TAVR Economics

How partnerships, a lean program, and a holistic view can grow structural heart programs.

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Since its approval in 2012, transcatheter aortic valve replacement (TAVR) has evolved from a complex procedure requiring extensive personnel and hospital resources to a highly streamlined and often minimalistic procedure. As TAVR indications have expanded to include all patient surgical risk categories, the outcomes have remained excellent, reflecting improvements in technology and better understanding of all aspects of the procedure.[1]

TAVR has been widely adopted in academic and community hospitals and now represents the dominant form of aortic valve replacement (AVR) in the United States. In 2021, TAVR accounted for 47.5% of AVR performed in patients under the age of 65 years.[2] Although initially seen as a cause for alarm given the lack of randomized data in patients in this age group, later data have confirmed that the treated patients were deemed by the valve team to be at increased risk for surgical complications.[3] Indeed, the concept of the patient-centric, multidisciplinary heart team may be one of the most important contributions that TAVR has bestowed upon the field.

MINIMALISTIC TAVR

As TAVR has become increasingly streamlined, the safety of minimalistic TAVR has been demonstrated.[4,5] The COVID pandemic and subsequent staff shortages brought a further impetus to move TAVR from the operating room to the cardiac cath lab to limit the size of the team involved and reduce length of stay. Structural volumes have also increased markedly, via expanding indications as well as the advent of new technologies. This has placed additional demands on the teams performing the procedures and created additional pressure on cath labs, imaging, and anesthesia.

TABLE 1. AN OPTIMAL TAVR SCHEDULE*

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7
Patient arrival	6:00	6:30	7:45	9:00	10:15	11:30	12:45
Anesthesia evaluation	6:45	8:15	9:30	10:45	12:00	13:15	14:30
Valve conference	7:00-7:30	–	–	–	–	–	–
Patient in room	7:00	8:30	9:45	11:00	12:15	13:30	14:45
Femoral access	7:30	8:45	10:00	11:15	12:30	13:45	15:00
Procedure completion	7:55	9:10	10:25	11:40	12:55	14:10	15:25
Transfer to holding	8:10	9:25	10:40	11:55	13:10	14:25	15:40
Ambulation	12:10	13:25	14:40	15:55	17:10	18:25	19:40
Potential discharge	14:10	15:25	16:40	17:55	19:10	20:25	–

*Longer procedure times may be needed in more complex cases, including alternative access, leaflet modification, etc. Fluctuations in staffing levels can also affect procedural turnaround.

Unique among the commonly performed structural procedures, TAVR is tied to a survival benefit, and TAVR delays carry a significant mortality risk for patients (3.7% per month in one series).[6] Aortic stenosis (AS) has been shown to be vastly underdiagnosed and undertreated, even in major academic institutions[7] and especially for underserved populations (in terms of sex, ethnicity, or socioeconomic background and also in terms of distance from TAVR centers).[8]

A range of interventions have been proposed to improve access to and the timeliness of treatment. Echo-mining software,[9] AI-assisted diagnostic algorithms,[10] automated referrals, and standardized echo reporting can facilitate getting patients to the heart team faster. Minimizing extraneous workup (eg, carotid duplex, pulmonary function test, urinalysis, coronary angiography) helps move patients from the heart team to treatment faster.[11-14] Minimalistic TAVR with limited anesthesia (nurse-administered sedation or monitored anesthesia care [MAC]) facilitates patient recovery and allows for faster room turnaround and treatment of more patients per day in one room.[15] Enhanced recovery protocols with ambulation as early as 2 to 4 hours postprocedure help expedite patient recovery and move the needle on reducing intensive care unit (ICU) usage and length of stay.[16] One-day lengths of stay are now becoming the norm in many institutions, and same-day discharge has been shown to be safe in carefully selected patients.[17,18]

THE BENCHMARK PROGRAM AT ALEXIAN BROTHERS MEDICAL CENTER

The structural program at Alexian Brothers started in 2014 with TAVR procedures performed under general anesthesia in the cardiac cath lab. The first patient was treated under MAC in 2016, and a hybrid room was built in 2019 in the cardiac cath lab. Our program was the first commercial site to adopt the Edwards Benchmark program in March 2020. The Edwards Benchmark program is designed to align the multidisciplinary heart team on the minimalist TAVR approach to improve the patient care pathway through evidence-based best practices and peer-to-peer guidance. The contemporaneous advent of the COVID epidemic spurred a need to bypass the ICU for the majority of patients and emphasize next-day discharge. To further reduce the risk of nosocomial COVID transmission, a same-day discharge program that had been started in 2011 for PCI was expanded to include a wide range of procedures, including left atrial appendage occlusion (LAAO), transcatheter edge-to-edge repair (TEER), endovascular aneurysm repair, and thoracic endovascular aortic repair. The same-day discharge program for selected TAVR patients was started in July 2020.

