Intra Aortic Balloon Pump

Karen Marzlin DNP, RN, CCNS, CCRN, CMC
Cynthia Webner DNP, RN, CCNS, CCRN, CMC
Questions?

- Why is it clinically important to verify that assisted systole is lower than unassisted systole?
- What is more dangerous – early inflation or early deflation?
- What are some reasons why your peak diastolic pressure (augmented pressure) may be low?

IABP: Counterpulsation Therapy

- Intra Aortic Balloon (IAB) is inflated during diastole and deflated during systole
- The IAB is a volume displacement device

IAB Placement
- Descending thoracic aorta
- 1 to 2 cm below the subclavian artery origin
- Above renal and mesenteric arteries
Hemodynamic Impact of IAB Pumping

- Increased diastolic aortic pressure
- Increased coronary blood flow
- Increase cardiac output / ejection fraction / forward flow
- Increased cerebral and renal blood flow
- Increased systemic perfusion
- Increased coronary and systemic oxygen supply
- Increased hemodynamic pulse rate
Hemodynamic Impact of IAB Pumping

- Decreased systolic aortic pressure
- Decreased afterload
  - Decreased MVO2
- Decreased LV wall tension
- Decreased preload
  - Decreased pulmonary congestion
- Decreased HR

Indications / Contraindications

Indications
- Cardiogenic Shock
- Extending MI
- Unstable Angina
- Intractable Ventricular Dysrhythmias
- Support for high risk intervention
- Bridging Device
- Mechanical Defects
- Post operative myocardial dysfunction

Contraindications
- Absolute
  - Aortic Valve insufficiency
  - Dissecting Aortic Aneurysm
- Relative
### Goals of Inflation

- Increase coronary perfusion pressure
- Increase systemic perfusion pressure and peripheral oxygen supply
- Increase baroreceptor response and decrease SNS stimulation
  - Decrease SVR
  - Decrease HR

### Goals of Deflation

- Decrease afterload
  - Decrease MVO2
  - Decrease assisted peak systolic pressure (APSP)
  - Increase cardiac output and ejection fraction
    (increase forward flow)
Why Inflation Works:
Inflation of the IAB during diastole increases aortic volume and pressure.

Why Deflation Works:
IAB deflation just prior to systole creates a potential space in the aorta. This reduces aortic volume and pressure.

Inflation Timing: *The IAB is inflated immediately upon closure of the aortic valve.*

Deflation Timing: *The balloon must be deflated before the full onset of systole.*
Arterial Pressure Timing

- IAB action is mechanical so the effect is evaluated by a mechanical event.
- Place the IABP in 1:2 assist mode
- Use the arterial wave form to assess timing
Timing Assessment Points

- PAEDP: Patient’s End Diastolic Pressure
  - This point determines afterload and is a major determinate of MVO2

Timing Assessment Points

- PSP: Peak Systolic Pressure
  - Pressure generated by the LV during mechanical contraction. No IAB effect with this point.
Timing Assessment Points

- **DN or Dicrotic Notch:**
  - Signifies the beginning of diastole when the aortic valve closes.

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Timing Assessment Points

- **PDP or Peak Diastolic Pressure:**
  - Pressure generated in the aorta as a result of balloon inflation during diastole. This increases aortic pressure and also increases the mechanical pulse rate.
Timing Assessment Points

**BAEDP or Balloon Assisted End Diastolic Pressure:**
- Lowest aortic pressure produced by the deflation of the IAB during isovolumetric contraction. Results in reduced afterload and preload and therefore decreased MVO2.

**ASSP or Assisted Systole:** The systole following IAB deflation.
- This pressure should be lower than PSP reflecting a decrease in LV work as a result of the shortened isovolumetric contraction phase and lower resistance to systolic ejection.
Augmented Diastolic Pressure
(Peak Diastolic Pressure)

- Caused by increased pressure (volume) in aorta during diastole
- PDP should be > than PSP
- The amount of augmentation will be affected by the timing of balloon inflation
  - Maximal augmentation: Balloon inflation 40 msec prior to dicrotic notch

Augmented Diastolic Pressure
(Peak Diastolic Pressure)

- PDP = additional mechanical pulse
  - Generated without MVO2
  - Has significant impact on regulatory and compensatory systems of the patient
- Additional perfusion event
  - Perfusion is a result of pressure and time
  - Coronary and peripheral circulation
    - Additional O2 and nutrient supply
    - The coronary system receives greatest benefit due to proximity to IAB.
Factors Impacting Augmentation

