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Transcatheter Aortic Valve Replacement vs Surgical Replacement in Patients With Pure Aortic Insufficiency

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Abstract

Objective: To compare the outcomes of transcatheter aortic valve replacement (TAVR) with surgical aortic valve replacement (SAVR) in patients with pure aortic insufficiency (PAI).

Background: The treatment of choice for patients with severe symptomatic PAI is SAVR. However, not all patients are candidates for surgery because of comorbidities or are deemed high

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risk for surgery. As a result, TAVR is being used as an off-label procedure in some patients with PAI.

Patients and Methods: We analyzed the National Inpatient Sample database from January 1, 2016, to December 31, 2017, using the International Classification of Diseases, 10th Revision. Inclusion criteria were patients with aortic valve insufficiency undergoing either TAVR or SAVR. Patients with concomitant aortic stenosis, or history of infective endocarditis, and those below the age of 18 years were excluded.

Results: A total of 14,720 patients with PAI underwent valve replacement. Of those, 6.2% underwent TAVR. The TAVR group was significantly older (median age 78 years vs 64 years; $P < .001$). There was no evidence of a difference in in-hospital mortality between the 2 groups. However, after adjustment, patients in the TAVR group were associated with favorable outcomes in terms of acute kidney injury, cardiogenic shock, postoperative respiratory complications, and length of stay. On the other hand, those in the SAVR group were less likely to need permanent pacemakers.

Conclusion: There was no evidence of a significant statistical difference in in-hospital mortality between patients with PAI treated by either SAVR or TAVR, both in unmatched and propensity-matched cohorts. TAVR could be considered for patients with PAI who are not candidates for surgery.

Transcatheter aortic valve replacement (TAVR) was first performed successfully on a human patient for a severe aortic valve stenosis with significant comorbidities that precluded him from being a surgical candidate in 2002.[1] In 2011, the United States Food and Drug Administration approved TAVR for severe aortic stenosis (AS) in patients with prohibitive risk factors for surgery and this was later expanded to include high-risk patients in 2012; to intermediate risk in 2016; and, more recently, to low-risk patients in 2019.[2–6] As TAVR is changing the landscape of treatment for patients with severe AS across all risk groups, surgical replacement of aortic valves remains the treatment of choice in patients with severe pure aortic valve in sufficiency (PAI) who are either symptomatic or asymptomatic, with left-ventricular dysfunction.[7,8] However, the use of TAVR as an off-label procedure for patients with PAI who are not candidates for surgery has been increasing over the years.[9] Several observational studies have demonstrated feasibility and short to medium-term outcomes of TAVR in patients with PAI with overall reasonable results, especially among patients who had newer-generation valves.[10–13]

Unfortunately, data from randomized control trials to assess the efficacy and safety of the procedure in this particular group of patients are still lacking. Hence, in the current study, we aim to compare the real-world outcomes of TAVR with SAVR in patients with PAI, using the national inpatient sample (NIS) database.

METHODS

Study Data

The NIS database from 2016 and 2017 was used for data analysis. The database was founded bythe Federal-State-Industry partnership sponsored by the Agency for Healthcare

Research and Quality. The database is derived from all states for national estimates of health care utilization, outcomes, and costs. Since 2012, the sampling method has been based upon regions rather than hospital based. The NIS is compiled annually, which would allow the data to be used for analysis of disease trends over time. Institutional Review Board approval and informed consents were not required for this study, given the deidentified nature of the database and its public availability.

Study Design and Data Selection

We analyzed the NIS database from January 2016 to December 2017, using the *International Classification of Diseases, 10th Revision (ICD-10)*. Inclusion criteria included patients with aortic valve insufficiency (ICD-10 I35.1) undergoing either TAVR (02RF0) or SAVR (02RF3). Patients who had concomitant aortic valve stenosis (ICD-10 I35.0 and I35.2) or history of infective endocarditis (ICD-10 I330 and I339) were excluded, given the fact that TAVR in a failed prosthetic valve might carry its own risks and challenges compared with native aortic valves. Patients younger than age 18 years were excluded as well. Discharge weight provided was used for analysis. The flow sheet of our selection of patients is shown in Figure 1. Patient characteristics in terms of age, race, chronic conditions, geographic location, size of hospital, and type of insurance before and after propensity matching are summarized in Table 1.

