Air Transport of the IABP Patient

Daniel C. Hatledstad, BA, EMT-I, and Julie Van Horn, RN, BSN, MBA, CCRN

Abstract
The intra-aortic balloon pump (IABP) has evolved into an easily transported, computer-driven device for invasively assisting circulation. This article reviews the use of the IABP during interfacility patient transport by air. Air transport of the IABP-dependent patient creates unique clinical, logistical, and technical challenges. We review the function and clinical application of IABP in various air transport conditions. We also identify the complications of intra-aortic balloon pumping, such as hemorrhage, loss of trigger signals, cardiac arrest, and atmospheric pressure changes, and offer solutions. The effective clinical use of IABP in the air transport environment involves more than familiarity with the device and implications for its use; rapid identification of problems and implementation of solutions are required for successful transport and patient outcomes.

Air medical transport services often move patients requiring hemodynamic support with the use of an intra-aortic balloon pump (IABP). The availability of IABP systems and advances in air transport technology enable flight crews to transport such critically ill patients. Advance preparation and optimal coordination improve the safety and outcome of such a critical care transfer. Currently, the system is used for patients in cardiogenic shock, interventional cardiology, and the medical management of the critically ill patient. Indications for IABP include failure to wean from cardiopulmonary bypass, heart failure, acute myocardial infarction, and high-risk percutaneous coronary intervention (PCI).

The Intra-Aortic Balloon Pump
The IABP is driven by computer-controlled pneumatics. The size and weight of the console have dropped significantly in recent years, as shown in Table 1, because of miniaturized components, expanded use of software for ECG and pressure waveform analysis, and advances in lightweight materials. These reductions in weight and physical size have provided significant benefits for flight crews in managing the logistics of transferring IABP-dependent patients. The operating controls enable the flight crew to manually control IABP operation or allow the IABP to operate on automatic. The pump console includes signal processing hardware and software, as well as timing and control mechanisms for appropriate inflation and deflation.
Table 1.

PHYSICAL CHARACTERISTICS OF BALLOON PUMPS COMMONLY USED IN AIR TRANSPORT

<table>
<thead>
<tr>
<th></th>
<th>Arrow ACAT 1 Plus</th>
<th>Datocalypse 98XT</th>
<th>Arrow AERO 1 Plus</th>
<th>Arrow TransAct</th>
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<tr>
<td>Power requirements</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Average</td>
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<td>300 watts</td>
<td>225 watts</td>
<td>150 watts</td>
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<td>450 watts</td>
<td>420 watts</td>
<td>300 watts</td>
</tr>
<tr>
<td>Battery life</td>
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<td>2.25 hours</td>
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<td>Weight</td>
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<td>40 kg</td>
<td>44 kg</td>
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<td>Height</td>
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<td>129 cm</td>
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</tr>
<tr>
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<td>42.7 cm</td>
<td>34 cm</td>
<td>59.7 cm</td>
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<tr>
<td>Depth</td>
<td>51 cm</td>
<td>56.6 cm</td>
<td>52 cm</td>
<td>22.9 cm</td>
</tr>
</tbody>
</table>

The system also contains a hemodynamic display and diagnostic unit capability. Depending on the unit, the built-in battery allows continuous operation for up to 2.25 hours.

Flight checks may include helium pressure, battery voltage, and, if required by the manufacturer, any leak safety test. The FAA does not certify IABPs or patient monitoring mechanisms unless they are included in the original aircraft design. IABP consoles remain under a FAA Category of cargo that must be in compliance with FAA requirement 135 and certified to handle G-force loads and pull tests. The equipment must tolerate a flight test to check for radio frequency and electromagnetic interference with navigation, communication, or flight control systems. The equipment also is tested for electrical load requirements to avoid overwhelming the aircraft's systems.

Cardiopulmonary Physiology

The heart functions as a mechanical pump within a dynamic vascular system. Contraction of the ventricles propels blood into the systemic or pulmonary circulation, and it is the result of cardiac chamber motion. This coordinated succession of cardiac events must be understood to grasp the interaction of the IABP with cardiac physiology.

