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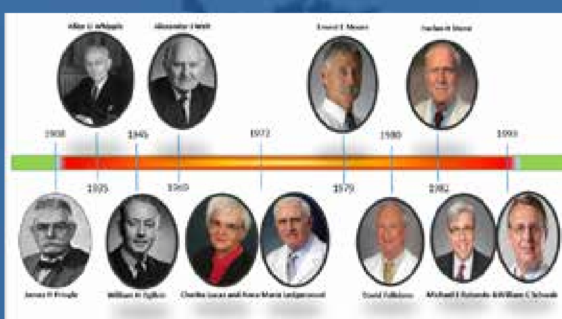
Milestones and Key Figures in the Development of Damage Control Surgery

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Transcatheter Aortic Valve Replacement for Severe Aortic Stenosis: A Review and Special Considerations

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Abstract
Introduction
Severe aortic stenosis is a prevalent and life-threatening disease among older adults. Transcatheter aortic valve replacement (TAVR) has transformed management across all surgical-risk categories, supported by clinical trial data and guideline recommendations. This review aims to summarize current indications, pre-procedural evaluation, and clinical outcomes of TAVR, and to highlight special considerations in access disparities, high-risk comorbid populations, antiplatelet strategies, and vascular complications.

Methods
This narrative review synthesizes guideline documents, landmark randomized trials, and selected meta-analyses published between 2010 and 2025. Additional focused evidence from four retrospective cohort studies was used to illustrate issues in geographic access, chronic obstructive pulmonary disease (COPD), dual antiplatelet therapy (DAPT), and vascular access complications.

Results
Guideline-directed criteria increasingly support TAVR across age and surgical-risk groups, with transfemoral access demonstrating the most favorable outcomes. Randomized trials consistently show comparable survival between TAVR and surgical aortic valve replacement (SAVR), with faster early recovery and improved early quality-of-life metrics. Complication profiles differ: TAVR reduces bleeding and atrial fibrillation but increases vascular injury, conduction disturbances, and paravalvular regurgitation. Special populations—including those with advanced COPD or remote geographic residence—derive meaningful benefit. DAPT before TAVR increases bleeding and may worsen survival, whereas vascular complications significantly affect early outcomes and are strongly predicted by anatomical factors such as sheath-to-femoral artery ratio.

Conclusions
TAVR provides excellent short- and mid-term outcomes for appropriately selected patients. Continued attention to anatomical planning, pre-procedural

optimization, and equitable access, along with long-term surveillance of valve durability, will shape future patient selection and procedural refinement.

Introduction

Severe aortic stenosis affects 1-2% percent of adults older than 65 years old and 12% of adults older than 75 years old in the United States.[1] Older age, male sex, hypertension, and diabetes are all risk factors for aortic stenosis. Untreated symptomatic severe aortic stenosis has a poor prognosis with a four-year mortality of approximately 50%. Despite high mortality rates, treatment rates for severe aortic stenosis remain low.[2] Over the past decade, there has been a notable shift in the treatment of severe aortic stenosis from surgical aortic valve replacement (SAVR) to transcatheter aortic valve replacement (TAVR). Initially, TAVR was reserved for patients at prohibitive or high surgical risk. More recently, robust evidence from randomized trials has led to the expansion of TAVR into intermediate- and low-risk populations as reflected in the current recommendations from the American College of Cardiology/American Heart Association and the European Society of Cardiology.[3-7] The purpose of this review is to discuss indications, pre-operative considerations, and current outcomes for TAVR. Additionally, special considerations will be discussed including inequality in access, challenges with difficult patient populations, and common vascular complications associated with TAVR.

Methods

This article was conducted as a narrative review to summarize contemporary evidence related to transcatheter aortic valve replacement (TAVR) for severe aortic stenosis. The first component of the review includes indications, pre-procedural evaluation, and major clinical outcomes, and was developed using a targeted evidence synthesis of guideline documents and landmark randomized trials.

To identify major clinical trials and guideline-relevant literature, a targeted PubMed search was subsequently conducted using search terms including "transcatheter aortic valve replacement," "TAVR randomized trial," "severe aortic stenosis," "guideline," and "meta-analysis." Sources informing this portion of the review included the 2020 ACC/AHA and 2021 ESC/EACTS valvular heart disease guidelines, landmark randomized controlled trials, and selected meta-analyses or systematic reviews published between approximately 2010 and 2025. Articles were included based on clinical relevance and contribution to current practice. Because this was a narrative review, no formal inclusion/exclusion criteria, risk-of-bias assessment, or systematic methodology was applied.

