



Intra-aortic Balloon Pump (IABP)

Troubleshooting Strategies

Learning Objectives



At the conclusion of this program, the participants will be able to:

- Identify two interventions to utilize in troubleshooting the ECG signal
- Identify two interventions to utilize in troubleshooting a poor quality or unobtainable aortic pressure signal
- Identify two interventions to utilize in troubleshooting fiber-optic catheter alarms
- Identify two interventions to utilize in troubleshooting gas loss/gas gain alarms

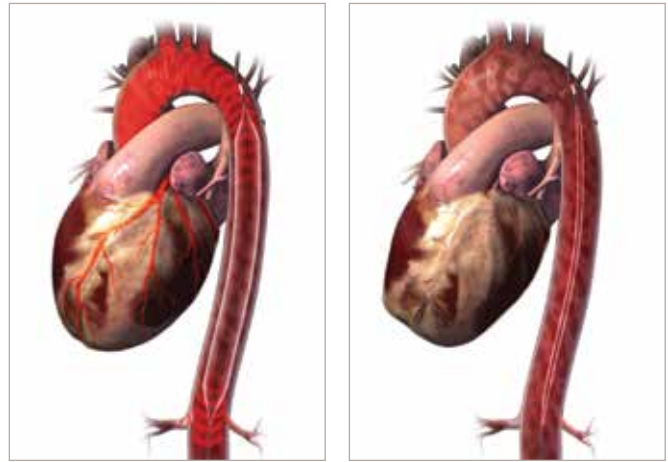
IABP therapy review

Physiologic Principles

- The IAB inflates in diastole*
- Augments diastolic pressure
 - Increases coronary perfusion and mean arterial pressure (MAP)
- The IAB rapidly deflates prior to systole*
- Reduces end diastolic and systolic pressure
 - Decreases LV workload

Inflation: Increases diastolic aortic pressure and augments coronary blood flow*

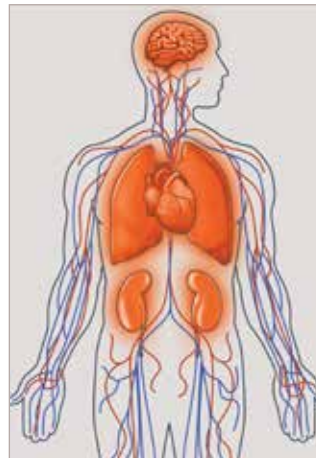
Deflation: Reduces aortic and left ventricular systolic pressure or afterload*



* Kapur N, Paruchuri V, et al. Hemodynamic Effects of Standard Versus Larger-Capacity Intraaortic Balloon Counterpulsation Pumps. *J Invasive Cardiol.* 2015;27(4):182-188.

What are the effects of IABP therapy on the following?^{1,2}

- Coronary perfusion ↑
- Cardiac output ↑
- Heart rate ↓
- PAWP ↓
- SVR ↓
- Systolic BP ↓
- Diastolic pressure with balloon inflation ↑
- End diastolic BP ↓
- MAP ↑
- Systemic perfusion (neurologic, respiratory, renal, vascular) ↑

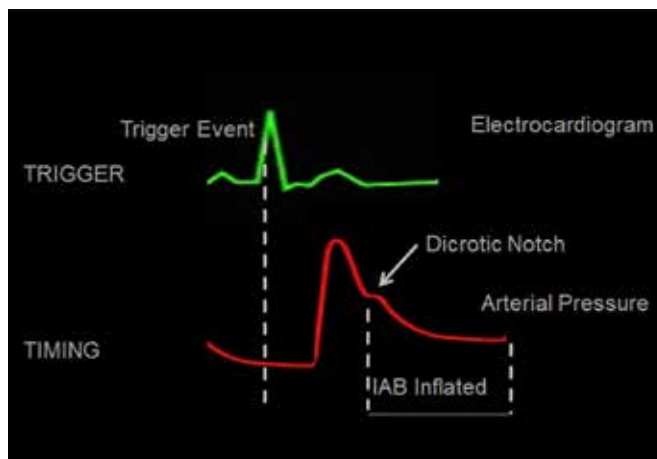


1. Parissis V, Graham S, et al. IABP: History-evolution-pathophysiology-indications: What We Need To Know. *Journal of Cardiothoracic Surgery.* 2016;11:122.

2. Kapur N, Paruchuri V, et al. Hemodynamic Effects of Standard Versus Larger-Capacity Intraaortic Balloon Counterpulsation Pumps. *J Invasive Cardiol.* 2015;27(4):182-188.

Timing – Synchronization with the cardiac cycle

- The IABP is synchronized with the cardiac cycle
- **Timing** – where the IAB is set to inflate and deflate using the arterial waveform*
- **Trigger** – event that signifies the beginning of a cardiac cycle and to deflate the balloon*



* Parissis V, Graham S, et al. IABP: History-evolution-pathophysiology-indications: What We Need To Know. *Journal of Cardiothoracic Surgery*. (2016); 11:122.