The cardiac cycle is divided into two major phases—diastole and systole. Ventricular filling and coronary artery perfusion occur during diastole. The onset of diastole relaxes the myocardium, known as isovolumetric relaxation. This relaxation begins immediately before the dicrotic notch on the arterial pressure waveform. Pressures in the ventricles fall below the pressure in the aorta and pulmonary artery when diastole begins. The higher pressure within the aorta and pulmonary artery causes the semilunar valves to close. This appears as the dicrotic notch on the arterial pressure waveform. During the period of isovolumetric relaxation, the semilunar valves are closed, but the pressures in the ventricles are greater than in the aorta, preventing the mitral and tricuspid valves from opening. The ventricles relax, and volume does not change for a brief period.

As the ventricular pressures fall below atrial pressures, the mitral and tricuspid valves open, rapidly filling the ventricles with blood, known as ventricular filling. The ventricles continue to relax as pressure drops. With ventricular filling, atrial pressures fall, and ventricular pressures and volume increase.

Late in the diastolic phase, the atria are depolarized, followed by atrial contraction. The volume of blood within the ventricles increases with atrial contraction.

In early systole, ventricular filling is complete, and the pressures in the atria and ventricles are approximately equal. At the onset of contraction, ventricular pressures increase, causing closure of the mitral and tricuspid valves in a process known as isovolumetric contraction. The aortic and pulmonary valves remain closed until ventricular pressures exceed the aortic and pulmonary artery pressures. The primary purpose of the isovolumetric contraction period is to develop pressure to forcefully eject ventricular blood.

The opening of the aortic and pulmonary valves signifies the onset of the rapid ventricular ejection phase. The aortic valve opens as ventricular pressure exceeds the aortic end diastolic pressure. Rapid ventricular ejection continues until peak systolic pressure (PSP) is reached. Pressure in the ventricles declines after PSP, and blood continues to flow out of the ventricles at a reduced rate. Systole ends with the onset of myocardial relaxation, and the cycle repeats with aortic valve closure.

Counterpulsation is the term that describes balloon inflation during diastole and deflation during isometric contraction or early systole. Balloon inflation causes volume displacement within the aorta during diastole. Blood volume within the aorta is displaced both proximally and distally, concomitant with balloon inflation. Proximal perfusion to the brain, aortic root, and coronary arteries is improved, as is distal perfusion to the renal arteries and systemic circulation.

Systemic or regional blood flow is improved by balloon inflation and volume displacement of arterial blood. Collateral coronary circulation also is enhanced. Balloon deflation conventionally occurs during isovolumetric contraction, potentially lowering the afterload component of cardiac work.

IABP Transport Rationale

Transportation of patients with IABP has the potential to improve care for the critically ill. However, recent technological advances in cardiopulmonary care are available only at certain medical facilities. This advanced care includes cardiac catheterization with PCI, continuous hemodynamic support provided in a critical care unit, cardiovascular surgery, artifi-
special heart implantation, and heart transplantation. Air transport significantly shortens the time between facilities.

IABP therapy should be considered for use only in patients who have the potential for left ventricular recovery or to support patients who are awaiting cardiac transplantation. Absolute contraindications of IABP are aortic insufficiency and dissecting aortic aneurysm.

The patient who presents at a community hospital with accelerating angina, complications after cardiac catheterization, or myocardial infarction requiring emergency cardiac surgery may require IABP as a lifesaving intervention. All patients must be stabilized before transfer. Appropriate management of hemodynamic instability or respiratory distress should be undertaken before beginning transport.

Clinical Considerations

Air transport of the IABP-dependent patient requires a high level of training and logistical management. The flight crew must be trained in all aspects of IABP operation and system troubleshooting. The flight crew must have experience in a variety of clinical scenarios (catheterization laboratory and critical care unit). The flight crew also must be prepared for unstable hemodynamic conditions, such as those that occur with arrhythmias, pacemakers, severe cardiogenic shock, and cardiac arrest.

Transport personnel should be completely familiar with the function and operation of the IABP console. The crew must be able to handle bleeding at the balloon site and deliver intravenous fluids and medications. Competency in ventilator operation, invasive hemodynamic monitoring, and assessing the impact of flight on the patient’s condition and IABP operation is critical.

Insertion Techniques and Sites

The insertion technique and location may have a significant impact on the logistics of air transport. The primary concerns include:

- Uninterrupted hemodynamic support
- Patient comfort
- Minimal potential for migration within the aorta
- Minimal potential for bleeding at the insertion site
- Impact of the insertion site on placement of the console within the aircraft

The most common insertion site is the femoral artery. Alternate sites include the subclavian, axillary, and brachial arteries. Percutaneous placement of the balloon is accomplished with or without a sheath. Sheathless insertion is recommended for small patients with severe peripheral vascular disease. The sheathless insertion provides more support for the balloon catheter in the artery and reduces kinking. The sheath may include a sideport for aspiration of blood samples and monitoring of arterial blood pressure.