- Physical
  - Position
  - Volume
  - Diameter
  - Oclusiveness
  - Drive Gas
  - Duration of Inflation
  - Efficiency of System
  - Timing

- Biological
  - Arterial Pressure
  - Aortic Pressure / Volume Relationship

High Augmentation

- Risks of increased augmentation (or PDP) are mechanical
- In low cardiac output states the benefits outweigh the risks
- High augmentation post cardiac surgery
  - **Benefits:** Maintenance of coronary graft patency
  - **Risks:** Bleeding and disruption of suture sites
  - Use of vasodilators
  - Lower placement
Low Augmentation

- Weaning states
- Low volume or output states

Early Inflation: Prior to Closure of Aortic Valve

- Increased aortic pressure: regurgitation of blood into the LV
- Rise in aortic pressure will prematurely close the aortic valve:
  decrease LV emptying

  *Rise in LVEDP with no change in systemic pressure*
Early Inflation

Hemodynamic and Clinic Implications of Early Inflation

- Increased ESV / ESP
- Increased Preload
- Increased MVO2
- Increased Stroke Work
- Decreased SV
- Decreased CO

- Increased work and oxygen requirements
- Significantly impaired LV function
- Decreased cardiac output and systemic perfusion
Late Inflation: After Closure of Aortic Valve

- PDP (augmentation) is decreased
  - Systolic volume has run off to peripheral circulation
Hemodynamic and Clinic Implications of Late Inflation

- PDP (augmentation) is less than optimal
  - Decreased perfusion pressure and volume to coronary arteries

Principles of IAB Deflation

- Decrease in aortic pressure during isovolumetric contraction
- Creates a potential empty space in aorta
- Allows part of LV stroke volume to be accommodated without resistance
- The decreased afterload results in increased CO and therefore decreased LVEDP
- Results in decreased diastolic pressure and decreased assisted systolic pressure
- Decreased static work
Static and Dynamic Work

- **Static Work**
  - Isometric effort requiring large amount of energy or MVO2
  - Occurs during isovolumetric contraction to develop and maintain ventricular pressure prior to aortic valve opening

- **Dynamic Work**
  - Occurs during ventricular ejection

Factors Impacting Unloading

- **Physical**
  - IAB volume
  - Occlusiveness
  - Duration of Inflation

- **Biological**
  - Arterial pressure
  - Vascular compliance
  - Cardiac reserve
Deflation Timing

- Deflation point is set to achieve two goals:
  - BAEDP < PAEDP
  - APSP < PSP

Early Deflation

- Aortic pressure is allowed to rise to the normal PAEDP
  - Blood fill in the space created by balloon deflation

- Produces a U shaped curve
- APSP = PSP

- No Cardiac Unloading
- No reduction in MVO2
Early Deflation

![Diagram of early deflation]

Late Deflation

- Results in:
  - Increased BAEDP
  - Increased workload of LV / increased MVO2
  - Increased isovolumetric contraction time
  - Decreased CO and SV

- BAEDP is > PAEDP
Late Deflation

Balloon Pressure Waveform

Height
Width
Plateau
Trouble Shooting

Low Plateau Pressure

- Low balloon volume
- Too small of balloon
- Balloon placement too low in aorta
- Decreased SVR (increased aortic compliance)
Balloon Pressure Waveform Artifact
- Balloon still in sheath
- Suture too tight
- Partial kink
- Slow helium speed
- Tortuous vessels

Elevated Baseline
- Kinked catheter
- Partially wrapped balloon
- Balloon in sheath
- Overfill
- Balloon too low in aorta
- Balloon too large
Baseline Below Zero

- Blood in tubing
- Leak in tubing (helium loss)
- Kinked catheter
- Ectopy

Square or Rounded Plateau (High Pressure)

- Partially wrapped balloon
- Kinked catheter or tubing
- Balloon in sheath
- Too large of balloon
- Inaccurate balloon placement
Discussion of Key Nursing Considerations

- Pressure assessment for optimization of therapy
- Balloon mobility
- Left radial pulse assessment
- Urine output
- Distal pulse assessment
- Groin care
- Platelets
- Other complications

RESULTS