Timing – refers to the positioning of inflate and deflate points on the arterial pressure waveform

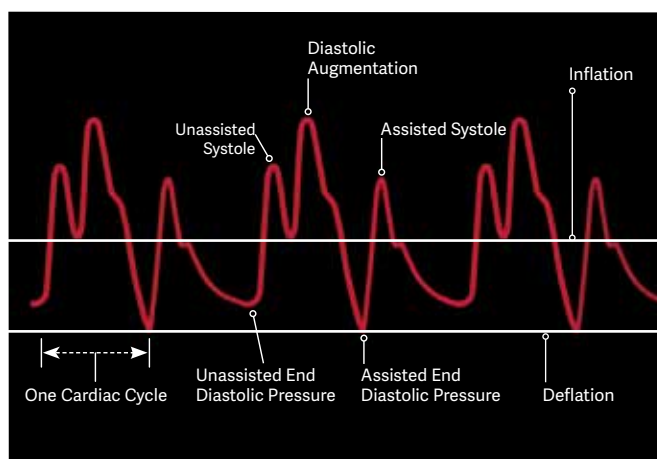
Proper IABP Timing

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

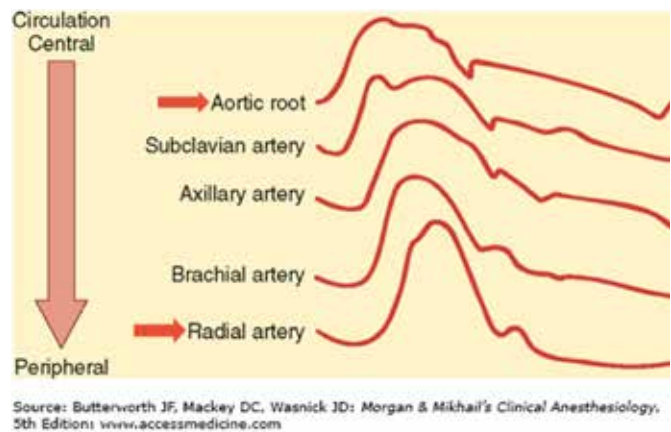


Source: Quaal SJ. Interpreting the arterial pressure waveform in the intra-aortic balloon-pumped patient. *Prog Cardiovasc Nurs*. 2001;16(3):116-118, 125.

Central vs. peripheral pressure

As the arterial pressure wave travels from the central aorta to the periphery changes occur:

- Arterial upstroke becomes steeper
- Systolic peak becomes higher
- Dicrotic notch appears later
- Diastolic wave becomes more prominent
- End-diastolic pressure becomes lower
- When compared with central aortic pressure, peripheral arterial waveforms have higher systolic pressure, lower diastolic pressure, and wider pulse pressure.



Source: Schroeder, RA. Miller R. Miller Anesthesia. 7th ed. Saunders; 2007.

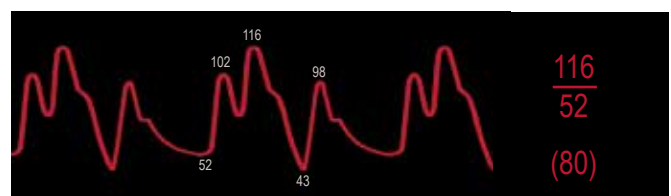
The bedside monitor vs. IABP pressures

- 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
- Not programmed to distinguish between a high pressure point generated by a patient's intrinsic systole or by balloon inflation during diastole

Source: Quaal SJ. Interpreting the arterial pressure waveform in the intra-aortic balloon-pumped patient. *Prog Cardiovasc Nurs.* 2001;16(3):116-118, 125.



Cardiosave IABP Display



Bedside Monitor

Mean arterial pressure – MAP (NIBP vs. IABP)

- Bedside monitor NIBP calculation
 - $MAP = \frac{[(2 \times \text{diastolic}) + \text{systolic}]}{3}$
- IABP assisted arterial mean pressure
 - Augmentation increases mean pressure by increasing pressure and time under the curve
 - The pump samples the BP every 4 msec on the pressure waveform = MAP



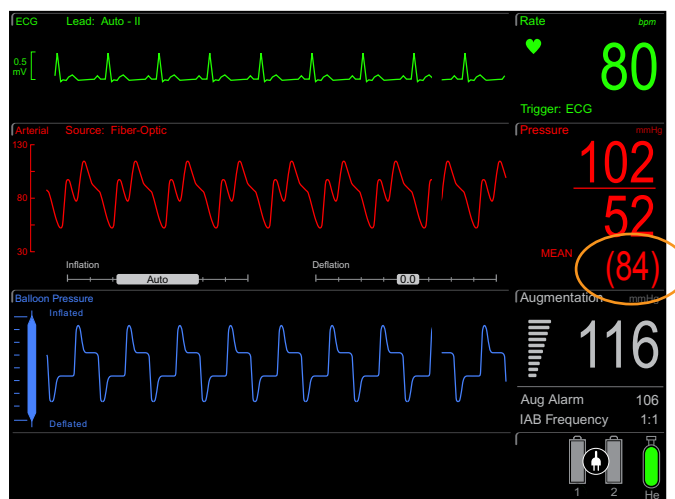
Bedside Monitor

Source: Quaal SJ. Interpreting the arterial pressure waveform in the intra-aortic balloon-pumped patient. *Prog Cardiovasc Nurs.* 2001;16(3):116-118, 125.