Our program has gradually moved our staffing for TAVR patients from a maximalist to a minimalist approach. We currently perform TAVR under MAC (generally provided by a certified registered nurse anesthetist), supported by a scrub tech, a circulating registered nurse, and a recorder; one additional staff member may be available to facilitate room turnaround. After valve deployment, an echo tech obtains limited images. We generally only evaluate for paravalvular leak and pericardial effusion; a more extensive evaluation involving ventricular ejection fraction and transaortic gradients is performed in the holding area after the patient has recovered from anesthesia and can get out of bed/turn on their side to facilitate imaging. A housekeeper is assigned to the cath lab to expedite room turnaround. Most patients are awake throughout the procedure and sedation is terminated the moment the valve is deployed, allowing for a brief neurologic examination to be performed on the table. Patient recovery can be completed in the procedure room. This allows for the anesthesia provider to evaluate the next procedure as the patient is undraped, Doppler pulses are

checked, and manual pressure is applied to the groin after administration of protamine (Table 1).

Since our program has transitioned to a limited staffing model for TAVR, we have seen no impact on outcomes and have observed an improvement in room turnaround. Our experience shows that additional staffing does not correlate with either increased safety or efficiency.

For most cases, only two ultrasound-guided access sites are obtained: femoral for the TAVR sheath and left radial for a pigtail. Most cases undergo pacing through the left ventricular wire, eliminating the need for another access site and risk of right ventricular injury from the pacing catheter. No central lines or Foley catheters are used.

In view of the known worse outcomes of patients who undergo emergent TAVR,[19] we try to avoid these procedures, performing balloon aortic valvuloplasty and offering patients a chance to rehab and recover from any acute comorbidities whenever possible before performing TAVR on a more elective basis.

Despite the surgical team and perfusion no longer being involved in the TAVR team for most patients, all patients are evaluated independently in the valve clinic by a cardiologist and a surgeon. Cases are discussed in the multidisciplinary valve conference on a weekly basis and a cardiologist and surgeon are present for every TAVR case. We consider the lifetime management of patients with AS for every valve implant—both surgical and transcatheter options.

Most patients require a single valve team visit, and the CT scan is performed the same morning. We generally maintain the ability to treat patients within 5 to 7 days of valve team evaluation. The brief procedure time and quick room turnaround allows our team to perform six to seven standard transfemoral TAVRs in one room in one day, and it facilitates ad hoc case additions on other days when needed.

Besides closely monitoring complications and STS/ACC TVT Registry database outcomes, the program conducts quarterly economic reviews. Although reimbursement and valve costs are outside most program's control, we closely monitor direct costs, including the cost and amount of equipment being used, general anesthesia use, ICU utilization, procedure time, time in room, room turnaround, length of stay, readmission rate, percentage of urgent TAVRs, and discharge destination.

THE ECONOMIC IMPACT OF A LEAN TAVR PROGRAM

As the field of structural interventions continues to expand, heart teams are required to participate in an ever-expanding range of procedures. TAVR, mitral and tricuspid TEER, LAAO, transcatheter tricuspid valve repair (TTVR), and transcatheter mitral valve repair (TMVR) procedures all compete for the same resources. At the same time, many programs are facing staffing challenges and high turnover, not only for cath lab staff but also for echo technicians, anesthesia providers, ICU, and general ward staff. Additionally, even as the population ages and cardiovascular diseases are projected to increase, the number of cardiologists retiring is outpacing the supply of new graduates.[20]

Improved diagnostics and the expansion of procedures to untreated populations—TAVR for asymptomatic AS, moderate AS, or aortic insufficiency; LAAO as first-line therapy for the prevention of cardio-embolic stroke in atrial fibrillation; percutaneous mitral valve replacement therapies—may add additional demands on already stretched providers and health systems. To accommodate the increasing demand for structural heart procedures, programs will need to increase capacity and decrease resource use, while maintaining outcomes, improving access to care, and minimizing patient wait times.

Implementing an efficient, minimalistic program that delivers good outcomes cannot be achieved overnight. This process needs to start with a strong administrator/physician leader dyad team and requires the participation of a range of stakeholders, including cardiologists, surgeons, anesthesiologists, and nursing. Transparency and data sharing on clinical and economic parameters is paramount, and savings need to return to the involved institutions and departments. Additionally, some redundancy needs to be maintained to account for inevitable surges in demand and decreases in staffing.

When confronted with the need for more streamlined procedures and economic efficiency, patient safety concerns are sometimes invoked. We now have solid clinical data demonstrating that minimalistic TAVR yields outcomes that are at least equivalent to traditional "maximalist" approaches. Enhanced recovery protocols have been widely adopted for surgical procedures and have improved patient outcomes while reducing length of stay.

Just because we have always done things this way does not mean that a better, more efficient way does not exist and should not be explored/adopted. At the same time, achieving economic efficiencies should never come at the expense of patient safety, and any deviation from prespecified safety endpoints should be closely scrutinized and addressed.

CONCLUSION

Since first becoming commercially available in the United States in 2012, TAVR has evolved considerably.

In an age of limited resources and increasing volumes for a wide variety of structural procedures, as well as new TAVR indications, programs need to be lean and efficient in order to thrive and accommodate growth. ■

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