Right Heart Catheterization
INDICATIONS

• Cause of shock
• Pulmonary hypertension
• Fluid management and hemodynamic monitoring
• Guidance for pericardial tamponade
• Constrictive versus restrictive cardiomyopathy
• Diagnosis of left to right shunt
CONTRAINDICATIONS

• ABSOLUTE contraindications:
  – None

• CAUTION:
  – Pulmonary hypertension
  – Elderly
  – Left bundle branch block
EQUIPMENT

Transducer

Fluid-filled (high pressure) tubing connects the catheter to the transducer

Physiologic recorder to display, analyze, and store the hemodynamic waveforms
PULMONARY ARTERY CATHETER

- Extra Port
- Distal Port
- Proximal Port
- Thermistor
- Balloon
TECHNIQUE
A Systematic Approach to Hemodynamic Interpretation

1. Establish the zero level and balance transducer.
2. Confirm the scale of the recording.
   -40 mmHg for RHC, 200 mmHg for LHC
3. Collect hemodynamics in a systematic method using established protocols.
4. Critically assess the pressure waveforms for proper fidelity.
5. Carefully time pressure events with the ECG.
6. Review the tracings for common artifacts
Components of a Right Heart Catheterization

1. Right atrium
   - Mean (1-5 mmHg)

2. Right ventricle
   - Phasic (25/5 mmHg)
   - Mean (7-12 mmHg)

3. Pulmonary capillary wedge
   - Mean (7-12 mmHg)

4. Pulmonary artery
   - Phasic and mean (25/10 mmHg; mean 10-20 mmHg)

Pulm HTN: mean PA pressure > 25mmHg
PCWP < 15mmhg
Precautions

• Always record pressures at end-expiration
• During inspiration, pressures will be lower due to decrease in intrathoracic pressure
• Always zero and reference the system
“SAT RUN”

SVC to RA STEP UP
If highest values are used, at least ≥ 11%
If average of multiple samples, then ≥ 7%

RA to PA STEP UP
highest or average values ≥ 5%

RA to RV STEP UP
highest values are used, at least ≥ 10%
If average of multiple samples, then ≥ 5%
(for L-> R shunt)
**SIMULTANEOUS RIGHT- and LEFT- HEART CATHETERIZATION**

1. Pulmonary artery (PA) catheter to pulmonary artery
2. Measure cardiac output by measuring oxygen saturation in PA and AO blood samples to determine Fick output or by thermodilution (x3); screen for shunt.
3. Record aortic pressures with AO catheter. Cross the AV into the ventricle -> Wedge the PA catheter -> Measure simultaneous LV-PCWP (*mitral valve assessment*).
4. Pull back from PCWP to PA.
5. Pull back from PA to right ventricle (RV) (*to screen for pulmonic stenosis*) and record RV.
6. Record simultaneous LV-RV (*constriction vs restriction*).
7. Pull back from RV to right atrium (RA) (*to screen for tricuspid stenosis*) and record RA.
8. Pull back from LV to AO (*to screen for aortic stenosis*).
CARDIAC CYCLE
PHASES

1: Atrial Contraction

2: Isovolumic Contraction
   (TV/MV closure to PV/AV opening)

3: Rapid Ejection

4: Reduced Ejection
   (PV/AV opening to PV/AV closure)

5: Isovolumic Relaxation
   (PV/AV closure to TV/MV opening)

6: Rapid Ventricular Filling

7: Reduced Ventricular Filling
   (TV/MV opening to TV/MV closure)
PRESSURE WAVE INTERPRETATION
LEFT HEART CATHETERIZATION
PITFALLS
femoral artery pressure
ARTIFACTS
CARDIAC OUTPUT
Cardiac Output

- Thermodilution
- Fick Method
Thermodilution

• Bolus injection of saline into the proximal port
• Change in temperature is measured by thermistor in the distal portion of the catheter
Fick Principle

- Described in 1870
- Assumes rate of O2 consumption is a function of rate of blood flow times the rate of O2 pick up by the RBC

Cardiac output = \( \frac{\text{Oxygen consumption}}{(\text{Arterial saturation} - \text{Mixed venous saturation}) \times \text{Hgb} \times 13.6 \times 10} \)

Oxygen consumption
1. Direct Fick: Directly measured
2. Indirect Fick: --3 ml O2/kg
Limitations

**Thermodilution**
- Not accurate in tricuspid regurgitation
- Overestimated cardiac output at low output states

**Fick**
- Oxygen consumption is often estimated by body weight (indirect method) rather than measured directly
- Large errors possible with small differences in saturations and hemoglobin.
- Measurements on room air
THANK YOU
## Normal Pressures

<table>
<thead>
<tr>
<th>Site</th>
<th>Normal Value (mmHg)</th>
<th>Mean Pressure (mmHg)</th>
<th>Saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Atrium (or CVP)</td>
<td>0-5</td>
<td></td>
<td>75%</td>
</tr>
<tr>
<td>Right Ventricle</td>
<td>25/5</td>
<td></td>
<td>75%</td>
</tr>
<tr>
<td>Pulmonary Artery</td>
<td>25/10</td>
<td>10-20</td>
<td>75%</td>
</tr>
<tr>
<td>PCWP</td>
<td>7-12</td>
<td></td>
<td>95-100%</td>
</tr>
<tr>
<td>LV</td>
<td>120/10</td>
<td></td>
<td>95-100%</td>
</tr>
<tr>
<td>Aorta</td>
<td>120/80</td>
<td></td>
<td>95-100%</td>
</tr>
</tbody>
</table>
## Normal Values

<table>
<thead>
<tr>
<th>Site</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sv02</td>
<td>0.60-0.75</td>
</tr>
<tr>
<td>Stroke Volume</td>
<td>60-100 ml/beat</td>
</tr>
<tr>
<td>Stroke Index</td>
<td>33-47 ml/beat/m²</td>
</tr>
<tr>
<td>Cardiac Output</td>
<td>4-8 L/min</td>
</tr>
<tr>
<td>Cardiac Index</td>
<td>2.5-4.0 L/min/m²</td>
</tr>
<tr>
<td>SVR</td>
<td>800-1200 dynes sec/-cm²</td>
</tr>
<tr>
<td>PVR</td>
<td>&lt;250 dynes sec/-cm²</td>
</tr>
<tr>
<td>MAP</td>
<td>70-110 mmHg</td>
</tr>
<tr>
<td>Wave pattern</td>
<td>Mechanism</td>
</tr>
<tr>
<td>-------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Cannon ‘a’ wave</td>
<td>AV dissociation</td>
</tr>
<tr>
<td>Tall ‘a’ wave</td>
<td>Increased atrial pressure</td>
</tr>
<tr>
<td>No ‘a’ wave</td>
<td>Loss of atrial kick</td>
</tr>
<tr>
<td>Tall ‘v’ wave</td>
<td>Increased volume during ventricular systole</td>
</tr>
<tr>
<td>Loss of ‘y’ descent</td>
<td>Equalization of diastolic pressures</td>
</tr>
<tr>
<td>Exaggerated ‘y’ descent</td>
<td>Rapid diastolic filling</td>
</tr>
</tbody>
</table>
References