Titrating drips during IABP therapy

Consider using MAP as a guideline, not systolic pressure

- Why?
 - IABP therapy lowers systolic and end diastolic pressure, which signifies afterload reduction and decreased MVO₂ demand on the left ventricle



Cardiosave IABP Display

Source: Quaal SJ. Interpreting the arterial pressure waveform in the intra-aortic balloon-pumped patient. *Prog Cardiovasc Nurs.* 2001;16(3):116-118, 125.

Troubleshooting the ECG signal and arterial line

Troubleshooting the ECG signal



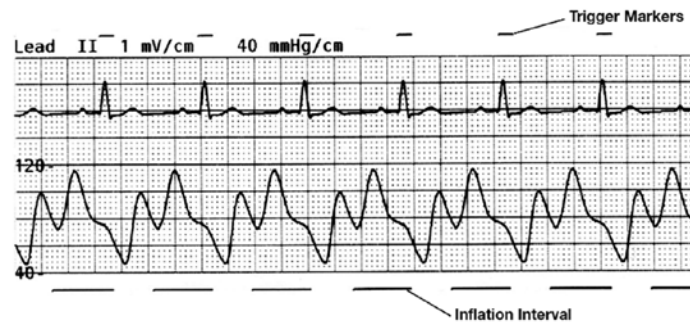
Changed to pressure trigger

Poor quality / unobtainable ECG signal

- Ensure Getinge ECG cable is securely attached to pump and all leads are attached to electrodes
- Change electrodes / reposition to appropriate locations
- Apply doppler gel to center of electrode and place on patient
- If using an interface cable, consider use of direct leads
- Consider changing current set of ECG cables for another set of Getinge cables
- Change to Semi-Auto operation mode to adjust lead
 - Press "ECG/AP sources" button and select lead with best R-wave
- CS300
 - Change to Semi-Auto operation mode
 - Press "Pump Options" button
 - Change gain to "Manual"
 - Increase gain (this will increase the strength of the signal)

Dash lines at the top of the printed strip

- Represents pump recognition of trigger event
- Trigger markers should be directly above R-wave when in the ECG trigger mode
- If not, pump is triggering off another landmark, such as P-wave or T-wave
 - Consider selecting alternate lead where R-wave is more prominent than P-wave or T-wave
 - Consider changing to pressure trigger



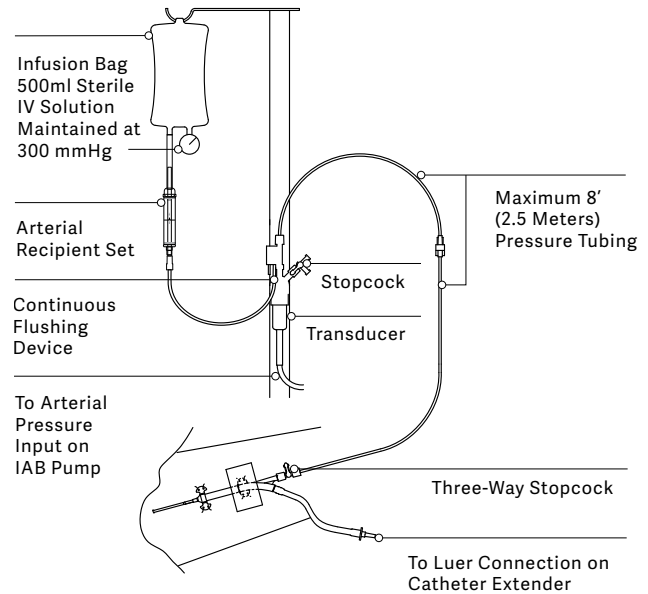
Trigger events

- ECG – Trigger event: R-wave
- Pressure – Trigger event: Systolic upstroke of arterial waveform
- Pacer V/AV – Trigger event: R-wave
- Pacer A – Trigger event: R-wave
- Internal – Trigger event: Asynchronous: balloon inflates / deflates at a set rate of 80 BPM

IAB catheter – Proper care of inner lumen

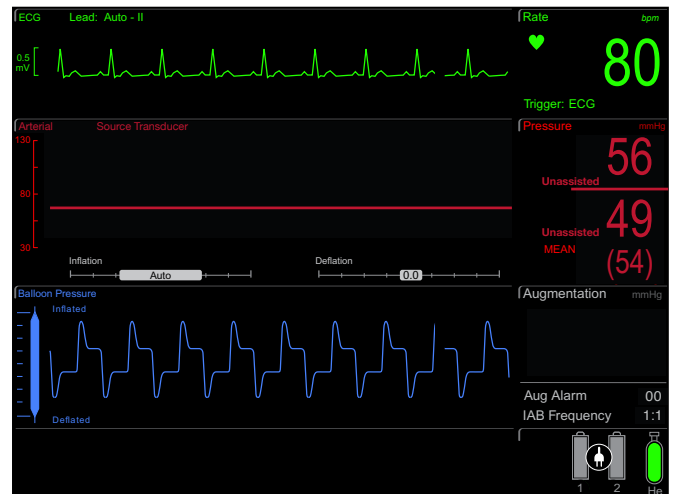
- If inner lumen aortic pressure signal becomes damped:
 - Aspirate and discard 3cc of blood
 - If **able** to aspirate blood, fast flush to clear pressure tubing for at least 15 seconds (with IABP on Standby)
 - If **unable** to aspirate blood, consider inner lumen clotted, cap lumen, provide alternate pressure source
 - **Do not** sample blood from inner lumen

