Cardiogenic Shock and IABP

Quick Reference Guide

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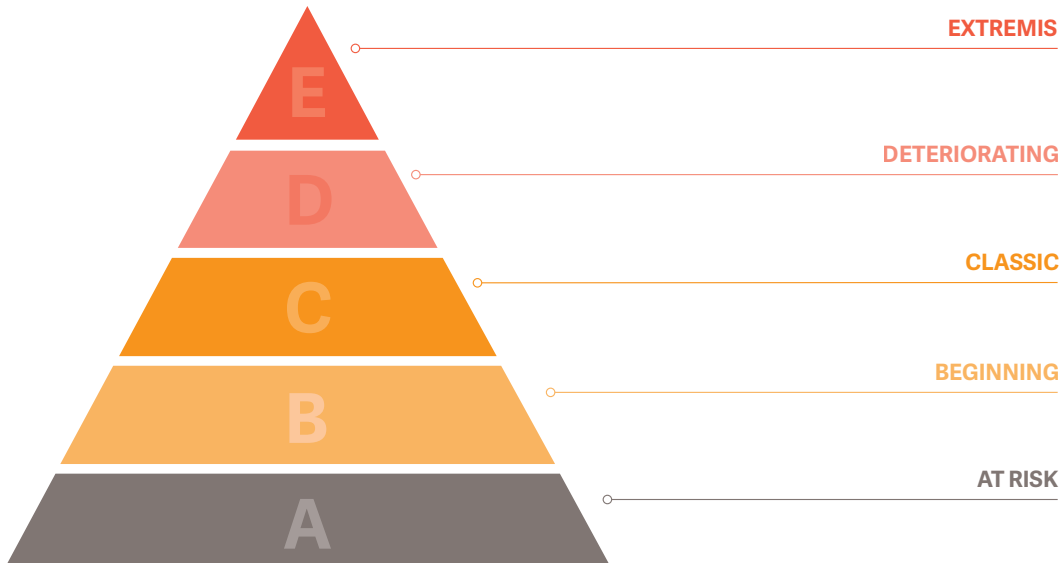


Stages of Cardiogenic Shock[1]

Cardiogenic Shock Stages	At Risk	Beginning	Classic	Deteriorating	Extremis
	A patient with risk factors for cardiogenic shock who is not currently experiencing signs or symptoms. For example, large acute myocardial infarction, prior infarction, acute and/or acute on chronic heart failure.	A patient who has clinical evidence of relative hypotension or tachycardia without hypoperfusion.	A patient presenting with hypoperfusion requiring intervention beyond volume resuscitation (inotrope, pressor, or mechanical support including ECMO). These patients typically present with relative hypotension.	A patient who fails to respond to initial interventions. Similar to Stage C and getting worse.	A patient being supported by multiple interventions who may be experiencing cardiac arrest with ongoing CPR and/or ECMO.
Physical Signs	• Normal JVP • Lung sounds clear • Strong distal pulses • Normal mentation	• Elevated JVP • Rales in lung fields • Strong distal pulses • Normal mentation	• Ashen, mottled, dusky • Volume overload • Extensive rales • Killip class 3 or 4 • Non-invasive or invasive ventilation • Acute alternation in mental status • Urine Output < 30 mL/h	• Any of stage C	• Near pulselessness • Cardiac collapse • Mechanical ventilation • Defibrillator used

Stages of Cardiogenic Shock, continued

Biochemical Markers	• Normal renal function • Normal lactate	• Normal lactate • Minimal renal function impairment • Elevated BNP	• Lactate ≥ 2 • Creatinine doubling **OR** > 50% drop in GFR • Increased LFTs • Elevated BNP	• Any of stage C **AND** deteriorating	• Lactate ≥ 5 • pH ≤ 7.2
Hemodynamics	• Normotensive (SBP > 100 **OR** normal for pt.) If hemodynamics done: • Cardiac index ≥ 2.5 • CVP < 10 • PA Sat ≥ 65%	• SBP < 90 **OR** MAP <60 **OR** > 30 mmHg drop • Pulse ≥ 100 If hemodynamics done: • Cardiac index ≥ 2.2 • PA Sat ≥ 65%	• Drugs/device used to maintain BP above stage B values If hemodynamics done: • Cardiac Index < 2.2 • RAP/PCWP > 0.8 • PCWP > 15 • PAPI < 1.85 • CPO ≤ 0.6	• Any of stage C **AND** requiring multiple pressors **OR** addition of mechanical circulatory support devices to maintain perfusion	• No SBP without resuscitation PEA **OR** Refactory VT/VF • Hypotensions despite maximal support

Adapted from the SCAI Clinical Expert Consensus Statement on the Classification of Cardiogenic Shock. Endorsed by ACC, AHA, SCCM, and STS.

