Intra-Aortic Balloon Pumps
"The Dirty 7"

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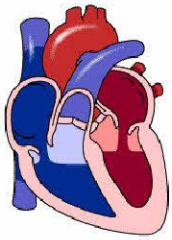
Objectives

- Understand the basic theory and physiologic effects of IAB and counterpulsation therapy
- Review balloon, console, and equipment
- Review key elements and essentials of transport with an IABP
- Discuss problematic situations during transport and solutions

Indications for use of IABP

- Acute MI
- Unstable angina
- Acute mitral valve rupture
- VSD
- Left Main Occlusion
- Cardiogenic shock
- Postoperative CABG



Cardiogenic Shock

- Cardiogenic shock is the most common cause of death from acute myocardial infarction
- According to data from the SHOCK registry mortality from cardiogenic shock complicating acute myocardial infarction is 50-80%
- Data indicates that anterior myocardial infarction is the most common territory

Contraindications

- Pulseless with no pacer capture
- Chronic end-stage heart disease
- Aortic insufficiency
- Aortic or thoracic aneurysm
- Severe PVD (relative)

Point # 1: Medications

- In learning about patient management with an IABP, do not lose sight of the medications aspect.
- Medications go hand-in-hand with the IABP.
- Much like ventilators do with medications for respiratory patients.

Point # 2: IABP acuity

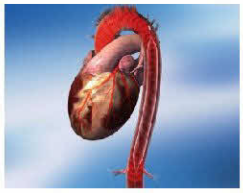
- Just because a patient may have an IABP in place, does not mean they are dependant on it.
- VAD patients may have an IABP in place that is doing little or nothing.
- The patient may have deteriorated beyond IABP benefits, however when weaned from VAD will benefit in the bridge back over.

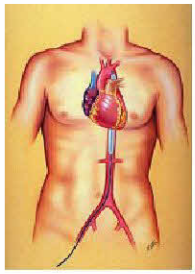
Point # 3: IABP is not:

- A replacement for defibrillation, pacing, or synchronized cardioversion.
- A medication pump.
- A ventilation unit.
- A ventricular assist device (VAD)
- ECMO
- So you will need this additional equipment.

IAB & Counterpulsation

- **In a nutshell:** A long balloon, on a catheter, is inserted in the femoral artery and placed between the aortic arch and the renal arteries. It inflates during diastole and deflates during systole, thereby perfusing the coronary arteries during the entire cardiac cycle, decreasing afterload and increasing MAP.

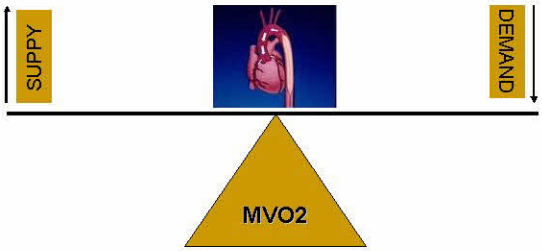




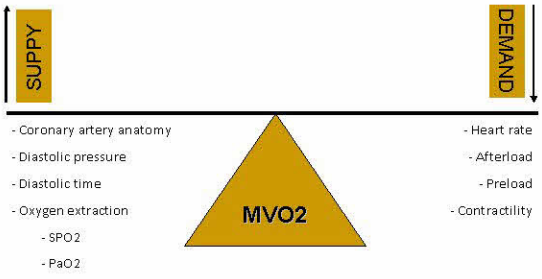
What is MAP?

- Forget blood pressure parameters…
- Learn **MAP** (mean arterial pressure)
- Term used in medicine to describe an "average" blood pressure in an individual
  - MAP = **[(2 x diastolic) + systolic] / 3**
  - 128/61: 61x2+130/3= **83 MAP**
  - 119/62: 62x2+119/3= **81 MAP**
  - 124/60: 60x2+124/3= **81 MAP**

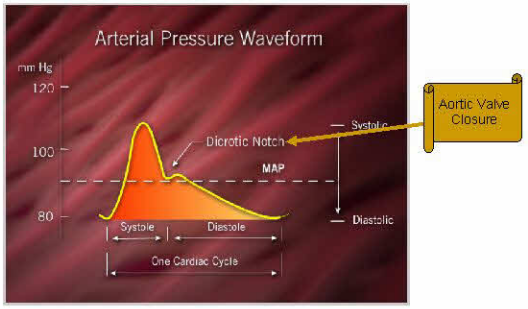
Goal of IABP



Determinants of MVO2



An arterial waveform



Inflation

- Inflation:
  - Occurs during diastole
  - Aortic (Ao) valve is closed
  - Displaces blood from arch back into coronaries
  - Aortic closure is key

IAB INFLATION - DIASTOLE

Deflation

- Deflation:
  - Occurs during systole
  - Ao valve is open
  - Causes rapid drop in aortic pressure, thereby lessening the workload on the LV
  - Decrease in myocardial O2 use
  - AFTERLOAD REDUCTION !!!!!

