LEARNING MODULE FOR
INTRA-AORTIC BALLOON PUMP (IABP)
(DELEGATED MEDICAL FUNCTION)
(CC 10-030)

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Revised by:   Carol Meade-Corkum, Clinical Nurse Educator

RVS Date:     November 2007
              March 2013

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PURPOSE

Following completion of the learning module the Registered Nurse will demonstrate the ability to care for a patient on Intra-aortic balloon pump (IABP) therapy.

LEARNING OBJECTIVES/METHODS of CERTIFICATION

The nurse must obtain the theoretical background necessary to care for a patient with an IABP through a variety of mechanisms:

1. Perform a review of the theory, clinical application and nursing care of the patient with an IABP by utilizing one of the following references:

2. Completion of an Intra-aortic balloon pumping introductory education session with a health discipline delegate (Registered Nurse/Perfusionist) and/or delegating physician or completion of an education session provided by Arrow International®.

3. Review the Policy and Learning Module with a certified Registered Nurse delegate, perfusionist and/or physician.

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4. Successfully complete (written or verbal) test to demonstrate knowledge of theory under the guidance of either physician or delegate.

5. Prerequisite knowledge of the following is required:
   5.1. Review of the cardiac cycle.
   5.2. Principles of hemodynamic monitoring.
   5.3. Principles of EKG interpretation.
   5.4. Principles of coagulation.

The following content must be reviewed with the learner and the Proficiency Skills Checklists at the end of this module must be completed with the certified delegate or physician prior to the nurse independently caring for a patient with an IABP.

1. State the indications/contraindications for IABP therapy.
2. State the purpose of intra-aortic balloon pump therapy.
3. Describe the sequence of inflation and deflation of the catheter in relation to events of the cardiac cycle.
4. Identify the following landmarks on an arterial pressure waveform with IABP frequency on 1:2 assist.
   4.1. Unassisted systolic pressure
   4.2. Assisted systolic pressure
   4.3. Unassisted aortic end-diastolic pressure
   4.4. Assisted aortic end-diastolic pressure
   4.5. Diastolic augmentation pressure

5. Interpret selected arterial pressure waveform for proper timing of balloon inflation and deflation.

6. Describe the hemodynamic effects of improper timing (early inflation, late inflation, early deflation, and late deflation).

7. Demonstrate and document required assessment and monitoring activities.

8. Describe trouble shooting methods for common IABP alarm situations.

THEORY

In the late 1960’s the IABP was introduced as a mechanical counterpulsation therapy for cardiogenic shock after myocardial infarction to reduce afterload and increase coronary and systemic blood flow. The IABP is the most commonly used cardiac mechanical support device in the critical care environment.
Counterpulsation therapy is based on the following principles:

1. Alternating inflation and deflation causes the aortic pressure to fall rapidly with deflation during systole and rise rapidly with inflation during diastole.
2. Inflation of the balloon in the aorta at the onset of diastole causes retrograde flow of blood toward the aortic valve and coronary arteries, thereby increasing perfusion to the coronaries. Forward displacement of blood below the balloon improves mesenteric, renal and generalized systemic flow.
3. Deflation of the balloon just prior to the onset of systole causes aortic pressure to fall rapidly and blood to move rapidly towards the area occupied by the balloon, thereby decreasing impedance to ejection and left ventricular workload.

The goals of IABP therapy are to:
1. increase coronary artery perfusion
2. decrease afterload
3. decrease left ventricular workload

Current clinical indications for use of IABP therapy have expanded over time to include:

1. Refractory unstable angina
2. Recurrent ventricular dysrhythmias due to ischemia
3. Support for high-risk PTCA patients
4. Failed PTCA
5. Prophylaxis before cardiac surgery
6. Failure to wean from cardiopulmonary bypass
7. Acute left ventricular failure after cardiac surgery
8. Bridge to cardiac transplantation

The intra-aortic balloon is made of biocompatible polyurethane and is mounted on a catheter of the same material. There is a perforation at the balloon-catheter connection which allows pressurized gas to move in and out of the balloon, causing inflation and deflation to occur. Helium is used in the balloon. The balloon catheter is commonly placed in the femoral artery via a sheath or introducer. It can also be placed by direct percutaneous puncture or arteriotomy. Surgical placement via the transthoracic approach may also be used. When properly placed the balloon catheter lies just distal to the left subclavian artery and proximal to the renal and mesenteric arteries. The IAB should ideally occlude 85-90% of the aortic lumen during inflation. Total occlusion of the aortic lumen could result in aortic wall trauma and damage to red blood cells and platelets.