The second part of this review focuses on special populations and procedural considerations. The review was informed by four independent retrospective studies evaluating: (1) geographic and socioeconomic disparities in access to TAVR, (2) outcomes and quality-of-life changes among patients with chronic obstructive pulmonary disease, (3) the impact of pre-procedural dual antiplatelet therapy on bleeding, transfusion, and survival, and (4) anatomical and procedural predictors of peripheral vascular complications. These studies were not identified through the general literature search described above but were incorporated because of their direct relevance to contemporary clinical practice and their focus on specific, high-risk or underserved patient groups.

This approach is consistent with the goals of a narrative clinical review: to integrate guideline-based recommendations, influential clinical trials, and meaningful contemporary cohort studies into a comprehensive and clinically useful synthesis of current TAVR practice.

Results

Indications for TAVR

The 2020 American Heart Association/American College of Cardiology (AHA/ACC) and 2021 European Society of Cardiology (ESC) guidelines on valvular heart disease provide age- and risk-stratified indications for transcatheter aortic valve replacement (TAVR) in severe aortic stenosis. The AHA/ACC and ESC both define severe aortic stenosis by an aortic valve area ≤1.0 cm², mean gradient ≥40 mm Hg, or peak velocity ≥4.0 m/s.[8] For symptomatic severe aortic stenosis, both societies recommend TAVR in patients who are inoperable or at high surgical risk. Surgical risk is based off Society for Thoracic Surgeons Predicted Risk of Mortality (STS-PROM) calculator (estimated surgical mortality >8% for high risk), frailty (≥2-4 indices, Katz Index), and specific major organ compromise (≥3 organ systems). In asymptomatic severe aortic stenosis, both guidelines recommend valve replacement (TAVR or SAVR) for patients with left ventricular ejection fraction <50%, abnormal exercise testing, or other indications for cardiac surgery.[6-7]

For age-stratified indications, the AHA/ACC guidelines recommend TAVR for patients aged ≥80 years regardless of surgical risk.[6] For ages 65 to 80 years, TAVR or surgical aortic valve replacement (SAVR) are both indicated based on individual patient factors including anatomical suitability, vascular access, comorbidities, frailty, local expertise, and patient preference. A multidisciplinary heart team is required to determine the optimal approach and to fairly inform patients of treatment options. For younger patients (less than 65 years old), concerns about long-term valve durability exist and SAVR should be strongly considered. Patient preference and the need for lifelong anticoagulation with mechanical valve replacement however mandate thorough discussion options with a heart team comprised of both cardiologists and surgeons. The ESC guidelines recommend TAVR for patients aged ≥75 years regardless of risk.[7] In patients <75 years, SAVR may be preferred if surgical risk is low (STS-PROM <4%). These guidelines are summarized in **Table 1**.

For special populations, the ACC/AHA and ESC/EACTS guidelines recommend guidance from a comprehensive heart team, anatomical considerations, and an individualized lifetime strategy when choosing between TAVR and SAVR.[6-7] In bicuspid aortic valves (BAV), TAVR may be considered if the anatomy is suitable or patient is older with a BAV. SAVR is preferred when anatomy not suitable or concomitant aortopathy or aneurysmal disease is present. For failed surgical bioprosthesis, TAVR is appropriate as redo surgical valve replacement increases risk if previous valve is appropriate size. If surgical valve needs correction due to prosthesis-patient mismatch (PPM), then SAVR is recommended to replacement.[9] Lastly, low-flow aortic stenosis follows same recommendations as high-grade severe aortic stenosis once severity is confirmed.[10]

Pre-Procedural Assessment and Management

The pre-procedural TAVR assessment is centered around the multidisciplinary heart team composed of cardiologists, interventional cardiologists, cardiac surgeons, imaging, cardiac anesthesia, and nursing.[11] The specific tasks of heart team are to review the patient's medical condition and severity of valve abnormality, which interventions are indicated and feasible, and to discuss the risk and benefits with patient and family for a shared decision on treatment.

The diagnostic evaluation for TAVR includes three essential modalities: echocardiography, computed tomography (CT) angiography, and coronary angiography.[11] Echocardiography measures the aortic valve area, mean gradient across aortic valve, left ventricular function, presence of mitral or tricuspid insufficiency, and pulmonary pressures to confirm the severity of the aortic stenosis. Dobutamine stress echocardiography or CT calcium scoring can be used in low-flow aortic stenosis to assess

Table 1. United States Versus European Guideline Recommendations for Severe Aortic Stenosis

