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REVIEW ARTICLE

Comparative Outcomes of Transcatheter Versus Surgical Aortic Valve Replacement in Elderly Patients With Severe Symptomatic Aortic Stenosis: A Systematic Review

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Abstract

Objectives: **Aortic stenosis is the most common valvular heart disease globally; while transcatheter aortic valve replacement (TAVR) has proven to be a competitive alternative to surgical aortic valve replacement (SAVR) and revolutionized treatment, its safety and efficacy has yet to be comprehensively assessed against SAVR for certain subsets of aortic stenosis patients; therefore, this study aims to systematically analyze all the available clinical evidence from randomized clinical trials on TAVR versus SAVR among intermediate and low-risk patients with severe symptomatic aortic stenosis.**

Methodology: **We performed a systematic review of the randomized controlled trials (RCT), studies comparing TAVR and SAVR in low- and intermediate-risk patients were identified by a comprehensive search of the major databases. Mortality, stroke, length of stay, and other perioperative outcomes were assessed.**

Results: **A comprehensive screening of 14,384 records identified 9 studies, encompassing 8884 patients with a mean age of 77.76 years and 49.47% male. TAVR demonstrated a significantly lower all-cause mortality at both 30 days and 1 year compared to SAVR, with comparable outcomes at 2 years, underscoring its potential for enhanced survival. Stroke incidence was markedly lower with TAVR at both 30 days and 1 year, highlighting its favorable neurological safety profile. Additionally, TAVR showed a reduced rate of myocardial infarction within the initial 30 days post-procedure. Prosthetic valve endocarditis rates remained low and comparable between the two approaches at both 30 days and 1 year. Notably, TAVR was associated with a significantly shorter hospital stay, suggesting a faster recovery trajectory and improved patient throughput. These findings collectively emphasize the superior efficacy and safety profile of TAVR over SAVR.**

Conclusion: **TAVR may serve as a viable therapeutic option for intermediate and low-risk patients with severe symptomatic aortic stenosis. Future research should focus on long-term outcomes and TAVR device durability, especially in younger, lower-risk populations.**

Keywords: Aortic stenosis, Transcatheter aortic valve replacement, Surgical aortic valve replacement, Mortality, Stroke

1. Introduction

Valvular heart disease (VHD) is the leading cause of global cardiovascular morbidity and mortality and represents a major threat to the quality of life of individuals, predisposing them to functional disability and worsening life expectancies [1]. According to the Euro Heart Survey on Valvular Disease, Aortic stenosis (AS) in particular is the most common VHD in economically-developed countries, and its prevalence continues to increase as the population ages [2]; while the prevalence of aortic stenosis in patients over 75 years of age is around 40% [3], only 2% end up progressing to hemodynamically-significant AS [4]. Concerningly, the number of DALYs has especially increased for

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calcific aortic valve disease (CAVD) by 101% as reported by the Global Burden of Disease study in 2017 [5]. If left untreated, severe symptomatic AS is associated with a poor prognosis and an average survival of no more than 3 years only [6].

For many decades, surgical aortic valve replacement (SAVR) has been the golden-standard modality of choice, although numerous patients have historically been considered unfit for the surgery and due to real or perceived risks, were rejected treatment [7,8]. Therefore, ever since its introduction back in 2002, transcatheter aortic valve replacement (TAVR) has emerged as a highly-efficacious percutaneous alternative that has replaced SAVR in many regards, particularly for patients with high and intermediate-risk severe symptomatic AS [9–11]. It is considered to be the more preferable treatment option for this subset of patients as determined by the Society of Thoracic Surgeons Predicted Risk of Mortality (STS-PROM). Furthermore, the 2020 American Heart Association (AHA) Valvular Guidelines have given TAVR a class I recommendation for symptomatic patients of any age with severe AS and high/prohibitive surgical risk [12].

However, there's still insufficient data on the efficacy & complications of TAVR in low & intermediate-risk patients with severe AS; this presents a new dilemma as the consensus remains unclear on whether or not SAVR should still be incorporated in the treatment plan of low surgical risk AS patients, since recently published data from large randomized controlled trials (RCT) have shown favorable outcomes with TAVR [11,13]. Our systematic review and meta-analysis aims to address this issue, which is of high clinical importance, by building upon previous knowledge and shedding light on the different aspects of TAVR vs. SAVR in intermediate and low-risk patients, ranging from all-cause mortality & the risk of different cardiovascular complications to the length of stay, most of which have only been dealt with briefly in previous review studies.

List of abbreviations

AHA	American Heart Association
AS	Aortic Stenosis
CABG	Coronary Artery Bypass Graft
CAVD	Calcific Aortic Valve Disease
CINAHL	Cumulative Index to Nursing and Allied Health Literature
COPD	Chronic Obstructive Pulmonary Disease
ICU	Intensive Care Unit
LOS	Length of Stay
MI	Myocardial Infarction
NOTION	Nordic Aortic Valve Intervention Trial
NYHA	New York Heart Association
PARTNER	Placement of Aortic Transcatheter Valves
PCI	Percutaneous Coronary Intervention
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROM	Patient-Reported Outcome Measures
PVE	Prosthetic Valve Endocarditis
RCT	Randomized Controlled Trial
ROB	Risk of Bias
SAVR	Surgical Aortic Valve Replacement
SD	Standard Deviation
STACATTO	Study of Transcatheter Aortic Valve Implantation vs. Surgical Aortic Valve Replacement
STS	Society of Thoracic Surgeons
SURTAVI	Surgical Replacement and Transcatheter Aortic Valve Implantation
TAVR	Transcatheter Aortic Valve Replacement
UAE	United Arab Emirates
VHD	Valvular Heart Disease

2. Methodology

We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses statement guidelines (PRISMA) during the preparation of this systematic review in reporting our methodology and findings.

