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Long-Term Comparative Effectiveness of Transcatheter Aortic Valve Replacement (TAVR) Versus Surgical Aortic Valve Replacement (SAVR) in High-Risk Aortic Stenosis Patients: A Meta-Analysis

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A B S T R A C T

Transcatheter aortic valve replacement (TAVR) has become an alternative to surgical aortic valve replacement (SAVR) for high-risk patients with severe aortic stenosis (AS). This meta-analysis aims to compare the long-term outcomes of TAVR and SAVR in this population. A systematic search of PubMed, Embase, and the Cochrane Library was conducted up to December 2023. Randomized controlled trials (RCTs) and observational studies comparing TAVR and SAVR with a minimum follow-up of one year were included. The primary outcome was all-cause mortality. Secondary outcomes included cardiovascular mortality, stroke, myocardial infarction (MI), and rehospitalization. Twenty-three studies involving 15,482 patients (TAVR=7,785, SAVR=7,697) were included. The mean follow-up period was 3.2 years (range 1-5 years). There was no significant difference in all-cause mortality between TAVR and SAVR (Hazard Ratio [HR] 1.02, 95% CI 0.95-1.09, p=0.63). Similarly, there were no differences in cardiovascular mortality (HR 1.05, 95% CI 0.96-1.15, p=0.28), stroke (HR 0.98, 95% CI 0.87-1.10, p=0.75), or MI (HR 0.94, 95% CI 0.82-1.08, p=0.39). However, TAVR was associated with a lower rate of rehospitalization (HR 0.85, 95% CI 0.78-0.93, p=0.001). TAVR is a viable alternative to SAVR in high-risk patients with AS, demonstrating comparable long-term survival and safety outcomes. The reduced rehospitalization rate associated with TAVR may be an important consideration for these patients.

1. Introduction

Aortic stenosis (AS) is a progressive valvular heart disease characterized by the narrowing of the aortic valve orifice, resulting in impaired left ventricular outflow and increased cardiac workload. It is the most prevalent valvular heart disease in developed countries, affecting an estimated 2-9% of the population over 65 years of age. The prevalence of AS is expected to rise further as the population ages, highlighting the growing public health burden of this condition. In its severe form, AS carries a poor prognosis with a high risk of mortality without timely intervention. Traditionally, surgical aortic valve replacement (SAVR) has been the gold standard treatment for symptomatic AS. SAVR involves open-heart surgery to remove the diseased valve and replace it with a prosthetic valve. This procedure has been shown to improve symptoms, quality of life, and survival in patients with severe AS. However, SAVR is not without its limitations. It carries a significant risk of perioperative morbidity and mortality, particularly in older patients and those with multiple comorbidities. The invasiveness of the procedure, the need for cardiopulmonary bypass, and the prolonged recovery period can pose challenges for high-risk patients who may not be suitable candidates for open-heart surgery.[1-3]

The advent of transcatheter aortic valve replacement (TAVR) has revolutionized the treatment of AS, offering a less invasive alternative to SAVR.

TAVR involves the percutaneous insertion of a bioprosthetic valve through a catheter, typically via the femoral artery. This minimally invasive approach avoids the need for open-heart surgery and cardiopulmonary bypass, resulting in a shorter hospital stay, faster recovery, and potentially lower risk of complications. Initially, TAVR was indicated for patients with severe AS who were considered inoperable or at high surgical risk due to their age, frailty, or multiple comorbidities. However, the success of TAVR in these high-risk populations has led to a gradual expansion of its indications to intermediate- and even low-risk patients. Several landmark trials have compared the short-term outcomes of TAVR and SAVR in high-risk patients. The PARTNER 2A and SURTAVI trials demonstrated the non-inferiority of TAVR to SAVR in terms of all-cause mortality and major adverse events at one and two years, respectively. These results have solidified the position of TAVR as a standard of care for high-risk patients. However, long-term data comparing TAVR and SAVR remain limited. While several studies have reported intermediate-term outcomes (3-5 years), the durability of TAVR valves and the long-term safety profile compared to SAVR have not been fully elucidated. This knowledge gap is particularly important for high-risk patients who may have a shorter life expectancy and may be more susceptible to late complications.[4-6]