IAB DEFLATION - SYSTOLE

Putting it together…

-Coronary artery anatomy
-Diastolic pressure
-Diastolic time
-Oxygen extraction
-SPO2
-PaO2

MVO2

-Heart rate
-Afterload
-Preload
-Contractility

Increases MAP

- Augmentation of Diastolic Pressure
- Causes an increase in MAP
- Results in overall increase of perfusion of end organs
- Always titrate drips according to IAB arterial MAP

Timing/Triggering

- **Triggering:** Inflation can be triggered by
  - ECG (r wave) **{Best}**
  - Arterial waveform **{2nd, and during CPR}**
  - Pacing spike **{during pacing}**
- **Timing:** Needs to be timed to perfection otherwise increase problems
  - More to be discussed on timing shortly…

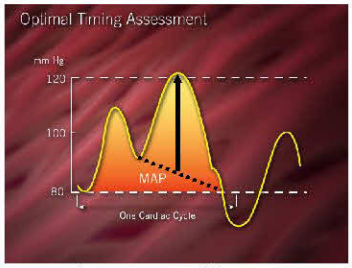
Triggering

- **Triggers-electric before mechanical**
  - ECG
    - Always preferred:
    - Upstroke of R-wave
  - Pressure
    - Second choice
    - Upstroke of Arterial waveform
    - **Good for arrest/CPR w HQ CPR**
  - Pacer
    - V-pace spike
    - Semi-Auto only
  - Internal
    - Asynchronous at 80 bpm,
    - When not generating C.O. - arrest, CPB

Good ECG signal

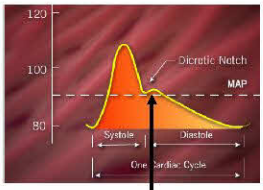
Poor ECG signal

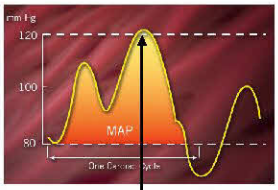
Arterial Pressure During Diastole



IABP Therapy raises the MAP Because of the increase in arterial blood pressure **DURING DIASTOLE**

Comparison

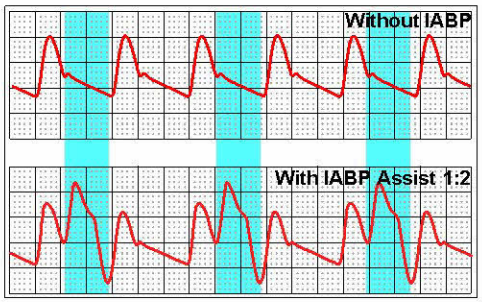




Normal Cycle, diastole peak

Augmented Cycle, diastole peak

Comparison



Rule of thumb:

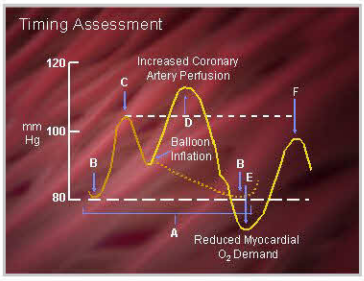
- Augmented pressure should always be higher than systole.

Unless:

1. Patient's stroke volume is significantly greater than the balloon volume
2. Balloon is positioned too low
3. Hypovolemia
4. Balloon is too small
5. Low SVR
6. Improper timing
7. Partial obstruction of gas flow

These 7 points are what will cause you problems!

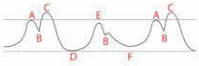
Timing is everything

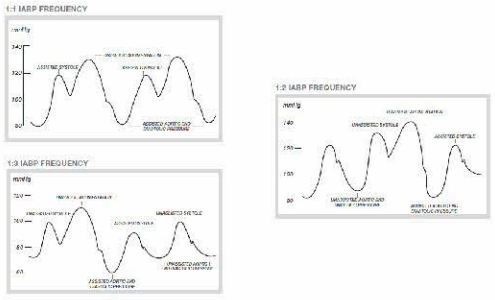


A = One cardiac cycle
B = Unassisted End Diastole
C = Unassisted Systole
D = Augmented Diastole
E = Assisted End Diastole
F = Assisted Systole

Do we miss a beat?