2.1. Criteria for considering studies for this review

The following criteria were applied for study inclusion: (1) randomized clinical trials; (2) comparing TAVR and SAVR; (3) population consists of elderly patients (typically aged 70 years and older) with severe symptomatic aortic stenosis, varying from low to intermediate surgical risk; (4) reporting outcomes such as all-cause mortality, stroke, prosthetic valve endocarditis, and length of hospital stay. We excluded non-randomized studies, animal studies, non-English publications, case reports, case series, editorials, reviews, and theses without original data.

2.2. Search strategy

To identify all the clinical trials comparing TAVR and SAVR in elderly patients with severe symptomatic aortic stenosis, varying from low to intermediate surgical risk, we conducted a systemic literature search in several medical databases. The databases included PubMed, Scopus, Ovid, CINAHL, and ProQuest through July 2024. The search strategy involved the use of specific keywords and Medical Subject Headings (MeSH) terms related to our study objectives. The search terms included “Transcatheter Aortic Valve Replacement,” “Transcatheter aortic valve implantation,” “Surgical Aortic Valve Replacement,” “Surgical aortic valve implantation,” “Cost-Effectiveness,”

"Health Economics," "complications," "Stroke," "Endocarditis," and "Mortality."

2.3. Selection of studies

The screening process involved two independent reviewers and was conducted in two stages: initially, titles and abstracts of retrieved studies were assessed for relevance, followed by a detailed review of the full texts of studies that appeared potentially eligible. Any disagreements between reviewers were resolved through discussion.

2.4. Data extraction

Three authors independently extracted data using an online data extraction form. The extracted data were categorized into the following areas: 1) **Study Design and Characteristics**, including details about the study type and key methodological aspects; 2) **Baseline Characteristics of the Population**, including demographic and clinical details such as age, sex, and comorbidities; 3) **Quality Assessment** using the Cochrane Risk of Bias (ROB 1) tool; and 4) **Outcomes**, including mortality rates at 30 days, 1 year, and 2 years, as well as the incidence of myocardial infarction (MI) and stroke, and the length of hospital stay.

2.5. Quality assessment of the included studies

Two authors independently evaluated the quality of the included RCTs using the Cochrane Risk of Bias (ROB 1) tool to evaluate the following seven items: randomization sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, and other bias. Any discrepancies in the assessments were resolved through discussion.

2.6. Dealing with missing data

In cases where the mean and standard deviation (SD) were not reported, we calculated these values using the median, interquartile range, and sample size, according to the methodology outlined by Wan et al. (2014) [14].

3. Results

3.1. Study selection

A total of 14,384 records were identified. There were no additional records identified through other sources. After removing 4875 duplicates, 9509 records remained for screening. During the screening process, 9484 records were excluded based on title and abstract. The full texts of 25 articles were assessed for eligibility, resulting in the exclusion of 16 articles due to incorrect study design. Finally, 9 studies met the inclusion criteria and were included in the systematic review. The detailed study selection process is illustrated in Fig. 1, the PRISMA flow diagram.

3.2. Study characteristics

A total of 9 studies were included in this systematic review. The key characteristics of these studies are summarized in Table 1. These characteristics include the study design, population, intervention details, comparator, and main findings.

The selected studies comprised 8884 patients from 9 RCTs. The mean age of the included population was 77.76 years, with 49.47% being male. The baseline characteristics were comparable between the TAVR and SAVR groups, with the proportion of patients having hypertension (80.97% vs. 81.85%), diabetes mellitus (26.94% vs. 27.33%), coronary artery disease (35.91% vs. 36.21%), atrial fibrillation (22.34% vs. 23.89%), previous stroke (12.96% vs. 12.7%), and COPD (16.26% vs. 17.94%). Additionally, the proportion of patients with a prior PCI or CABG was 24.37% vs. 22.2% between TAVR and SAVR, respectively. The mean Society of Thoracic Surgery (STS) score (TAVR 3.02 vs. SAVR 3.07) and Log EuroSCORE (TAVR 5.4 vs. SAVR 5.56) were also comparable. Furthermore, the percentage of patients with a NYHA (3/4) score was 44.83% vs. 44.38% between TAVR and SAVR, respectively. The demographics and detailed baseline characteristics are given in Table 2.

3.3. Risk of bias in studies

Risk of bias assessment using the Cochrane risk of bias tool suggested low-to-moderate risk of bias amongst the 9 included studies. The overall risk of bias for each study is summarized in Fig. 2.

3.4. Results of individual studies

3.4.1. All-cause mortality

Analysis of 30-day all-cause mortality revealed varied outcomes between TAVR and SAVR across the studies. Blankenberg (2024) [15] reported 5 deaths in the TAVR group (n = 701) and 10 deaths in the SAVR group (n = 713), indicating a lower mortality rate for TAVR. Similarly, STACATTO (2012) [20] showed 2 deaths in the TAVR group (n = 34) with no deaths in the SAVR group (n = 36). For 1-