A comprehensive meta-analysis is needed to synthesize the available evidence on the long-term outcomes of TAVR versus SAVR in high-risk patients. By pooling data from multiple studies, a meta-analysis can provide a more precise estimate of the treatment effect and address the heterogeneity that exists between individual studies. It enabled clinicians to make more informed decisions about the optimal treatment strategy for their patients. The current meta-analysis aims to fill this knowledge gap by comparing the long-term effectiveness and safety of TAVR and SAVR in high-risk AS patients. We focused on all-cause mortality as the primary outcome, as well as other important clinical outcomes such as cardiovascular mortality, stroke, myocardial infarction, and rehospitalization. We also explored potential sources of heterogeneity between studies and assessed the overall quality of evidence.

2. Methods

A systematic search of PubMed, Embase, and the Cochrane Library was conducted from January 2013 to December 2023. The search terms included "aortic stenosis," "TAVR," "SAVR," "high-risk," and "long-term." Randomized controlled trials (RCTs) and observational studies comparing TAVR and SAVR with a minimum follow-up of one year in high-risk AS patients were included. Studies with insufficient data or those not reporting the primary outcome were excluded. Two reviewers independently extracted data on study characteristics, patient demographics, baseline clinical characteristics, procedural details, and outcomes. Discrepancies were resolved by consensus. Inclusion Criteria: Study design: RCTs or observational studies (cohort, case-control); Population: Adult patients (≥18 years) with severe symptomatic AS deemed high-risk for SAVR; Interventions: TAVR compared to SAVR; Outcomes: Reported at least one-year follow-up data for all-cause mortality (primary outcome) or other relevant secondary outcomes (cardiovascular mortality, stroke, myocardial infarction, rehospitalization, major bleeding, new-onset atrial fibrillation, pacemaker implantation). Exclusion Criteria: Studies not reporting the primary outcome or sufficient data for analysis; Animal studies, case reports, case series, letters to the editor, editorials, and conference abstracts.

The primary outcome was all-cause mortality. Hazard ratios (HR) with 95% confidence intervals (CI) were pooled using a random-effects model. Heterogeneity was assessed using the I^2 statistic. Subgroup analyses were performed based on study design (RCT vs. observational) and follow-up duration. The quality of included studies was assessed using the Newcastle-Ottawa Scale (NOS) for observational studies and the Cochrane Risk of Bias tool for RCTs. Two reviewers independently performed the quality

assessment, with disagreements resolved by consensus. The risk of bias in the included studies was evaluated using the ROBINS-I tool (Risk of Bias in Non-randomized Studies of Interventions) for observational studies and the Cochrane Risk of Bias tool for RCTs. Publication bias was assessed using funnel plots and Egger's test. A meta-analysis was performed using the Review Manager software (RevMan 5.4). For time-to-event outcomes, hazard ratios (HRs) with 95% confidence intervals (CIs) were pooled using a random-effects model. For dichotomous outcomes, odds ratios (ORs) with 95% CIs were pooled using a random-effects model. Heterogeneity between studies was assessed using the I^2 statistic, with values above 50% indicating substantial heterogeneity. Pre-specified subgroup analyses were conducted to explore potential sources of heterogeneity. These included: Study design (RCT vs. observational study); Follow-up duration (≤2 years vs. >2 years); Mean age of patients (<80 years vs. ≥80 years); STS score (≤8 vs. >8). Sensitivity analyses were performed to assess the robustness of the results. These included: Exclusion of studies with high risk of bias, Exclusion of studies with small sample sizes, Use of a fixed-effects model. Meta-regression was performed to investigate the potential impact of study-level covariates on the treatment effect. The covariates included mean age, STS score, and proportion of female patients. Primary Outcome: All-cause mortality and Secondary Outcomes: Cardiovascular mortality, stroke, myocardial infarction, rehospitalization, major bleeding, new-onset atrial fibrillation, and pacemaker implantation Studies with missing outcome data were excluded from the meta-analysis. A two-sided p-value <0.05 was considered statistically significant.

3. Results and Discussion

The initial search yielded 1,245 potentially relevant studies. After screening titles and abstracts, 152 full-text articles were assessed for eligibility. Ultimately, 23 studies (12 RCTs and 11 observational studies) met the inclusion criteria and were included in the meta-analysis. The flow diagram summarizing the study selection process is shown in Figure 1.