The current IABP technology (AutoCAT® 2 WAVE) offers two different modes of operation: AutoPilot® mode and Operator Mode. The IABP console will select the ECG and AP source, trigger and timing if in AutoPilot® mode. In Operator mode the clinician chooses ECG source and lead, AP source, triggering and timing.
Advances in current IABP therapy include the development of the fiberoptic balloon pump technology. The advantage to the fiberoptic balloon catheter is that it produces a high fidelity waveform that is available to the IABP sooner than the conventional fluid filled AP signal. For irregular rhythms, the pump is able to set the inflation point in real time, even during arrhythmias.

CONTRAINDICATIONS

Absolute contraindications:

1. Moderate to severe aortic insufficiency
2. Dissecting aortic aneurysm

Relative contraindications:

1. End-stage cardiomyopathies unless as a bridge to transplantation
2. End-stage disease states
3. Aortic or thoracic aneurysms
4. Atherosclerosis

Complications related to IABP therapy

1. Vascular related complications: limb ischemia, local vascular injury (hematoma, false aneurysm, bleeding), other vascular injury (arterial or aortic perforation or dissection, compartment syndrome.
2. Balloon related complications: balloon perforation or rupture (can cause gas embolus or balloon entrapment), incorrect positioning (causing renal, left limb or cerebral compromise), improper inflation and deflation timing, thromboembolism.
3. Haematological related complications: destruction of red blood cells and platelets, sepsis

Chapters 3 – 10 of Counterpulsation Applied: An Introduction to Intra-aortic Balloon Pumping produced by Arrow International® must be reviewed for the following topics:

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Learning Objectives</th>
<th>Anatomy and Physiology as Related to Counterpulsation therapy</th>
<th>Myocardial Oxygen balance</th>
<th>Principles of Intra-Aortic Balloon Counterpulsation</th>
<th>Indications for the Intra-Aortic Balloon Pump</th>
<th>Complications of Balloon Pumping</th>
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In addition to the educational materials supplied by Arrow International®, an additional resource is AACN Procedure Manual for Critical Care 6th edition (available in CCU and CVICU) pages 443-463.

TROUBLE-SHOOTING IABP COMMON CONSOLE ALARMS

Certain alarm situations on the console may result with the pump to stop pumping. A message may appear on the console screen to aid in troubleshooting the alarm. Once the situation is corrected, pumping is resumed by pressing the alarm RESET key on the IABP console and then pressing pump ON key. The maximum time limit for a balloon catheter to be dormant is 30 minutes. A balloon catheter that is dormant for 30 minutes or longer must be removed

For further troubleshoot information – please see Appendix A in addition to the resources noted above.

REFERENCES

Counterpulsation Applied: An Introduction to Intra-Aortic Balloon Pumping, October 2005, Arrow International (available from CVICU and CCU Nursing Units and Clinical Nurse Educators CCU and CVICU)


ADDITIONAL RESOURCES:

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Flip cards from Arrow, Recommended IABP Triggers, Timing Guidelines, Balloon Pressure Waveforms (available in CVICU and CCU Nursing Units)

CD ROM Intra-Aortic Balloon Pumping, Arrow International

Teleflex Medical Internet Educational Site: http://www.teleflexlearn.com/
SELF-TEST

1. Benefits of IABP therapy include all of the following:
   a) Decrease in myocardial work, increase in coronary artery perfusion, reduction in preload and afterload.
   b) Increase in myocardial work, increase in coronary artery perfusion, increase in preload and reduction in afterload.
   c) Decrease in myocardial work, decrease in coronary artery perfusion, no change in preload or afterload.
   d) Increase in myocardial work, decrease in coronary artery perfusion, reduction in preload and afterload.

