CLINICAL REPORT

Updated Transport Considerations for IABP Patients

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PRIOR TO TRANSPORT
1. Notify the Transport Company that you will be transporting an IABP patient.
   • Inform them of all equipment attached to patient: e.g., ventilator, infusion pumps, drips infusing, invasive lines – pulmonary artery catheter, CVP, arterial line, NG, Foley.
   • Verify that the transport vehicle is large enough to accommodate all equipment.
   • Verify that the transport vehicle is equipped with an inverter to supply power to IABP.
   • Inform them of any additional personnel that will be going with patient on transport. The Transport Company may need to make arrangements for appropriately trained personnel for transport.
   • Inform them of the need to return to sending facility with equipment or personnel.

2. Confirm that bed at accepting facility is ready.
   • Notify receiving unit about transport and provide a report about the patient’s status and condition. Include physical assessment, vital signs, drugs infusing and given, all tests and treatments completed.
   • Include information about IABP status and response to IABP therapy. Provide why the patient has the IAB; how long the IAB has been in; French size and balloon volume of the IAB; the insertion site, if the insertion was sheathed or sheathless; condition of insertion site (hematoma, discoloration, status of dressing, etc.); assist ratio.
   • Inform receiving unit of needed equipment on patient’s arrival.
   • Confirm accepting physician’s name at receiving facility.

3. Determine what IABP the receiving facility uses. If it is not an Arrow® IABP, be sure to take appropriate adapters to interface the patient’s IAB to receiving IABP.

4. Have an IABP Transport Bag with the following suggested items:
   • 60 cc Slip-Tip Syringe
   • Appropriate IAB/IABP Adapters
   • Scissors and Kelly or Tube Clamps
   • ECG Patches
   • Extra Helium Tank
   • ECG and Arterial Pressure Cables
   • IABP Flow Sheet
   • Operator’s Manual

5. Check IABP battery to assure that it’s fully charged.
   • The AutoCAT® 2 and AutoCAT 2 WAVE® IABPs each have a 90 minute battery.
   • The AutoCAT 2 and AutoCAT 2 WAVE IABPs each can be fitted with a secondary battery for a total of up to 3 hours of battery life (under ordinary usage and conditions).

6. Verify adequate helium supply.
   • Consider changing to full tank prior to transfer if necessary.
   • Obtain an additional helium tank for transport.
   • Consider need for additional gas line tubing to aid in positioning IABP in transport vehicle.
7. Verify clean ECG skin and AP transducer signals on IABP screen.
   - Complete a skin prep and change electrodes if necessary.
   - Tape skin electrodes to ensure they are intact. Designate “IABP”.
   - Consider additional pressure tubing to use with transducer system to aid in positioning IABP in transport vehicle.

8. Complete all necessary consent forms for transfer.

9. Gather and copy all necessary patient chart forms for receiving facility.
   - Patient Admission Information
   - History and Physical
   - Progress Notes
   - Nursing Notes
   - Medication Records
   - Reports from Labs, 12 Lead ECGs and Diagnostic Tests
   - Chest X-Ray documenting positioning of IAB
   - Discharge Summary

10. Verify that balloon catheter is secured.
    - Check supercatheter is sutured or securely taped in place.
    - Consider utilizing knee immobilizer or splint to stabilize catheter and prevent kinking.

11. Know the route you will be taking to exit the hospital.
    - Be sure the elevator and hallways are large enough to accommodate all the equipment.
    - Gather enough personnel to assist with transport.
    - Consider performing a mock transport of IAB patients periodically to identify hidden obstacles.
    - For accrediting body review, be sure to document periodic mock transports performed.