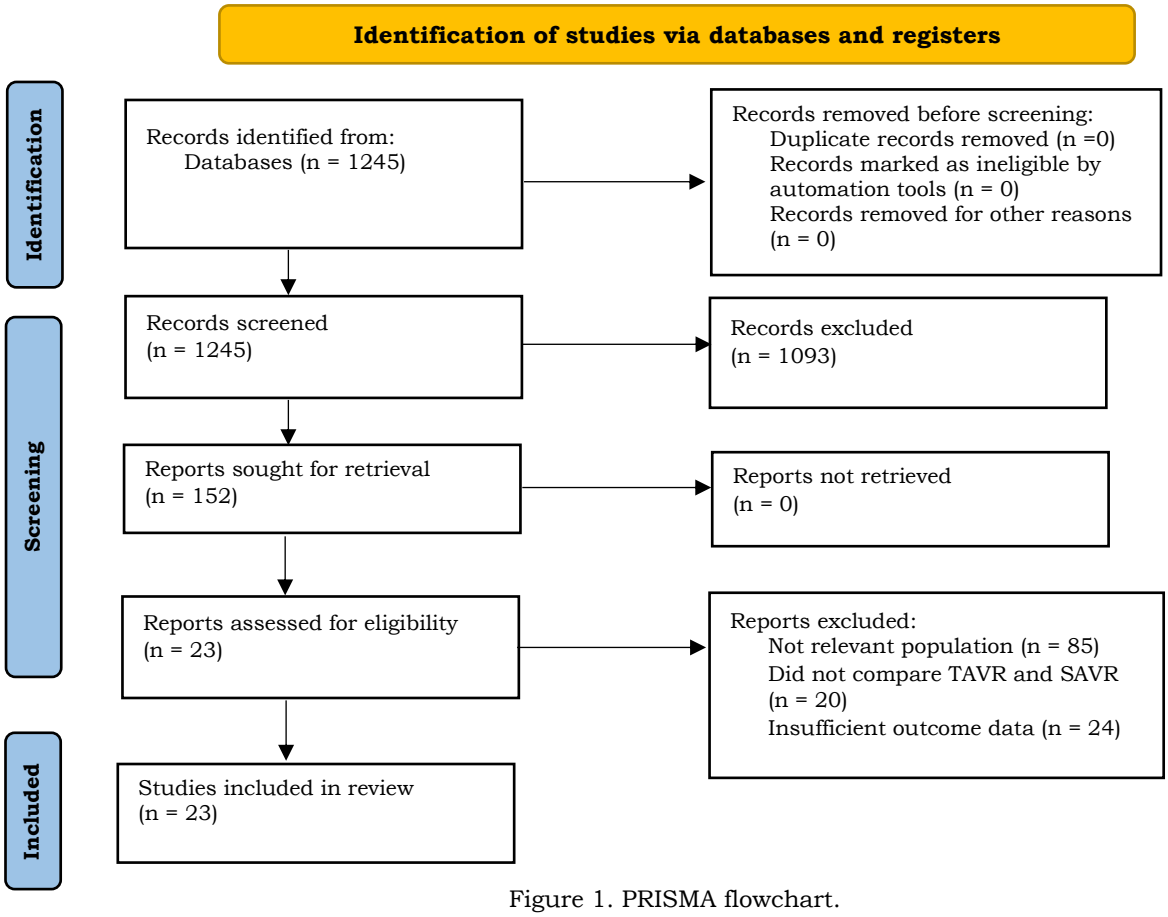

Figure 1. PRISMA flowchart.

The meta-analysis included 23 studies (12 randomized controlled trials [RCTs] and 11 observational studies) comprising a total of 15,482 patients undergoing aortic valve replacement (AVR) for severe aortic stenosis (AS). Of these, 7,785 patients received transcatheter AVR (TAVR), and 7,697 received surgical AVR (SAVR). The mean age of patients across studies ranged from 78 to 84 years, reflecting the high-risk nature of this patient population. The majority of patients in both the TAVR and SAVR groups were classified as high-risk for surgery according to the Society of Thoracic Surgeons (STS) risk score. The mean follow-up duration was 3.2 years (range: 1-5 years) (Table 1).