Category	2020 AHA/ACC[6]	2021 ESC/EACTS[7]
Indication for Intervention	Severe symptomatic AS or severe AS with LVEF <50%	Severe symptomatic AS or severe AS with LVEF <50%, abnormal exercise test, or rapid progression
Preferred Intervention:		
Low Surgical Risk	SAVR if <65 years or life expectancy >10 years	SAVR if <75 years and low surgical risk
High Surgical Risk	TAVR preferred regardless of age	TAVR preferred if ≥75 years or high surgical risk
Intermediate Surgical Risk	Either TAVR or SAVR (shared decision-making)	Either TAVR or SAVR for intermediate risk (age & anatomy dependent)
Age Considerations	TAVR favored if ≥80 years; SAVR if <65 years	TAVR favored if ≥75 years; SAVR if <75 years
Heart Team Recommendation	Multidisciplinary Heart Team essential	Heart Team assessment mandatory

Comparison of 2020 AHA/ACC and 2021 ESC/EACTS guideline recommendations for intervention in severe aortic stenosis, highlighting differences in indications, preferred approaches, surgical risk stratification, age considerations, and the role of the Heart Team.[6-7]

the severity of valvular abnormality. Stress testing is useful in asymptomatic aortic stenosis to unmask symptoms. CT angiography measures the aortic dimensions of annulus, leaflet, left ventricular outflow root. Additionally, the valve morphology, coronary ostial height, sinotubular junction size, and peripheral vessel suitability are all assessed. These measurements guide valve size and procedural accessibility. Coronary angiography is used to evaluate for coronary artery disease (CAD). For patients with low CAD probability, computed tomographic angiography may be used, although cardiac catheterization is preferred in our practice. Invasive angiography is useful to guide revascularization in significant left main disease before TAVR. If complex left main or multivessel CAD is present, then CABG and SAVR are recommended over TAVR and percutaneous coronary intervention. The management of significant concomitant coronary disease is a matter of controversy, and for patients with extensive disease, SAVR plus coronary artery bypass may be preferred. Isolated or single vessel disease may be treated with percutaneous intervention, recognizing that PCI mandates dual antiplatelet therapy which must be managed at the time of TAVR. This special consideration will be more fully discussed.

Risk is assessed by several modifiers including frailty, cognition, functional status, social support, and risk for delirium.[11] Anatomical considerations including low coronary ostial height, annulus size discrepancy, severe asymmetric calcification, unfavorable BAV, and small failed surgical valves favor a SAVR over TAVR strategy. Cardiac risk factors including left ventricular dysfunction, pulmonary hypertension, concomitant valve disease, porcelain aorta, or previous sternotomy and non-cardiac factors including chronic kidney disease (CKD) and pulmonary disease help inform both the risk and appropriate anesthesia for the procedure.

Clinical Outcomes

Transcatheter aortic valve replacement (TAVR) has progressed from an intervention reserved for high-risk patients to an established treatment option for severe aortic stenosis across all surgical risk categories and more recently for asymptomatic patients with severe aortic stenosis. Early studies in inoperable and high-surgical-risk patients demonstrated a significant survival benefit compared with surgical aortic valve replacement (SAVR), a benefit that persisted for at least five years.[12-13] As seen in **Table 2**, subsequent randomized trials expanded TAVR's use to intermediate- and low-risk populations, showing outcomes comparable to those of surgery.[3–5,14-15]

Mortality and disabling stroke have been primary endpoints across multiple randomized controlled trials. In low-risk patients, early reductions in all-cause mortality or disabling stroke have been observed with TAVR.[5,14] These advantages tend to diminish over the mid-term (2–5 years), with stroke incidence remaining similar in

Table 2. Major Clinical Trials Comparing TAVR versus SAVR Including Outcomes

Trial	Population	Comparison	Major Outcome(s)	Key Finding
PARTNER 1[13]	High-risk severe AS	TAVR vs SAVR	All-cause mortality at 1 yr	TAVR non-inferior to SAVR; reduced hospital stay
PARTNER 2A[3]	Intermediate-risk severe AS	TAVR vs SAVR	Death or disabling stroke at 2 yrs	TAVR non-inferior; transfemoral access superior to SAVR
PARTNER 3[4]	Low-risk severe AS	TAVR vs SAVR	Death, stroke, or re-hospitalization at 1 yr	TAVR superior to SAVR; faster recovery
CoreValve High Risk[15]	High-risk severe AS	TAVR vs SAVR	All-cause mortality at 1 yr	TAVR superior to SAVR
SURTAVI[19]	Intermediate-risk severe AS	TAVR vs SAVR	Death or disabling stroke at 2 yrs	TAVR non-inferior; lower atrial fibrillation, higher pacemaker rates
Evolut Low Risk[14]	Low-risk severe AS	TAVR vs SAVR	Death or disabling stroke at 2 yrs	TAVR non-inferior; better early QoL, higher pacemaker rates

