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Establishing a TAVR Program in a Non-ECMO Center: Anesthetic Considerations and Safety Workflow

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Abstract

Optimal anesthetic management during the initiation of a transcatheter aortic valve replacement (TAVR) program in centers without extracorporeal membrane oxygenation (ECMO) capability remains underexplored. This case report describes anesthetic considerations and contingency planning for establishing a new TAVR program in a cardiac catheterization laboratory. A 66-year-old male patient with severe aortic stenosis (valve area: 0.74 cm^2; mean gradient: 43.89 mmHg; ejection fraction: 47%), coronary artery disease, congestive heart failure (NYHA class II), and chronic kidney disease stage III underwent transfemoral TAVR under general anesthesia as the inaugural procedure of the program. The procedure was performed in a cardiac catheterization laboratory without on-site ECMO support, with cardiac surgery standby and cardiopulmonary bypass equipment prepared in an adjacent operating room. Hemodynamic management during rapid ventricular pacing (180 beats/min for 10 seconds during balloon valvuloplasty and 120 beats/min during valve deployment) included preemptive phenylephrine boluses (total dose: 2 mg) and cautious crystalloid administration (500 mL). A 27 mm VitaFlow valve was successfully deployed. Post-deployment transesophageal echocardiography demonstrated mild paravalvular leak without intravalvular regurgitation or valve dislodgement. The patient was discharged on postoperative day 3 without complications. General anesthesia supported by structured hemodynamic management protocols and clearly defined cardiac surgery contingency planning enabled safe TAVR implementation during program initiation in a non-ECMO center. This case provides a practical framework for institutions establishing similar programs without immediate ECMO capability.

INTRODUCTION

Transcatheter aortic valve replacement (TAVR) has increasingly adopted minimalist approaches using monitored anesthesia care (MAC) in high-volume centers (Friess et al., 2017; Billings et al., 2009; Ko et al., 2023). However, during program initiation, particularly in centers without extracorporeal membrane oxygenation (ECMO) capability, the optimal anesthetic strategy and safety infrastructure remain insufficiently defined (Billings et al., 2009; Pani et al., 2017; Angelillis et al., 2022). The cardiac catheterization laboratory presents unique challenges, including limited physical space, restricted patient access during critical procedural phases, and variable availability of rescue modalities (Abadié et al., 2024; Weitzel, 2015). Rapid ventricular pacing can induce significant hemodynamic instability, requiring proactive and anticipatory management (Ree et al., 2008; Fassl et al., 2009). In patients with chronic kidney disease, maintaining adequate perfusion pressure while minimizing fluid overload is particularly important (Covello et al., 2010).

What This Case Adds: This report describes the anesthetic management and safety workflow for the inaugural TAVR procedure in a newly established program conducted in a cardiac catheterization laboratory without on-site ECMO capability. The report details contingency planning involving cardiac surgery standby and cardiopulmonary bypass resources, hemodynamic management during rapid ventricular pacing, and practical considerations for institutions establishing TAVR programs in resource-limited settings.

The research gap addressed by this report lies in the limited evidence guiding anesthetic management and safety infrastructure during TAVR program initiation in centers without on-site ECMO capability. Although extensive literature has evaluated TAVR outcomes in experienced, high-volume centers, practical guidance for newly established programs in resource-limited environments remains limited. Previous single-center experiences suggest that structured program development approaches, including appropriate patient selection, conservative anesthetic strategies, and clearly defined contingency planning, can support safe TAVR implementation even without comprehensive rescue capabilities (Im et al., 2016; Pyne et al., 2021). However, detailed descriptions of anesthetic protocols, hemodynamic management strategies, and safety workflows during program initiation remain necessary to provide practical guidance for similar institutions (Aboali et al., 2026; Dobson et al., 2021; Klein et al., 2021; Scott, 2023).

The importance of this research is highlighted by the expanding indications for TAVR and the increasing number of centers establishing TAVR programs worldwide. As TAVR indications continue to expand toward lower-risk and younger patient populations, demand for these procedures continues to increase, encouraging more institutions to develop structural heart programs. The expectation of excellent clinical outcomes, rapid recovery, and efficient resource utilization in contemporary practice creates additional challenges for newly established programs. Institutions without ECMO capability must develop robust safety protocols to maintain patient safety while managing the learning curve associated with program initiation (Baxi et al., 2024; Larson, 2022; Moore et al., 2026). Benchmark programs and studies such as the 3M TAVR study have demonstrated that standardized, multidisciplinary approaches can achieve consistently favorable outcomes across different healthcare settings; however, these frameworks require adaptation according to local resources, expertise, and institutional limitations.