Balloon catheters are available in sizes appropriate for most patients, from 7 to 10 French. Larger catheters increase the potential for limb ischemia. Balloon catheters are available in 30, 40, and 50 mL balloon sizes. Normally, the patient’s height correlates well with the cross-sectional area of the aorta and provides a sizing method for the balloon. Patients ranging in height from 162 cm to 182 cm normally need a 40 mL balloon. Patients shorter than 162 cm should receive a 30 mL balloon. Patients more than 182 cm tall may require the 50 mL balloon. Confirm the balloon and catheter size before responding to the referring facility.

After IABP catheter insertion and counterpulsation initiation, in-flight patient care focuses on assessing the patient’s response to therapies and the transport, monitoring proper titration of vasoactive medications, and confirming proper function of the IABP console and balloon.

IABP Triggering and Timing

To achieve the optimal effect of counterpulsation, inflation and deflation need to be timed correctly to the patient’s cardiac cycle. To accomplish this, the flight crew must provide an ECG signal and an arterial pressure from the patient to the IABP console. The IABP console uses this signal to initiate the pump’s pneumatics and must recognize a signal each time the pump inflates and deflates the balloon. The most common trigger signal is the R wave of the patient’s ECG; however, the IABP can use the patient’s arterial pressure waveform or an intrinsic pump signal. The pump can use signals directly from the patient to the pump or a signal cabled from other transport monitors.

Redundant monitoring of ECG and invasive arterial pressure provides the flight crew with multiple signals for pump triggering. To establish an adequate ECG signal, the flight crew must assess the signal from the skin leads. The lead chosen to monitor should provide the tallest R wave while minimizing the P wave and T waves, and the signal should receive no or little artifact. The quality of the ECG signal may be degraded during transport as a result of motion artifact in the vehicle or aircraft; therefore, it may be necessary for the flight team to change electrode placement and reprep the skin.

Artifact produced in flight may interfere with triggering when the ECG mode is used. In such cases, the arterial pressure waveform may be used for triggering. Pressure trigger is suitable if the ECG is temporarily lost, excessive artifact exists, or the patient has no organized cardiac function and is receiving chest compressions. When using the arterial pressure waveform for triggering, the IABP console can identify very small pulse pressures. The flight crew may need to adjust the pressure threshold to ensure that the pump recognizes systolic events.

IABP consoles also can use patient pacemaker spikes for triggers. When triggering from the paced spikes, the pump ignores the patient’s intrinsic beats and operate only with paced impulses. The paced trigger mode is preferable only when crew members know the patient is 100% paced. If the patient has a demand pacemaker, the ECG trigger will work well. In this mode, the pump uses the R wave from either the patient’s intrinsic beat or the paced beat.

Although the ECG is the main signal used for triggering, the arterial pressure waveform must be used to “time” the inflation and deflation, as shown in Figure 1. The optimal effects of counterpulsation are achieved when the balloon inflates at the beginning of diastole and deflation occurs just before full systole. Ideally, the deflation will be set to occur during the isovolumetric contraction phase of systole. Nor-
ental balloon inflation is set to occur at the dicrotic notch on the arterial waveform that represents diastole start. Deflation is set to occur just before the next arterial upstroke that represents rapid ventricular ejection during systole.

It may be necessary for the flight crew to troubleshoot the arterial pressure waveform to ensure that the pump has an adequate signal to adjust timing. Generally, the central lumen of the balloon catheter provides the arterial waveform that the pump uses for timing. The central lumen will be connected to a pressurized continuous flow device. The transducer is maintained at the phlebotastic axis of the patient and must not be used for blood sampling. Crewmembers should position the transducer tubing so that movement and artifact generated on the arterial waveform will be minimized. If the waveform becomes dampened, the central lumen may be flushed using the transducer’s fast flush device. Manually flushing the central lumen with a syringe is not recommended because the pressures may cause bradycardia and vasodilatation.

The arterial pressure waveform and blood pressure values (assisted and unassisted BP, augmented pressure, and mean arterial pressure) are displayed on the IABP console monitor for easy assessment, as shown in Figure 2. Most IABP consoles enable the flight crew to adjust the inflation and deflation manually, and once the timing is adjusted, the consoles will self-adjust for changes in heart rate.