Summary of major randomized trials comparing TAVR and SAVR across surgical risk groups, highlighting study populations, outcomes, and key findings.[3-4,13-15,19] the long term.[5] However, recent data suggest a sustained hazard reduction at five years in favor of TAVR among low-risk patients.[16] In intermediate-risk patients, mortality and disabling stroke rates remain comparable through five years.[17–20] Other important outcomes, including myocardial infarction, endocarditis, and prosthetic valve thrombosis also appear similar between TAVR and SAVR over this time frame.[21–23] Rehospitalization rates favor TAVR early in low-risk patients but may be higher at five years in intermediate-risk cohorts.[5,19] Contrary to other studies, a recent meta-analysis showed increased rates or transient ischemic attacks in TAVR with no differences in hospital rates at two years.[21]

Quality-of-life data consistently show faster early recovery and superior patient-reported outcomes with TAVR at one month.[5] By one year and through five years, improvements in New York Heart Association (NYHA) functional class and Kansas City Cardiomyopathy Questionnaire (KCCQ) scores are similar between TAVR and SAVR.[24] This is true for patients with significant concomitant medical problems such as obstructive lung disease (discussed below).

Periprocedural and early postprocedural complications differ between the modalities. TAVR is associated with lower rates of acute kidney injury, major or life-threatening bleeding and new-onset atrial fibrillation, but higher rates of vascular complications, permanent pacemaker implantation, and paravalvular regurgitation.[17,19,25] Transfemoral access yields the most favorable outcomes, whereas transthoracic approaches generally underperform compared with SAVR.[17] Hemodynamic performance with TAVR typically includes larger valve areas and similar gradients compared with SAVR, although paravalvular leak remains more common.[18] Structural valve deterioration and bioprosthetic valve failure rates appear similar in contemporary devices, though some meta-analyses note higher late rehospitalization and reintervention rates in intermediate-risk patients undergoing TAVR.[21]

Patient access to TAVR

Access to complex medical procedures is not equal in the United States. Socioeconomic, racial and geographic disparities exist when caring for patients with heart disease and for patients requiring complex medical care at tertiary centers, access may be compromised. TAVR is an example of a cardiac procedure requiring extensive preoperative testing and is done in centralized, high-volume centers with access to specialists. Tupa et al. (2024) examined whether rural location and social vulnerability influence outcomes of patients undergoing transcatheter aortic valve replacement (TAVR), as TAVR is not only the predominant therapy for severe aortic stenosis, but requires complex preoperative evaluation typically available at tertiary care centers.[26] This raises concerns about access and outcomes for patients in remote or disadvantaged areas.

The authors retrospectively reviewed 1,565 patients who underwent TAVR at a single tertiary care referral center in North Dakota between 2012 and 2023.[26] Geographic remoteness was measured by distance from the implanting center, while social vulnerability was quantified using the CDC Social Vulnerability Index (SVI). Primary outcomes, defined by the Valve Academic Research Consortium-3, included stroke, myocardial infarction (MI), transient ischemic attack/delirium, pacemaker implantation, and atrial fibrillation/flutter. Wait times between preoperative testing (coronary angiography [CATH] and computed tomography angiography [CTA]) and TAVR were also analyzed. Survival probabilities were estimated using Kaplan-Meier methods.

The study population consisted mainly of older adults, with an average age of 79 years.[26] The majority were male (58%) and White (98%), and their mean Society of Thoracic Surgeons (STS) risk score was 4.2%. Geography played an important role in patient experience. Those who lived farthest from the implant site faced longer delays between their diagnostic catheterization (CATH) and the transcatheter aortic valve replacement (TAVR). On average, their wait time was nine days longer compared to patients who lived closer to the center (78 versus 69 days). In contrast, the interval from computed tomography angiography (CTA) to TAVR did not vary significantly by distance. Social factors also influenced wait times. Patients from regions with higher social vulnerability index (SVI) scores tended to wait about a week longer for TAVR after CATH compared to patients from less vulnerable areas. However, CTA-to-TAVR wait times remained consistent regardless of SVI category.

Despite these disparities in timing, clinical outcomes were largely similar across groups.[26] Rates of stroke, atrial fibrillation, pacemaker implantation, and overall survival showed no significant differences based on either geography or social vulnerability. Interestingly, patients who lived closer to the implant center had nearly double the incidence of myocardial infarction compared to those living farther away. Survival outcomes over time revealed further insights. Medium-term survival, measured at five years, did not differ significantly across distance or SVI groups. However, by the ten-year mark, patients who experienced longer waits between CATH and TAVR had the lowest survival rates, underscoring the importance of minimizing procedural delays. Unexpectedly, long-term survival was actually higher among patients living farthest from the implant center.