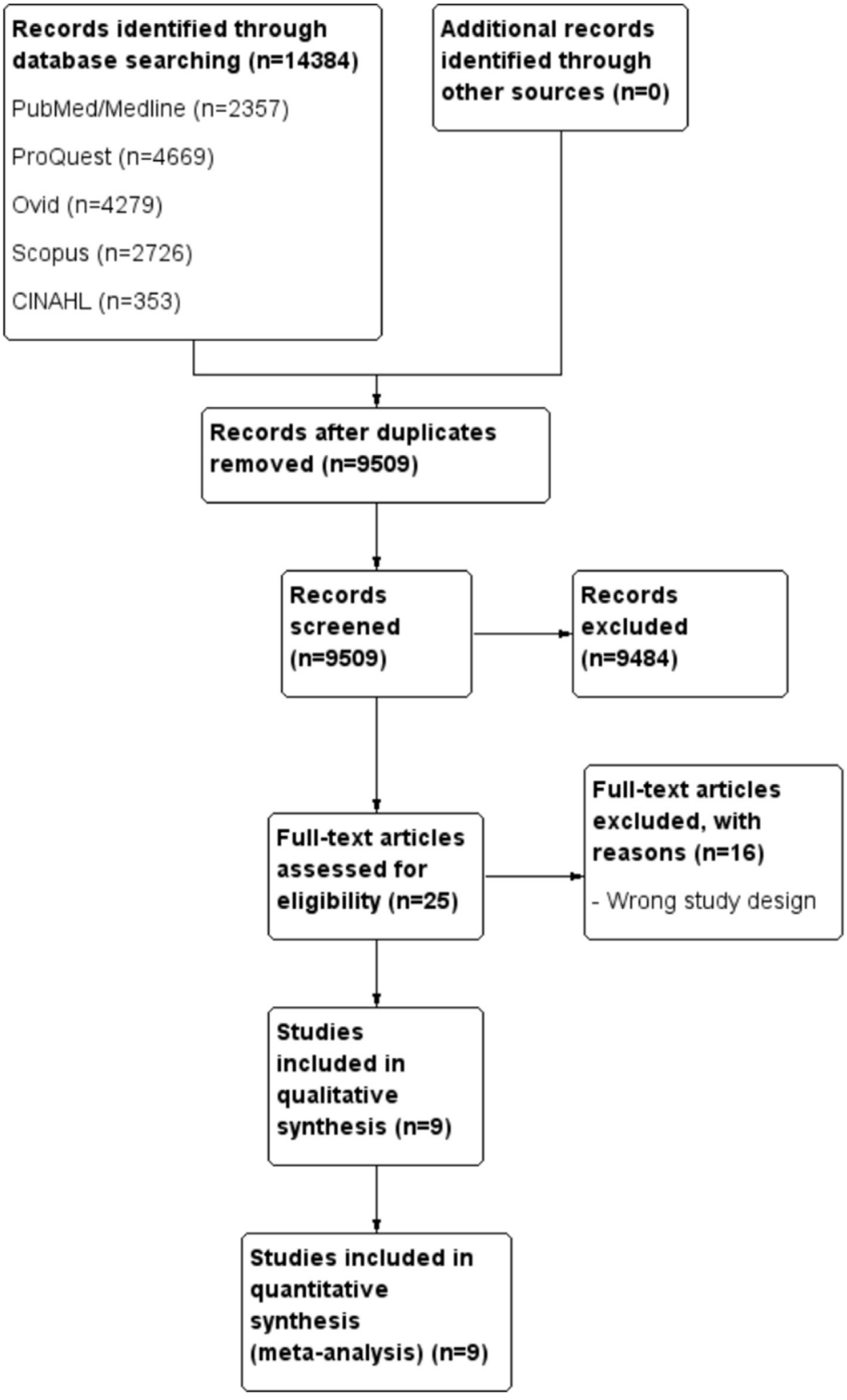

Fig. 1. PRISMA flow diagram: A total of 14,384 records were identified. After removing 4875 duplicates, 9509 records remained for screening. During the screening process, 9484 records were excluded based on title and abstract. The full texts of 25 articles were assessed for eligibility, resulting in the exclusion of 16 articles due to incorrect study design. Finally, 9 studies met the inclusion criteria and were included in the systematic review. The detailed study selection process is illustrated in the PRISMA flow diagram.

Table 1. Study characteristics.

Study ID	Study design	Population	Intervention	Comparator	Findings
Blankenberg (2024) [15]	Randomized noninferiority	Low-risk patients with severe, symptomatic AS	TAVR (valve prostheses selected according to operator discretion)	SAVR (valve prostheses selected according to operator discretion)	TAVI in patients at low or intermediate surgical risk, had noninferior death from any cause or stroke at 1 year in comparison to SAVR.
Forrest/Evolut (2023) [16]	Multinational, prospective, randomized study	Severe AS, trileaflet aortic valve morphology, low predicted risk of death	TAVR (CoreValve, Evolut R, or Evolut PRO, Medtronic)	SAVR	Low–surgical risk patients who underwent TAVR had durable benefits with regard to all-cause mortality and disabling stroke compared with SAVR.
Notion (2024) [17]	Randomized, multicenter, superiority	Patients ≥70 years old with severe AS and no significant CAD	TAVR (Medtronic CoreValve)	SAVR	No significant differences were found between the 2 procedures regarding death from any cause, stroke, or MI after 1 year.
Leon/PARTNER 2 (2016) [18]	Multicenter randomized clinical trial	Patients with severe symptomatic AS at low surgical mortality risk	TAVR (SAPIEN 3 valve)	SAVR	In intermediate-risk patients, TAVR was similar to SAVR with respect to the primary end point of death or disabling stroke.
PARTNER 3 (2019) [13]	Multicenter, randomized	Patients with severe AS and a low risk for death with surgery	TAVR (SAPIEN 3 system), (Edwards Lifesciences)	SAVR with a commercially available bioprosthetic valve	At low surgical-risk, the rate of the composite of death, stroke, or rehospitalization at 1 year was significantly lower with TAVR than with surgery.
Rodés-Cabau (2024) [19]	Prospective multicenter international randomized	Elderly (≥65 years) patients with severe AS and small aortic annulus	TAVR (SAPIEN 3/Ultra, Evolut R/PRO/PRO+/FX, and Accurate neo/neo 2 valves)	SAVR	Patients with AS low-to-intermediate-risk showed no evidence of TAVR superiority versus SAVR in valve hemodynamic outcomes and clinical outcomes.
STACATTO (2012) [20]	Randomized, multicenter, non-inferiority	Operable patients with isolated AS, aged ≥75 years	TAVR (Edwards Sapien)	SAVR	a-TAVI is associated with higher complications in low-risk patients and lower device success rates in comparison to SAVR
SURTAV| (2022) [21]	Randomized, multicenter, non-inferiority	Patients with symptomatic, severe AS at intermediate surgical risk	TAVR (CoreValve (84%)	SAVR	TAVR in symptomatic intermediate surgical risk patients is noninferior to surgery regarding death from any cause or disabling stroke at 24 months
Toff (2022) [22]	Randomized clinical trial, multicenter	Patients aged ≥70 years with severe, symptomatic AS and moderately increased operative risk	TAVI using any valve with a CE mark	SAVR	TAVI is noninferior to surgery regarding all-cause mortality at 1 year among intermediate surgical risk patients aged 70 or above

