

# Cardiac Catheterization Indications and Considerations

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- What are the **indications** for the CATH?
- What are the **methods** of CATH?
- What should **consider** when doing CATH?

# Indications for the CATH

*Resolves discrepancy between non-invasive measurements*

- Gold **standards** for assessment of cardiac hemodynamics.
- Diagnostic of **pulmonary hypertension**, and identification of cause.
- Pre **HTPL / LVAD evaluation** on end-stage heart failure patient.
- The treatment direction for patients with **valve disease**.
- Diagnostic of **shunt** (congenital heart disease)
- Constrictive pericarditis, etc.

# Indication for the CATH

## GROUP 1: PAH

- 1.1 Idiopathic PAH
- 1.2 Heritable PAH
- 1.3 Drug- and toxin-induced PAH
- 1.4 PAH associated with:
  - 1.4.1 Connective tissue disease
  - 1.4.2 HIV infection
  - 1.4.3 Portal hypertension
  - 1.4.4 Congenital heart disease
  - 1.4.5 Schistosomiasis
- 1.5 PAH long-term responders to CCB
- 1.6 PAH with overt features of PVOD/PCH
- 1.7 Persistent PH of the newborn

## GROUP 3: PH DUE TO LUNG DISEASE AND/OR HYPOXIA

- 3.1 Obstructive lung disease
- 3.2 Restrictive lung disease
- 3.3 Other lung disease with mixed restrictive/obstructive pattern
- 3.4 Hypoxia without lung disease
- 3.5 Developmental lung disorders

## GROUP 5: PH WITH UNCLEAR AND/OR MULTIFACTORIAL MECHANISMS

- 5.1 Hematological disorders
- 5.2 Systemic and metabolic disorders
- 5.3 Others

## GROUP 1: PAH

1.1 Idiopathic PAH

1.2 Heritable PAH

1.3 Drug- and toxin-induced PAH

## GROUP 4: PH DUE TO PULMONARY ARTERY OBSTRUCTIONS

- 4.1 Chronic thromboembolic PH
- 4.2 Other pulmonary artery obstructions

# Indications for the CATH

## 2022 ESC Guidelines on PAH

Recommendations	Class <sup>a</sup>	Level <sup>b</sup>
<b>Right heart catheterisation (RHC)</b>		
RHC is recommended to confirm the diagnosis of PH (especially PAH or CTEPH), and to support treatment decisions [25, 26]	I	B
In patients with suspected or known PH, it is recommended to perform RHC in experienced centres [125]	I	C
It is recommended that RHC comprises a complete set of haemodynamics and is performed following standardized protocols [25, 26, 145]	I	C
<b>Vasoreactivity testing</b>		
Vasoreactivity testing is recommended in patients with I/H/DPAH to detect patients who can be treated with high doses of a CCB [129, 146]	I	B
It is recommended that vasoreactivity testing is performed at PH centres	I	C
It is recommended to consider a positive response to vasoreactivity testing by a reduction in mPAP $\geq 10$ mmHg to reach an absolute value of mPAP $\leq 40$ mmHg with an increased or unchanged CO <sup>c</sup> [129]	I	C
Inhaled nitric oxide, inhaled iloprost, or i.v. epoprostenol are recommended for performing vasoreactivity testing [129–132]	I	C
Vasoreactivity testing, for identifying candidates for CCB therapy, is not recommended in patients with PAH other than I/H/DPAH, and in PH groups 2, 3, 4, and 5 [124, 129]	III	C

# Methods of CATH

## *Hemodynamic parameter*

- $VO_2$  : Venous oxygen saturation
- $Q_p / Q_s$  : Indexed pulmonary & systemic blood flow
- CO & CI : Cardiac Output(L/min) & Cardiac Index(L/min/m<sup>2</sup>)
- $R_p / R_s$  : Pulmonary to systemic vascular resistance
- PVR : Pulmonary Vascular Resistance
- SVR : Systemic Vascular Resistance
- SVI : Stroke Volume Index

# Methods of CATH

## *Hemodynamic parameter*

- Cardiac index(L/min/m<sup>2</sup>) = CO / BSA
  - PVR(dynes \* sec \* cm<sup>-5</sup>) = 80 x (mPAP - PAWP) / CO
  - SVR(dynes \* sec \* cm<sup>-5</sup>) = 80 x (mAP - mRAP) / CO
  - Rp/Rs = (mPAP - mLAP) / (mAP - mRAP) \* (1/(Qp/Qs))
  - SVI = CI / Heart rate \* 1000
  - RVSWI(Right ventricular stroke work index) = SVI(mPAP - mRAP)
- } = WU

