# Anesthetic Considerations for Trans-Catheter Aortic Valve Replacement

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**Background:**

Trans-catheter aortic valve replacement (TAVR) has become an approved therapy for replacement of the stenotic aortic valve in patients at extreme and high risk for open, surgical replacement. Studies are currently underway to establish the role of TAVR in patients with lower risk profiles. In any event, it has become clear that the use of TAVR will continue to expand and given the epidemiologic considerations of aortic stenosis, the cardiac anesthesiologist can expect to be involved in many of these procedures. These procedures are extraordinarily challenging given the nature of the patients that undergo these procedures. Communication amongst the care team starting at the pre-planning meeting with extension throughout and after the procedure is absolutely critical.

There are currently two available TAVR systems - the Edwards Sapien and the Medtronic CoreValve. The Sapien system is a balloon expandable prosthesis that has three current sizes – 23 mm, 26 mm, and 29 mm. The CoreValve is a self-expanding system and also has three sizes – 26 mm, 29 mm, and 31mm. Both systems can deploy from the femoral approach. The Sapien system can also be used from an LV apical approach. The CoreValve can be used from a direct, thoracic aortic approach or subclavian arterial approach in patients wherein the femoral approach is not feasible. The direct aortic approach of the CoreValve system can be done through a limited thoracotomy approach requiring single lung ventilation or through a limited sternotomy.

The purpose of this document is to serve as a very basic reference for typical setup for TAVR. Please keep in mind that this guide must always be adapted to the specifics of each patient/procedural situation. Expect modifications to procedural plans both before and during the procedure. Flexibility and accommodation are important; please develop an anesthetic plan and frame of mind that allows for such.

**Pre-operative preparation:**

1. Please make every attempt to have both your resident/fellow and you attend the pre-procedural meeting that is scheduled for 4 to 5 pm for CoreValves and 5 to 6 pm for Sapien valves in the Baker 4 conference room (adjoining the cath lab holding area). If you cannot attend this meeting, it is imperative that you contact the cardiologist overseeing the procedure to discuss all relevant issues. Currently, Jeff Popma is the cardiologist supervising the CoreValve patients and Donald Cutlip is overseeing the Sapien patients.

2. If there are contraindications to TEE, please discuss these issues at the pre-planning meeting so that alternative echocardiographic evaluations of valve deployment can be arranged. These alternatives include intra-cardiac ultrasound or TTE. In either of these alternative situations, outside, non-anesthesia equipment will be used. Marilyn Riley (beeper # 32029), the chief sonographer for the Department of Cardiology, can be contacted for any assistance in arranging for TTE evaluation.

3. All of these patients will be admitted to the institution no later than the day prior to the procedure. The involved resident/fellow should perform a thorough preoperative evaluation as they would for any cardiac patient. Please carefully consider and discuss any preoperative conduction abnormalities given the potential for AV node disruption (CoreValves).

4. It is recommended that the operating bed (room 1) be turned to the "fluoroscopy" position before the patient enters the room so as to minimize repositioning during the case.

5. In addition to a standard cardiac "set up," the recommended room set-up includes placement of infusion pumps on left side of the bed, TEE machine on right side of C-arm, Level 1 in the room and prepared for use, R2 pads on patient, and an under body Bair hugger. Add extensions to all IV lines, arterial lines, and drug infusion lines as, at times, the fluoroscopy table will be moved at some distance away from the typical "anesthesia" position.

6. All patients will require IV access that is appropriate for the potential need for large volume, rapid fluid resuscitation as well as the use of concentrated vasoactive drugs. 2 large bore IV's are optimal for fluid resuscitation but, when not feasible, may require the placement of dedicated central access. Please keep in mind that in CoreValve patients a small, 5 Fr internal jugular introducer will be placed after anesthetic induction for a PA catheter/pacing wire. This introducer is small and should not be considered as access for fluid resuscitation or even drug infusion.

7. A left side arterial line is preferred. This is due to the fact that the procedural team will sometimes use the right radial for a pigtail catheter. (Please discuss with the cardiologist to determine if the radial or subclavian arteries may be needed for such access.) The arterial line can be radial but axillary catheters may be necessary in some patients.

8. Always ensure, before proceeding in to the operating room that a type and cross for at least 4 units of PRBCs has been undertaken and that blood will be available in the room. This request can and should be modified by specific patient issues (anemia, redo, etc.).

9. Please ensure that all necessary "non-anesthesia" equipment, e.g. 5 Fr introducer and sheath, is available. This equipment can be obtained from the circulating nurse before the patient is brought into the OR.

10. An immediate pre-procedural briefing with the entire team will occur about 15 minutes before the patient is brought into the OR to discuss any issues that have developed during preparation.