Patients with chronic obstructive pulmonary disease

Schwartz et al. investigated the relationship between chronic obstructive pulmonary disease (COPD) severity and outcomes after transcatheter aortic valve replacement (TAVR).[27] COPD is a frequent comorbidity in patients with severe aortic stenosis and often contraindicates surgical valve replacement, making TAVR an important therapeutic alternative. However, the degree to which COPD severity influences procedural risks, survival, and quality of life (QoL) after TAVR remains unclear. This retrospective study reviewed 1,565 patients who underwent TAVR at Sanford Health (Fargo, ND) between 2012 and 2023. Of these, 1,273 patients had preoperative pulmonary function testing and were categorized into COPD severity groups using Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria (none, mild, moderate, severe, very severe). Additional analyses stratified patients by home oxygen use. Clinical outcomes included stroke, transient ischemic attack, pacemaker implantation, atrial fibrillation, myocardial infarction (MI), and mortality at 30 days and 1 year. QoL was assessed with the Kansas City Cardiomyopathy Questionnaire (KCCQ) preoperatively, and at 30 days and 1-year post-procedure.

Increasing COPD severity correlated with higher rates of new-onset atrial fibrillation and myocardial infarction ($p = 0.0046$ and $p = 0.0342$, respectively).[27] Severe and very severe COPD patients experienced the highest rates of these complications. Stroke, pacemaker implantation, and transient ischemic attack did not significantly differ by severity. Additionally, there were no statistically significant differences in 30-day ($p = 0.5281$) or 1-year mortality ($p = 0.1369$) among GOLD severity groups. However, patients on home oxygen had higher 1-year mortality (16.6% vs. 10.0%, $p = 0.0163$) and significantly worse long-term survival.

TAVR did improve the quality of life for patients with COPD. All groups experienced improved KCCQ scores after TAVR.[27] Patients with severe COPD demonstrated the greatest improvements in QoL at both 30 days and 1 year, while those with very severe COPD showed the least. Patients on home oxygen started with lower baseline QoL scores but achieved greater relative gains compared to those not requiring oxygen**.**

Patients on anti-platelet therapy

While transcatheter aortic valve replacement (TAVR) is becoming the standard of care for older patients with severe aortic stenosis, management of concomitant coronary artery disease remains a particular challenge for those patients who do not undergo surgical AVR plus coronary artery bypass grafting. Patients with concomitant coronary artery disease (CAD) also frequently undergo percutaneous coronary intervention (PCI), necessitating dual antiplatelet therapy (DAPT), prior to TAVR. This introduces a clinical dilemma, as DAPT may elevate bleeding and transfusion risk during TAVR.

In a retrospective study, Matter et al evaluated the impact of preoperative antiplatelet therapy on bleeding complications, transfusion needs, and long-term survival following TAVR.[28] This retrospective cohort study included 1,116 patients who underwent TAVR between 2012 and 2021. Patient antiplatelet regimens were categorized as aspirin monotherapy, clopidogrel DAPT, ticagrelor DAPT, or no therapy. Bleeding complications were classified using Bleeding Academic Research Consortium (BARC) criteria per Valve Academic Research Consortium-3 (VARC-3) standards. Overall, 248 patients were on DAPT, while 276 received no antiplatelet therapy and 504 received aspirin monotherapy. Patients receiving DAPT were more often female and had higher prevalence of hyperlipidemia, CAD, and peripheral vascular disease. Procedural complications such as myocardial infarction, stroke, pacemaker implantation, or atrial fibrillation did not significantly differ across groups.

Patients on DAPT prior to TAVR experienced more bleeding and transfusions.[28] Transfusions were required in 9.4% (n=105), with most occurring within 24 hours post-TAVR. Patients on DAPT—particularly ticagrelor (26.3%)—demonstrated significantly higher transfusion rates compared to clopidogrel (12.8%), aspirin (7.9%), or no therapy (9.2%). Aspirin alone did not significantly increase transfusion risk. Severe BARC type 3 bleeding was most common among ticagrelor-treated patients.