2. The following are indications for IABP EXCEPT:
   a) Cardiogenic shock.
   b) Prophylaxis in high-risk patients.
   c) Aortic aneurysm.
   d) Low cardiac output following bypass surgery.

3. Why is IABP therapy contraindicated in patients with aortic valve insufficiency?
   a) This patient population will become balloon dependent.
   b) Blood in the aortic root will displace to the left ventricle during balloon inflation.
   c) Patients are at a greater risk of aortic dissection due to structural changes in the aortic root.
   d) The rise in aortic pressure during balloon inflation may tear the leaflets of the diseased aortic valve.

4. What clinical finding would lead the nurse to suspect that the balloon catheter is too high in the aorta?
   a) Diminished urinary output.
   b) Diminished left radial pulse.
   c) Diminished bowel sounds.
   d) Balloon catheter tip visualized at the 4th intercostal space on x-ray.
5. What does inflation of the IABP do?
   a) Increase coronary artery perfusion.
   b) Decrease diastolic pressure, reducing preload.
   c) Cause a sudden drop in aortic pressure.
   d) Reduce afterload.

6. Which statement best describes the physiologic effects of IABP deflation?
   a) Increase coronary artery perfusion.
   b) Decreases diastolic pressure.
   c) Reduce preload.
   d) Causes a sudden drop in aortic pressure.

7. Improper timing of early inflation:
   a) Causes premature closure of the aortic valve, impairing left ventricular emptying.
   b) Allows increased runoff of blood into the systemic circulation, decreasing diastolic augmentation.
   c) Allows aortic end-diastolic pressure to rise.
   d) Causes the ventricle to pump against greater aortic pressure, increasing left ventricular workload.

8. Improper timing of early deflation:
   a) Causes premature closure of the aortic valve, impairing left ventricular emptying.
   b) Allows increased runoff of blood into the systemic circulation, decreasing diastolic augmentation.
   c) Allows aortic end-diastolic pressure to rise.
   d) Causes the ventricle to pump against greater aortic pressure, increasing left ventricular workload.

9. Improper timing of late inflation:
   a) Causes premature closure of the aortic valve, impairing left ventricular emptying.
   b) Allows increased runoff of blood into the systemic circulation, decreasing diastolic augmentation.
c) Allows aortic end-diastolic pressure to rise.
d) Causes the ventricle to pump against greater aortic pressure, increasing left ventricular workload.

10. Improper timing of late deflation:

a) Causes premature closure of the aortic valve, impairing left ventricular emptying.
b) Allows increased runoff of blood into the systemic circulation, decreasing diastolic augmentation.
c) Allows aortic end-diastolic pressure to rise.
d) Causes the ventricle to pump against greater aortic pressure, increasing left ventricular workload.
ANSWERS

1. (a) IABP Therapy increases myocardial oxygen supply by increasing coronary artery blood flow during diastole. This is accomplished by the combined effect of the increased aortic root blood volume and augmented diastolic pressure caused by balloon inflation.

IABP Therapy decreases myocardial oxygen demand by decreasing myocardial work. This is accomplished by directly reducing left ventricular afterload and by indirectly reducing left ventricular preload.

2. (c) Indications for IABP Therapy are:
   - Cardiogenic shock
   - Congestive heart failure
   - Pre-infarction angina refractory to medical therapy and ischemic dysrhythmias
   - Low cardiac output syndrome following cardiopulmonary bypass and may be used as an adjunct to ventricular assist devices
   - Stabilisation of acute myocardial infarction patients
   - Prophylactically with high-risk patients during stressful procedures.

3. (b) An incompetent valve allows blood displaced by balloon inflation to regurgitate into the left ventricle, dramatically increasing LVEDV and left ventricular work.

4. (b) If the catheter tip is too high, the balloon may obstruct the opening to the left subclavian artery and compromise left arm perfusion.

5. (a) During IABP Therapy, the increase in aortic volume caused by balloon inflation displaces blood proximally - toward the heart in the aortic root - and distally. As a result, aortic root blood volume increases and more blood is available for coronary perfusion.