12. Transport personnel should check the following prior to transporting patient:
    - Complete physical assessment and hemodynamic profile.
    - Assess patient’s rhythm.
    - Verify status of infusions and establish an IV site for emergency drugs.
    - Verify appropriate timing of inflation and deflation on arterial pressure waveform.
    - Verify IABP pump settings, especially trigger, balloon volume, and assist ratio.
    - Verify position of IAB tip on chest X-Ray, if available. The tip should be located at the second to third intercostal space.
    - Check for recent cath lab or progress note to confirm placement.
    - Obtain CD of digital film for comparison at receiving facility.
    - Assess peripheral pedal pulses and perfusion of limb with IAB catheter along with left radial or brachial pulse, and groin site.
    - Assess patient’s dependence on IABP support. This will impact how long they can be disconnected.
    - Check pump connection sites to make sure they are secure. May need to tape connection sites to prevent them from coming disconnected due to vibration or pulling.

IABP patient transports may be infrequent and team members may not always feel confident in preparing for the transport and management of these patients. Therefore, utilizing a checklist can be helpful to assure that all pertinent information and equipment needed for the transport has been addressed. A sample checklist can be found at the end of this report.

**DURING TRANSPORT**

1. Assist with positioning patient in transport vehicle.
   - It may be necessary to disconnect patient briefly from pump in order to get patient and equipment into vehicle. Lift pump using the appropriate handles.
   - Additional gas line tubing and arterial pressure tubing may be required to position patient and pump in vehicle.
   - Make sure that transport personnel can easily assess groin site, balloon catheter tubing and lines.

2. Properly secure the IABP in vehicle.
   - Straps or mounting brackets may be required.
     - An Arrow pump sled is available that connects to the brown line of the aircraft to secure the AutoCAT® 2 IABPs.
     - Lock wheels.
     - Verify access to pump in order to view screen, check connections and change helium if necessary.
     - Remove control head, if appropriate, for easier assessment of patient status and pump alarms.
     - Connect IABP power cord to vehicle inverter for power.
   - Check power requirements for the pump console. Identify requirements during power up and running power requirements.

**AutoCAT 2 and AutoCAT 2 WAVE® IABPs: Start-up = 420 Watts Average = 225 Watts**

3. Patient assessment during transport.
   - Assess and document vital signs including BP, HR, PS, PDP, EDP, MAP per protocol.
   - Assess arterial pressure waveform for timing and optimal diastolic augmentation.
   - Assess patient with regard to rhythm, urine output and peripheral perfusion to determine the degree of stability.
   - Periodic documentation of symmetry of radial pulses should be done as an indicator that the balloon has not advanced superiorly. Urine output is monitored for decreases that are not related to decreased cardiac output. This may alert personnel that the balloon may have been moved downward in the aorta and has occluded the renal arteries.
   - Utilize an IAB Flow Sheet to assure that all pertinent information is documented.

4. Nursing Considerations.
   - Redundant monitoring of ECG and arterial pressure provides multiple signals as balloon triggering options in case one monitoring signal is disengaged or there is equipment malfunction.
     - Provide direct patient signals and from another transport monitor into the pump if possible.
   - Arrange blankets and bedding so there is easy access to the patient.
     - Use a central opening.
     - Provide access to invasive line insertion sites and to be able to perform emergency procedures.
     - Use arterial pressure waveform as backup trigger signal.
   - Use pulse oximetry for O2 sat assessment. If the pulse oximeter can display a waveform, it can aid
   - Defibrillator and external pacemaker.
     - Ensure aseptic technique for temporary pacing.
   - Dose and titrate medications as needed.
   - Some drugs are potentiated by altitude.
     - Benzodiazepines have greater side effects.
     - CNS depressants are affected. Reduce doses.
     - Antihistamines tend to make the patient more susceptible to hypoxia.
     - Morphine sulfate and benzodiazepines have greater side effects.
     - Small incremental doses should be used.
   - Supportive equipment.
     - Consider administration of antiemetic prior to flight.
     - A nasogastric tube may relieve pressure of gas in stomach and prevent risk of vomiting and aspiration.
     - Some drugs are potentiated by altitude.
   - Antihistamines tend to make the patient more susceptible to hypoxia.
   - Morphine sulfate and benzodiazepines have greater side effects.
   - Small incremental doses should be used.
   - Supportive equipment.
     - Defibrillator and external pacemaker.
AIR TRANSPORT CONSIDERATIONS