- Does ***every*** waveform have to be augmented?
  - **NO…**
    - 1:1 – **standard support**
    - 1:2 – supportive, ***check waves***
    - 1:3 – weaning
    - 1:4 – weaning & older tech for tachy's
- This is referred to "augmentation"
  - 1:2 – is good to evaluate timing & check waves



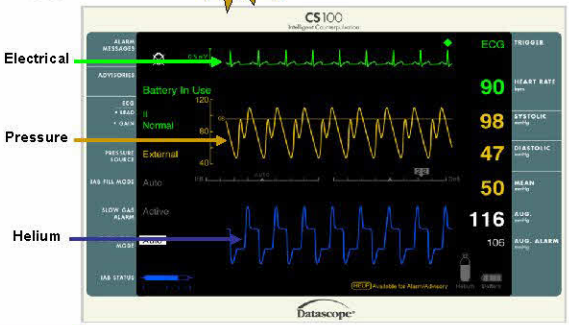


The console

- Functions of Console
  - Modes;
    - **Auto – standard operation**
    - Semi-Auto – allows for adjustment of controls
      - Any time you change a setting, it automatically goes to stand-by
      - Must manually push start

Wave Forms

Regardless of Brand



Wave Forms

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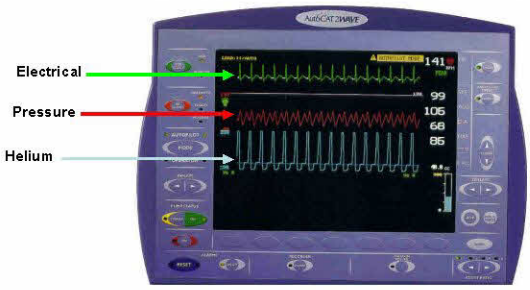
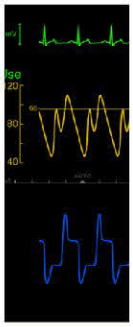


Wave Forms

- ECG
  - Green
  - Make sure it's pretty
- Arterial
  - Red or gold
  - Flush on stand-by
- Balloon inflation/deflation
  - Chair shape
  - **Will change morphology w brady, tachy, a-fib, kinking, under inflation**



Monitoring

- Pedal pulses – distal to insertion
- Radial pulses – L radial
- Helium tubing – clean and clear, one fleck of blood is bad
- Insertion site – bleeding is normal, gushing is not
- U.O. – make sure not occluding renals
- CBC – need O2 carrying capacity
- HOB – watch waveform 30-40°

Think…right now…

- The value is in a higher DBP.
  - So in a patient who is not getting better or is getting worse… **"why is the DBP not getting higher?"**
    - ✓Is it the balloon?
    - ✓Is it my patient?
    - ✓Is it the IABP control console?

It's 1 of these 3!!!

Why can't I get my DBP higher?

- Is it the balloon?
- Is it my patient?
- Is it the IABP control console?

Is it the Balloon?

- Is it still in the sheath?
- Has it not unfolded?
- Is it in the right position?
- Is it kinked?
- Is there a leak in the balloon?
- Is there condensation in the tubing?
- Do I have enough Helium?

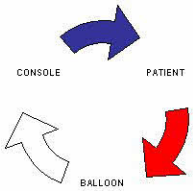
Is it my Patient?

- What is the heart rate?
- How is my stroke volume?
  - (or is the tank full)
- Is there an adequate mean arterial pressure?
- What is the patient's Systemic Vascular Resistance?

Is it the Pump Console?

- Battery life?
- Unit on stand-by?
- Check the timing
- Check the amount of Helium available

Reassessment



The Dirty Seven

The 7 things that will cause you problems in transport.

The Dirty Seven

1. Patient's stroke volume is significantly greater than the balloon volume
2. Balloon is positioned too low/displaced
3. Hypovolemia
4. Balloon is too small
5. Low SVR
6. Improper timing
7. Partial obstruction of gas flow/gas loss

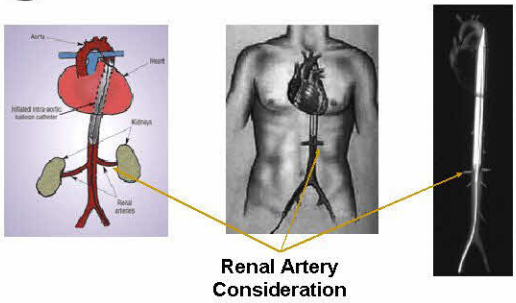
1. Stroke Volume

- **Patient's stroke volume is much greater than IABP.**
  - Good:
    - Your patient is getting better and is becoming independent of the device.
    - Often the case during weaning or post CABG cases.
    - Also the case when an IABP is inserted and not fully needed.
    - Evaluate your patients MAP with no IABP assistance.

2. Balloon is too low

- **Balloon is positioned too low.**
  - Could occlude renal artery resulting decrease U.O.
  - Documentation of last current insertion depth* should reveal if device has been "pulled".
  - PCXR would reveal correct placement.
  - *In the field, this will depend on how well you assessed the insertion depth prior to transport.