Outcomes assessed include in-hospital mortality; acute kidney injury; postoperative stroke; postoperative respiratory complications; cardiogenic shock; and need for blood transfusions, mechanical ventilation, and pacemaker placement (Table 2 and Supplemental Material, available online at http://www.mayoclinicproceedings.org). Our analysis also included assessing the length of hospital stay and median cost of stay—inflation adjusted—as well as discharge disposition (Table 2).

Data Analysis

For missing value imputation, multiple iterations of Markov chain Monte Carlo (MCMC) was used to avoid data loss before propensity match could be done; MCMC is a simulation method that creates samples from a continuous random variable, with probability density proportional to a known function. To account for potential confounding factors and selection bias, a propensity score-matching model was developed, using logistic regression, to derive 2 matched groups for comparative outcomes analysis. Given the much larger SAVR group, and to minimize case losses, a nearest neighbor 1:1 variable ratio, parallel, balanced propensity-matching model was made using a caliper width of standard deviation 0.1. Descriptive statistics were presented as frequencies with percentages for categorical variables and as a median for continuous variables. Baseline characteristics were compared using a Pearson x^2 test and Fisher's exact test for categorical variables and independent samples, and a Mann-Whitney U test for continuous variables (Supplemental Material, available online at http://www.mayoclinicproceedings.org). All statistical analyses were performed using statistical package for social science version 26 (SPSS Inc, IBM Corp, Chicago, Illinois) and R 3.5 for propensity matching.

RESULTS

Our analysis demonstrated that a total of 14,720 patients with PAI underwent aortic valve replacement between January 2016 and December 2017. Of those patients, 13,805 underwent SAVR, representing 93.8% of the cohort, whereas 915 patients underwent TAVR, representing 6.2% of all patients. Baseline characteristics of the study are shown in Table 1.

Median age for the SAVR group was 64 years vs 78 years for the TAVR group (interquartile range [IQR] was 54 to 72 years for SAVR vs 68 to 85 years for TAVR; *P*<0.001). Female patients represented 26.7% of all patients who underwent SAVR vs 29% of all those who underwent the TAVR procedure; *P*=.14. The percentage of White patients who underwent TAVR was greater than those who underwent SAVR (84.2% vs 74.1%; *P*<.001), but the opposite was true for African Americans (8.2% vs 12.1%; *P*<.001), Hispanics (2.7% vs 7%; P<.001), and other races (4.9% vs 6.8%; P<.001). Significant differences in comorbidities between the SAVR and TAVR groups were noted in terms of history of congestive heart failure (41.5% vs 79.8%, *P*<.001), chronic pulmonary disease (19.2% vs 25.1%, *P*<.001), coronary heart disease (43.2% vs 62.8%; *P*<.001), coagulopathy (38.5% vs 24%, *P*<.001), diabetes with and without complications (7.4% vs 12.6% and 8.5% vs 14.8%, respectively; *P*<.001), hypertension (59.3 % vs 44.8%; *P*<.001), hypothyroidism (10.6% vs 18%; *P*<.001), peripheral vascular disease (39.4% vs 21.9%; *P*.001), history of renal failure (16.4% vs 39.9%; *P*<.001), and history of smoking (13.3% vs 6%; *P*<.001). Of all patients who underwent SAVR for PAI, 555 patients (4.02%) had bicuspid aortic valves, whereas none of the TAVR group had this anomaly (*P*<.001).

Most of the TAVR procedures were done in large (78.1%) and urban teaching hospitals (87.4%). Medicare was the primary payer for the vast majority of TAVR group: 85.2% vs 57.7% for those who underwent SAVR; *P*<.001. As expected, based on other observational studies, the number of TAVR procedures for patients with PAI was slightly higher in 2017, with a total of 460 procedures vs 455 procedures done in 2016. On the other hand, the number of SAVR procedures slightly dropped in 2017 to a total of 6865 surgeries, compared with 6940 surgeries done in 2016 (Figure 2).