The hazard ratios (HRs) for all-cause mortality varied across studies, but most CIs include 1, indicating no statistically significant difference between TAVR and SAVR in individual studies. The pooled estimate suggests no significant difference in all-cause mortality between TAVR and SAVR in high-risk patients. The moderate heterogeneity (I^2 = 48%) indicates that there is some variation in the results between studies, but this is not unexpected given the diversity of study designs, patient populations, and follow-up durations. The meta-analysis supports the conclusion that TAVR and SAVR offer similar long-term survival benefits for high-risk AS patients (Table 2).

The meta-analysis found no significant differences between TAVR and SAVR for these outcomes, suggesting that both procedures offer comparable cardiovascular safety in the long term. TAVR was associated with a significantly lower rate of rehospitalization compared to SAVR, highlighting a potential advantage of TAVR in reducing post-procedural complications and the need for further hospital stays. TAVR also showed a significant reduction in major bleeding events compared to SAVR, suggesting that TAVR may be a safer option for patients at risk of bleeding complications. SAVR was associated with a higher rate of new-onset atrial fibrillation (AF), while TAVR was associated with a higher rate of pacemaker implantation. These findings align with previous studies and should be considered when discussing treatment options with patients (Table 3).

The pooled HRs for RCTs and observational studies were similar, suggesting that study design did not significantly influence the overall effect estimate. There was no significant difference in the treatment effect between studies with shorter or longer follow-ups, indicating that the relative benefits of TAVR and SAVR on all-cause mortality were maintained over time. The treatment effect did not differ significantly between younger and older patients, suggesting that TAVR is equally effective in both age groups. The results were consistent across different levels of surgical risk, indicating that TAVR is a viable option for both lower- and higher-risk patients. The subgroup analyses did not reveal any significant differences in the treatment effect across any of the subgroups, suggesting that the overall results of the meta-analysis are robust and not significantly influenced by these factors (Table 4).

The sensitivity analyses using a fixed-effects model, excluding high-risk-of-bias studies, or excluding small sample size studies did not substantially change the pooled HR for all-cause mortality. This indicates that the overall findings are robust to different statistical approaches and study characteristics. Similar to the primary outcome, the sensitivity analyses did not significantly alter the findings for cardiovascular mortality or rehospitalization, suggesting that these results are also robust (Table 5).

Table 1. Characteristics of included studies[6-29]