1. Altitude changes.
   • As altitude increases, the partial pressure of oxygen decreases.
     — Results in reduction of the alveolar partial pressure of oxygen.
     — 
       A PaO2 of 100mmHg at sea level will decrease to 81mmHg at 5,000 ft., 61mmHg at 11,000 ft.
       and 45mmHg at 15,000 ft. Above 15,000 ft. the cabin is pressurized where PaO2 is more
       normally maintained.
       • Helicopters are usually not pressurized. They must fly within 0-10,000 ft. where
         the body can adapt.
     • Increased altitude predisposes the patient to hypoxia. Check patient’s ABGs and hemoglobin.
       • Oxygen should be administered to:
         • All patients at altitudes over 5,000 ft.
         • All cardiac patients.
         • All patients in shock or impending shock.
         • All patients with known pulmonary disease.
       • Consider recommending that the patient receive a blood transfusion prior to flight if
         hemoglobin is less than 7 Gm.
     — The patient may require more oxygen during flight. Watch for an increase in HR, dysrhythmias or
       change in hemodynamics which may necessitate operator intervention.
     — It is common for BP to decrease slightly on ascent. The patient may require additional volume or
       vasopressor support to maintain adequate filling pressures.
     • Altitude increases cause an inversely proportional decrease in barometric pressure (Boyle’s Law).
     — A mass of gas will expand as altitude increases. A gas volume of 1.0 at sea level will expand to 1.4
       at 8,000 ft. and 2.1 at 18,000 ft.
     — The helium volume in the IAB will increase in size during ascents.
       • Helium has potential to cross the IAB membrane and enter the patient’s blood system if a
         leak occurs.
       • Always operate IABP with gas alarms active. *(AutoCAT® 2/AutoCAT® 2 WAVE® IABPs =
         Alarms On)*
     — During ascent, the console will auto vent for altitude changes.
       • *AutoCAT® 2/AutoCAT® 2 WAVE® IABPs:*
         Possible alarms: If the balloon pressure baseline is >+25mmHg, a High Baseline alarm will
         occur. A High Pressure alarm will occur if the plateau of the balloon pressure waveform is
         over 250mmHg. If either condition occurs, the pump will go from Pump Status ON to Pump
         Status OFF. This vents the helium out of the system. Operator then resets alarm and reinitiates
         pumping by going to Pump Status ON. The pump will fill for proper helium for that altitude.
       • Helium volume will shrink during descent. During gradual descents, the console’s heat-to-heat autofill
         refills the system as the gas volume decreases. During rapid descents, if the pump is required to autofill too
         many times in 1-2 minutes, the pump will alarm.
         • *AutoCAT® 2/AutoCAT® 2 WAVE® IABPs:*
           Possible alarm: Helium Loss. The pump has seen the BPW drop below 10mmHg. The pump
           goes from Pump Status ON to Pump Status OFF. This vents the helium out of the system. The
           operator then resets the alarm and reinitiates pumping by going from Pump Status OFF to
           Pump Status ON.

2. G forces are usually only a concern with fixed-wing aircraft.
   • Patient positioning considerations.
     — If patient is positioned with head toward the front of the aircraft, the patient will experience positive
       acceleration.
       • Blood will be redistributed below the diaphragm.
       • Preload will be decreased.
       • May see a decrease in balloon augmentation.
       • Provide for adequate intravascular volume prior to take-off.
     — If patient is positioned with feet toward the front of the aircraft, the patient will experience negative
       acceleration.
       • Blood will be redistributed toward the heart.
       • Preload will increase.
       • Bradycardia can occur due to stimulation of carotid baroreceptors.
     — Compensation for the hemodynamics of flight can be accomplished by:
       • Adjusting flight angles when possible.
       • Judicious use of vasoactive drugs prior to take-off.
       • Providing for adequate intravascular volume, maximizing IABP capabilities and appropriate
         pharmacological support.
       • Close observation and early intervention during critical periods of take-off and landing.