**Preparation for Air Transport of the IABP Patient**

Weight and physical size are critical constraints in air transport operations. The flight crew and mechanics must confirm and approve the weight of the IABP and all required supplies before the actual transport. Along with these considerations, the flight crew needs to determine the appropriate physical placement and method for securing the IABP in the aircraft. Alternate insertion sites of the balloon catheter may alter the position for the IABP console relative to the patient.

Power for the IABP console and all equipment, monitors, intravenous pumps, and ventilators used during flight are a concern, especially in prolonged transport situations. Current IABP consoles have a 2- to 2.25-hour battery life at full charge. The flight crew will use the battery during transfer in and out of the facilities and between units. During flight, the crew will connect the IABP console to the on-board inverter. The crew will need to assess the power consumption of all equipment connected to the inverter to avoid overloading the system.

**Air Transport of the IABP Patient**

Communication is the primary tool in preparing transport of the IABP patient. This communication lays the groundwork for a successful and problem-free transfer of patient care from the referring facility through the flight and into the receiving facility. Communication between the critical care staff at both facilities and the flight crew must include the standard information regarding the patient’s condition, current therapies, and reason for transport. In addition to this customary information, the referring facility should provide the following details:

- The patient’s medical record
- Consent for transport
- Confirming placement of catheter on chest radiograph
- Patient height and weight
- IABP insertion site
- Catheter and balloon size
- Console and balloon manufacturer

The air transport team must confirm which facility is re-
Figure 2. Arterial Pressure Waveform and Blood Pressure Values
To evaluate inflation and deflation timing, the physical characteristics of the unassisted and assisted arterial pressure waveform must be assessed. The balloon is timed to inflate at the dicrotic notch (DN) of the augmented beat, resulting in elevated pressure during diastole known as peak diastolic pressure (PDP). Deflation is adjusted so the balloon-assisted end diastolic pressure (BAEDP) is lower than the patient’s aortic end diastolic pressure (PAEDP), and the assisted peak systolic pressure (APSP) is lower than the augmented beat’s peak systolic pressure (PSP).

Responsibility for providing the IABP for transport. If the referring facility provides the system, the flight crew must confirm that the unit meets weight, size, power, and mounting restrictions. The flight crew may also be required to make arrangements to return it to the referring facility.

If the flight crew provides the IABP console for transport, a different set of conditions exist. The crew must confirm all the information related to the balloon before departure to make modifications to the connectors between the pump and balloon. The crew’s IABP kit should include connectors for the various IABP consoles.

To ensure a safe and optimal transport, institutions and transport teams should develop specific policies, procedures, and preparations for patients supported on IABPs. The policies should be developed in accordance with the institution’s policies and practices and those standards identified by critical care and flight nursing organizations. Policies should include the type of personnel and training required to manage these types of patients. Protocols for managing every possible emergency also must be identified within these policies and procedures.

Transport Care
The flight crew must continually assess the patient’s response to the transport situation. Limited access to the patient during transport presents challenges for assessment. Positioning the patient on the transport cart using a centerfold blanket covering will provide easier access. Positioning the patient supine reduces the efficiency of the respiratory muscles and increases the potential for respiratory compromise. To minimize this effect with a femorally inserted IAB, elevate the head of the cart 15 to 30 degrees.

Objective evidence of the patient’s tolerance to air transport is obtained by comparing hemodynamics and vital signs with pretransport baseline values. Documenting the patient’s status can help the flight crew recognize problems and rapidly solve them during flight. Hemodynamics and vital signs for documentation include heart rate, assisted blood pressures, augmentation pressure, and mean arterial pressure. If the patient is on a 1:2 assist ratio, the unassisted blood pressure also may be recorded.

IABP patients also may have other invasive monitoring lines in place to provide additional monitoring and assessment parameters, such as central venous, pulmonary systolic, diastolic, and mean pressure. The respiratory status can be monitored and documented by the respiratory rate, SpO2, and EtCO2. Vital signs should be documented within the time frames required by the crew’s policies and procedures.

Crew members should assess and document the patient’s ECG rhythm, urinary output, and peripheral perfusion. Serious dysrhythmias must be managed immediately. Given the severe reduction in stroke volume during dysrhythmias, the IABP may not be able to provide optimal support, and the patient’s condition may deteriorate. Urinary output should be monitored for both fluctuations in cardiac output and inferior migration of the balloon to a position that occludes the renal arteries. Periodic assessment and documentation of the left radial artery pulses should be performed as an indicator of potential superior migration of the balloon. Using a specific IABP flow sheet for documentation will ensure that all pertinent information is recorded.