2. Balloon is too low



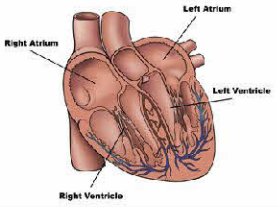
Renal Artery Consideration

3. Hypovolemia

- **Your patient has become hypovolemic resulting in decrease cardiac output or vol for potential output.**
  - Urine output considered
  - CVP
  - Suspect with administration of diuretics.
  - Potential blood loss during procedure in post operative cases
  - STAT CBC is indicated.

3. Hypovolemia

- Loss of intrinsic function of left ventricle
- Not much can be done:
  - VAD
  - Impella 2.5 or 5
  - Tandem Heart
  - ECMO



4. Balloon is too small

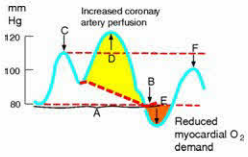
- **The balloon inserted is too small for this patient.**
  - This does happen.
  - Reference the sizing chart to identify the recommended size. There may have been a reason in the smaller size was used in the OR or CCL.

5. Low SVR

- **Low systemic vascular resistance can be caused by several factors.**
  - Change in pt condition, such as sepsis
  - Change in vasoctive medication dosages
  - Remember: Titrate pressors to augmented MAP

6. Improper timing

- Timing is everything. If the balloon is not inflating after aortic valve closure, the effectiveness is very little.
- Inflation & Deflation is key here

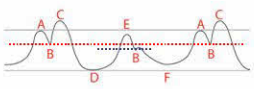


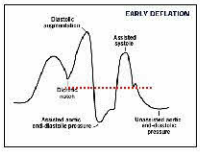
Inflation

- **Early inflation:** balloon inflates before dicrotic notch (aortic valve closure)
  - Causes premature closure of aortic valve
  - Reduces stroke vol & cardiac output
- **Late inflation:** dicrotic notch is present during systole & augmentation.
  - Less than optimum augmentation
  - Decreases perfusion pressures

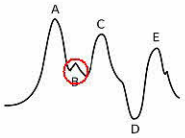
Inflation

- **Early inflation:**





- **Late inflation:**

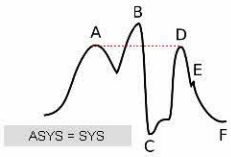


Deflation

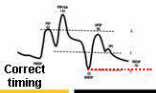
- **Early deflation:** Augmented systole = systole.
  - Results in on afterload reduction
- **Late deflation:** Augmented end diastolic pressure > non-augmented end diastolic pressure
  - Increases workload of LV
  - Increases MVO2 demand

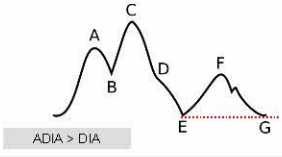
Deflation

- **Early deflation:**



- **Late deflation**





7. Gas problem (helium)

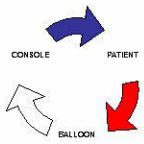
- You will get a "high gas" alarm or a "low gas" alarm.
  - **High gas:** the tubing has a kink. Possibly the patient is sitting above recommended angle and kinking the tubing. Possible kink on stretcher. Ascending into flight.
  - **Low gas:** connection has come lose. Severed tubing. Severed balloon. Descending in flight. Helium tank is empty.

Transport

- Battery life
  - 3 hours unplugged
  - 18 hours to fully charge "low battery"
  - Make sure AC power is available in ambulance/helicopter
- Altitude
  - Increase – for every 1000 ft rise, should autofill
  - Decrease – for every 2000 ft drop, should autofill
- Transport of console
  - Weight
  - Securing in vehicle/aircraft
- Balloon stand-still – 30 minutes; hand pump
- Must be managed by Critical Care RN or Critical Care PM with IABP competency

Summary

- These patients can present very ill, and potentially may not survive.
- There are 3 elements to this transport scenario:
  - The patient (clinically)
  - The balloon itself
  - The IABP console and components



Summary

- Most common IABP problems are with timing or triggers.
- Use the "Dirty 7" to troubleshoot problems
- Titrate your medications to the **augmented** MAP. Bolus doses are fine.
- Take your time in transport, and preplan every move.

Summary

- If the pump fails, ie complete failure, gas loss, etc… Manual inflate the balloon q30 min or less (do not let balloon stand still for >30 min).
- If the patient arrests, put pump in pressure mode and provide high quality CPR.

Summary

- You must stay competent and educated on this subject matter.
- Manufacturers vary widely in details.
- Regular clinical experience is must.
- Annual testing competency with documentation.
- Never pass up an opportunity to study an IABP pt or participate in care.

Questions?

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Thanks

www.woundedwarriorproject.org

- During the study period, 173 transports involving an IABP were performed.
- Few patients require significant intervention before transport.
- Attention must be paid to balloon inflation and deflation timing despite the existence of timing algorithms.