**Intraoperative Management:**

1. Currently, all procedures are performed under general anesthesia. Eventually, some patients may be considered for deep sedation. The default goals include early extubation and, when feasible, extubation in the OR at the end of the procedure. To this end, doses of narcotics and muscle relaxants should be tailored to allow such.

2. **In CoreValve cases:** After induction and intubation, a 5 Fr Arrow introducer (see figure 1) obtained from the circulating nurse should be placed in the right IJ (unless not feasible). A special 5 Fr PA catheter and appropriate sheath, all obtained from the nurse, will be placed by our team through this introducer. This PA catheter is very short and, as a result, will require a pressure tubing extension to hook up to the transducer. In addition, the individual placing the catheter will have to manipulate the balloon on their own. At the end of the procedure, the PA catheter will replaced with a temporary pacing wire by the cardiology team. In situations considered high risk for the development of complete heart block (e.g. patient with RBBB and left axis deviation), the EP team will be consulted to place a temporary "screw in" pacing lead at the beginning of the case. In this situation, the 5 Fr introducer will not be place by our team. Instead, the EP team will place their own introducer specific to the lead they will place. If such a lead is placed, the anesthesia team will be responsible for using it to institute rapid ventricular pacing during the valvuloplasty and valve deployment phase of the procedure. This lead will have two needle-like terminals coming off of it (figure 2a and b). One of these needles is longer than the other and should be hooked up to the negative terminal of the pacemaker wire that attached to the pacemaker box (figure 3). An EP nurse will be available to assist with this setup.

3. **In Sapien Valve cases:** As the Sapien valve does not carry the same risk of intra or post-operative complete heart block, it does not require the placement of a temporary pacemaker at the end of the procedure. In these cases either a triple lumen or PA catheter introducer can be inserted in an IJ vein. In these cases, the cardiology team will insert a temporary pacing wire from the femoral MAC trauma line that they will place for the case. Unless otherwise specified, this MAC line will be removed at the end of the procedure.

4. In both CoreValve and Sapien cases, the procedural team will place a femoral MAC line. This line can be used as an access point for fluid resuscitation and/or vasoactive drug infusions. When used for drug infusions, it is important that the "gang of 5" stopcock system be placed just proximal to the site of entry. This will require extensions on the infusion lines so that they may reach the ultimate location of the "gang of 5" near the patients' hip. In all situations other than a CoreValve case that requires a screw in lead (as described in #2 above), the procedural team will place a temporary pacing wire through the MAC line to allow for the ability to employ rapid pacing during valvuloplasty and valve deployment.

5. A 3D TEE probe should be inserted after intubation unless contraindicated. A complete exam should be expeditiously performed. X-plane imaging of the LVOT is critical to give additional information regarding valve sizing to the procedural team. The procedural team will use our surface ultrasound probe to obtain arterial access.

6. In situations where appropriate, consideration to placement of a left IJ introducer for fluid resuscitation and/or PA catheter monitoring should be given. This can be placed in patients where post-operative use of a PA catheter may be of particular importance.

7. When specified by the procedural team, heparin will be dosed with the goal of an ACT of 300. Please remember that, other than CoreValve cases using a direct aortic approach, these patients are all pre-medicated with 300mg of clopidogrel which will influence baseline and final ACT results.

8. After placement of the deployment sheaths and before initiation of actual valve deployment, a "time-out" process to review deployment strategy and potential issues will be initiated. It is imperative to understand and prepare for the hemodynamic consequences of deployment as well as to express concerns and ask relevant questions at this point in time.

9. Just prior to device deployment, generation of a higher blood pressure is beneficial to allow for ensuing periods of decreased cardiac output as occur with rapid ventricular pacing. Once again, during this period communication is essential to allow for proper interventions with blood pressure. Following device deployment, immediate TEE assessment of the deployed valve is critical. This evaluation should key in on peri-valvular leaks, valve position, valve function, injury to the thoracic aorta, function of the mitral valve and the presence of new wall motion abnormalities. Periodic assessment for pericardial tamponade should also occur. A full description of methods to evaluate these valves can be found elsewhere (J Am Coll Cardiol 2013;61:1125–36).

10. When peri-valvular regurgitation is significant, further balloon dilations may be performed to minimize such.

11. The removal of the device introducer should be considered a high risk period given its size and the potential for significant arterial injury. It is essential to monitor for acute blood loss during this time.

12. Protamine will be given once the procedural team is satisfied with the valve deployment. Doses can be determined using the Hepcon system or by the administration of small doses based on heparin dosing during the procedure.

13. **In CoreValve cases:** As mentioned above, at the end of the procedure, the procedural team will replace the right IJ 5 Fr PA catheter with a temporary pacing wire.