The novelty of this report lies in its detailed description of a comprehensive anesthetic strategy for the inaugural TAVR procedure in a center without on-site ECMO capability, providing a practical framework for similar institutions. Unlike previous publications that have primarily focused on outcomes from established programs, this report addresses the specific challenges associated with program initiation, including anesthetic technique selection, invasive monitoring decisions, hemodynamic management protocols, and surgical contingency planning. This case demonstrates how conservative anesthetic strategies and structured safety protocols can support the safe implementation of advanced structural heart interventions even in the absence of comprehensive rescue modalities. The proposed framework contributes to the expanding evidence base supporting TAVR program development across diverse healthcare environments.

The purpose of this report was to describe the anesthetic management and safety workflow involved in establishing a TAVR program in a non-ECMO center and to provide practical guidance for institutions facing similar circumstances. The contributions of this report include detailed hemodynamic management strategies during rapid ventricular pacing, explicit contingency planning with cardiac surgery standby, considerations for invasive monitoring during program initiation, and recommendations for gradual transition toward minimalist approaches as institutional experience increases. The objectives were to demonstrate the feasibility and safety of performing TAVR under general anesthesia in a newly established program without on-site ECMO capability, describe the implemented anesthetic protocols and safety infrastructure, and provide practical recommendations for institutions developing TAVR programs in resource-limited settings. The findings may support improved patient safety during program initiation, reduce procedural risks through structured protocols, and expand access to TAVR services across diverse healthcare systems.

METHOD

This report was prepared as a single case report in accordance with the CARE (CAse REport) guidelines. Clinical data were obtained through a retrospective review of the patient's medical records, anesthesia charts, echocardiographic reports, and cardiac catheterization laboratory procedural documentation. Data extraction included the pre-procedural evaluation, intra-procedural anesthetic and hemodynamic management, and post-procedural clinical course until hospital discharge. The collected variables included patient demographics and comorbidities, baseline transthoracic echocardiographic parameters, anesthetic techniques, monitoring modalities, administered pharmacological agents, hemodynamic parameters and interventions during rapid ventricular pacing, intra- and post-procedural transesophageal echocardiographic findings, procedural complications, and clinical outcomes at discharge. Written informed consent was obtained from the patient for the TAVR procedure and publication of deidentified clinical information for educational and research purposes, in accordance with institutional policies for single case report publication.

RESULTS AND DISCUSSION

Case Presentation

A 66-year-old male presented with progressive dyspnea (NYHA class II) secondary to severe aortic stenosis. Comorbidities included mild aortic regurgitation, coronary artery disease, congestive heart failure, type 2 diabetes mellitus, hypertension, and chronic kidney disease stage III. Baseline rhythm was sinus. Transthoracic echocardiography revealed: aortic valve area 0.74 cm², mean gradient 43.89 mmHg, left ventricular ejection fraction 47%, and mild aortic regurgitation. This was the inaugural TAVR in our newly established program, performed in the cardiac catheterization laboratory. Our institution lacks on-site ECMO capability. The contingency plan included:

1. Cardiac surgery team on standby throughout the procedure
2. Heart-lung machine with perfusionist team readily available in the adjacent operating room
3. Predetermined protocol for emergent transfer to OR
4. Vascular surgical instruments and sternotomy equipment immediately available

General anesthesia was selected for this first case to prioritize maximal airway control, patient immobility, comprehensive transesophageal echocardiography (TEE), superior hemodynamic control during rapid pacing, and rapid response capability for complications.

Standard ASA monitoring was established. A radial arterial line was placed before induction. A central venous catheter was inserted in the right subclavian vein under local anesthesia with ultrasound guidance. The decision to place a central line for this inaugural case was based on: (1) ensuring reliable large-bore access for rapid fluid resuscitation if complications arose, (2) providing a secure route for vasoactive medication infusions, (3) enabling central venous pressure monitoring to guide fluid management in a patient with chronic kidney disease stage III and heart failure, and (4) maintaining rescue access if peripheral lines failed during critical procedural phases. This conservative approach reflected our institutional inexperience and prioritization of preparedness in a non-ECMO center. We recognize that as our program matures, central venous access may be reserved for selected high-risk patients rather than used routinely. Nasopharyngeal temperature monitoring and indwelling urinary catheter were utilized.

For induction of anesthesia we administer midazolam 3mg IV followed by dexmedetomidine infusion 0.3-0.5 mcg/kgbw/hour, remifentanil with target-controlled infusion (Minto model) 2-4 ng/mls, sevoflurane 1-2 vol%, and rocuronium 50mg IV. Airway was secured with ETT 7.5 by videolaryngoscopy and mechanical ventilation with protective lung strategy.