Note: It is recommended that a continuous flush of 3cc/hour be maintained through the inner lumen of all Getinge IAB catheters (conventional and fiber-optic)



Lost arterial pressure waveform

- Check arterial pressure cable connections
- Always aspirate 3 cc initially if inner lumen pressure signal becomes damped
- If resistance met during aspiration, consider inner lumen to be occluded
- Discontinue use of inner lumen by placing luer cap on female luer hub
- An alternative arterial pressure signal, radial artery or external monitor source, is required to establish arterial pressure waveform
- Femoral signal is not recommended



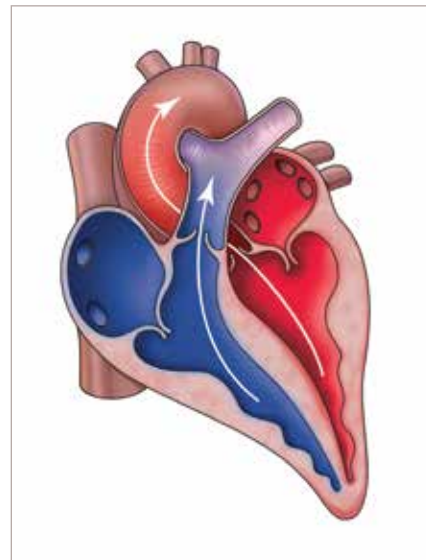
Factors that affect augmentation

Sub-optimal diastolic augmentation



Patient hemodynamics

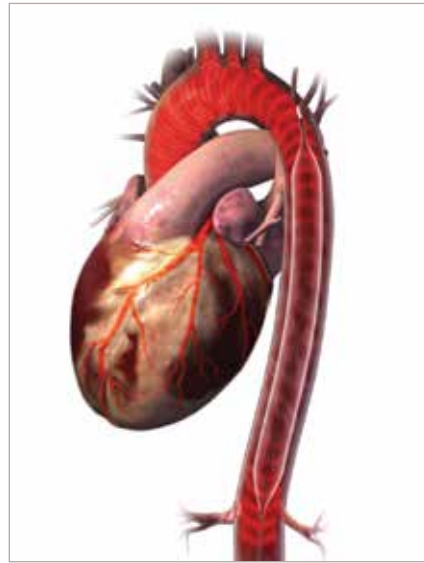
- Heart rate
- Stroke volume
- Mean arterial pressure
- Systemic vascular resistance
- Aortic wall compliance



Source: Parissis H, Graham V, et al. IABP: History-evolution-pathophysiology-indications: What We Need To Know. *J Cardiothorac Surg*. 2016 Aug 4;11(1):122.

IAB catheter

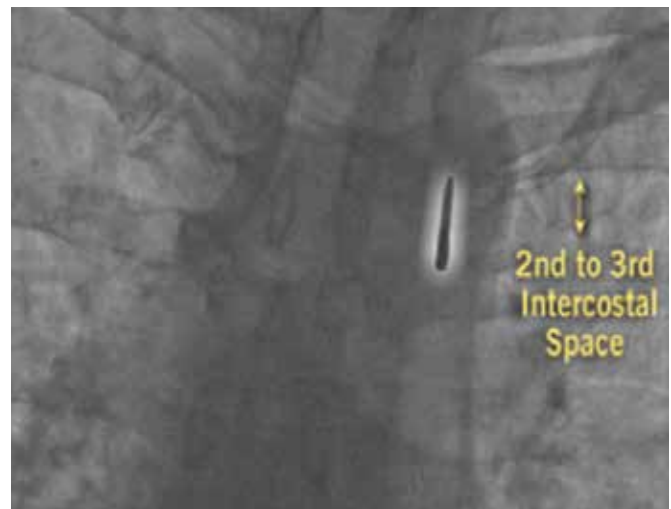
- IAB position
- IAB size
- Kink in IAB catheter
- IAB leak
- Balloon-to-aorta cross-sectional area



Source: Parissis H, Graham V, et al. IABP: History-evolution-pathophysiology-indications: What We Need To Know. *J Cardiothorac Surg*. 2016 Aug 4;11(1):122.

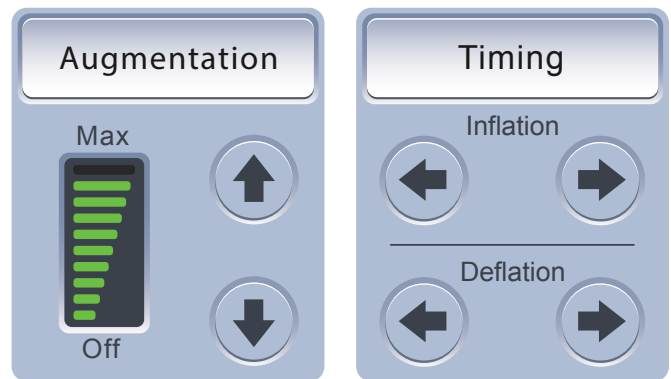
Proper placement of IAB catheter

- Tip of IAB catheter
 - Positioned approximately 1 to 2 cm distal to the left subclavian artery
- Base of balloon
 - Positioned above renal arteries