# Methods of CATH

## *Cardiac output measurements (Fick method)*

- Direct( $\text{VO}_2$  measurement) & Indirect( $\text{VO}_2$  estimate)
- Estimate  $\text{Vo}_2 \left( \frac{\text{mL } \text{O}_2}{\text{min}} \right) = 125 \times \text{BSA}$
- Cardiac output(L/min) =  $\text{VO}_2 / [(\text{SaO}_2 - \text{SvO}_2) \times \text{Hb} \times 13.4]$
- Mixed venous  $\text{O}_2$  saturation(MV sat) =  $(3\text{SVC} + \text{IVC}) / 4$
- $\text{Qp}/\text{Qs} = (\text{Ao sat} - \text{Mv sat}) / (\text{PV sat} - \text{PA sat})$

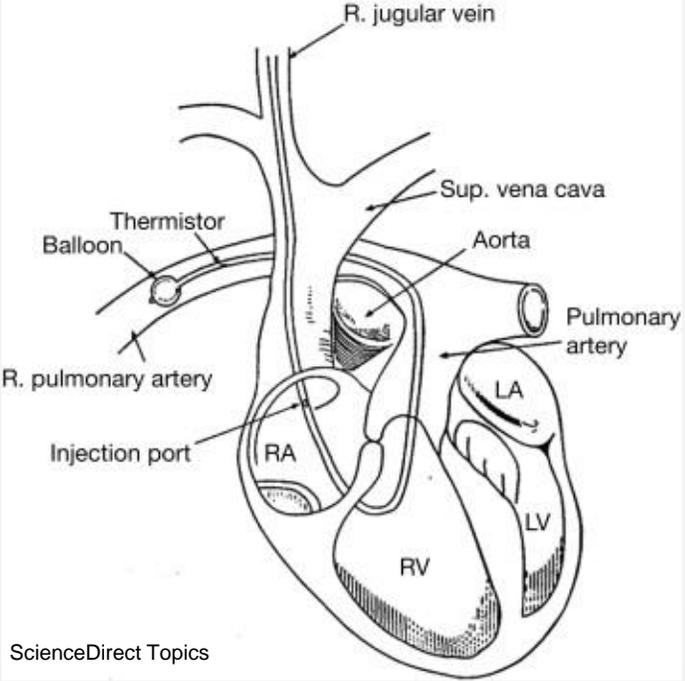
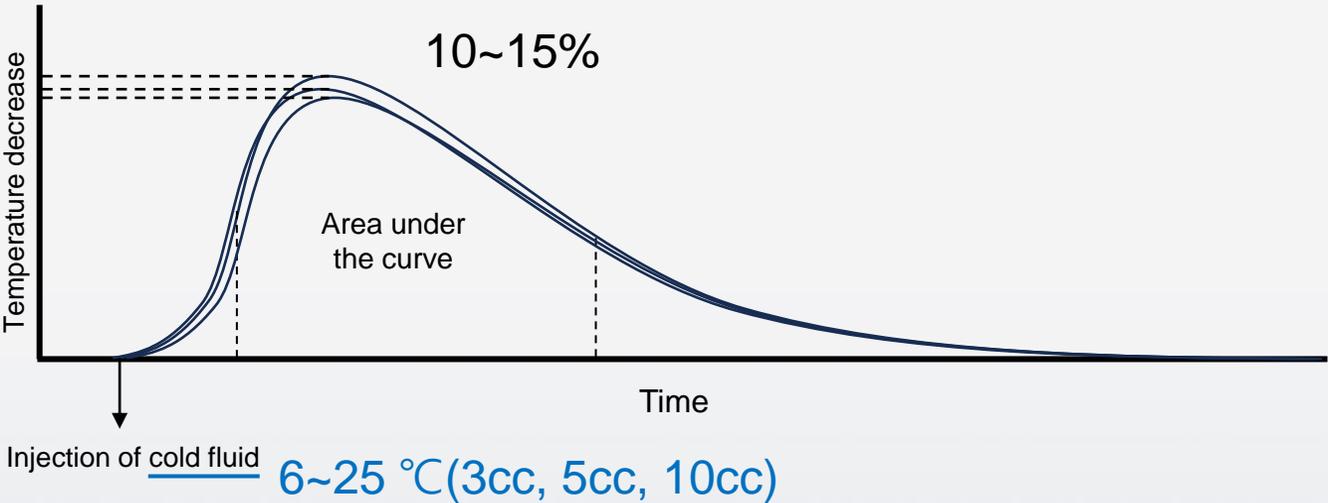
# Methods of CATH