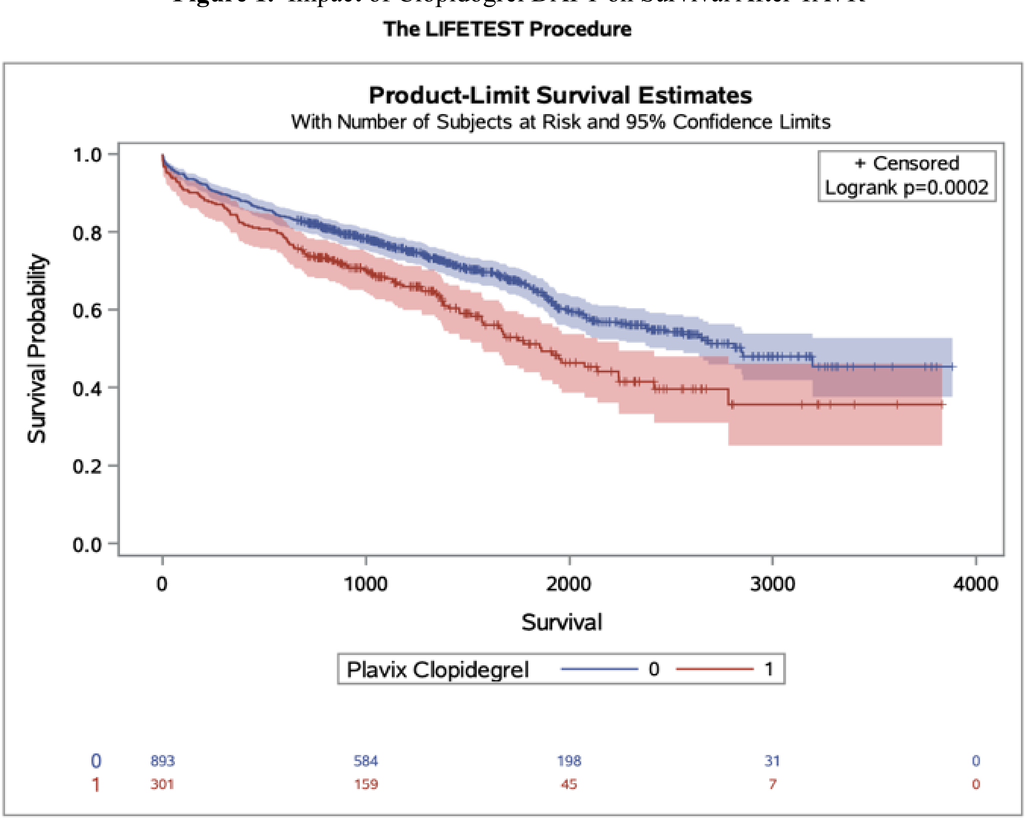
DAPT also negatively impacted survival after TAVR.[28] As seen in **Figure 1**, Kaplan-Meier survival curves demonstrated significantly reduced long-term survival in patients on DAPT (median 5.1 years) compared with those on aspirin or no therapy (median 7.8 years; $p<0.01$). The survival difference became evident beyond the first-year post-procedure. Severe bleeding independently predicted decreased survival, though no difference in 30-day or 1-year mortality was observed. Medium-term (3-year) survival was notably worse in patients who required transfusions or experienced bleeding complications. Preoperative DAPT significantly increases peri-procedural bleeding and transfusion risk in TAVR patients, which negatively influences long-term survival. While aspirin alone is safe and does not elevate bleeding risk, DAPT nearly doubles transfusion rates and is linked to reduced survival.

Considerations for the vascular and general surgeon: peripheral vascular complications

Aortic root complications are a dreaded and lethal complication of transcatheter aortic valve replacement which fortunately occur rarely. Peripheral vascular complications during TAVR are much more common, occurring in 5-7% of patients, and while less lethal, do significantly contribute to in-hospital morbidity and length of stay.[29] Additionally, vascular and general surgeons may find themselves involved with these patients and should be aware of factors influencing peripheral vascular complications. Vascular access complications such as dissection, perforation, hematoma, pseudoaneurysm, or occlusion are associated with increased morbidity, need for surgical or endovascular intervention, prolonged hospitalization, and higher morbidity. Identifying predictors of vascular complications is therefore essential for risk stratification, patient counseling, and procedural planning.

Prior studies have explored clinical, anatomical, and procedural risk factors for vascular complications, but findings have often been inconsistent or limited by smaller cohorts. Row et al have examined factors influencing peripheral vascular complications in a large, single-center experience.[29] This retrospective study analyzed 1,565

Figure 1. Impact of Clopidogrel DAPT on Survival After TAVR



Kaplan–Meier survival analysis comparing patients who received clopidogrel (red) versus those who did not (blue) following transcatheter aortic valve replacement (TAVR).[28] Patients on clopidogrel demonstrated significantly reduced long-term survival, with separation of the curves evident early and persisting throughout follow-up (Log-rank $p = 0.0002$). Shaded regions represent 95% confidence intervals, and tick marks indicate censored observations.

patients who underwent transcatheter aortic valve replacement between August 2012 and June 2023, with a focus on vascular access complications classified according to the Valve Academic Research Consortium-3 (VARC-3) criteria. Complications were categorized as major or minor, and predictors were assessed through univariate and multivariate logistic regression. Kaplan–Meier survival analyses were conducted to examine the association between vascular complications and long-term outcomes.