Intraoperatively, transfemoral access was obtained by interventionist to deploy the device via femoral artery and transvenous pacing via femoral vein. Interventionist also insert pigtail through radial artery. Hypotension was managed by phenylephrine injection and fluid loading as necessary. Significant hemodynamic compromise occurs during rapid ventricular pacing with rate 180 bpm for balloon aortic valvuloplasty and aortic valve positioning, and was returned to baseline after cessation of pacing. Vitaflow 27mm was deployed successfully and confirmed with fluoroscopy and TEE. TEE findings were valve in appropriate position with mild paravalvular leak. Vascular was successfully closed using one Proglide pre-closure devices.

Patient was extubated after procedure finished and transported to the HCU for observation. Patient was transferred to the general ward on POD 1 and discharged home on POD 2 without complications

Clinical significance: Why this case matters

This case illustrates a comprehensive anesthetic approach for TAVR program initiation in a center without on-site ECMO capability. Key elements include general anesthesia selection during the learning curve, structured hemodynamic management during rapid pacing, thoughtful invasive monitoring decisions, and explicit surgical contingency planning.

Anesthetic technique selection

The choice between general anesthesia (GA) and monitored anesthesia care (MAC) for TAVR remains institution- and patient-dependent (Friess et al., 2017; Billings et al., 2009; Pani et al., 2017). While experienced centers have demonstrated safety and efficiency with MAC and even "anesthesiologist-free" approaches (Ko et al., 2023; Abadié et al., 2024), GA offers distinct advantages during program initiation (Billings et al., 2009; Ree et al., 2008; Fassl et al., 2009).

For our inaugural case, GA provided: (1) guaranteed airway security in a patient with multiple comorbidities and no institutional TAVR experience; (2) optimal conditions for transesophageal echocardiography, essential for real-time valve assessment (Covello et al., 2010); (3) patient immobility during precise valve positioning; and (4) immediate readiness for emergency conversion to open surgery without additional airway management. These considerations outweighed the potential benefits of faster recovery and shorter procedure times associated with MAC (Friess et al., 2017; Pani et al., 2017).

The combination of sevoflurane, remifentanil via target-controlled infusion, and low-dose dexmedetomidine provided hemodynamic stability with rapid titrability (Billings et al., 2009; Fassl et al., 2009). This balanced technique avoided excessive myocardial depression while maintaining adequate anesthetic depth.

Hemodynamic Management During Rapid Ventricular Pacing

Rapid ventricular pacing (typically 180-220 bpm) during balloon valvuloplasty and valve deployment creates near-pulsatile flow, dramatically reducing cardiac output and blood pressure (Ree et al., 2008; Fassl et al., 2009; Sammour et al., 2021). In patients with severe aortic stenosis and pre-existing ventricular dysfunction, this hemodynamic insult can precipitate cardiovascular collapse if not promptly managed.

Our strategy emphasized preemptive vasopressor administration rather than reactive treatment (Ree et al., 2008; Covello et al., 2010). Phenylephrine boluses (100-200 mcg) were administered immediately before pacing initiation, maintaining coronary perfusion pressure during the critical 10-15 second pacing period. Total phenylephrine dose (2 mg) reflected the cumulative effect of two pacing episodes plus baseline vasopressor requirements in a patient with reduced ejection fraction.

Fluid management was deliberately restrictive (500 mL total crystalloid) given chronic kidney disease stage III and pre-existing heart failure (Covello et al., 2010). Excessive fluid administration in this population risks pulmonary edema without meaningfully improving cardiac output during pacing. The primary determinant of perfusion during pacing is systemic vascular resistance, not preload.

Contingency planning in non-ECMO centers

The absence of on-site ECMO capability necessitated explicit contingency planning (Loberman et al., 2018; Augoustides & Patel, 2018). Our protocol included :

1. Cardiac Surgery Standby: Surgeon, perfusionist, and OR nursing team immediately available
2. Prepared Cardiopulmonary Bypass: Circuit primed, tested, and ready in adjacent operating room
3. Transfer Protocol: Rehearsed plan for rapid patient transfer from catheterization laboratory to OR in event of cardiovascular collapse, annular rupture, or coronary occlusion
4. Communication Strategy: Direct phone line between catheterization laboratory and cardiac surgery team with real-time updates during critical procedural phases

This infrastructure provided rescue capability comparable to centers with ECMO, though with slightly longer response time. For centers establishing TAVR programs, such contingency planning is non-negotiable until sufficient institutional experience demonstrates acceptably low complication rates (Loberman et al., 2018; Augoustides & Patel, 2018; Ruggeri et al., 2012).