Develop a Treatment Plan

Identify

Any attempt to improve outcomes in CS should begin with its early identification. Models of care including a multi-disciplinary CS team, hold potential for the early identification and individualized treatment of CS.[2]

Initiate

Experts suggest use of advanced hemodynamic monitoring to diagnose and/or manage patients with CS.[1] To avoid the negative impact of inotropes, consideration should be given to early initiation of intra-aortic balloon pumping.[3,4]

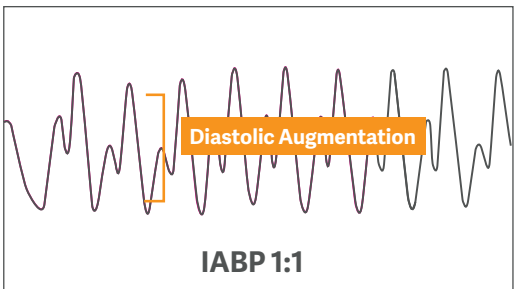
Evaluate

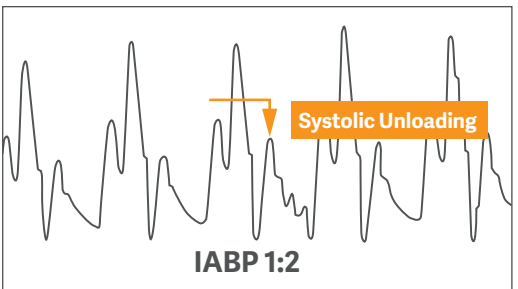
Quick feedback loops incorporating patient status and hemodynamics are required to assess the responseto initial therapies.[5]

Escalate

If patients do not respond to treatments initiated, consider the next level of support and transfer to experienced shock centers if required.[1]

Benefits of IABP Therapy[6]





↑ Coronary Perfusion Pressure
↑ Coronary Blood Flow
↑ Myocardial Oxygen Supply

↓ LV Wall Tension/Afterload
↓ LVEDP
↑ Cardiac Output
↓ Myocardial Oxygen Demand

Diastolic Augmentation
Difference between non-augmented and augmented diastolic pressure

Systolic Unloading
Difference between unassisted systole and assisted systole pressure

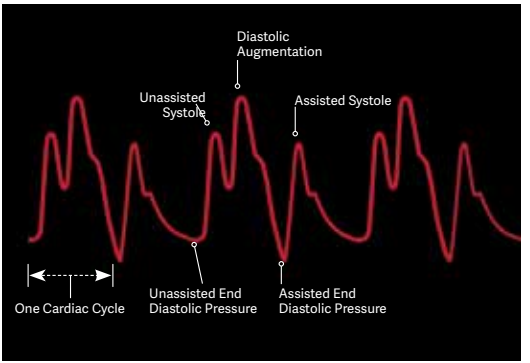
IABP Proper Timing

Inflation

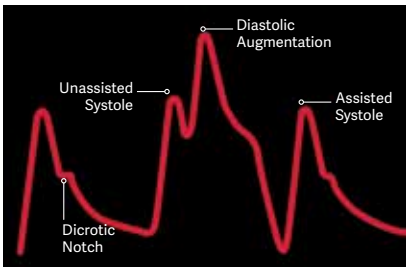
- Occurs at the dicrotic notch
- Appears as a sharp “V”
- Ideally diastolic augmentation rises above systole

Deflation

- Occurs just prior to systolic ejection
- Results in a reduction in assisted end diastolic pressure
- Results in a reduction in assisted systolic pressure



Timing Errors



Early Inflation

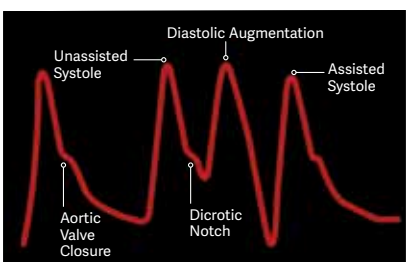
Inflation of IAB prior to aortic valve closure.

Waveform characteristics

- Inflation of IAB prior to dicrotic notch
- Diastolic augmentation encroaches onto systole (may be unable to distinguish)

Physiologic Effects

- Potential premature closure of aortic valve
- Potential increase in LVEDV/LVEDP/PCWP
- Increased left ventricular wall stress or afterload
- Aortic regurgitation
- Increased MVO_2 demand



Late Inflation

Inflation of IAB markedly after closure of aortic valve.