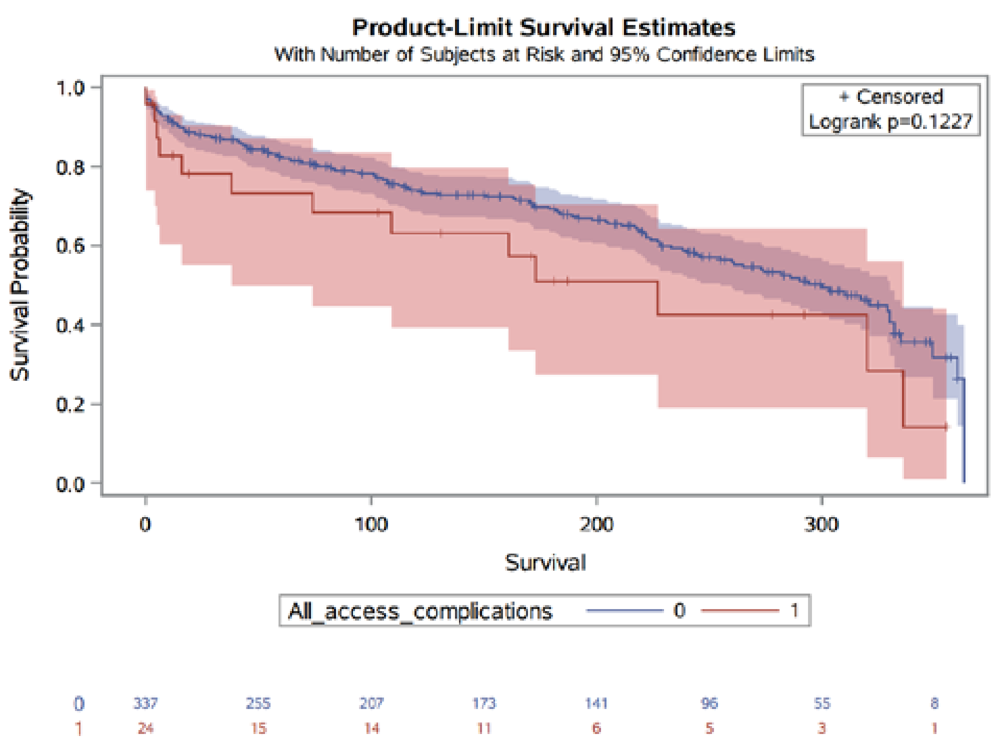
Vascular access complications occurred in 10.5% of patients (n=165), including 6.1% major and 4.4% minor events.[29] The majority of cases were managed percutaneously, although some required surgical intervention or transfusion. The mean age was 79 years, with 57.7% male and 42.3% female participants. Traditional cardiovascular comorbidities such as diabetes, hypertension, and coronary artery disease were common but did not independently predict complications. In contrast, female sex emerged as a significant risk factor, likely related to smaller vessel diameters relative to body surface area. Peripheral vascular disease was also strongly associated with vascular complications, emphasizing the influence of underlying arterial pathology.

Row et al identified several preoperative anatomic predictors of peripheral vascular complications in patients undergoing TAVR.[29] Key anatomical risk factors included smaller iliofemoral vessel diameters, and the sheath-to-femoral artery ratio (SFAR) was one of the strongest predictors, with ratios exceeding 1.05 significantly increasing the risk of dissection, rupture, or sheath advancement failure. Posterior vessel wall calcification and overall atherosclerotic burden were also highly predictive of complications, while tortuosity contributed additional, albeit weaker, risk. Left sided transfemoral access was associated with a higher incidence of complications as well. As seen in **Figure 2**, patients experiencing major vascular complications had significantly higher in-hospital and 30-day mortality rates. Long-term survival was also adversely affected, although differences diminished beyond the first year. In addition, vascular complications were associated with increased transfusion requirements, prolonged hospitalization, and greater likelihood of conversion to open repair.

Discussion

In this narrative review, the available clinical outcomes evidence demonstrates that TAVR offers comparable

Figure 2: One-Year Survival Curve: Impact of Vascular Complications



Kaplan–Meier survival analysis demonstrating one-year survival following the procedure. No significant difference in survival at one year for those with vascular access complications compared to those without.[29]

survival to SAVR, rapid symptomatic relief, and sustained quality-of-life benefits for patients with severe aortic stenosis across the spectrum of surgical risk, and with more rapid and easier recovery. The complication profile differs from surgery, with trade-offs between reduced bleeding and atrial fibrillation versus increased vascular injury and paravalvular regurgitation. As the procedure expands into younger, lower-risk populations, extended follow-up will be essential to determine long-term valve durability, refine patient selection, and optimize lifetime management strategies.