Clinical outcomes are shown in (Table 2). For unadjusted in-hospital mortality, there was no evidence of statistical difference between SAVR and TAVR groups (3% vs 2.7%; *P*=.60). Unadjusted outcomes suggested that TAVR group had more favorable outcomes in terms of being less likely to develop an ST-segment elevation myocardial infarction (STEMI) (0% vs 1%; *P* =0.002), postoperative respiratory complications (4.9% vs 11.6%; *P*<.001), need for blood transfusion (4.9% vs 22.3%; *P*<.001), pericardial effusion or hemopericardium (1.6% vs 4%; *P*<.001) and pneumonia (2.2% vs 4.5%; *P*<.001). There was no evidence of significant statistical difference between the TAVR and SAVR groups in terms of acute kidney injury (23% vs 20.6%; *P*=.1) and cardiogenic shock (7.7% vs 7.4%; *P*=.70. On the other hand, our data suggest that the patients in the SAVR group were less likely to develop a non-STEMI (4.3% vs 7.1%; *P*=.02) and the need for cardiopulmonary resuscitation (1.2% vs 2.2%; *P*=.01). It is also worth noting that of the 13,805 SAVR surgeries performed, 3205 (23.2%) patients had concomitant coronary artery bypass graft surgeries as well, whereas 8.2% of all patients who underwent TAVR had percutaneous coronary interventions (PCIs) during the same admission, which includes all PCIs that were performed before, during, or after the TAVR procedure.

However, to account for possible confounding factors and selection bias between the 2 groups, a propensity score match was done using logistic regression to have 2 matched groups for comparative outcomes. For in-hospital mortality, the data remained with no evidence of significant statistical difference between the SAVR and TAVR groups after adjustment (3.2% vs 2.7%; *P*=.49). After adjustment, our analysis demonstrated that the patients in the TAVR group had more favorable outcomes and were less likely to develop acute kidney injury (23% vs 30.2%; *P*<.001), cardiogenic shock (7.7% vs 10.4%; *P*=.03), postoperative respiratory complications (4.9% vs 8.6%; P<.001), need for blood transfusions (4.9% vs 21.9%; *P*<.001), pneumonia (2.2% vs 4.7%; *P*=.001), and pericardial effusion and hemopericardium (1.6% vs 2.9%; *P*=.002). After adjustment, our analysis could not demonstrate any statistical significant difference between the TAVR and SAVR groups in terms of developing non-STEMI (7.1 vs 7.6%; *P*=.69) (Table 2). After adjustment, the data demonstrated that the SAVR group had more favorable outcomes in terms of being less likely to require cardiopulmonary resuscitation (2.2% vs 1.1%; *P*=.03) and less likely to require new pacemaker placement (11.5% vs 19.7%; *P*<.001).

In addition, more patients on the TAVR group were discharged home compared with patients in the SAVR group (89.9% vs 81.1%; *P*<.001), and this is true for adjusted analysis as well (89.9% vs 69.1%; *P*<0.001). Moreover, patients on the TAVR group had less hospital stay with a median of 4 days vs 7 days for the SAVR group (*P*<.001), and the difference remains significant after adjustment (4 days vs 9 days; *P*<.001); this is true in both 2016 and 2017 (Figure 3). Moreover, the overall median cost of hospitalization was not statistically significantly different between TAVR and SAVR groups before adjustment ($205,888 vs $195,003; *P*=.12). However, after adjustment, the cost of hospitalization was lower in the TAVR group, with a median of $205,888 vs $212,979 (*P*=.03) (Figure 4).

DISCUSSION

In our study, we report the real-world outcomes of TAVR and SAVR in those patients who have PAI, using the NIS database. A few observations are notable in the current study. First, patients who underwent TAVR were significantly older than those who underwent SAVR, with a median age of 78 years compared with 64 years, and they were more likely to have anemia, congestive heart failure, type 2 diabetes mellitus, and significant other organ involvement including chronic obstructive lung disease, liver disease, and kidney disease. Second, there was not sufficient evidence of difference in terms of in-hospital mortality between the 2 groups both before and after propensity matching. Third, our analysis demonstrated that the TAVR group had better outcomes for end points such as acute kidney injury, postprocedure stroke, postprocedure respiratory complications, and the need for blood transfusion. Fourth, the SAVR group, on the other hand, had better outcomes in term of being less likely to need pacemaker placement. Finally, our study showed that the hospital course for the TAVR group of patients was significantly shorter and, overall, less costly compared with the SAVR group patients (Figure 3).

