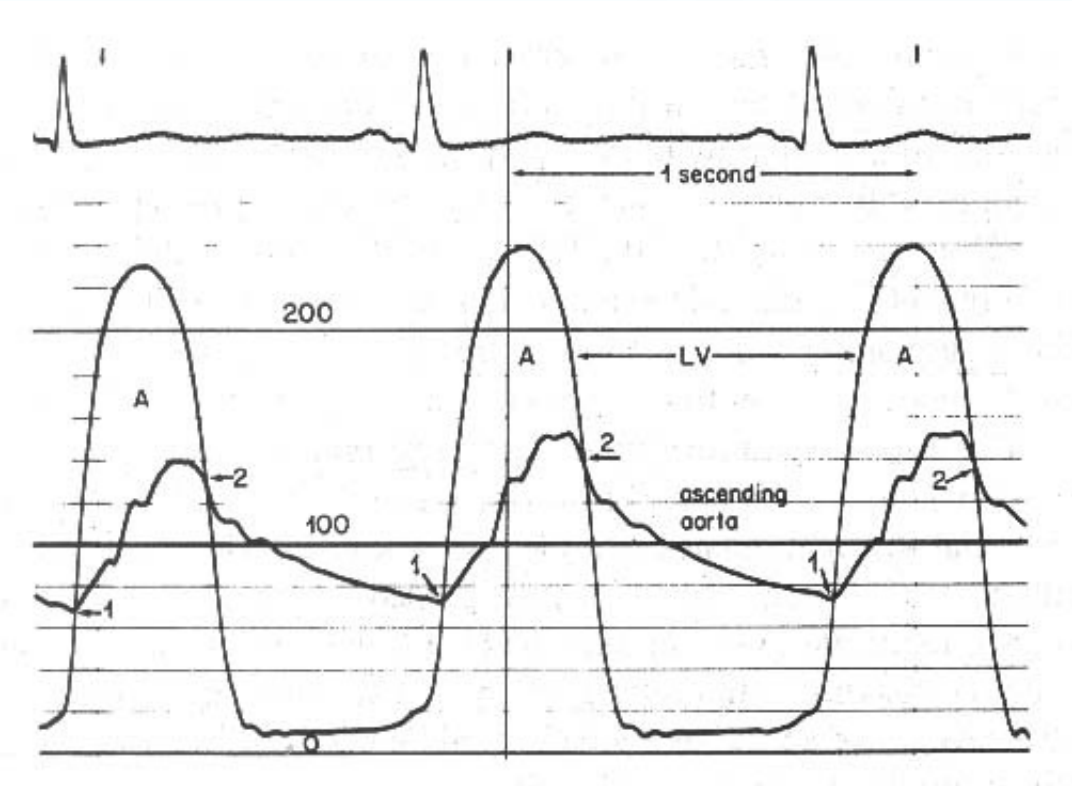
## Left Ventricular Pressure

- Systole
  - The upstroke of the LV trace tends to be more rapid with a flatter plateau phase
- Diastole
  - The diastolic upstroke tends to have a more pronounced end diastolic hump



# Left Heart Catheterisation
## Abnormalities in LV Tracing

- Severe Aortic Stenosis

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# Left Heart Catheterisation
## Abnormalities in LV Tracing

- Elevated LVEDp
  - CHF
  - Diminished compliance
  - Hypertrophy
  - Tamponade
  - Mitral regurgitation
  - Pericardial constriction
  - Restrictive cardiomyopathy

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# Cardiac Catheterisation
## Shunts

- SVC
- IVC
- RA
- PA
- RPA / LPA
- LA
- Ao
- PVs

# Shunt Detection & Measurement

- Fick Principle
  - Pulmonary circulation (Qp) utilises PA and PV saturations
  - Systemic circulation (Qs) utilises Ao and mixed venous Sats

$$O_2 \text{ content} = 1.36 \times Hgb \times O_2 \text{ saturation}$$

$$Qp = \frac{O_2 \text{ consumption}}{(PvO_2 - PaO_2) \times 10}$$

# Shunt and PVR assessment

Qp : Qs Ratio =

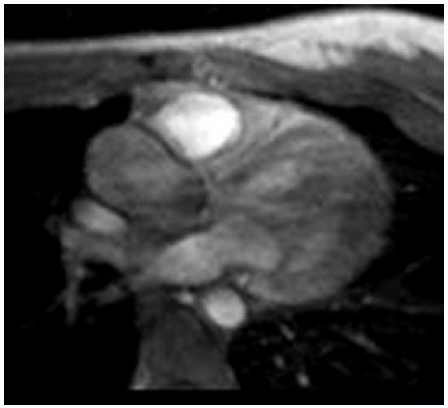
$(AoO_2 – MVO_2) / PvO_2\text{-}PaO_2$

Sats: $(Ao\text{-}MVO_2) / (PV\text{-}PA)$

**PVR (WU.m$^2$) = Transpulmonary gradient (MPA- LA )**

**/ PA flow in lt.min.m$^2$**

# Cardiac Output /PVR Measurement
# XMR method



**Cardiac catheterisation:**

Right heart catheter and assessment of PAp and LAp

(or PA wedge)

**MRI:**

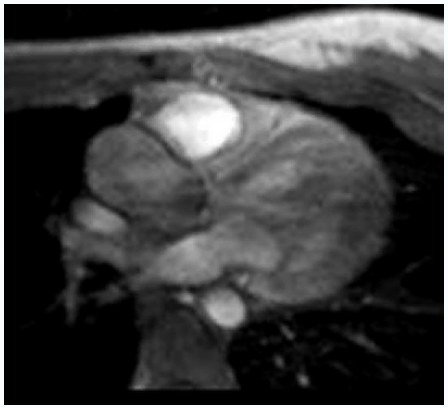
Assess Qp (and shunts / anatomy as required)

**PVR (WU.m$^2$) = Transpulmonary gradient (MPA- LA (or $PA_2$ wedge) /**

**PA flow in lt.min.m$^2$ ***

* selected phase contrast flow images at rest and with 100 $FiO_2$ / NO

# PVR Assessment



**Condition I: FiO2 21%**

**Condition II: FIO2 100%**

**Condition III: FiO2 100% + 20ppm NO**

PVR < 3 OK

PVR 3-7 Borderline

PVR > 7 Inoperable

*Thank you*

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