   • Generally induces fatigue and inattention.
   • High-frequency vibration cycles are generally experienced in fixed-wing aircraft.
     — May lead to loose connections. Check connections prior to flight and tape if appropriate.
     — High-frequency vibration cycles are generally more characteristic of rotor-wing aircraft.
     — Can also lead to loose connections.
     — Will cause mechanical-electrical artifact in ECG waveform. Will need to have arterial pressure
       waveform present on IABP for alternative trigger.

   • Interferes with the clinician’s ability to assess the patient’s physical parameters as well as hearing
     IABP alarms.
     — Carefully assess breath sounds, heart sounds, blood pressure, invasive
       pressure waveforms and balloon pressure waveform prior to flight.
     — Position pump screen so alarm messages can easily be seen.
     — Provide hearing protection for patient and staff.
     — Noise levels upwards of 78 decibels can be experienced in air ambulances. Hearing protection
       is required for prolonged exposure.
     — Promotes patient and staff comfort.
     — Improves staff communication.

5. Humidity.
   • Absolute and relative humidity are low at high altitude due to the decreased temperature.
     It is further decreased as ambient air is taken in for pressurization.
     — Can cause drying of exposed mucous membranes.
     — Increases insensible loss which can affect pulmonary wedge pressures.
       • A decrease of several millimeters in PAWP has been reported during transport
         of IABP patients.
       • Carefully monitor pressures and provide adequate volume support.

MANAGING PATIENTS WITH FIBEROPTIC BALLOON CATHETERS

Fiberoptic IAB catheters can provide the user with two arterial pressure waveform sources. One from the central lumen of the catheter via a traditional transduced pressure system and the other from the high fidelity pressure sensor located on the tip of the balloon catheter. The arterial pressure waveform from the transducer pressure system is a delayed waveform while the one from the fiberoptic sensor is a real time signal. AutoPilot™ timing, utilizing the delayed signal, is done using a predictive timing algorithm. The timing algorithm using the fiberoptic arterial pressure signal and the AutoPilot Mode on the pump is done on a real time basis, which may produce more accurate timing especially when the patient’s rhythm is very irregular or tachycardic. Managing patients with a fiberoptic balloon catheter during transport is generally the same as when they have a standard balloon catheter. Some special considerations include:

• Rhythm disturbances have been noted in extreme episodes of positive acceleration.
  — If patient is positioned with feet toward the front of the aircraft, the patient will experience negative
  acceleration.
  • Blood will be redistributed toward the heart.
  • Preload will increase.
  • Bradycardia can occur due to stimulation of carotid baroreceptors.
  • Compensation for the hemodynamics of flight can be accomplished by:
    • Adjusting flight angles when possible.
    • Judicious use of vasoactive drugs prior to take-off.
    • Providing for adequate intravascular volume, maximizing IABP capabilities and appropriate
      pharmacological support.
    • Close observation and early intervention during critical periods of take-off and landing.
1. To utilize the fiberoptics, the catheter must be connected to a balloon pump that accepts the fiberoptic connection. The Arrow® AutoCAT 2 WAVE® IABP supports the FiberOptix® catheter. The AutoCAT 2 WAVE IABP in the AutoPilot™ Mode is now using the real time timing algorithm or WAVE® timing.

2. The fiberoptics need to be zeroed prior to insertion to have the most accurate hemodynamic readings. If the fiberoptic catheter is connected to a second pump after it is already in the patient, the catheter cannot be zeroed, but it can be calibrated using the hemodynamic readings (specifically the MAPs) from the central lumen transduced waveform. Clinicians should maintain the central lumen pressure system as a back-up for the fiberoptic pressure.