## Cardiac output measurements (Thermodilution)

### The Stewart-Hamilton equation

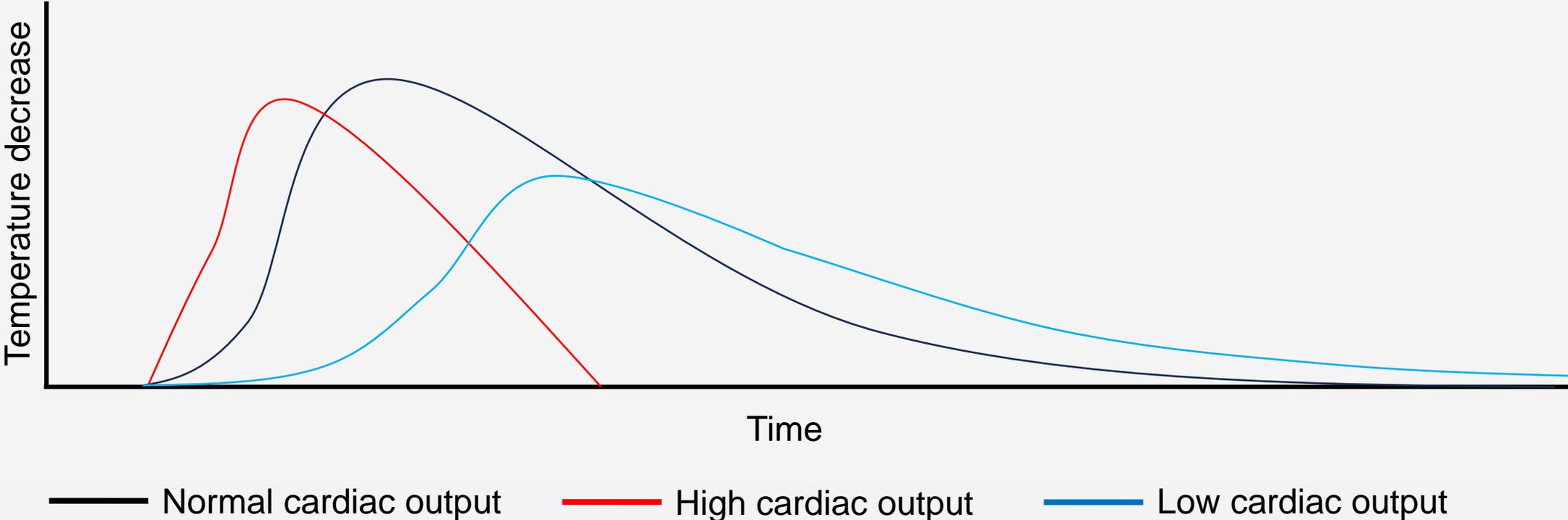
$$\dot{Q} = \frac{V \times (T_b - T_i) \times K_1 \times K_2}{\int T_b(t) dt}$$

Q = cardiac output  
 V = injected volume  
 T<sub>b</sub> = blood temperature  
 T<sub>i</sub> = injectate temperature  
 K<sub>1</sub> and K<sub>2</sub> = corrections for specific heat and density of the injectate and for blood and dead space volume  
 T<sub>b</sub>(t)dt = change in blood temperature as a function of time