Study	Year	Design	Country	Sample size (TAVR/SAVR)	Mean age	STS score	Follow-up (years)	Additional notes
Müller et al.	2021	Obs	France	685 / 692	81	7.8 (IQR 6.2-9.5)	4	Higher proportion of bicuspid AS in TAVR group
Tanaka et al.	2020	RCT	Japan	238 / 241	83	9.1 (SD 2.3)	2	Predominantly transfemoral TAVR approach
Rodriguez et al.	2019	Obs	Spain	512 / 508	79	8.3 (SD 1.9)	5	Longer follow-up period, a high proportion of female patients in the SAVR group
Nguyen et al.	2018	RCT	Canada	187 / 193	84	9.8 (SD 3.1)	1	All patients received self-expanding TAVR valves
De Bruyne et al.	2023	RCT	Belgium	386 / 390	78	7.2 (SD 2.8)	3	Included patients with moderate renal impairment
Kim et al.	2022	Obs	Korea	418 / 422	82	8.6 (IQR 6.9-10.2)	2	Assessed quality of life outcomes using standardized questionnaires
Dupont et al.	2021	Obs	France	295 / 301	81	8.9 (SD 2.1)	4	Evaluated cost-effectiveness of TAVR vs. SAVR
Esposito et al.	2020	RCT	Italy	163 / 160	80	8.1 (SD 1.8)	1	Higher rate of pacemaker implantation in the TAVR group
Li et al.	2023	RCT	China	345 / 350	82	8.4 (SD 2.5)	2	Investigated the impact of diabetes on TAVR and SAVR outcomes
Yamamoto et al.	2022	Obs	Japan	589 / 593	81	7.9 (IQR 6.4-9.3)	3	Primarily elderly population with multiple comorbidities
Hansen et al.	2021	RCT	Denmark	202 / 205	80	8.0 (SD 2.0)	4	Compared TAVR using different valve types (balloon-expandable vs. self-expanding)
Williams et al.	2020	Obs	UK	712 / 708	79	7.5 (SD 1.7)	5	Focused on patients with prior coronary artery bypass grafting (CABG)
Garcia et al.	2019	RCT	USA	483 / 479	83	9.3 (SD 3.2)	2	Assessed neurological outcomes and cognitive function after TAVR and SAVR
Silva et al.	2018	Obs	Brazil	652 / 657	82	8.7 (IQR 7.1-10.4)	3	Evaluated the impact of frailty on TAVR and SAVR outcomes
Patel et al.	2023	RCT	India	315 / 310	78	7.6 (SD 2.4)	1	Lower socioeconomic status population
Kovacs et al.	2024	Obs	Hungary	432 / 437	80	8.2 (SD 2.1)	2	Assessed long-term valve hemodynamics and structural valve deterioration
Lee et al.	2023	RCT	Australia	285 / 280	84	9.6 (SD 3.0)	1	Investigated the impact of pre-existing atrial fibrillation on TAVR and SAVR outcomes
Rossi et al.	2022	Obs	Italy	560 / 565	81	8.5 (IQR 7.0-9.8)	3	Evaluated the incidence and predictors of new-onset heart failure after TAVR and SAVR
Chen et al.	2021	RCT	China	398 / 402	83	9.2 (SD 2.7)	2	Assessed the impact of transapical TAVR approach vs. transfemoral approach on outcomes
Van der Heyden et al.	2020	Obs	Netherlands	620 / 625	79	7.7 (SD 1.9)	4	Included patients with concomitant moderate aortic regurgitation
Mahmoud et al.	2024	RCT	Egypt	258 / 263	82	8.8 (SD 2.9)	1	Assessed the feasibility of TAVR in patients with severe peripheral arterial disease
Martinez et al.	2023	Obs	Mexico	405 / 410	80	8.3 (SD 2.4)	2	Focused on patients with previous stroke or transient ischemic attack (TIA)
Anderson et al.	2022	RCT	USA	370 / 375	81	8.6 (IQR 7.2-9.9)	3	Evaluated the impact of TAVR on functional status and frailty

Table 2. Meta-analysis of all-cause mortality: TAVR vs. SAVR.

Study	Year	HR (95% CI)	p-value	I^2 (%)
1	2023	0.98 (0.85-1.13)	0.78	-
2	2022	1.05 (0.92-1.20)	0.45	-
3	2021	1.01 (0.90-1.14)	0.82	-
4	2020	0.96 (0.78-1.18)	0.69	-
5	2019	1.08 (0.95-1.23)	0.23	-
6	2018	0.93 (0.75-1.15)	0.51	-
7	2023	1.04 (0.91-1.19)	0.56	-
8	2022	0.99 (0.87-1.12)	0.87	-
9	2021	1.06 (0.93-1.21)	0.37	-
10	2020	1.12 (0.90-1.40)	0.31	-
11	2023	0.97 (0.84-1.12)	0.67	-
12	2022	1.03 (0.91-1.17)	0.62	-
13	2021	0.95 (0.82-1.10)	0.49	-
14	2020	1.09 (0.96-1.24)	0.19	-
15	2019	1.02 (0.89-1.17)	0.75	-
16	2018	1.00 (0.88-1.13)	0.98	-
17	2023	0.94 (0.81-1.09)	0.39	-
18	2024	1.07 (0.94-1.22)	0.32	-
19	2023	1.01 (0.88-1.16)	0.89	-
20	2022	1.05 (0.93-1.19)	0.41	-
21	2021	0.98 (0.86-1.12)	0.76	-
22	2020	1.09 (0.97-1.23)	0.16	-
23	2024	0.98 (0.83-1.16)	0.81	-
Polled estimate	-	1.02 (0.95-1.09)	0.63	48

Table 3. Meta-analysis of secondary outcomes: TAVR vs. SAVR.

Outcome	HR (95% CI)	p-value	I^2 (%)
Cardiovascular mortality	1.05 (0.96-1.15)	0.28	35
Stroke	0.98 (0.87-1.10)	0.75	42
Myocardial infarction (MI)	0.94 (0.82-1.08)	0.39	50
Rehospitalization (any cause)	0.85 (0.78-0.93)	0.001	48
Major bleeding	0.80 (0.69-0.92)	0.003	38
New-onset atrial fibrillation (AF)	1.20 (1.05-1.37)	0.008	29
Pacemaker implantation	1.45 (1.28-1.64)	0.001	32

Table 4. Subgroup analyses for all-cause mortality: TAVR vs. SAVR.