Generally, the incidence of clinically significant PAI increases with age and is reported to be as high as 2.3% in those who are above the age of 70 years, with men more affected than women.[14,15] The treatment of choice in symptomatic patients who have severe aortic insufficiency, or those who are asymptomatic but have associated left-ventricular dysfunction, is surgical valve replacement in those who can undergo surgery.[7,16] Patients who have severe aortic insufficiency with left-ventricular dysfunction (New York Heart Association class 3 or 4) have poor prognoses without valve replacement and a reported survival rate of 28% at 5 years.[17] However, despite the overall poor prognoses of symptomatic patients, a study reported that only 22% of those with ejection fractions between 30% and 50% undergo surgical valve replacement, and only 3% of patients with ejection fractions of less than 30% will undergo surgery.[15,18]

Compared with SAVR, TAVR has emerged as a less invasive procedure for patients with AS. The unmet needs of patients with PAI who are not candidates for surgery, and the accumulating experience of heart teams with transcatheter technology, has pushed the envelope with off-label use in patients with PAI.[9] Data from the Transcatheter Valve Therapy Registry, which included all patients receiving TAVR in the United States, showed that 9.5% of the procedures were done for an off-label indication, with severe PAI being the most common.

The TAVR group with PAI in the current study was older compared with the SAVR group and those patients had significant comorbidities such as anemia, chronic obstructive lung disease, chronic kidney disease, and liver disease. This finding is reflective of practice pattern as shown in the Euro Heart Survey.[18] The survey reported noncardiac causes such as old age, chronic obstructive lung disease, and renal failure as the most frequent reasons for not performing surgery despite poor functional class in more than 55% of patients.[18] It is likely that comorbidities and frailty, which was not assessed in the current study, could have been the reason the patients underwent TAVR.

In-hospital mortality did not differ between the TAVR and SAVR groups. The in-hospital mortality of 2.7% is consistent with the findings reported from the Aortic Regurgitation (AR)-TAVR registry, in which procedure-related mortality was 3%. Yoon et al reported an all-cause mortality of 24% at 1 year in this cohort; TAVR was performed in elderly patients and patients with comorbidities, a cohort at higher mortality risk with SAVR. This might be one of the reasons that TAVR mortality was numerically lower but not statistically significant compared with SAVR.

Stroke and pacemaker rates noted in our study are similar to those reported in a recent systematic review.[19] Pacemaker implantation continues to be high, relative to SAVR, irrespective of indication: AS or AR. The less invasive nature of the procedure can explain the difference in length of stay, acute kidney injury, pneumonia, respiratory complications, and requirement for blood transfusion.

Based on the results of the current study and observational data, it appears that TAVR is feasible with acceptable outcomes and might be considered as an alternative to surgery in patients who meet the criteria for valve replacement but are deemed high risk or inoperable.[9,10,20–22] However, several challenges still remain whenever a patient is being considered to undergo TAVR for this indication. Eighty-six percent of patients with PAI have either nodor milddvalve calcifications, which can represent a challenge when the device is deployed, owing to the difficulty of anchoring the device in place and the associated risk of dislodgement and migration.[10,11,13] Newer-generation valves demonstrated superior outcomes when compared with older-generation valves because of better anchoring mechanisms with higher rates of successful deployment.[10–13]

Limitations

The NIS is an administrative claim-based database that uses ICD-10-CM codes for diagnosis that may be subject to error. The NIS collects data on in-patient discharges, and each admission is registered as an independent event. The NIS samples are not designed to follow patients longitudinally therefore, long-term outcomes could not be assessed from the current dataset. Like any retrospective database study, association does not mean causation, and conclusions should be drawn cautiously. Although optimal matching was performed, both populations could not be matched with respect to some characteristics such as age and some comorbidities. It is also worth noting that possible unmeasured confounders might exist among the research cohorts.

Data on left-ventricular function, New York Heart Association class, and imaging parameters in patients coded as having PAI could not be obtained because of the nature of the database. However, it is likely that the PAI was severe enough to warrant valve intervention.

Residual AR or postprocedural AR could not be assessed as well. Residual AR is associated with increased mortality at 1 year and is unlikely to affect in-hospital mortality. Moreover, long-term complications—such as paravalvular leaks, conduction abnormalities, need for pacemaker placement, burden of valve calcifications, or prevalence of leaflet thrombosis—were not assessed because of the nature of the NIS database. Type of transcatheter valve that was used— balloon expandable vs self-expanding—was not available. As was stated, newer-generation valves are associated with better rates of success.