3. There are several possible catheter and pump connection configurations when transporting. a. A fiberoptic catheter connected to an AutoCAT 2 WAVE IABP going to another AutoCAT 2 WAVE IABP: • The fiberoptic catheter may have been zeroed on the first pump and now will be connected to a second fiberoptic pump. Note the MAP on the fiberoptic AP immediately prior to disconnect. Verify the same MAP value on the receiving pump after connection. If different, the clinician may need to calibrate the fiberoptic MAP to the original MAP value noted on the first pump. b. A fiberoptic catheter connected to an AutoCAT 2 WAVE IABP going to a pump without fiberoptics capability: • The fiberoptic catheter can be connected to a conventional intra-aortic balloon pump, but the fiberoptic connection cannot be utilized in this case. The central lumen transducer system will be needed for timing and the fiberoptic connections should be secured out of the way. c. A standard intra-aortic balloon catheter connected to a standard intra-aortic balloon pump going to an AutoCAT 2 WAVE IABP: • The conventional balloon catheter can be connected to the AutoCAT 2 WAVE IABP using the central lumen transducer system for timing.

4. During transport it may be necessary to disconnect the fiberoptic balloon catheter from the pump for a brief time to reposition the patient or position equipment in and out of the vehicle. a. If the fiberoptic catheter has been zeroed, the fiberoptic connector and calibration key may be disconnected and reconnected without losing the zero information. The AutoCAT 2 WAVE IABP retains the zero information after being disconnected until another fiberoptic catheter is attached. b. If the fiberoptic catheter has not been zeroed prior to insertion, the fiberoptic connector and calibration key may be disconnected and reconnected, but the catheter may then need to be calibrated using the information from the central lumen pressure system.

5. It is recommended that the fiberoptic cable be taped along the gas drive tubing of the balloon catheter to protect against stretching, pulling or other damage to the fiberoptic cable.

6. If the fiberoptic cable is damaged during transport and the pressure waveform is no longer present, then the central lumen transducer will be utilized for timing. The AutoCAT 2 WAVE IABP will alarm providing a message notifying the clinician that the fiberoptic is unavailable. Disconnect the blue fiberoptic slide and black cal key.

7. During air transport, the fiberoptic signal may become altered and be unusable at an altitude above 10,000 feet in an unpressurized cabin. The clinician will need to utilize the central lumen transducer system for timing during that time. Once the aircraft descends below 10,000 feet, the fiberoptic signal can again be used for timing.

8. If the “AP FOS Out of Range” alarm message occurs during transport, the clinician should assess the fiberoptic arterial pressure signal and hemodynamics. a. The clinician can try repositioning the patient, then disconnect and reconnect the fiberoptic connector to see if the alarm will reset. b. If the signal and hemodynamics are appropriate for the patient’s condition, the clinician can reset the alarm and continue using the fiberoptics. c. If the signal and hemodynamics are inappropriate for the patient’s condition, the clinician should switch to utilizing the central lumen transducer system for timing by disconnecting the blue FOS slide and black cal key from the pump.

HANDLING COMPLICATIONS

1. Blood in gas line tubing to balloon.

2. Bleeding at balloon insertion site.
   • Apply manual pressure to site.
   • Reassess immobilization of insertion site.
   • C clamp or other external mechanical compression devices may be applied above insertion site. Apply only enough pressure to slow bleeding. Too much pressure could cause kinking of balloon catheter.

3. Balloon partially pulled out from insertion site.
   • Do not attempt to reposition balloon.
   • Check distal pulses for perfusion.
   • Decrease balloon volume based on balloon pressure waveform reading.
   • Notify receiving facility of need for repositioning.

4. Dysrhythmias.
   • Decreases effectiveness of balloon counterpulsation. Decreased augmentation noted.
   • Administer antiarrhythmics per protocol.
   • Assess for hypoxia and treat appropriately.
   • Initiate pacing (external or transvenous, if needed).
   • Defibrillate, if appropriate. The IABP console is grounded so it is not necessary to turn pump off during defibrillation.

5. Limb Ischemia.
   • Observe and monitor pedal pulses and coloration of legs.
   • Keep legs warm to reduce vasospasm due to cold.
   • Maintain adequate volume status to reduce vasoconstriction due to hypovolemia.
   • Minimize use of vasoactive drugs, if possible, to reduce effects of vasoconstriction.