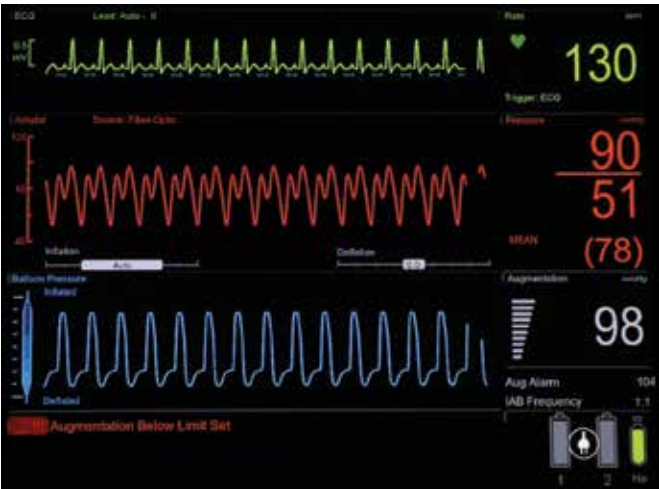
Intra-aortic Balloon Pump

- Timing
 - late inflation
 - early deflation
- Position of the IAB augmentation control

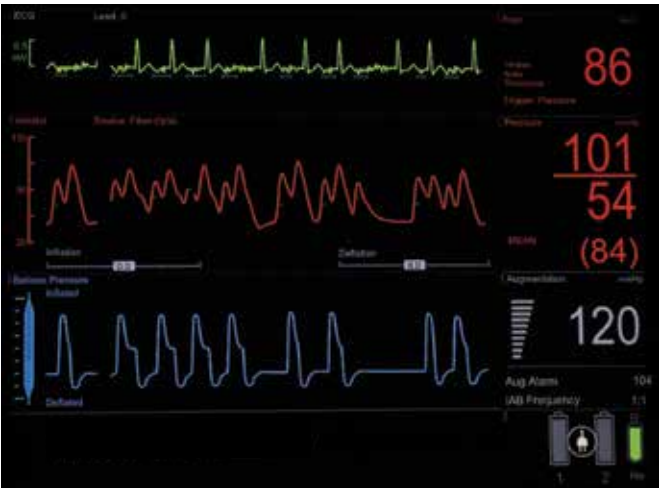


Patient conditions

Sinus tachycardia

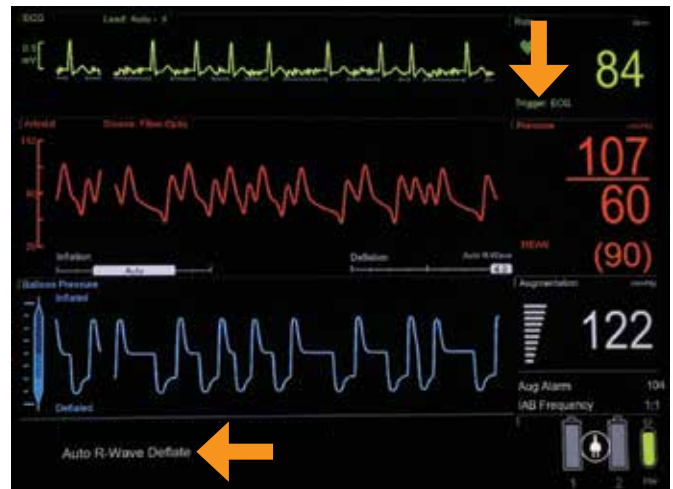
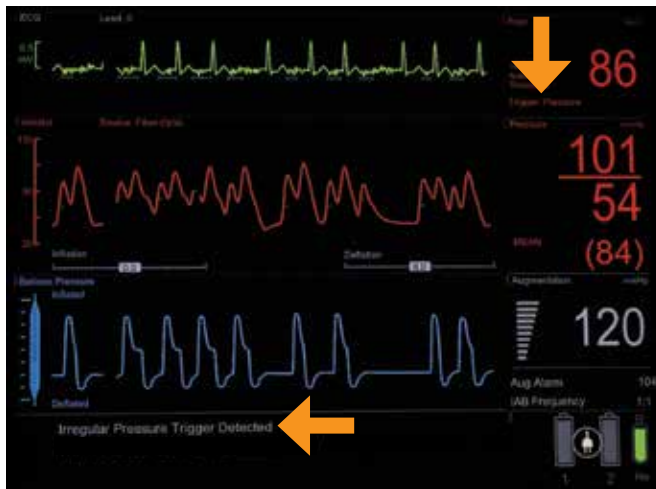