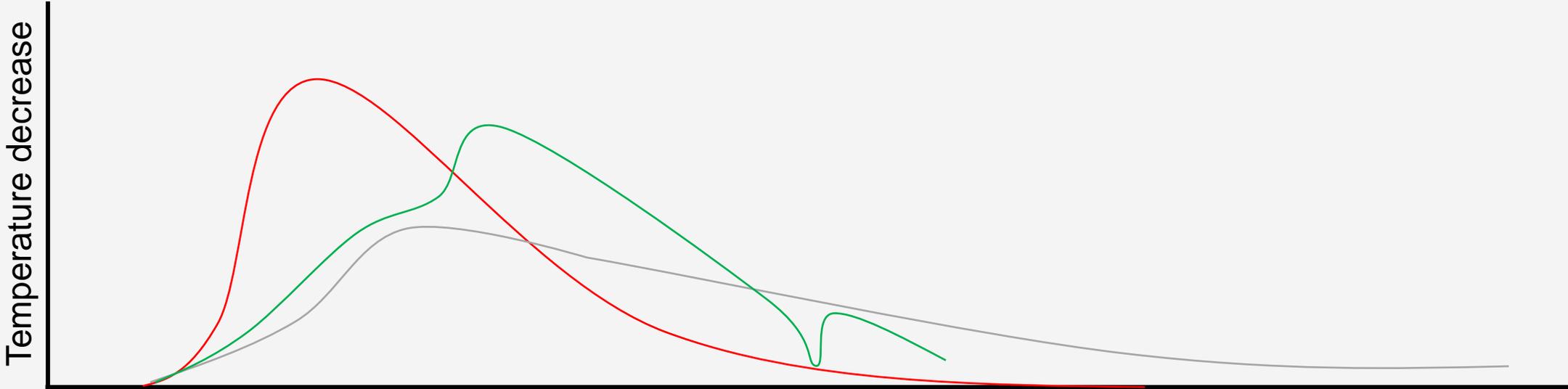
# Methods of CATH

*Cardiac output measurements (Thermodilution)*



# Methods of CATH

Cardiac output measurements (Thermodilution)



— Normal cardiac output    — Improper injection technique    — Tricuspid regurgitation

Inaccurate examination : Severe TR, low CO state(overestimate CO), intracardiac shunts, etc.

# Methods of CATH

*Cardiac output measurements (Thermodilution)*



# Methods of CATH

## *Vasoreactivity test*

- The purpose is to give the Vasodilator and then see if the **PVR decreases**.
  - Idiopathic, heritable or drug induced PAH
  - Congenital heart disease with severe PAH
  - Terminal heart failure (evaluation of lung transplantation prior to HTPL)
- Vasodilator
  - **Inhaled iloprost (ventavis)**, inhaled NO
  - IV adenosine
  - 100% O<sub>2</sub>, etc.