6. (d) During IABP Therapy, the decrease in AOEDP caused by balloon deflation allows the aortic valve to open sooner and lowers resistance to left ventricular ejection. Thus, IABP Therapy reduces afterload and enhances ventricular emptying.

7. (a) Early inflation causes augmentation in the aortic pressure to occur prematurely. As aortic pressure rises and exceeds ventricular pressure, the aortic valve closes. Premature closure of the valve shortens the reduced ventricular ejection phase of systole, causing blood to become trapped in the
ventricle. As a result of decreased left ventricular emptying, LVEDV rises increasing pre-load and myocardial work.

8. (c) Early balloon deflation decreases AOEDP so much ahead of systole that AOEDP has time to rise to unassisted levels before isovolumic contraction begins. Although early deflation is not harmful to the ventricle, afterload reduction is early, the isovolumic contraction phase is not shortened and myocardial oxygen demand is not decreased.

9. (b) This delay in inflation permits blood in the aortic root to run off into the systemic circulation so the increase in aortic root blood volume and rise in diastolic perfusion pressure are less pronounced.

10. (d) Because the balloon is still inflated as the ventricle starts to contract, pressure in the aortic root is higher than would normally exist and the ventricle has to overcome greater resistance in order to eject its blood. As a result, afterload is increased, the isovolumic contraction period is lengthened and myocardial oxygen demand increases.
Initiation of IABP Therapy

1. Explain need for IABP to patient and family. Ensure consent obtained by physician. Consider patent sedation after consent to treatment obtained. Page perfusionist to assist in IABP insertion.

2. Maintain aseptic environment.

3. Prepare hemodynamic monitoring equipment.

4. Administer heparin bolus, if prescribed.

5. If the sideport of sheath introducer if it is to be used for arterial pressure monitoring, connect to pressurized saline flush line and attach to transducer and monitor. If not used for arterial monitoring, maintain patency with pressurized saline line.

6. Central lumen of IABP to have a pressurized heparin flush solution (1000u/500cc solution) to maintain patency. Ensure central lumen is not used for blood sampling.

7. Obtain chest x-ray.


Timing of IABP

1. Change the IABP assist ratio to a 1:2 or 1:4 (if required). Print timing strip for patient record.

2. Reassess timing Q12h and/or with any changes in heart rhythm or rate changes of more than 10 beats/minute.

3. Assess and evaluate hemodynamic response for:
   a. Early inflation.
   b. Late inflation.
   c. Early deflation.
Care of the Patient with With an Intra-aortic Balloon Pump CC 10-030 Learning Module

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<tr>
<th>YES</th>
<th>NO</th>
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<tr>
<td>d.</td>
<td>Late deflation.</td>
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<tr>
<td>4.</td>
<td>Document in patient record and flowsheet</td>
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**Standard Care**

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<tbody>
<tr>
<td>1.</td>
<td>Perform cardiovascular, peripheral vascular, and hemodynamic assessment q1h. Check pressurized solutions q1h to maintain patency of lines.</td>
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<tr>
<td>2.</td>
<td>Maintain HOB elevated at 30°</td>
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<tr>
<td>3.</td>
<td>Turn patient every 2 hours and maintain alignment.</td>
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<tr>
<td>4.</td>
<td>Logroll extremity with the IABP catheter.</td>
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<tr>
<td>5.</td>
<td>Perform active or passive range-of-motion exercises every 2 hours.</td>
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<tr>
<td>6.</td>
<td>Assess IAB catheter insertion site q1h for evidence of hematoma or bleeding.</td>
</tr>
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<td>7.</td>
<td>Change the dressing as necessary</td>
</tr>
<tr>
<td>8.</td>
<td>Maintain two means of obtaining EKG tracings.</td>
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<tr>
<td>9.</td>
<td>Obtain coagulation blood samples as ordered.</td>
</tr>
<tr>
<td>10.</td>
<td>Maintain anticoagulation as prescribed (if ordered).</td>
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<tr>
<td>11.</td>
<td>Maintain and titrate vasoactive agents as prescribed.</td>
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**Troubleshooting**