Atrial fibrillation

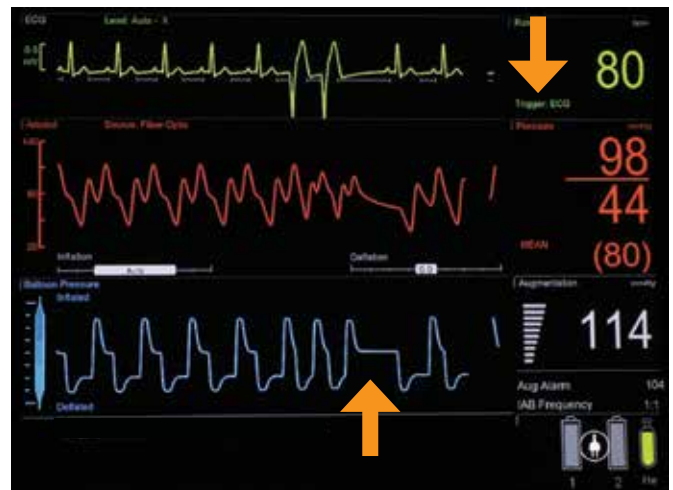
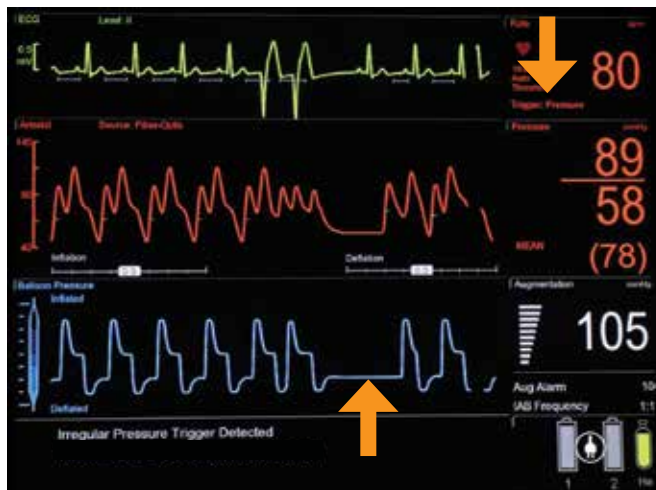


Auto R-wave Deflate

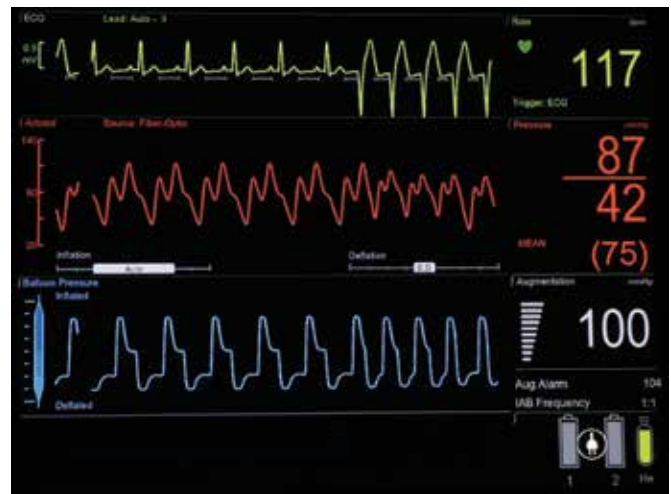
Why is ECG the preferred trigger with an irregular rhythm?



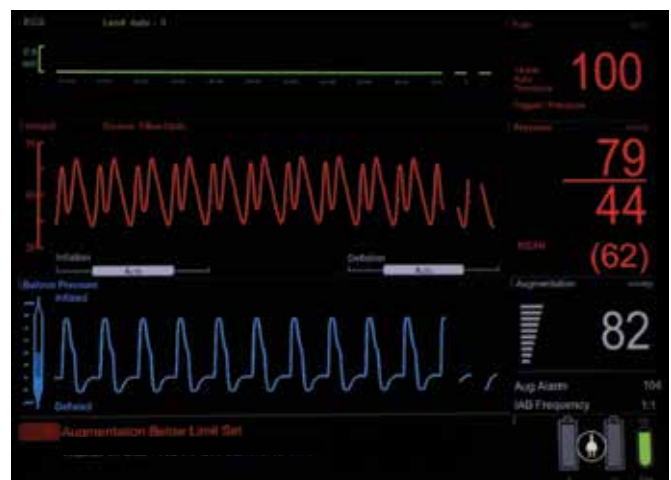
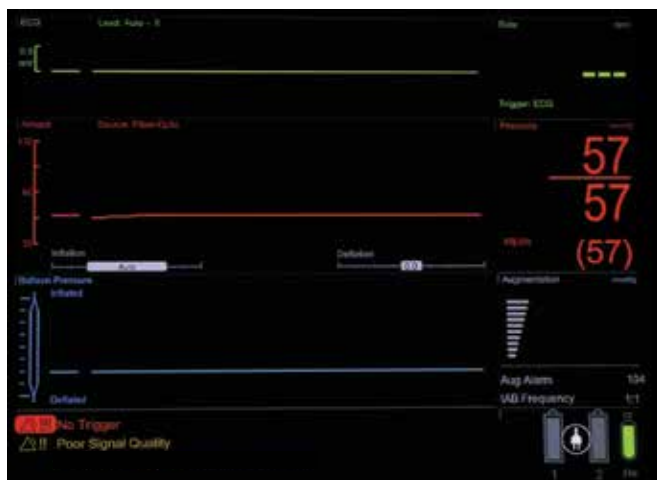
Ectopics