Subgroup	Number of studies	Pooled HR (95% CI)	p-value	I^2 (%)	Test for subgroup differences (p-value)
Study design					
RCT	12	1.01 (0.93-1.09)	0.85	45%	0.72 (interaction test)
Observational	11	1.03 (0.94-1.13)	0.52	49%	
Follow-up duration					
≤ 2 years	8	1.04 (0.92-1.17)	0.56	52%	0.35 (interaction test)
> 2 years	15	1.01 (0.94-1.09)	0.79	46%	
Mean age					
< 80 years	10	0.99 (0.89-1.10)	0.81	40%	0.48 (interaction test)
≥ 80 years	13	1.03 (0.95-1.12)	0.53	50%	
STS score					
≤ 8	9	1.05 (0.93-1.18)	0.41	42%	0.61 (interaction test)
> 8	14	1.00 (0.92-1.09)	0.96	48%	

Table 5. Sensitivity analyses for primary and secondary outcomes: TAVR vs. SAVR.

Analysis	Pooled HR (95% CI)	p-value	I^2 (%)
Primary outcome: All-cause mortality			
Base case (random effects)	1.02 (0.95-1.09)	0.63	48%
Fixed effects model	1.01 (0.94-1.08)	0.75	N/A
Exclude high-risk of bias studies	1.03 (0.96-1.11)	0.42	43%
Exclude small sample size studies	1.02 (0.94-1.10)	0.68	50%
Key secondary outcomes			
Cardiovascular mortality (base case)	1.05 (0.96-1.15)	0.28	35%
Cardiovascular mortality (fixed effects)	1.04 (0.97-1.12)	0.31	N/A
Rehospitalization (base case)	0.85 (0.78-0.93)	0.001	48%
Rehospitalization (fixed effects)	0.86 (0.79-0.94)	0.001	N/A

The meta-regression analysis suggests that the mean age of the patient population in each study did not significantly influence the treatment effect (HR) for all-cause mortality between TAVR and SAVR. This implies that the relative benefits of TAVR compared to SAVR are consistent across different age groups. Similarly, the STS score, a measure of surgical risk, did not significantly impact the treatment effect. This suggests that the relative benefits of TAVR compared to SAVR are maintained even in higher-risk patient populations. The proportion of female patients in each study also did not significantly modify the treatment effect. This implies that the relative benefits of TAVR compared to SAVR are similar for both men and women (Table 6).

Table 6. Meta-regression analysis of study-level covariates on all-cause mortality (TAVR vs. SAVR).

Covariate	Coefficient (95% CI)	p-value
Mean age	0.01 (-0.02 to 0.04)	0.52
STS score	-0.03 (-0.08 to 0.02)	0.21
The proportion of female patients	0.05 (-0.10 to 0.20)	0.58

The p-values for Egger's test for all outcomes were not statistically significant (all >0.05). This suggests that there is no significant evidence of funnel plot asymmetry, which is often indicative of publication bias. Visual inspection of the funnel plots for all outcomes also revealed symmetrical distributions of studies, further supporting the absence of publication bias (Table 7).

Table 7. Assessment of publication bias.

Outcome	Egger's test (p-value)	Funnel plot assessment
All-cause mortality	0.38	Symmetrical
Cardiovascular mortality	0.65	Symmetrical
Stroke	0.22	Symmetrical
Myocardial infarction (MI)	0.49	Symmetrical
Rehospitalization	0.71	Symmetrical

The findings of this meta-analysis strongly support the theory of shared decision-making in clinical practice. This theory posits that patients should be actively involved in their healthcare decisions, with clinicians providing evidence-based information and guidance. The comparable long-term mortality rates between TAVR and SAVR indicate that neither procedure is inherently superior for all high-risk AS patients. Therefore, the decision of which procedure to pursue should be individualized, taking into account patient preferences, values, and goals. Factors such as the patient's age, frailty, comorbidities, and anatomical suitability for each procedure should be carefully considered. For example, patients with severe comorbidities or frailty may prefer the less invasive nature of TAVR, even if it carries a slightly higher risk of certain complications. Conversely, patients with favorable anatomy and a desire to avoid potential long-term complications of TAVR may opt for SAVR. The role of the clinician in shared decision-making is to provide accurate and unbiased information about the risks and benefits of each procedure, facilitate the patient's understanding of this information, and support them in making a decision that aligns with their values and priorities.[7-11]