**Postoperative Management:**

1. In appropriate cases, extubation in the operating room can be considered. The requirements for extubation of the TAVR patient are no different than for extubation of any patient. As these patients are often quite debilitated, the expectations regarding extubation should be appropriately tempered. CoreValve patients requiring direct aortic access for deployment should go to the CVICU intubated. All other patients will be transported, intubated or extubated, to the CCU. The CCU nursing team has been trainied in the use of our infusion pumps.

2. It is important to ensure that the temporary pacemaker and box are adequately secured during transport.

3. Appropriate hand off and communication is essential for continued safe patient care. Please make sure that the appropriate caregivers are present for handoff. At a minimum, this team should include a member of the intraoperative anesthesia care team, a member of the intraoperative procedural team, the receiving unit nurse, and one member of the receiving unit physician team. A plan for short term management of respiratory, hemodynamic, and analgesic issues must be communicated during the handoff.

**References**


1. Smith CR, et al. N Engl J Med 2011;364:2187-98.

2. Svensson LG, et al. J Thorac Cardiovasc Surg 2013;145:S11-6

3. Lange R, et al. J Am Coll Cardiol 2012;59:280–7

4. Genereux P, et al. J Am Coll Cardiol 2013;61:1125–36

5. Leon MB, et al. N Engl J Med 2010;363:1597-1607

6. Lange R, et al. J Thorac Cardiovasc Surg 2013;145:S17-21


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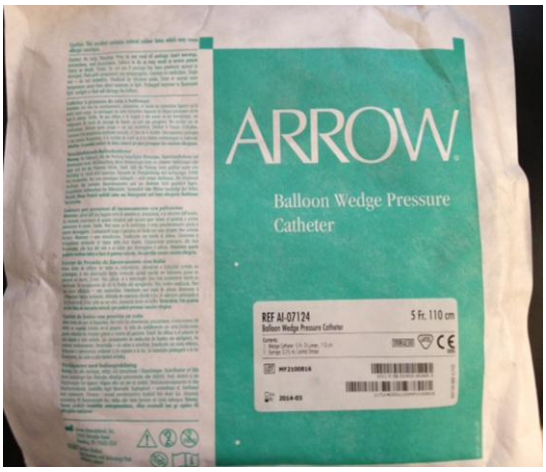
**A** **B**




C

Figure 1 – TAVR Equipment

A. 5 Fr introducer for CoreValve - Used for placement of 5 Fr PA catheter during case and temporary pacing wire at end of case.

B. Sheath for 5 Fr PA catheter

C. 5 Fr PA catheter package

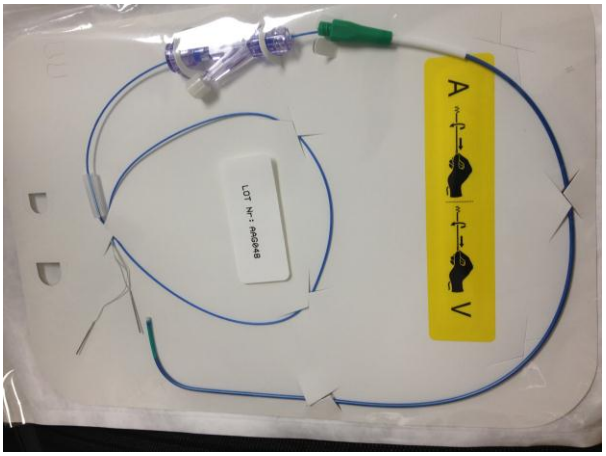



Figure 2a – “Screw in” pacemaker lead used by EP in TAVR patients at high risk for AV block.

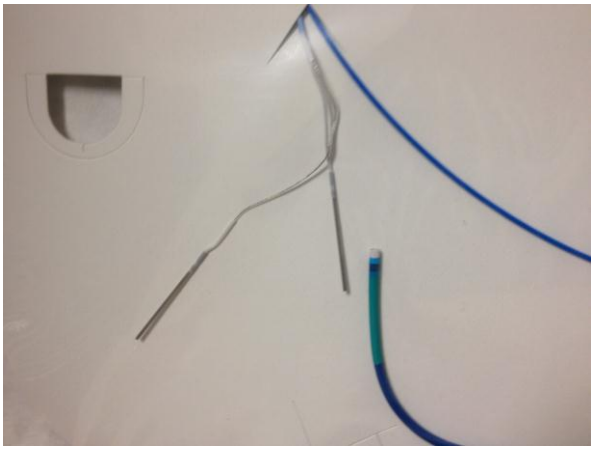


Figure 2b – Close up of terminals for “screw in” lead. Longer needle goes to negative terminal.

Figure 3 – Pacemaker wire set used to interface “screw in” lead with pacemaker box.