AS: aortic stenosis, CAD: coronary artery disease, TAVR: transcatheter aortic valve replacement, SAVR: surgical aortic valve replacement. CE mark: (indicating the valve meets all legal and safety requirements for sale throughout the European Economic Area).

year all-cause mortality, Forrest/Evolut (2023) [16] observed a significantly higher mortality rate in the SAVR group (47 out of 684) compared to the TAVR group (21 out of 730). At 2 years, the mortality rates between TAVR and SAVR were closely aligned in Leon/Partner 2 (2016) [18] with 166 deaths in the TAVR group and 170 in the SAVR group, indicating comparable long-term survival rates.

3.4.2. Stroke

Stroke incidence within 30 days post-procedure showed a trend towards lower rates in TAVR compared to SAVR. Blankenberg (2024) [15] found 12 strokes in the TAVR group (n = 701) and 18 in the SAVR group (n = 713). PARTNER 3 (2019) [13] reported 3 strokes in the TAVR group (n = 496) versus 11 in the SAVR group (n = 454), suggesting a favorable profile for TAVR. At 1 year, Evolut (2023) [16] recorded 24 strokes in the TAVR group (n = 730) and 56 in the SAVR group (n = 684), reinforcing the lower stroke risk associated with TAVR and indicating a consistently higher risk of stroke with SAVR in the first year post-procedure.

Table 2. Baseline clinical characteristics.

Study ID	Group	Sample size	Male N (%)	Age	Mean STS score	NYHA score (3/4)	Log EuroSCORE	AF	CAD	Stroke	Hypertension	Diabetes	COPD	Prior PCI or CABG
Blankenberg	TAVR	701	390 (56%)	74.3 ± 4.6	1.8 ± 0.9	321 (46.2%)	2.1 ± 1.4	201 (28.9%)	238 (34.3%)	42 (6.1%)	588 (84.7%)	588 (33.8%)	101 (14.5%)	
(2024) [15]	SAVR	713	400 (57.3%)	74.6 ± 4.2	1.9 ± 1	318 (45.6%)	2.1 ± 1.8	191 (27.4%)	266 (38.2%)	42 (6%)	605 (87.2%)	605 (32.8%)	118 (16.9%)	
Evolut	TAVR	730	464 (63.6%)	74.1 ± 5.8	2.0 ± 0.7	182 (24.9%)		112 (15.4%)			618 (84.8%)	229 (31.4%)	106 (15.1%)	121 (16.6%)
(2023) [16]	SAVR	684	451 (65.9%)	73.7 ± 5.9	1.9 ± 0.7	193 (28.2%)		98 (14.4%)			564 (82.6%)	210 (30.7%)	118 (18%)	102 (14.9%)
Notion	TAVR	145	78 (53.8%)	79.2 ± 4.9	2.9 ± 1.6	70 (48.6%)		40 (27.8%)	8 (5.5%)		103 (71.0%)	26 (17.9%)	17 (11.7%)	11 (7.6%)
(2024) [17]	SAVR	135	71 (52.6%)	79.0 ± 4.7	3.1 ± 1.7	61 (45.5%)		34 (25.6%)	6 (4.4%)		103 (76.3%)	28 (20.7%)	16 (11.9%)	12 (8.9%)
PARTNER 2	TAVR	1011	548 (54.2%)	81.5 ± 6.7	5.8 ± 2.1	782 (77.3%)		313 (31.0%)	700 (69.2%)	325 (32.1%)		381 (37.7%)	321 (31.8%)	513 (50.7%)
(2016) [18]	SAVR	1021	560 (54.8%)	81.7 ± 6.7	5.8 ± 1.9	776 (76.1%)		359 (35.2%)	679 (66.5%)	317 (31.0%)		349 (34.2%)	306 (30.0%)	440 (43.1%)
PARTNER 3	TAVR	496	335 (67.5%)	73.3 ± 5.8	1.9 ± 0.7	155 (31.2%)	1.5 ± 1.2	78 (15.7%)	137 (27.7%)	17 (3.4%)		155 (31.2%)	25 (5.1%)	
(2019) [13]	SAVR	454	323 (71.1%)	73.6 ± 6.1	1.9 ± 0.6	108 (23.8%)	1.5 ± 0.9	85 (18.8%)	127 (28.0%)	23 (5.1%)		137 (30.2%)	28 (6.2%)	
Rodés-Cabau	TAVR	77	4 (5.2%)	75.9 ± 5.3	2.55 ± 1.1	23 (29.9%)		6 (7.8%)	17 (22.1%)		62 (80.5%)	23 (29.9%)	7 (9.1%)	17 (22.1%)
(2024) [19]	SAVR	74	7 (9.5%)	75.1 ± 4.9	2.47 ± 1.2	24 (32.4%)		14 (18.9%)	14 (18.9%)		61 (82.4%)	22 (29.7%)	14 (18.9%)	14 (18.9%)
STACATTO	TAVR	34	9 (26%)	80 ± 3.6	3.1 ± 1.5		9.4 ± 3.9					1 (2.9%)	1 (2.9%)	
(2012) [20]	SAVR	36	12 (33.3%)	82 ± 4.4	3.4 ± 1.2		10.3 ± 5.8					3 (8.3%)	1 (2.8%)	
SURTAV|	TAVR	864	498 (57.6%)	79.9 ± 6.2	4.4 ± 1.5	520 (60.2%)	11.9 ± 7.6	243 (28.1%)	541 (62.6%)	151 (17.5%)	801 (92.7%)	296 (34.3%)	305 (35.4%)	320 (37.0%)
(2022) [21]	SAVR	796	438 (55.0%)	79.7 ± 6.1	4.5 ± 1.6	463 (58.2%)	11.6 ± 8.0	211 (26.5%)	511 (64.2%)	130 (16.3%)	719 (90.3%)	277 (34.8%)	267 (33.5%)	306 (38.4%)
Toff	TAVR	458	247 (53.9%)	81 ± 3.7	2.7 ± 1.1	184 (40.3%)	2.1 ± 1.2	110 (24%)	133 (30%)	26 (5.7%)	328 (72.1%)	107 (23.4%)	95 (20.7%)	56 (12.2%)
(2022) [22]	SAVR	455	242 (53.2%)	81 ± 4.5	2.7 ± 1	204 (45.2%)	2.3 ± 1.3	110 (24.3%)	145 (33.3%)	23 (5.1%)	327 (72.3%)	111 (24.5%)	106 (23.3%)	41 (9%)

