Critical Care Monitoring

Hemodynamic Monitoring

Arterial Blood Pressure

- Cannulate artery
- Uses
  - 
  - 
  - 

Technique

- Sites
  - 
  - 
  - 
  - 
  - 
- Locate artery, prep
Monitoring 1

**Technique**

- Local anesthetic?
- Aseptic technique
- Hyper-extend (if radial)

**Technique**

- Needle + catheter inserted
- Catheter advanced while needle pulled out
- Connect to pressure monitoring system

**Technique**

- Confirm waveform
- Secure, tighten connections
- Flush system
Complications

- Occlusion of artery distal to cath
- Hemorrhage
- Hematoma
- Local tenderness
- Vasospasm
- Infection
- Skin necrosis
- Microelectric shock
Interpretation

• Blood pressure = force exerted against arterial wall as the blood moves
  • Systolic -
  • Diastolic -
  • Mean -

Interpretation

• Arterial BP determined by -
  • Force of LV contraction
  • Systemic vascular resistance (SVR)
  • Blood volume

Interpretation

• Normal BP = 90-140/60-90
  • Keep diastolic pressure > 50 mmHg since most of coronary artery perfusion occurs during diastole
  • Kidney perfusion drops to near zero if systolic pressure < 40 mmHg
Monitoring 1

**Interpretation**

- Mean arterial pressure (MAP) is the average pressure
  - Indicator of tissue perfusion
  - Normal =
  - Calculated by monitor
  
  \[ \text{MAP} = \frac{\text{systolic} + (2 \times \text{diastolic})}{3} \]

- Pulse pressure = systolic - diastolic
  - Normal =
  - Indicator of arterial wall tone

<table>
<thead>
<tr>
<th>↑ pulse pressure</th>
<th>↓ pulse pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arteriosclerosis</td>
<td>Aortic stenosis</td>
</tr>
<tr>
<td>Aortic valve disease</td>
<td>Mitral stenosis</td>
</tr>
<tr>
<td>Head injury</td>
<td>Circulatory shock</td>
</tr>
<tr>
<td></td>
<td>Pulmonary emboli</td>
</tr>
</tbody>
</table>

**Interpretation**

- Hypertension = BP consistently
- Hypotension = BP consistently
- Paradoxical pulse (pulsus paradoxus)
  -
  -
**Paradoxical Pulse**

- Inspiration

  - Increased neg press
  
  - Venous return ↑
  
  - RV filling ↓
  
  - Interventricular septum distends left
  
  - LV filling ↓
  
  - LV SV ↓
  
  - Airflow to lungs

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**Central Venous Pressure**

- Uses

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  - 
  
  - 
  
  - 
  
  -
Central Venous Pressure

- Insertion
  - Sites
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  - 
  - Aseptic
  - Skin prepped

CVP

- Insertion (con't)
  - Tourniquet
  - Tongue blade
  - Trendelenberg

CVP

- Insertion (con't)

Method 1 - Catheter through needle
Monitoring 1

**CVP**

**Insertion (con't)**

**Method 2 - Catheter with guidewire**

**Measurement**

- Transducer method
  - Normal:
    - 
    - 

**Water manometer method**

- Normal:
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**Conversion**

1 mmHg = cmH$_2$O

**CVP**

- Complications
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**CVP Interpretation**

- During diastole (vent filling time) - tricuspid valve is open - SO-o-o-o...
CVP Interpretation

• Why is CVP important?
  1. Determined by vascular blood volume
  2. Determines blood flow through the pulmonary circuit

Causes of ↑ CVP

• Any factor that increases the amount of blood volume returning to the heart
  •

Causes of ↑ CVP

• Any factor that decreases the pumping ability of the right ventricle (blood “backs up” in the venous system)
  •
  •
  •
  •
Causes of $\uparrow$ CVP

- Any factor that increases PVR
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  - 
  - 

Causes of $\uparrow$ CVP

- Any factor that increases intrathoracic pressure
  - 
  - 
  - 
  - Misc
    - 

Causes of $\downarrow$ CVP

- Hypovolemia
  - Dehydration, hemorrhage, GI loss, diuresis, interstitial edema, relative
- Air bubbles
- Leaks
- 0 level above RA
CVP Summary

• Trends most important
• Blood sampling (central)
• Assess
  •
  •
  •

Pulmonary Artery Catheterization

The inability to catheterize the left heart led to the development of the Swan-Ganz catheter in the late 1960s.

PA Catheters

• BTFDC - balloon-tipped flow-directed catheter
• Ideal catheter has many parts & functions
PA Catheters

• Pacemaker connections
  • Atrial bands -
  • Ventricular bands -

• Thermodilution (computer) connection

PA Catheters

• Distal lumen connector
  • Opens in PA

• Proximal lumen connector
  • Opens 30 cm from tip in RA
  • May have 2-3 connectors + thermodilution lumen

PA Catheters

• Balloon lumen connector
  • Opens inside balloon
  • Each balloon has max capacity marked on connector (0.8 - 1.5 ml)

• Thermistor bead
  • 4 cm from tip
  • For Q̇ measurement
PA Catheters

- All caths have at least
  - 
  - 
  -
- Sizes for adults: 5 - 7.5 Fr.

PA Catheter Uses

- Measure pressures
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  - 
  - Measure Q_{\text{T}}

PA Catheter Uses

- Blood sampling
  - 
  -
- Fluid infusion
  -
**PA Catheter Insertion**

- Transducer set-up, cal, zero
- Patient supine, trend if needed
- Sedation
- Draped with sterile towels
- Aseptic prep
- BTFDC placed in bowl of sterile saline

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**PA Catheter Insertion**

- Balloon checked in saline then deflated
- Cath flushed with heparinized solution
- Local anesthetic applied
- Site
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**PA Catheter Insertion**

- Catheter through needle or guidewire method used + introducer
- Connected to IV, transducer, tubing, all fluid-filled, heparinized, pressurized
PA Catheter Insertion

- Cath advanced into RA
- Balloon inflated
- As cath advanced flow of blood carries cath (w/ balloon inflated) into RV . . . . .

PA Catheter Insertion

- . . . Through pulmonic valve . . .
- into PA . . . . .
- wedges in small pulmonary artery

PA Catheter Insertion

- Balloon immediately deflated !!!
- If cath is in correct position, PA waveform will appear on monitor
- Balloon never left inflated for longer than it takes to obtain PCWP reading (< 15 sec.)
- Cath anchored w/suture, dressing
- CXR to confirm placement
Monitoring 1