In addition to objective assessments during transport, the flight crew also should evaluate the patient’s subjective interpretation of comfort, pain, shortness of breath, and sensa-
tions of anxiety or fatigue. Counterpulsation therapy simultaneously increases coronary blood flow and reduces left ventricular stroke work that reduces ischemia processes, relieves pump failure, and stabilizes the cardiac patient. However, in the severely hemodynamically compromised patient, the IABP may not prevent further decline in heart function. If the patient reports increased chest pain, severe shortness of breath, or signs of cardiovascular collapse, the flight crew needs to intervene immediately.

**Troubleshooting and Managing Complications during Flight**

Although counterpulsation therapy generally stabilizes the patient's condition during transport and modern IABP consoles require minimal operator intervention, the flight crew must be aware of potential troubleshooting concerns and complications.

- **Hemodynamic changes as a result of patient position.** The patient may experience a decrease in preload, with a drop in arterial pressure, during ascent when the head of the cart is toward the pilot. It may be necessary to increase fluid infusion and vasopressors. During descent, the patient may experience an increase in preload and present with signs of fluid overload. This redistribution of volume toward the heart may produce bradycardia. Crewmembers must compensate for fluid overload by providing oxygen and slowing intravenous infusions. Diuretics may be needed for severe cases. It may be necessary to institute measures to control the heart rate if the rate does not support adequate cardiac output. These conditions will be reversed if the patient's head is positioned away from the pilot.

- **Poor augmentation by the balloon.** During balloon inflation, the pressure generated during diastole will exceed systolic pressure. When the diastolic pressure is lower than the patient's systolic pressure, augmentation is less than optimal. Several clinical situations may produce suboptimal augmentation. The patient's stroke volume may be greater than the balloon volume. In this situation, the balloon may be used prophylactically and does not provide extensive hemodynamic support. The flight crew must confirm optimal timing to provide the best support.

  A second condition occurs when the balloon does not occlude 85% to 90% of the aorta's cross-section. The balloon is either too small for the patient, or the patient is vasodilating. The flight crew should compare the size of the balloon with the patient's height before transport and use vasopressors as required.

  A third condition is balloon migration. The flight crew must check the chest x-ray film before transport and reposition the balloon as necessary. During transport, the crew can assess the left radial pulse and urine output. Repositioning the balloon during transport is not recommended; instead, the crew should notify the receiving facility of the situation for intervention on arrival.

- **Poor ECG signal.** ECG signal problems may be related to artifact, signal strength, and pacing. The IABP console requires a clear ECG signal for triggering in ECG mode. If the signal is inadequate to trigger the IABP, crewmembers are advised to use arterial pressure triggering. If possible, they should resolve ECG signal issues after switching and confirming proper function of the IABP in pressure mode and subsequently return to ECG trigger mode.

- **Limb ischemia.** The most common vascular complication related to IABP therapy is limb ischemia. The flight crew must diligently assess peripheral perfusion before transport and continue assessing for signs and symptoms of ischemia during flight. Passive and active measures for warming the extremities during transport may minimize peripheral vasoconstriction. Vasoactive drugs should be kept at the lowest infusion rate possible to reduce the effects of vasoconstriction. Nitroglycerine paste applied to the affected extremity may dilate the superficial blood vessels to aid in limb perfusion. Crewmembers should maintain an adequate fluid volume status to avoid vasoconstriction.

  **Bleeding at the insertion site.** Bleeding may occur more often during air transport because of patient movement. Critically ill cardiac patients may also be receiving anticoagulants or fibrinolytic therapy. The patient should be positioned for access to the groin site for assessment and interventions. The minimal amount of direct pressure required to control bleeding should be used, avoiding extreme pressure because it may restrict the flow of helium through the catheter and generate pump alarms. Use of a knee splint or immobilizer during transport stabilizes the groin site during transport.