Data are n, mean ± SD, or n (%).

STS, Society of Thoracic Surgeons; AF, Atrial fibrillation; CAD, Coronary artery disease; COPD, Chronic obstructive pulmonary disease; PCI, Percutaneous coronary intervention; CABG, Coronary artery bypass grafting.

3.4.3. *Myocardial infarction (MI)*

MI rates within 30 days post-procedure demonstrated a lower incidence for TAVR compared to SAVR. Blankenberg (2024) [15] reported 1 MI in the TAVR group (n = 701) versus 6 in the SAVR group (n = 713). Similarly, Leon/Partner 2 (2016) [18] observed 12 MIs in the TAVR group (n = 1011) and 19 in the SAVR group (n = 1021). These findings suggest a lower incidence of MI in patients undergoing TAVR compared to those undergoing SAVR, particularly in the immediate post-operative period.

3.4.4. *Prosthetic valve endocarditis (PVE)*

PVE rates at 30 days and 1 year were relatively low for both TAVR and SAVR. At 30 days, Blankenberg (2024) [15] reported no PVE cases in the TAVR group (n = 701) and 1 in the SAVR group (n = 713). Notion (2024) [17] found 1 case of PVE in the TAVR group (n = 145) and none in the SAVR group. At 1 year, Blankenberg (2024) [15] reported 4 PVE cases in the TAVR group and 7 in the SAVR group, while Notion (2024) [17] recorded 4 cases in both groups, indicating a comparable risk. This consistency suggests that PVE remains a relatively infrequent complication for both procedures within the first year.

3.4.5. *Differences in length of stay (LOS)*

Length of stay post-procedure varied significantly between TAVR and SAVR, with TAVR generally associated with shorter hospital stays. Blankenberg (2024) [15] reported a mean hospital stay of 5.33 days for TAVR patients (SD 2.23) and 9.66 days for SAVR patients (SD 2.97). PARTNER 3 (2019) [13] showed similar trends, with TAVR patients staying average of 2.67 days (SD 0.74), whereas SAVR patients stayed 7 days (SD 1.49). The STACATTO (2012) [20] study found TAVR patients stayed an average of 8.8 days, slightly longer than SAVR patients who stayed 7.6 days, possibly due to specific study conditions or patient characteristics. Overall, these findings indicate that TAVR generally results in shorter hospital stays, contributing to potentially faster recovery times compared to SAVR.

4. Discussion

Our systematic review analyzed over 8000 low to intermediate-risk patients with severe symptomatic AS, providing a comprehensive comparison between TAVR and SAVR across various outcome endpoints. Our analysis demonstrated that TAVR generally had lower or comparable mortality rates compared to SAVR. At 30 days, studies such as Blankenberg et al. (2024) [15]. and PARTNER 3 (2019) [13] reported lower mortality rates for TAVR

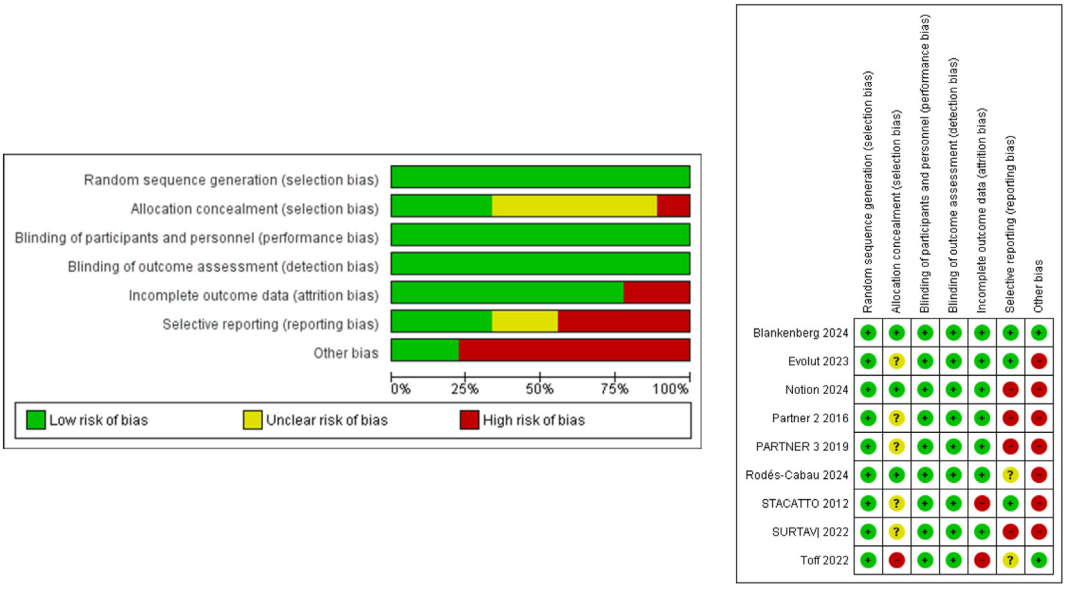

Fig. 2. Assessment of risk of bias: Risk of bias assessment using the Cochrane risk of bias tool suggested low-to-moderate risk of bias amongst the 9 included studies. The overall risk of bias for each study is summarized. Risk of bias assessment using the Cochrane risk of bias tool suggested low-to-moderate risk of bias amongst the 9 included studies. The overall risk of bias for each study is summarized.