Central venous catheterization: necessity vs minimalism

The role of central venous catheterization in contemporary TAVR practice is evolving (Ko et al., 2023; Angelillis et al., 2022; Sammour et al., 2021). High-volume centers performing hundreds of procedures annually have successfully transitioned to peripheral intravenous access for uncomplicated cases, reducing procedural invasiveness and cost (Ko et al., 2023; Angelillis et al., 2022). However, this minimalist approach assumes institutional experience, established workflows, and confidence in managing complications. In our case, CVC placement was appropriate given the combination of reduced ejection fraction (47%), chronic kidney disease, first-in-program status, and absence of ECMO rescue capability. As our program develops, we anticipate adopting more selective criteria.

Catheterization Laboratory Environment Considerations

Performing TAVR in the cardiac catheterization laboratory rather than a hybrid operating room presents unique challenges (Weitzel, 2015; Augoustides & Patel, 2018). Space constraints limit anesthesia equipment placement and personnel movement. Radiation exposure requires lead protection and distance from fluoroscopy equipment. Ambient temperature is often cooler than standard operating rooms, necessitating active patient warming. Anesthesiologists must adapt workflows to this environment (Weitzel, 2015; Augoustides & Patel, 2018): (1) compact anesthesia workstation positioned to allow emergency access to patient's head; (2) all emergency drugs and equipment immediately accessible; (3) clear communication protocols with interventional cardiology team regarding procedural phases; and (4) familiarity with catheterization laboratory emergency procedures, including radiation safety during crisis management.

Transesophageal Echocardiography Guidance

TEE was essential for real-time procedural guidance (Covello et al., 2010; Ruggeri et al., 2012). Key assessments included: (1) pre-deployment confirmation of aortic stenosis severity and annular measurements; (2) intra-procedural monitoring of valve position and deployment; (3) immediate post-deployment evaluation of paravalvular leak, valve function, and ventricular performance; and (4) exclusion of complications such as aortic dissection or pericardial effusion.

The finding of mild paravalvular leak is common and typically benign, with most leaks improving over subsequent weeks as endothelialization occurs (Covello et al., 2010; Ruggeri et al., 2012). Severe paravalvular leak would have required consideration of post-dilation or, rarely, valve-in-valve deployment.

Clinical implications and practical takeaways

Based on this experience, we offer the following recommendations for centers establishing TAVR programs:

1. Contingency planning: Establish formal partnership with cardiac surgery including pre-procedure case review, surgeon availability, prepared CPB equipment, rehearsed transfer protocols, and documented communication pathways.
2. General anesthesia initially: Use GA during early program development (first 50-100 cases) for secure airway, patient immobility, comprehensive TEE, and optimal emergency response conditions. Transition to MAC gradually with low-risk patients.
3. Anticipatory hemodynamics: Implement standardized protocols for rapid pacing: preemptive vasopressor boluses or continuous infusions, target MAP >60-65mmHg during pacing, minimize pacing duration to <10 seconds, judicious fluid guided by CVP, special attention to patients with coronary disease, CKD, or cerebrovascular disease.

4. Invasive monitoring de-escalation: During program initiation, consider central venous access for reliable large-bore access, vasoactive medication delivery, and CVP-guided fluid management, particularly in non-ECMO centers. As institutional experience grows (>50-100 cases), transition to selective central line placement based on patient risk stratification (complex comorbidities, difficult peripheral access, anticipated prolonged vasoactive support, high-risk anatomy) rather than routine use. Adequate peripheral intravenous access (two large-bore IVs) may be sufficient for uncomplicated cases in experienced programs.
5. Patient selection: For first 20-50 cases, select patients with favorable anatomy, lower-risk profile (STS <8%, EuroSCORE II <10%), sinus rhythm, and absence of high-risk features. Gradually expand to complex cases.
6. Post-procedure monitoring: Establish standardized care pathways with ICU/HCU monitoring, serial troponin and ECG monitoring for 24-48 hours, daily assessment of vascular sites and renal function, early mobilization, pre-discharge TTE, and structured 30-day follow-up.

Limitations

This single case report from program initiation limits generalizability. The conservative approach (GA, surgery standby, comprehensive monitoring) may not be necessary for all new programs, particularly those with experienced teams transitioning from surgical AVR. The optimal timing for transitioning to MAC and minimalist techniques requires further study.

CONCLUSION

This case demonstrated the feasibility and safety of transfemoral TAVR under general anesthesia during program initiation in a cardiac catheterization laboratory without on-site ECMO capability. Key elements included explicit contingency planning with cardiac surgery standby and cardiopulmonary bypass availability, anticipatory hemodynamic management during rapid ventricular pacing using preemptive vasopressor support, judicious fluid administration in patients with chronic kidney disease, comprehensive transesophageal echocardiography (TEE) guidance for procedural monitoring, and effective multidisciplinary team coordination. This framework provided practical guidance for centers establishing TAVR programs in resource-limited environments, demonstrating that careful planning, conservative anesthetic strategies, and structured safety protocols can enable the safe delivery of advanced structural heart interventions without comprehensive rescue modalities.

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