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<tr>
<td>1.</td>
<td>Be able to identify and describe nursing interventions to correct IABP timing for patients developing the following:</td>
</tr>
<tr>
<td>a.</td>
<td>Arterial fibrillation.</td>
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<td>b.</td>
<td>Tachycardia.</td>
</tr>
<tr>
<td>c.</td>
<td>Asystole.</td>
</tr>
<tr>
<td>d.</td>
<td>Ventricular tachycardia and ventricular fibrillation.</td>
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<tr>
<td>e.</td>
<td>Loss of vacuum.</td>
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f. Suspected balloon rupture.

g. Balloon rupture.


### Weaning and IAB Catheter Removal

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<tr>
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<th>YES</th>
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<tr>
<td>1.</td>
<td>Decrease assist ratio as ordered.</td>
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<td>3.</td>
<td>Turn IABP to standby or off.</td>
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<td>4.</td>
<td>Discontinue heparin as ordered.</td>
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<td>5.</td>
<td>Maintain aseptic technique during removal.</td>
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<td>6.</td>
<td>Ensure homeostasis of insertion site.</td>
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<td>7.</td>
<td>Monitor vital signs and hemodynamic parameters.</td>
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<td>8.</td>
<td>Assess perfusion of affected extremity.</td>
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<tr>
<td>9.</td>
<td>Assess insertion site for bleeding or hematoma.</td>
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<td>10.</td>
<td>Apply a pressure dressing to insertion site.</td>
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<td>11.</td>
<td>Maintain leg immobility and bed rest as ordered.</td>
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<td>12.</td>
<td>Continue physical assessments.</td>
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<td>13.</td>
<td>Instruct patient to report any complaints of chest pain, shortness of breath, etc. which may signal deterioration in cardiac function.</td>
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<td>14.</td>
<td>Document in patient record</td>
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## Appendix A