compared to SAVR. This aligns with findings from previous research indicating that the less invasive nature of TAVR results in reduced early post-operative mortality. For instance, PARTNER 3 (2019) [13] highlighted a significant survival advantage of TAVR over SAVR in patients with lower surgical risk. At the 2-year mark, the SURTAVI trial (2022) [21] also showed comparable long-term mortality outcomes between TAVR and SAVR, reinforcing TAVR's non-inferiority in intermediate-risk patients as demonstrated in the PARTNER 2 trial (2016) [18].

The incidence of stroke at both 30 days and 1 year was lower in the TAVR group across several studies. For example, the NOTION trial (2024) [17] and Søndergaard et al. (2016) [23] reported reduced stroke rates in TAVR patients over short and long-term follow-ups, respectively. The reduced stroke incidence in TAVR can be attributed to the avoidance of cardiopulmonary bypass and aortic cross-clamping, known risk factors for cerebrovascular events in SAVR. Similarly, TAVR demonstrated lower rates of myocardial infarction compared to SAVR. Gupta et al. (2018) [24] found that the less invasive nature of TAVR leads to reduced myocardial stress and injury. Studies such as PARTNER 2 (2016) [18] and NOTION (2024) [17] supported these findings by reporting lower MI rates in TAVR groups, indicating that TAVR reduces myocardial ischemia and reperfusion injury associated with SAVR.

Regarding PVE, TAVR was associated with lower infection rates compared to SAVR. Butt et al. (2019) [25] reported a significantly lower incidence of infective endocarditis in TAVR patients over long-term follow-up. This can be explained by the shorter procedural times, which minimize the duration that tissues are exposed to potential contaminants and reduce biofilm formation on prosthetic devices or heart valves, thereby decreasing the risk of persistent infection. Moreover, the less invasive nature of TAVR results in less tissue damage and a smaller wound area, further reducing the potential for infection compared to the more extensive surgical procedures involved in SAVR. One of the most distinct advantages of TAVR observed in our review was the significantly shorter length of hospital stay. Studies like Baron et al. (2019b) [26] highlighted that TAVR patients benefited from reduced intensive care unit stays and overall hospital durations compared to SAVR patients. This finding underscores the efficiency and rapid recovery associated with TAVR, making it a preferable option for patients seeking quicker postoperative recovery and enhanced long-term immune system function.

While TAVR demonstrates clear clinical advantages over SAVR, it incurs higher initial procedural costs. Studies by Baron et al. (2019b) [26] and Galper et al. (2023) [27] both highlight this cost disparity, with TAVR consistently more expensive upfront than SAVR. However, TAVR offers significant cost savings in other areas, such as hospitalization and physician fees. Hospitalization costs and physician fees for TAVR are notably lower compared to SAVR in both studies, suggesting that while TAVR's initial expense is higher, the overall economic burden may be offset

by these savings. Nonetheless, the total indexed admission costs show mixed results, with Baron's study finding TAVR slightly less expensive than SAVR, whereas Galper's data indicate higher total costs for TAVR. These findings imply that although TAVR is a promising technique, its integration into the healthcare system poses financial challenges. It requires a nuanced approach to balance its higher procedure costs with the potential savings in other areas to ensure broader adoption [26,27].

TAVR has significant implications for clinical practice and policy, given its demonstrated benefits and the evolving landscape of aortic stenosis treatment. The shorter recovery times and reduced early mortality associated with TAVR make it an attractive option for patients, particularly those at high surgical risk or with comorbidities that preclude traditional surgery. As noted by PARTNER 3 (2019) [13] and Søndergaard et al. (2016) [23], the less invasive nature of TAVR leads to faster postoperative recovery and fewer complications, which translates to shorter hospital stays and lower healthcare resource utilization. This can alleviate the burden on healthcare systems, especially in settings where hospital capacity and resources are constrained. However, the higher initial costs of TAVR, as highlighted by Baron et al. (2019b) [26] and Galper et al. (2023) [27], pose a challenge for its widespread adoption. Policymakers and healthcare providers must balance these upfront costs with the long-term benefits of reduced hospitalization and improved patient outcomes. Economic analyses and cost-effectiveness studies should continue to assess the financial implications of TAVR to inform compensation policies and ensure equitable access to this advanced treatment modality. Additionally, the standardization of procedural techniques and the adoption of best practices across centers can help optimize outcomes and reduce variability in clinical results.

Future research should focus on long-term outcomes and the durability of TAVR devices, particularly in younger and lower-risk populations. Studies examining the comparative effectiveness of different TAVR devices and procedural techniques will be crucial in refining patient selection criteria and improving overall outcomes. Furthermore, ongoing clinical trials and registries should aim to include more diverse patient populations to enhance the generalizability of findings across different healthcare settings and demographic groups. By addressing these research gaps, we can better understand the full potential of TAVR and continue to improve the management of aortic stenosis, ultimately leading to better patient care and health system efficiencies.