The geographic disparity findings indicate that geographic remoteness contributes to modestly longer preoperative evaluation times, but it does not compromise procedural safety or short-term survival.[26] Social vulnerability had minimal impact on access or outcomes, suggesting that in a rural state such as North Dakota, distance rather than socioeconomic factors is the dominant barrier. Crucially, extended preoperative wait times were associated with worse long-term survival, underscoring the need for streamlined referral pathways, improved coordination with local facilities, and the use of telemedicine to reduce delays. TAVR is safe and effective for patients across geographic and socioeconomic spectra. While remoteness slightly delays care, it does not adversely affect short- or medium-term outcomes. The most significant determinant of long-term survival is the duration of preoperative evaluation, highlighting the necessity of minimizing delays between diagnostic workup and valve implantation.

COPD severity increases the risk of certain adverse outcomes (notably atrial fibrillation and MI), it does not significantly influence short-term or one-year mortality following TAVR.[27] Long-term mortality was higher in patients with very severe COPD and in those requiring home oxygen, likely reflecting the systemic burden of COPD rather than TAVR-specific risks. Importantly, TAVR consistently improved QoL across all COPD severities, with the most substantial benefits observed in patients with severe disease. This suggests that even patients with advanced COPD can derive meaningful symptomatic and functional improvement from the procedure and that TAVR is a safe and effective intervention for patients with severe aortic stenosis and COPD, regardless of COPD severity. These findings support offering TAVR to patients with COPD patients and not withholding TAVR from patients even with advanced disease

DAPT usage with TAVR have significant clinical implications regarding the treatment of concomitant coronary artery disease. Pre-TAVR PCI commits the patient to DAPT which must be managed at the time of TAVR to avoid bleeding. Strategies such as performing TAVR prior to PCI, shortening DAPT duration, or transitioning to aspirin monotherapy may mitigate bleeding risk without compromising procedural safety. Clinical decision-making should carefully weigh the timing of PCI and antiplatelet strategies to minimize peri-procedural complications while preserving long-term outcomes. Future prospective studies are warranted to refine guidelines and establish optimal antiplatelet regimens for TAVR candidates.

Given the adverse impact of major vascular complications on short-term outcomes, emphasis should be placed on prevention through meticulous preprocedural imaging, patient counseling, and team-based decision-making. Maintaining an SFAR $\leq$ 1.05 should guide device and access route selection. In patients at high risk, alternative access strategies and newer-generation, lower-profile devices may mitigate complications. Overall, this study reinforces the critical importance of anatomy-driven procedural planning in TAVR and highlights avenues for future research, including novel access techniques, sheath design, and closure technologies to reduce vascular complications.

The evidence supports TAVR as a safe option across all risk groups and select patient populations for severe aortic stenosis. There are many factors that influence whether TAVR is the best option for the patient depending on anatomic suitability, concomitant aortic disease, surgical risk, and risk for bleeding a dual anti-platelet therapy among other factors. This emphasizes the role of a comprehensive heart team and shared decision-making necessary in the pre-operative evaluation. The pre-operative planning is particularly important in younger patients with severe aortic stenosis for optimal lifetime manage of their disease. Looking forward, future research should evaluate the long-term durability in younger patients, optimizing antithrombotic therapy, device profile improvements to reduce vascular complications, and models to reduce geographic disparities that delay care in patients receiving TAVR. This study in is limited by non-systematic review of severe aortic stenosis in TAVR, possible omission of small or unpublished datasets, and reliance on observation data in special populations.

Conclusion

Transcatheter aortic valve replacement has emerged as a suitable option for severe aortic stenosis, supported by strong evidence across low-, intermediate-, and high-risk populations. Contemporary data confirm that TAVR provides rapid recovery, meaningful symptomatic improvement, and durable mid-term outcomes when used in carefully selected patients. Its expanding use in younger and lower-risk groups highlights the importance of rigorous anatomical assessment, multidisciplinary decision-making, and lifetime management planning. Evidence from special populations reinforces that TAVR remains safe and effective even in patients with complex comorbidities, provided procedural considerations are tailored appropriately. As long-term durability data continue to emerge, ongoing refinement of antithrombotic strategies, vascular access planning, and pathways to reduce pre-procedural delays will remain essential. Ensuring equitable access and optimizing outcomes across diverse patient groups should guide the next phase of TAVR innovation and practice.

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