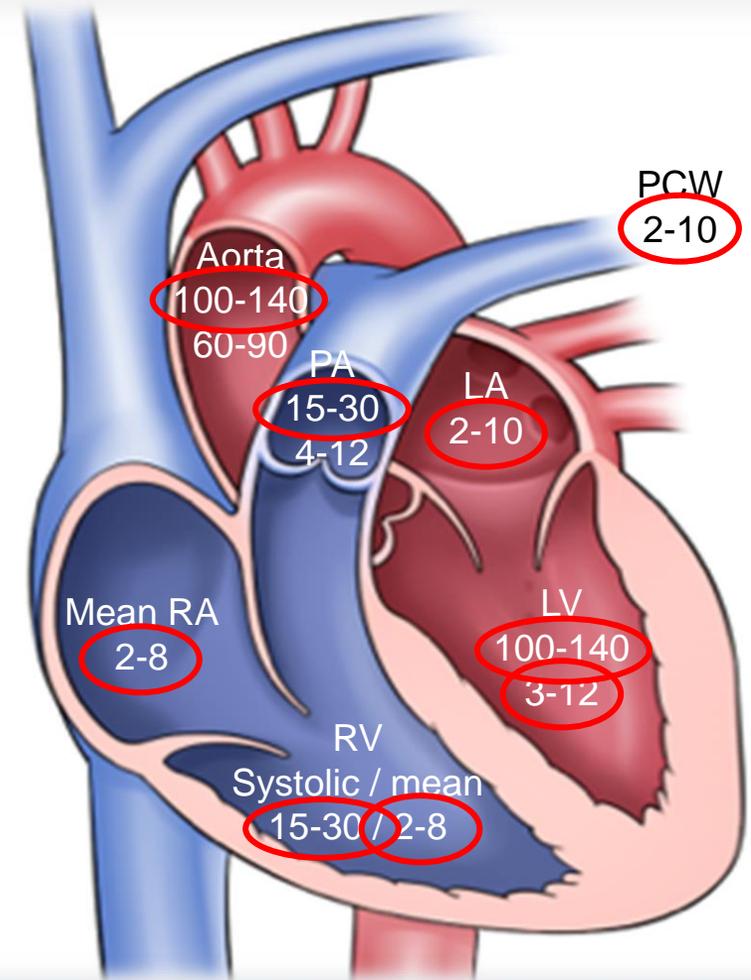
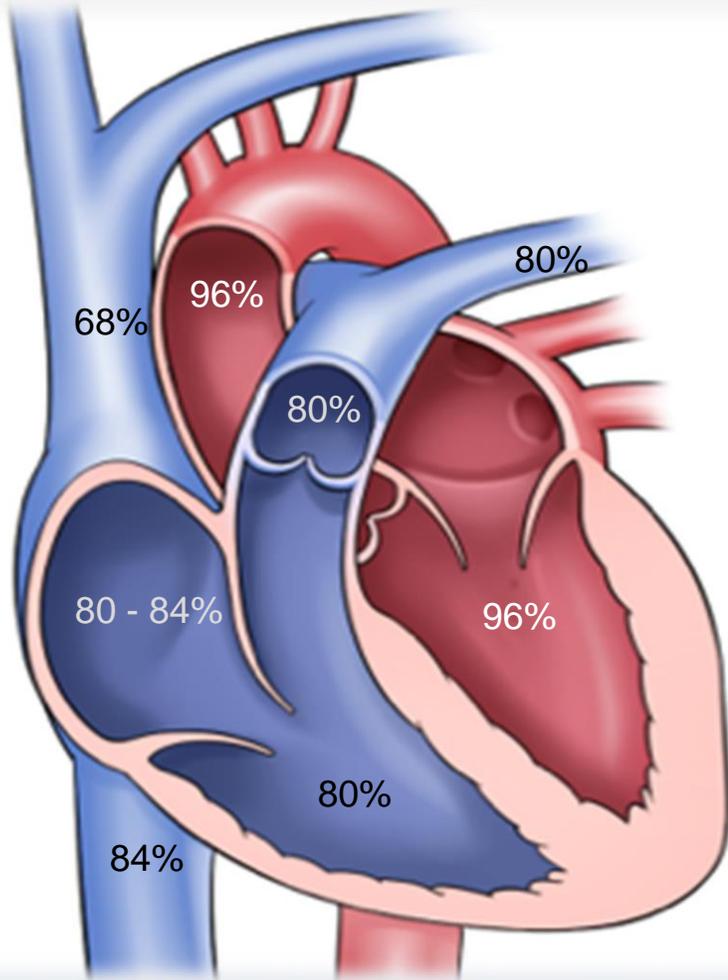
# Methods of CATH

## *Vasoreactivity test*

- Positive response (No change in CO & CI)
  - Reduction in mPAP  $\geq 10$ mmHg
  - 20% reduction in mPAP
  - mPAP  $\leq 40$ mmHg
- Responder : PAH Tx(Group1) CCB candidate.