Ventricular tachycardia



CPR

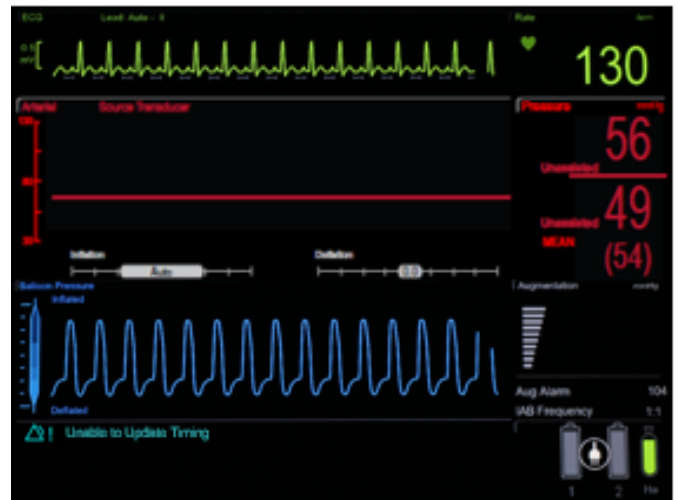


Additional alarms and informational messages

Unable to update timing

Potential causes

- Arterial pressure signal quality is poor, markedly damped or absent
- Pulse pressure unusually low
- HR <30 BPM or HR >150 BPM
- Diastolic augmentation is unusually low



Gas loss in IAB circuit (Cardiosave)

Probable causes

- A helium loss has been detected in IAB circuit

Corrective actions

- Check catheter extender tubing for blood
 - If blood observed, stop pumping, notify physician and prepare for removal of the IAB
 - If no blood present initiate an Autofill and resume pumping
- Check for loose connections
- Patient tachycardia and febrile – treat accordingly
- Perform an autofill more often than scheduled Q 2 hours
- Reposition patient keeping leg straight and/or decrease HOB (if tolerated)
- Confirm proper placement – obtain CXR



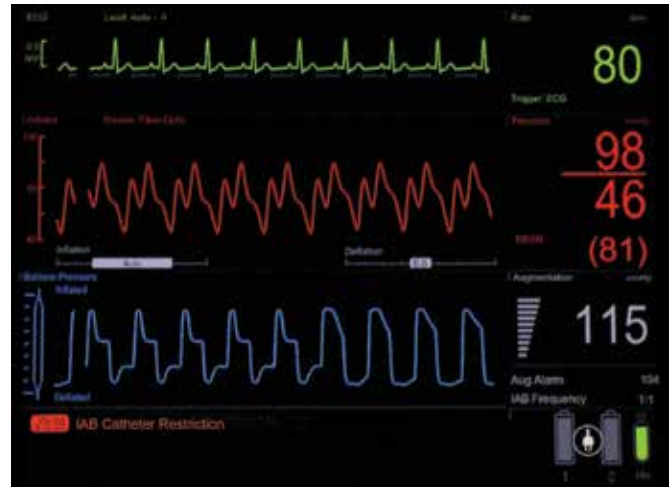
Kink in IAB catheter

Probable causes

- Kink in IAB catheter

Corrective actions

- Check catheter/tubing for visible kinks
- Immobilize affected extremity
- Consider obtaining CXR to check for proper placement



Proper installation of pump console into hospital cart

- You've recently received a newly admitted patient from your hospital transport team
- The Cardiosave IABP being utilized for this patient, is plugged into AC power, yet you see the battery indicators displaying you are on battery power
- What could be the cause for this?



Proper installation of pump console into hospital cart

1



2



3



4

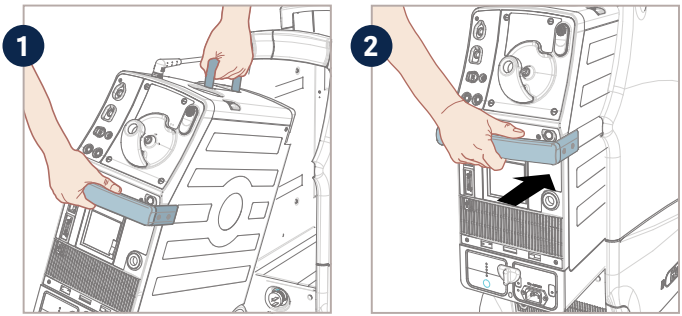


Proper Installation of pump console into hospital cart

1. Grab the handles located on top and front of the console and lift the console into the Hospital Cart
2. Grab the handle and slowly slide the Pump Console into the Hospital Cart until it locks into place

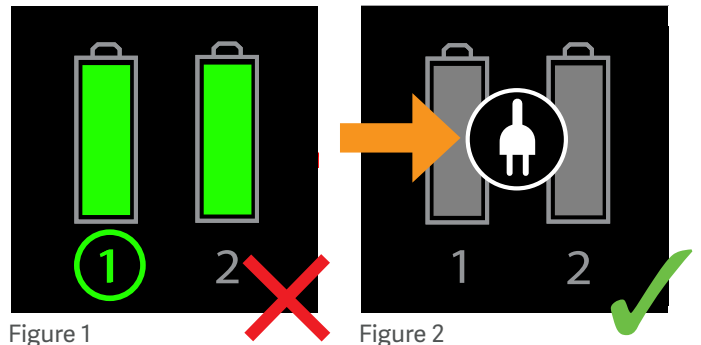
Note: An audible click will be heard when console is locking into cart and 3 audio tones will sound

3. To ensure the Pump Console was successfully installed into the Hospital Cart, plug the Hospital Cart power cord into a compatible grounded AC receptacle, and confirm AC operation by checking that the AC Plug Icon is present in the Battery Icon Display Area



If AC Plug icon is not present after installing console into the cart (Figure 1):

- Release latch on Hospital Cart located below Pump Console
- Grab handle and slowly slide Console out approximately one quarter of the way
- Repeat steps 1 to 3 to ensure Pump Console was successfully installed into Hospital Cart (Figure 2)



Proper Installation of pump console into hospital cart

The Cardiosave Configuration Icon shows the current mode of configuration for the IABP, Hybrid Mode or Rescue Mode.