5. Limitations

Despite the robust data in our analysis, several limitations must be noted. Variability in patient populations across studies introduces potential heterogeneity. Although our review focused on low to intermediate-risk patients with severe symptomatic AS, differences in baseline characteristics such as age, comorbidities, and surgical risk scores may affect the generalizability of our findings. Additionally, follow-up durations varied among studies, with some providing long-term data and others shorter periods. This inconsistency impacts the assessment of long-term outcomes like valve durability and late complications, as shorter follow-ups may miss late-onset issues. Endpoint definitions and reporting standards also differed, complicating comparisons. Variations in definitions of stroke and myocardial infarction across studies, highlighted by Leon et al. (2011) [28], can lead to discrepancies in incidence rates and underscore the need for standardized definitions in future research. Moreover, the predominance of studies from high-income countries may limit the applicability of our findings to lower-resource settings, potentially affecting the broader relevance of the results. Lastly, differences in procedural techniques, bioprosthetic valve types (self-expanding vs. balloon-expandable), and operator expertise may contribute to outcome variability.

6. Conclusion

Our systematic review shows that TAVR has a lower mortality rate and incidence of stroke among intermediate and low-risk patients compared to previous beliefs. Additionally, TAVR is associated with lower MI rates, shorter ICU stays, and reduced overall hospital durations due to its less invasive nature and shorter procedural times. Despite its clinical advantages over SAVR, TAVR incurs higher initial procedural costs but offers cost savings in hospitalization and physician fees. This financial challenge requires a balanced approach for broader adoption. Future research should focus on long-term outcomes and TAVR device durability, especially in younger, lower-risk populations. Comparative effectiveness studies of different TAVR devices and techniques, along with more diverse patient inclusion in clinical trials and registries, will enhance the generalizability of findings.

Author contribution

Conception and design of Study: OH, SA. Literature review: OH, SA. Acquisition of data: OH. Analysis and interpretation of data: SA. Research

investigation and analysis: OH, SA. Data collection: OH, SA, SN. Drafting of manuscript: OH, SA, SN. Revising and editing the manuscript critically for important intellectual contents: OH, SA, SN. Data preparation and presentation: OH, SA, SN. Research coordination and management: OH, SA. Funding for the research: OH, SA.

Conflict of interest

None declared.

Ethical approval

As this systematic review does not involve primary data collection from human participants, ethical approval was not required. The review adheres to the guidelines and principles of evidence synthesis and analysis.

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References

[1] Santangelo G, Bursi F, Faggiano A, Moscardelli S, Simeoli PS, Guazzi M, et al. The global burden of valvular heart disease: from clinical epidemiology to management. J Clin Med 2023;12(6):2178. https://doi.org/10.3390/jcm12062178.

[2] Iung B, Baron G, Butchart EG, Delahaye F, Gohlke-Bärwolf C, Levang OW, et al. A prospective survey of patients with valvular heart disease in europe: the Euro heart Survey on valvular heart disease. Eur Heart J 2003;24(13):1231–43. https://doi.org/10.1016/s0195-668x(03)00201-x.

[3] Kearney K, Sigursdsson S, EirÍksdÓttir G, O'Brien KD, Gudnason V, Owens DS. Abstract 17756: incidence and progression of aortic valve calcification among the elderly: a prospective analysis of the age, gene-environment susceptibility (AGES)-Reykjavik study. Circulation 2012;126(suppl_21). https://doi.org/10.1161/circ.126.suppl_21.A17756. [Accessed 1 August 2024].

[4] Messika-Zeitoun D, Bielak LF, Peyser PA, Sheedy PF, Turner ST, Nkomo VT, et al. Aortic valve calcification. Arterioscler Thromb Vasc Biol 2007;27(3):642–8. https://doi.org/10.1161/01.atv.0000255952.47980.c2.

[5] Yadgir S, Johnson CO, Aboyans V, Adebayo OM, Adedoyin RA, Afarideh M, et al. Global, regional, and national burden of calcific aortic valve and degenerative mitral valve diseases, 1990-2017. Circulation 2020;141(21):1670–80. https://doi.org/10.1161/CIRCULATIONAHA.119.043391.

[6] Marquis-Gravel G, Redfors B, Leon MB, Généreux P. Medical treatment of aortic stenosis. Circulation 2016;134(22):1766–84. https://doi.org/10.1161/CIRCULATIONAHA.116.023997.

[7] Bach DS, Siao D, Girard SE, Duvernoy C, McCallister Jr BD, Gualano SK. Evaluation of patients with severe symptomatic aortic stenosis who do not undergo aortic valve replacement: the potential role of subjectively overestimated operative risk. Circ Cardiovas Quality Outcomes 2009;2(6):533–9. https://doi.org/10.1161/CIRCOUTCOMES.109.848259.

[8] Pellikka PA, Sarano ME, Nishimura RA, Malouf JF, Bailey KR, Scott CG, et al. Outcome of 622 adults with asymptomatic, hemodynamically significant aortic stenosis during prolonged follow-up. Circulation 2005;111(24):3290–5. https://doi.org/10.1161/CIRCULATIONAHA.104.495903.

[9] Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP 3rd, Fleisher LA, et al. 2017 AHA/ACC focused update of the 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American college of cardiology/American heart association task force on clinical practice guidelines. Circulation 2017;135(25):e1195. https://doi.org/10.1161/CIR.0000000000000503.

[10] Baumgartner H, Falk V, Bax JJ, De Bonis M, Hamm C, Holm PJ, et al. 2017 ESC/EACTS Guidelines for the management of valvular heart disease. Eur Heart J 2017;38(36):2739–91. https://doi.org/10.1093/eurheartj/ehx39111.

[11] Popma JJ, Deeb GM, Yakubov SJ, Mumtaz M, Gada H, O'Hair D, et al. Transcatheter aortic-valve replacement with a self-expanding valve in low-risk patients. N Engl J Med 2019;380(18):1706–15. https://doi.org/10.1056/NEJMoa1816885.