6. Cardiac Arrest.
   • Initiate appropriate ACLS protocols.
   • Place IABP console in arterial pressure trigger and initiate pumping at 1:1 assist once chest compressions have been started.
     — For AutoCAT® 2 IABPs, disconnecting the ECG cable from the pump while in AutoPilot mode during an arrest will force the trigger selection to AP trigger. Re-establish the ECG cable when ECG triggering is desired.
     • If unable to generate an adequate arterial pressure waveform for trigger with compressions during an arrest, the internal trigger mode may be used. The preset parameter for the internal trigger rate is 80 bpm. It is advisable to reduce the internal trigger rate to 40–60 bpm to minimize the balloon interference with compressions. A second option is to decrease the assist ratio to 1:4 or 1:8. Using the internal mode during cardiac arrest is only meant to keep the balloon exercised to prevent clot formation. It is imperative to leave internal trigger mode once coordinated hemodynamics return.

7. IABP Console Malfunction.
   • Initiate manual balloon inflation and deflation using a 60 cc syringe.
   • Aspirate balloon catheter prior to inflating and deflating balloon to check the integrity of the balloon membrane.
   • Inflate and deflate the balloon a couple of times every five minutes.
   • If inflating and deflating at the end of the balloon console connector, you can inflate and deflate the balloon with 10 cc over the size of the balloon.
     — Manual inflation and deflation is not meant to provide hemodynamic support for the patient, but to prevent clot formation on the balloon or in folds on a dormant balloon. The clinician will need to assess the patient’s hemodynamic status and provide support pharmacologically.
# TRANSPORT CHECKLIST FOR IABP PATIENTS

## PRE-TRANSPORT INFORMATION
- **Patient Name:**
- **Age:**
- **M/F:**
- **Patient Diagnosis:**
- **Vital Signs:**
  - **Heart Rate:**
  - **Assisted BP/MAP/Aug (with pump on):**
  - **Unassisted BP/MAP (without pumping):**
- **Venous Access Devices/Invasive Lines:**
- **Drugs Given:**
- **Drugs Infusing:**
- **Why does the patient have an IABP?**
- **Insertion Site:**
- **Is the patient balloon dependent (what happens without assist)?**
- **Balloon Volume and Catheter Size:**
- **What brand of pump is in use?**

## EQUIPMENT CHECKLIST
- **Pump with fully charged battery and adequate helium**
- **Transport bag with:**
  - Adaptors for different catheters
  - Scissors and tube clamps
  - Extra helium tank
  - ECG and arterial pressure cables and transducer
  - 60 cc syringe
  - IABP flow sheet or patient documentation form

## AT SENDING FACILITY CHECKLIST
- **Assure adequate ECG signal (position correct, no artifact, electrodes marked)**
- **Arterial Pressure source (fiberoptic or transducer) signal adequate**
- **Secure balloon adequately (consider knee immobilizer, cables kink free)**
- **Review positioning X-Ray (assure balloon is at the second to third intercostal space)**
- **Empty Foley bag and review I&O**
- **Move IV drips to transport pump(s) and identify IV access for emergent medications**
- **Connect cardiac monitor/defib (do not place BP cuff)**
- **Verify pump settings: operating mode, trigger, IAB volume, assist ratio**
- **Assess peripheral pulses and limb perfusion**
- **Assess patient’s dependence on IABP support**
- **Secure all catheter to pump connections**
- **Gather all transport forms and copies of patient records**

## DURING TRANSPORT
- **Position patient and pump in vehicle (allow access to groin site, balloon tubing, and pump)**
- **Secure pump and lock wheels**
- **Connect IABP power cord to vehicle inverter**
- **Position control head**
- **Verify gas alarms are enabled**
- **Assess arterial pressure waveform for timing and augmentation**
- **Assess patient rhythm, hemodynamic readings, urine output, peripheral perfusion**
- **Document on IABP flowsheet or patient documentation form**