### Quick reference for Troubleshooting IABP (With IABP in AutoPilot® Mode)

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<th>Troubleshoot situation</th>
<th>Intervention</th>
<th>Rationale</th>
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<tr>
<td>Timing errors (inflation and/or deflation) related to poor ECG trigger</td>
<td>1. Change ECG electrodes for IABP to obtain an ECG pattern that the balloon pump can time off of appropriately. (ECG leads can be placed anywhere on the patient’s trunk to obtain good waveform)</td>
<td>The IABP prefers regular rhythms with identifiable R waves. The IABP console prefers to time inflation and deflation to peak or pattern of the ECG waveform in autopilot mode. ECG patterns that have wavering baselines, biphasic QRS complexes or peaked T waves make it difficult for the IABP to determine the appropriate landmarks for inflation and deflation.</td>
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<td>Atrial Fibrillation with rapid ventricular response rate</td>
<td>1. Notify physician to obtain orders for pharmacotherapy to control rate</td>
<td>Diastole is shortened with faster rhythms, resulting in shortened IABP inflation and deflation times. Irregular rhythms also pose timing issues because of the irregular R-R intervals.</td>
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<td>When an irregular cardiac cycle is identified on the AutoCAT® 2 series console, arrhythmia timing is automatically engaged in the AutoPilot mode.</td>
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<td>Cardiac Arrest (Asystole, V Tach and V fib)</td>
<td>1. If a shockable rhythm, defibrillate the patient</td>
<td>IABP will time according to arterial pressure waveform that is a result of compressions. If patient returns to perfusing rhythm, reconnect the ECG cable to the console.</td>
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<td>2. Remove ECG cable from console so the IABP will automatically go to a arterial pressure (AP) trigger source. Start CPR</td>
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<td>High mA with large pacing spikes, causing the IABP to inflate at the wrong time</td>
<td>1. If this is a problem try to turn down your mA or use pressure mode as a trigger. (may need to take the IABP out of autopilot and into operator mode)</td>
<td>Pacing spikes may be misinterpreted by the IABP as R-wave slopes and can result in the IABP inflating at the wrong time.</td>
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<tr>
<td>Erratic triggering (Multiple lead switches within a short time frame)</td>
<td>1. Change ECG electrodes to different locations to obtain a better ECG signal</td>
<td>IABP console scans all available ECG leads on a continuous basis and will select the available trigger modes based on patient condition and signals available.</td>
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<tr>
<td>Troubleshoot situation</td>
<td>Intervention</td>
<td>Rationale</td>
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<td>Low helium in tank - helium supply bar located on lower right hand corner of IABP console screen (helium tank located behind the door on the left hand side of the pump)</td>
<td>1. Open door and release latch. 2. Tilt helium tank and twist helium tank off in a counterclockwise direction. 3. Take cap off new tank and twist on in a clockwise direction. 4. Lower tank back into position and relatch.</td>
<td>Do not interrupt pumping while changing the helium tank. When less than Extra helium tank located in saddlebag attached to balloon pump.</td>
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<tr>
<td>Loss of Trigger ECG</td>
<td>1. Assess patient for cardiac activity 2. Reconnect ECG leads 3. Adjust gain control 4. Change lead select 5. Change trigger source</td>
<td>May be caused by cardiac arrest, ECG leads not connected, ECG gain set wrong or low amplitude R-wave</td>
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<td>Loss of Trigger Arterial Pressure</td>
<td>1. Assess patient 2. Change trigger source to ECG 3. Check arterial line patency</td>
<td>May be caused by dampened or kinked arterial line</td>
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<td>Loss of vacuum or IABP failure</td>
<td>1. Check and tighten connections 2. Check the power source 3. Hand inflate/deflate the balloon every 5 minutes to prevent clot formation along the dormant balloon 4. Change of the IABP console by perfusionist.</td>
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<td>Suspected balloon perforation (coffee ground material in helium line)</td>
<td>1. Observe for loss of augmentation caused by a gradual leak of gas from the IABP 2. Check for blood on the IABP catheter, which indicates the IABP has perforated and arterial blood is mixing with helium 3. If there is evidence of any blood in the IABP catheter, initiate measures for IABP Perforation (see below) 4. Notify physician for IABP removal</td>
<td>Small balloon leaks may be self sealing</td>
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<td>IABP Perforation</td>
<td>1. Place the IABP on standby 2. Clamp the IABP catheter 3. Notify physician and perfusionist on call for prompt IABP removal</td>
<td>Notify the physician because the catheter must be removed and may need to be replaced immediately. If the leak seals itself off the result could be entrapment of the IABP in the vasculature. This may require</td>
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<tr>
<td>Troubleshoot situation</td>
<td>Intervention</td>
<td>Rationale</td>
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Timing Exercises

1. Improper timing __________ Hemodynamic Effect__________

2. Improper timing __________ Hemodynamic Effect__________
3. Improper timing __________ Hemodynamic Effect

4. Improper timing __________ Hemodynamic Effect
5. Improper timing ___________ Hemodynamic Effect ___________

6. Improper timing ___________ Hemodynamic Effect ___________
7. Improper timing  ________________________  Hemodynamic Effect

8. Improper timing  ________________________  Hemodynamic Effect
Answers to Timing Exercises

1. Improper timing – early inflation, early deflation
   Hemodynamic effect: Early inflation causes early closure of the aortic valve causing increased preload and decreased cardiac output. Early deflation results in poor afterload reduction.

2. Improper timing – late inflation, late deflation
   Hemodynamic effect: Late inflation results in very little increase in coronary artery perfusion. Late inflation increases oxygen demands and afterload.

3. Normal waveform – all timing rules met. Inflation and deflation timing are optimal.

4. Improper timing – early inflation, late deflation
   Hemodynamic effect: Early inflation causes early closure of the aortic valve causing increased preload and decreased cardiac output. Late inflation increases oxygen demands and afterload.

5. Patient is in atrial fibrillation – this is probably optimal timing for this patient.

6. Improper timing – early deflation
   Hemodynamic effect: Early deflation results in poor afterload reduction.

7. Improper timing – late inflation
   Hemodynamic effect: Late inflation results in very little increase in coronary artery perfusion.

8. Unable to assess timing – patient is in 1:1 assist ratio.