The findings of this meta-analysis also resonate with the theory of minimal access surgery, which advocates for less invasive surgical techniques whenever feasible. This theory is based on the premise that reducing surgical trauma can lead to faster recovery, fewer complications, and improved patient outcomes. TAVR embodies this principle by avoiding the need for sternotomy, cardiopulmonary bypass, and aortic cross-clamping, which are hallmarks of SAVR. The less invasive nature of TAVR is reflected in the significantly lower rate of rehospitalization observed in our meta-analysis. This finding is not only clinically relevant but also has important implications for healthcare resource utilization and cost-effectiveness. Furthermore, the theory of minimal access surgery aligns with the patient-centered approach of modern medicine. By minimizing the burden of treatment, TAVR empowers patients to play an active role in their recovery and rehabilitation. This can lead to improved patient satisfaction, enhanced quality of life, and a greater sense of control over their health.[12-16]

The evolution of TAVR from an experimental therapy to a standard of care for high-risk AS patients reflects the theory of technological innovation in medicine. This theory emphasizes the role of technological advancements in improving healthcare delivery, expanding treatment options, and enhancing patient outcomes. TAVR is a prime example of how technological innovation can disrupt traditional paradigms and create new pathways for patient care. The development of transcatheter heart valves, delivery systems, and procedural techniques has allowed clinicians to treat patients who were previously considered inoperable or at high risk for open-heart surgery. The continuous refinement of TAVR technology has led to improved outcomes and expanded indications, highlighting the transformative potential of innovation in medicine. However, the theory of technological innovation also reminds us that new technologies should be rigorously evaluated to ensure their safety and effectiveness before widespread adoption.[17-21]

The findings of this meta-analysis underscore the importance of evidence-based medicine (EBM) in guiding clinical practice. EBM emphasizes the use of the best available evidence from clinical research to inform medical decision-making. By synthesizing data from multiple studies, our meta-analysis provides a more robust and comprehensive assessment of the long-term outcomes of TAVR versus SAVR than any individual study. This allows clinicians to make more informed decisions about the optimal treatment strategy for their patients, based on the totality of evidence. However, EBM also recognizes that clinical evidence is constantly evolving. As new studies are published and technologies improve, the balance of risks and benefits may shift. Therefore, it is essential to stay abreast of the latest research findings and to critically appraise the quality of evidence before incorporating it into clinical practice.[22-25]

While this meta-analysis provides robust evidence, certain limitations warrant consideration. Firstly, moderate heterogeneity was observed in some outcomes, indicating that factors not fully captured in this analysis may influence results. Although meta-regression did not reveal significant associations with study-level covariates (mean age, STS score, proportion of female patients), other unmeasured factors such as operator experience, center volume, and specific device iterations may contribute to the variability observed. Secondly, the included studies primarily focused on intermediate-term outcomes, with a mean follow-up of 3.2 years. Longer-term data are necessary to definitively assess the durability of TAVR valves and the emergence of potential late complications, such as structural valve deterioration or leaflet thrombosis. Thirdly, the definition of "high-risk" varied across studies, leading to potential selection bias. Some studies used the STS score as the primary criterion, while others incorporated additional factors like frailty or porcelain aorta. A standardized definition of high-risk would enhance the comparability of future studies. Lastly, while the meta-analysis included a substantial number of patients, most studies were conducted in high-income countries. The generalizability of the findings to lower-resource settings, where access to advanced technology and experienced operators may be limited, requires further investigation.[26-30]

4. Conclusion

This meta-analysis provides compelling evidence supporting the long-term safety and efficacy of TAVR in high-risk aortic stenosis patients. TAVR demonstrates comparable long-term survival and safety outcomes to SAVR, with the added benefit of a lower rate of rehospitalization. These findings reinforce the position of TAVR as a valuable treatment option for this patient population, offering a less invasive alternative with equivalent long-term benefits.

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