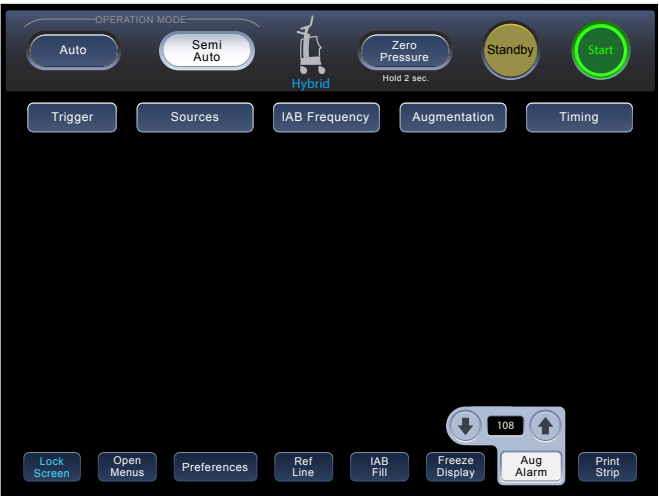
The Cardiosave must be in Hybrid Mode to properly charge the batteries

Hybrid Mode

The Rescue unit is docked into the Hospital Cart



IABP is in Hybrid mode

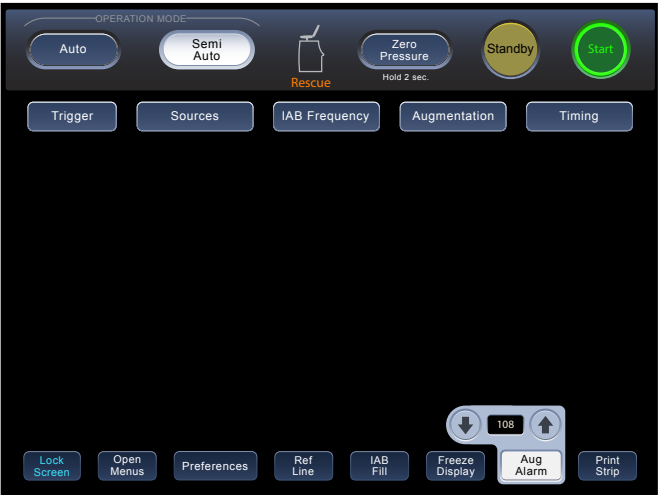


Rescue Mode

The IABP is in Rescue configuration and is not docked into the Hospital Cart



IABP is in Rescue mode

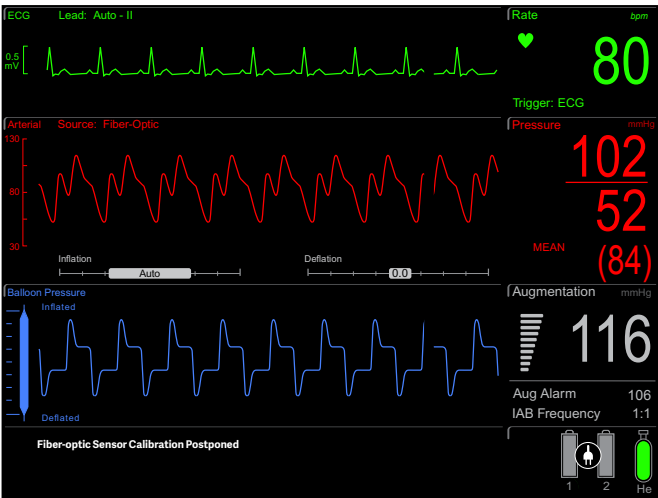


Fiber-optic IAB case studies

Case study 1: Fiber-optic sensor calibration postponed

You walk into the room and see a new informational message on the display screen:

“Fiber-optic Sensor Calibration Postponed”



Probable cause: Fiber-optic sensor calibration postponed

Probable cause	Corrective action
A non-scheduled calibration update has been intentionally postponed because either patient’s mean arterial pressure may be too low to pause assist	Assess patient to determine if a brief pause in assist would be tolerated, and if so, press CALIBRATE PRESSURE key for 2 seconds while IABP is assisting.
OR	
Less than 15 minutes have elapsed since last calibration.	
A non-scheduled calibration has been postponed because the IABP is in STANDBY.	Resume pumping, then press CALIBRATE PRESSURE key for 2 seconds to initiate a calibration.

Case study 2: Fiber-optic sensor failure

Your patient has been restless throughout your shift.

He sits up in bed then lies back down.

The IABP begins to alarm.



Probable cause: Fiber-optic sensor failure

Probable cause	Corrective action
There is a failure in communication of the fiber-optic sensor signal with the IABP.	Firmly grasp the Fiber-Optic Sensor Connector using the raised grips. Remove it from the Fiber-Optic Sensor Input and reinsert until it clicks. Check for visible kinks in the orange Fiber-Optic cable, if found relieve the kink. If problem persists, disconnect Fiber-Optic Sensor Connector and provide alternate A.P. source (i.e. radial).

**For clinical assistance
24-hours/day – 7 days/week:
800 777- 4222**



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