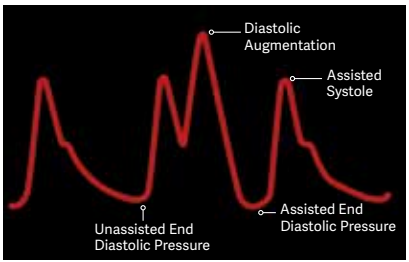
Waveform characteristics

- Inflation of IAB after dicrotic notch
- Absence of sharp "V"
- Sub-optimal diastolic augmentation

Physiologic Effects

- Sub-optimal coronary artery perfusion

Timing Errors



Early Deflation

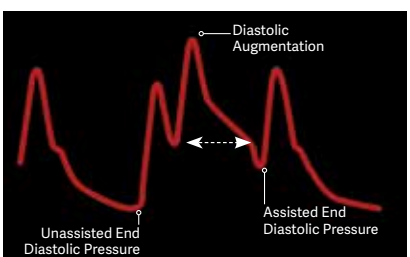
Premature deflation of IAB during diastolic phase.

Waveform characteristics

- Deflation of IAB is seen as a sharp drop following diastolic augmentation
- Sub-optimal diastolic augmentation
- Assisted end diastolic pressure may be equal to or less than unassisted end diastolic pressure
- Assisted systolic pressure may rise

Physiologic Effects

- Sub-optimal coronary perfusion
- Potential for retrograde coronary and carotid blood flow
- Angina may occur as a result of retrograde coronary blood flow
- Sub-optimal afterload reduction
- Increased MVO_2 demand



Late Deflation

Deflation of IAB after aortic valve has opened.

Waveform characteristics

- Assisted end diastolic pressure may be equal to or higher than unassisted end diastolic pressure
- Rate of rise of assisted systole is prolonged
- Diastolic augmentation may appear widened

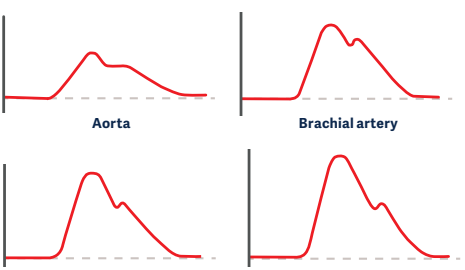
Physiologic Effects

- Afterload reduction is essentially absent
- Increased MVO_2 consumption due to left ventricle ejecting against a greater resistance and a prolonged isovolumetric contraction phase
- IAB may impede left ventricular ejection and increase afterload

Blood pressure differences between the IABP monitor and the patient's bedside monitor

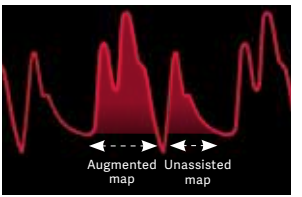
- The IABP displays assisted and unassisted systolic and diastolic pressures as well as the augmented diastolic pressure.
- Patient monitors do not have the capability of displaying both systolic and diastolic augmentation or differentiating assisted from unassisted systolic or diastolic pressures.
- Some bedside monitors analyze the arterial waveform over several seconds and display an average of the highest and lowest pressure points measured during the sampling period. They are not programmed to distinguish between a high pressure point generated by a patient's intrinsic systole or by balloon inflation during diastole.[7]
- It is both confusing and inaccurate to record "blood pressure" from the bedside digital display during balloon pumping.[1]
- Serious errors can occur if one nurse records systole as the patient's actual systolic pressure and another nurse erroneously documents systole as the high pressure point actually occurring during diastolic balloon inflation (augmented diastolic pressure).[7]
- Check with the bedside monitor manufacturer for further information on how the arterial pressures are calculated and displayed when an IABP is in use.

Arterial waveform: Peripheral vs. Central[8]



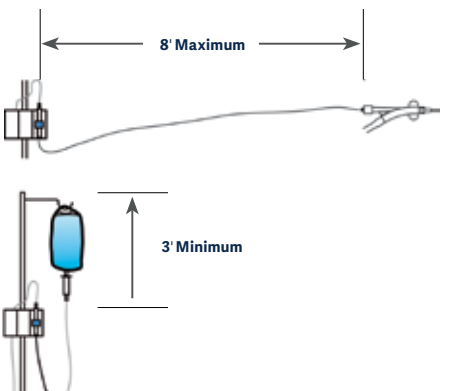
Mean Arterial Pressure on IABP

Augmentation increases the mean arterial pressure by increasing the time and pressure under the curve. The IABP samples the pressure every 4 seconds on the waveform to determine the mean pressure. The standard formula does not take into account the diastolic augmentation.