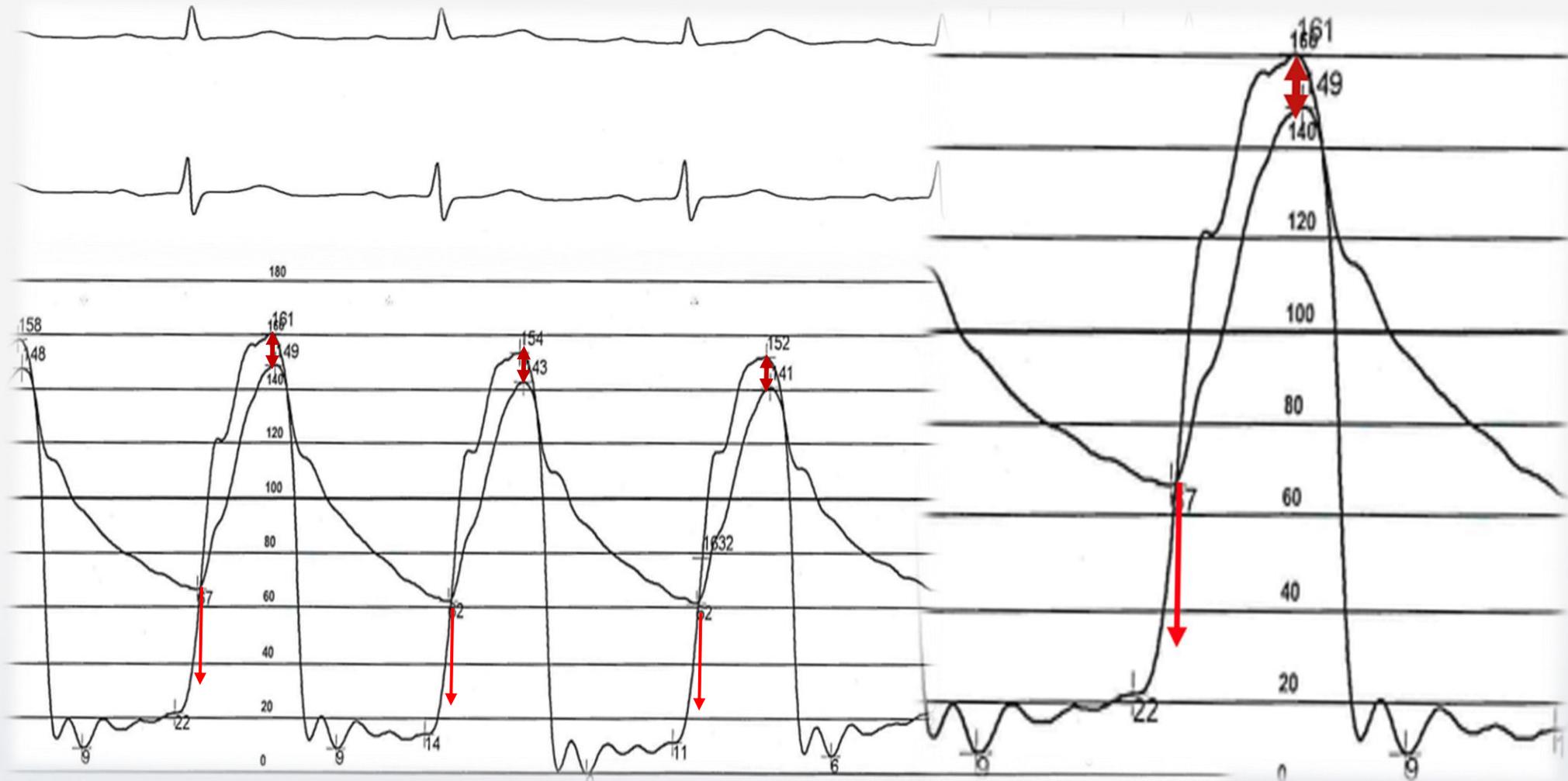
# What to consider when CATH

*Normal range of the heart*



# What to consider when CATH

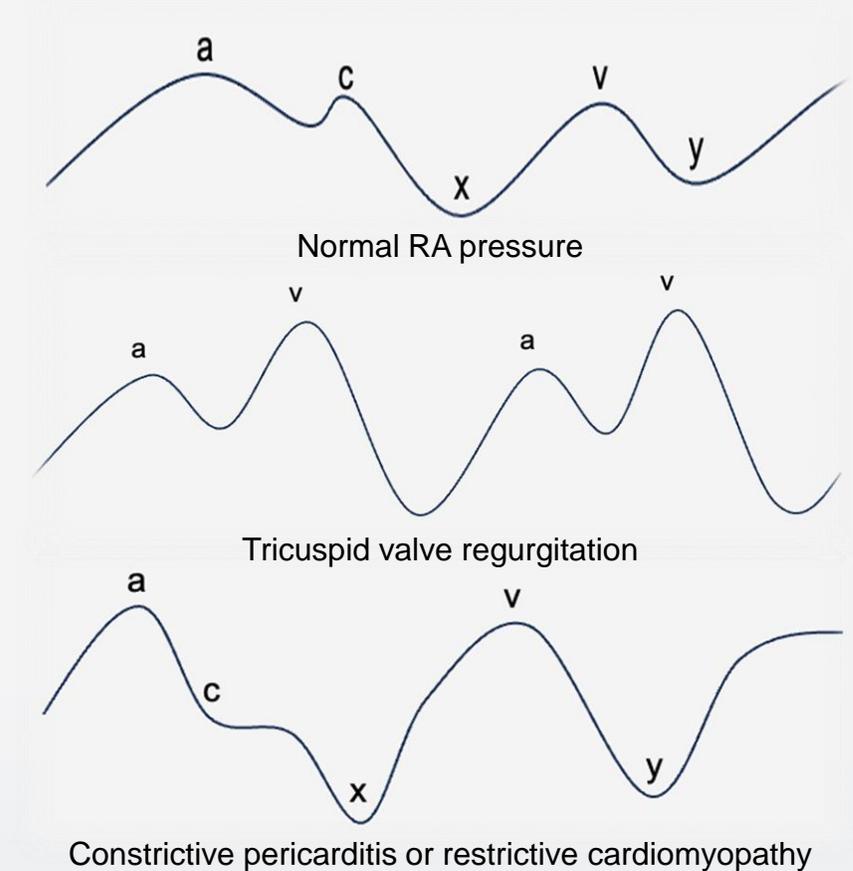
*LV & Aorta pressure and waveform*



# What to consider when CATH

## *RA pressure and waveforms*

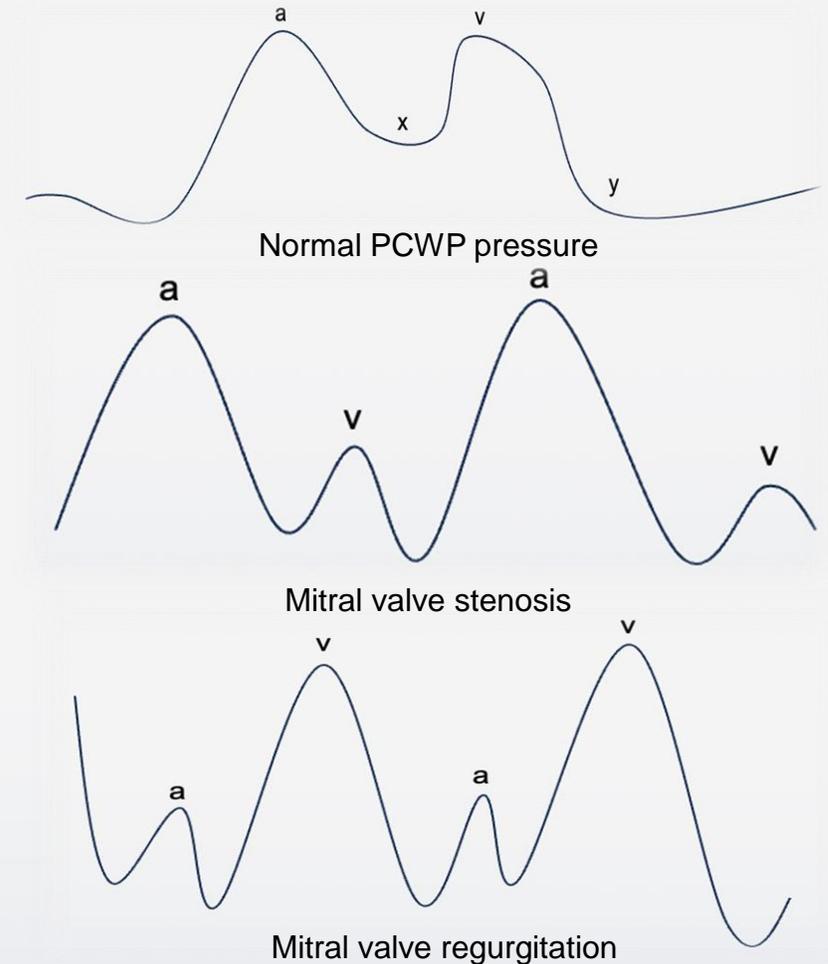
- A wave : contraction in **atrial systole**
- X descent : fall in RA pressure (**atrial diastole**)
- C wave : **closure of the tricuspid valve.**
- V wave : **ventricular systole** & passive atrial filling in atrial diastole.
- Y descent : fall in RA pressure following opening of the TV & passive filling of RV



# What to consider when CATH

## *PCWP pressure and waveforms*

- A wave : **atrial systole**
- X descent : **atrial diastole**
- V wave : **ventricular systole**  
+ passive atrial filling.
- Y descent : atrial emptying



# Conclusion

- RHC is an **important therapeutic indicator** for patients with end-stage heart failure or pulmonary artery hypertension.
- When procedure Fick or Thermodilution method, know what **we need to prepare and pay attention to each indication**.
- If you are well aware of a normal heart, it helps with a quick diagnosis of the operator.

**Thank you for listening.**