[12] Otto CM, Nishimura RA, Bonow RO, Carabello BA, Erwin JP 3rd, Gentile F, et al. 2020 ACC/AHA guideline for the management of patients with valvular heart disease: executive summary: a report of the American college of cardiology/American heart association joint committee on clinical practice guidelines. Circulation 2021;143(5):e35–71. https://doi.org/10.1161/CIR.0000000000000932.

[13] Mack MJ, Leon MB, Thourani VH, Makkar R, Kodali SK, Russo M, et al. Transcatheter aortic-valve replacement with a balloon-expandable valve in low-risk patients. N Engl J Med 2019;380(18):1695–705. https://doi.org/10.1056/NEJMoa1814052.

[14] Wan X, Wang W, Liu J, Tong T. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. BMC Med Res Methodol 2014;14:135. https://doi.org/10.1186/1471-2288-14-135.

[15] Blankenberg S, Seiffert M, Vonthein R, Baumgartner H, Bleiziffer S, Borger MA, et al. Transcatheter or surgical treatment of Aortic-Valve stenosis. N Engl J Med 2024;390(17):1572–83. https://doi.org/10.1056/nejmoa2400685.

[16] Forrest JK, Deeb GM, Yakubov SJ, Gada H, Mumtaz MA, Ramlawi B, et al. 3-Year outcomes after transcatheter or surgical aortic valve replacement in low-risk patients with aortic stenosis. J Am Coll Cardiol 2023;81(17):1663–74. https://doi.org/10.1016/j.jacc.2023.02.017.

[17] Thyregod HGH, Jørgensen TH, Ihlemann N, Steinbrüchel DA, Nissen H, Kjeldsen BJ, et al. Transcatheter or surgical aortic valve implantation: 10-year outcomes of the NOTION trial. Eur Heart J 2024. https://doi.org/10.1093/eurheartj/ehae043.

[18] Leon MB, Smith CR, Mack MJ, Makkar RR, Svensson LG, Kodali SK, et al. Transcatheter or surgical aortic-valve replacement in intermediate-risk patients. N Engl J Med 2016;374(17):1609–20. https://doi.org/10.1056/NEJMoa1514616.

[19] Rodés-Cabau J, Ribeiro HB, Mohammadi S, Serra V, Al-Atassi T, Iñiguez A, et al. Transcatheter or surgical aortic valve replacement in patients with severe aortic stenosis and small aortic annulus: a randomized clinical trial. Circulation 2024;149(9):644–55. https://doi.org/10.1161/CIRCULATIONAHA.123.067326.

[20] Nielsen HH, Klaaborg KE, Nissen H, Terp K, Mortensen PE, Kjeldsen BJ, et al. A prospective, randomised trial of transapical transcatheter aortic valve implantation vs. surgical aortic valve replacement in operable elderly patients with aortic stenosis: the STACCATO trial. EuroIntervention 2012;8(3):383–9. https://doi.org/10.4244/EIJV8I3A58.

[21] Van Mieghem NM, Deeb GM, Søndergaard L, Grube E, Windecker S, Gada H, et al. Self-expanding transcatheter vs surgical aortic valve replacement in intermediate-risk patients: 5-year outcomes of the SURTAVI randomized clinical trial. JAMA Cardiology 2022;7(10):1000–8. https://doi.org/10.1001/jamacardio.2022.2695.

[22] UK TAVI Trial Investigators, Toff WD, Hildick-Smith D, Kovac J, Mullen MJ, Wendler O, et al. Effect of transcatheter aortic valve implantation vs surgical aortic valve replacement on all-cause mortality in patients with aortic stenosis: a randomized clinical trial. JAMA 2022;327(19):1875–87. https://doi.org/10.1001/jama.2022.5776.

[23] Søndergaard L, Steinbrüchel DA, Ihlemann N, Nissen H, Kjeldsen BJ, Petursson P, et al. Two-year outcomes in patients with severe aortic valve stenosis randomized to transcatheter versus surgical aortic valve replacement: the all-comers nordic aortic valve intervention randomized clinical trial. Circulation: Cardiovascular Interventions 2016; 9(6):e003665. https://doi.org/10.1161/CIRCINTERVENTIONS.115.003665.

[24] Gupta T, Khera S, Kolte D, Goel K, Kalra A, Villablanca PA, et al. Transcatheter versus surgical aortic valve replacement in patients with prior coronary artery bypass grafting: trends in utilization and propensity-matched analysis of in-hospital outcomes. Circulation: Cardiovascular Interventions 2018; 11(4):e006179. https://doi.org/10.1161/CIRCINTERVENTIONS.117.006179.

[25] Butt JH, Ihlemann N, De Backer O, Søndergaard L, Havers-Borgersen E, Gislason GH, et al. Long-term risk of infective endocarditis after transcatheter aortic valve replacement. J Am Coll Cardiol 2019;73(13):1646–55. https://doi.org/10.1016/j.jacc.2018.12.078.

[26] Baron SJ, Wang K, House JA, Magnuson EA, Reynolds MR, Makkar R, et al. Cost-effectiveness of transcatheter versus surgical aortic valve replacement in patients with severe aortic stenosis at intermediate risk. Circulation 2019;139(7):877–88. https://doi.org/10.1161/CIRCULATIONAHA.118.035236.

[27] Galper BZ, Chinnakondepalli KM, Wang K, Magnuson EA, Lu M, Thourani VH, et al. Economic outcomes of transcatheter versus surgical aortic valve replacement in patients with severe aortic stenosis and low surgical risk: results from the PARTNER 3 trial. Circulation 2023;147(21):1594–605. https://doi.org/10.1161/circulationaha.122.062481.

[28] Leon MB, Piazza N, Nikolsky E, Blackstone EH, Cutlip DE, Kappetein AP, et al. Standardized endpoint definitions for transcatheter aortic valve implantation clinical trials. J Am Coll Cardiol 2011;57(3):253–69. https://doi.org/10.1016/j.jacc.2010.12.005.