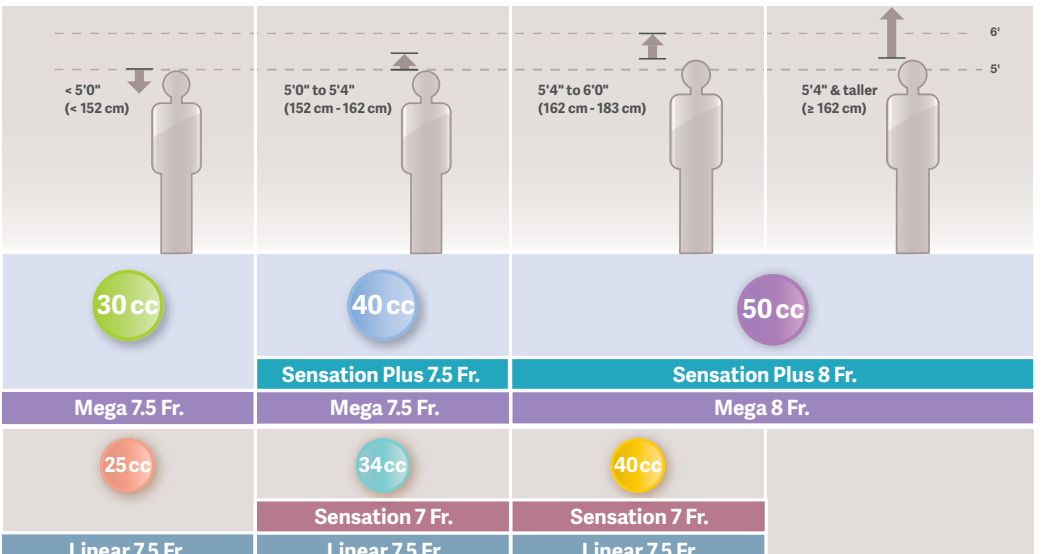


Proper care of inner lumen

- Minimize length of pressure tubing.
- Use **only** low compliance pressure tubing.
- Elevate flush bag at least 3' (91.44 cm) above transducer.
- A 3cc/hour continuous flow through inner lumen is recommended.
- If inner lumen becomes damped.
  - Aspirate and discard 3cc of blood.
  - If **unable** to aspirate blood, consider inner lumen clotted, cap lumen, provide alternate pressure source.
  - If **able** to aspirate blood, fast flush to clear pressure tubing for **at least 15 seconds** (with IABP on Standby).
  - **Do not** sample blood from inner lumen.



IAB Sizing Guide



Note: This information is to be used as a guidance only. Clinical information and patient factors such as torso length should be considered when selecting the appropriate balloon size. Sensation and Sensation Plus are fiber-optic IAB catheters.

Alarms

Augmentation below limit set

Diastolic Augmentation is lower than Systolic pressure

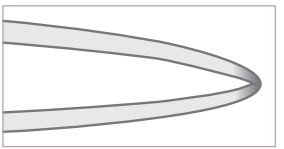
Probable Cause	Corrective Action
Hemodynamic status has changed: ↑HR, ↓SV, ↓MAP.	Attempt to optimize patient's hemodynamic status.
Alarm limit set too high.	Press AUG. ALARM key, decrease limit.

Alarms

Kink in IAB Catheter

Balloon Pressure Waveform: appears rounded

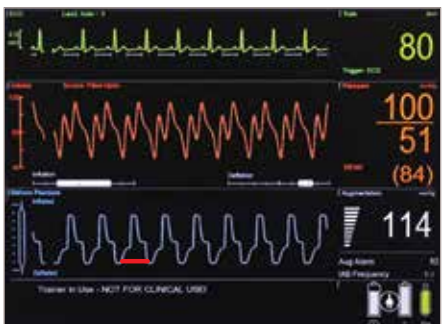
IAB Catheter Restriction



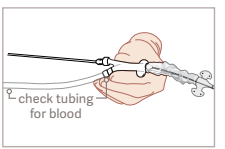
Probable Cause	Corrective Action
Restriction in IAB catheter or tubing.	Relieve restriction. if possible, press START.
Membrane has not completely unfolded.	Manually inflate and deflate IAB.
IAB remains in sheath.	Check markings on IAB and if IAB has not exited sheath, refer to IFU to reposition sheath relative to IAB catheter.

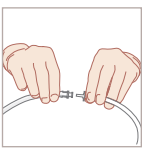
Alarms

Gas Loss in IAB Circuit



Balloon Pressure Waveform: slow rise to baseline





Probable Cause	Corrective Action
A helium loss has been detected in IAB circuit.	If blood observed - STOP pumping. Prepare for removal of IAB.
	If blood is not observed, verify connections are tight.
	If appropriate, perform an Autofill, then press START to resume pumping.

References

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