  **Balloon migration.** The IAB is positioned with the distal tip 1 to 2 cm below the left subclavian. Transfer of the patient from the critical care bed to the transport cart, movement of the patient and the aircraft during flight, and the impact of therapies initiated during flight increase the risk of catheter migration. The flight crew should check the chest x-ray film for position before transport. The tip of the balloon will be noted at the level of the second to third intercostal space. If the balloon is out of position, it should be repositioned before transport. Crewmembers must confirm the stability of sutures securing the catheter and tape the catheter as needed to prevent migration during flight. If the balloon migrates inferiorly during flight, the crew should not attempt to remove the balloon; instead, they should check the distal pulses for perfusion, decrease the balloon volume to prevent damage to the aorta, use the high pressure alarms, and notify the receiving facility of the need for immediate removal or repositioning of the catheter on arrival.

  **Balloon abrasion.** Although balloon leaks are not welcomed in a hospital environment, they become more of a concern at altitude. During transport, IABP consoles should always have the gas surveillance alarms activated. Operating the consoles with the gas surveillance alarms disabled increases the risk for helium migration through the balloon membrane into the patient's arterial bloodstream if an abrasion occurs during flight. With the gas surveillance alarms activated, the pump automatically terminates counterpulsation, evacuates the helium from the balloon and the system, and alerts the operator if it detects a leak. The alarm will read "helium loss" or "gas loss." The flight crew should immediately assess the balloon catheter tubing for signs of blood. If there are any, the crew should leave the pump off,
clamp the catheter tubing, and notify the receiving facility to prepare for balloon removal. At this point, the flight crew must support the patient's hemodynamics with pharmacologic support.

**Cardiac arrest.** In the event of a cardiac arrest during flight, the crew should immediately institute ACLS protocols. If the patient is in pulseless ventricular tachycardia, the IABP may continue to trigger from the R wave of the QRS and pump. Immediate defibrillation is required. The IABP is grounded and does not require disconnection during defibrillation. If the patient develops ventricular fibrillation or asystole, the IABP console will display “no trigger” and terminate counterpulsation. Chest compressions should generate an arterial pressure waveform capable of acting as a trigger.

Crewmembers should place the IABP in arterial pressure trigger mode and initiate counterpulsation. The pump inflates and deflates with the chest compressions. If compressions are unable to generate an adequate pressure waveform to trigger the pump, the crew should initiate the “internal trigger” on the IABP. The pump will inflate and deflate the balloon at a rate of 80 beats per minute. This movement reduces the potential for clot formation on the balloon.

**Altitude changes that affect IABP operation.** In the air transport environment, changes in barometric pressure and temperature and patient movement can rapidly affect the patient’s condition. Of these environmental changes, one in particular generates equipment considerations. Standard atmospheric pressure is 760 mmHg. As an increase in altitude occurs, the atmospheric pressure drops, allowing the gas molecules in the balloon to expand (Boyle’s Law). During ascent, the volume in the IAB will increase. The IABP console will monitor this expansion on helium in the balloon and, in many cases, automatically adjust. These automatic adjustments occur at each 1000-foot gain in altitude during ascent and 2000-foot decline in altitude. If the ascent is too rapid, the IAB pump may not be able to adjust for this change and the alarms “high baseline” or “fill pressure” will occur, terminating counterpulsation.

Crewmembers should press the “pump status on” so that the pump will automatically adjust for altitude. During descent, the volume in the IAB will decrease. Again, with gradual descent, the console adjusts automatically. With rapid descent, the pump alarm “helium loss” or “gas loss” may occur and terminate counterpulsation. Reinitiate counterpulsation by pressing the “pump status on.”

**IABP console malfunction.** Pump failure during flight requires the flight crew to institute manual inflation and deflation of the balloon. The maximum idle for a balloon in the aorta is 30 minutes. Clot formation on the idle balloon may lead to a “showering” of emboli when pumping starts again. Manually inflating and deflating the balloon requires a 60 mL syringe. Before manually inflating the balloon, the operator will attach the syringe to the gas line connection and aspirate the balloon.

Crewmembers should discontinue the manual procedure with any signs of blood in the catheter and clamp the catheter. If the catheter is clear, the crewmember should disconnect the syringe from the tubing, pull the plunger back to the size of the balloon volume (30, 40, or 50 mL), reconnect the syringe to the tubing, and rapidly inflate and deflate a couple of times every 5 minutes. This manual inflation exercises the balloon to prevent thrombus formation. The flight crew also will need to assess and support the patient’s hemodynamic status and notify the receiving facility to have a pump console available on arrival.

**Conclusion**

Air transport has distinct advantages for critically ill IABP patients. A well-trained and prepared flight team will be able to quickly assess and institute appropriate interventions for the patient’s needs, troubleshoot and manage possible complications, and successfully transport the IABP patient.

**References**