CONCLUSION

There was not sufficient evidence of a difference in patients with in-hospital mortality with PAI treated by either SAVR or TAVR, both in unmatched and propensity-matched cohorts. Randomized controlled trials comparing the outcomes of TAVR and SAVR in patients with PAI are needed.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Abbreviations and Acronyms:

ICD	international classification of diseases

NIS	national inpatient sample
PAI	pure aortic insufficiency
PCI	percutaneous coronary intervention
SAVR	surgical aortic valve replacement
TAVR	transcatheter aortic valve replacement

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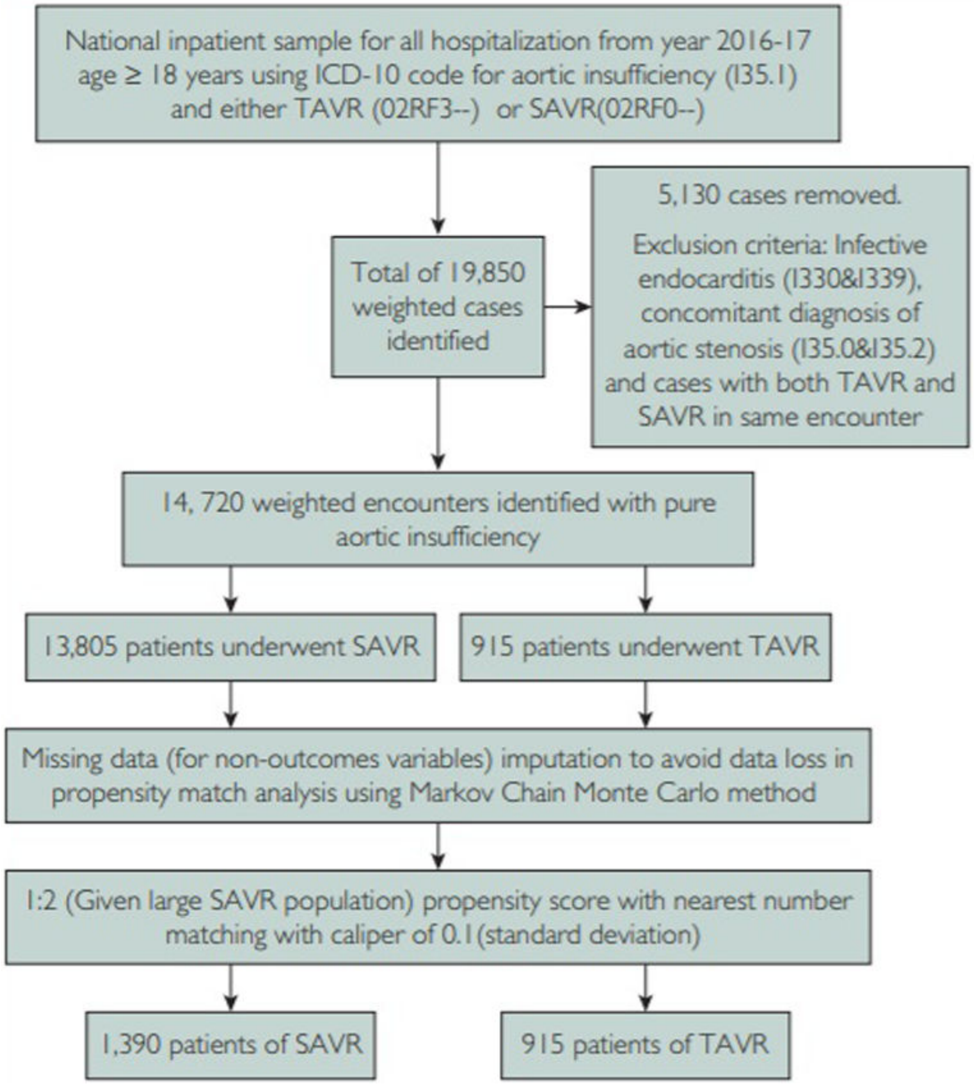

FIGURE 1.

Flow sheet of the patient selection process from the NIS database. NIS = national inpatient sample; SAVR = surgical aortic valve replacement; TAVR = transcatheter aortic valve replacement.

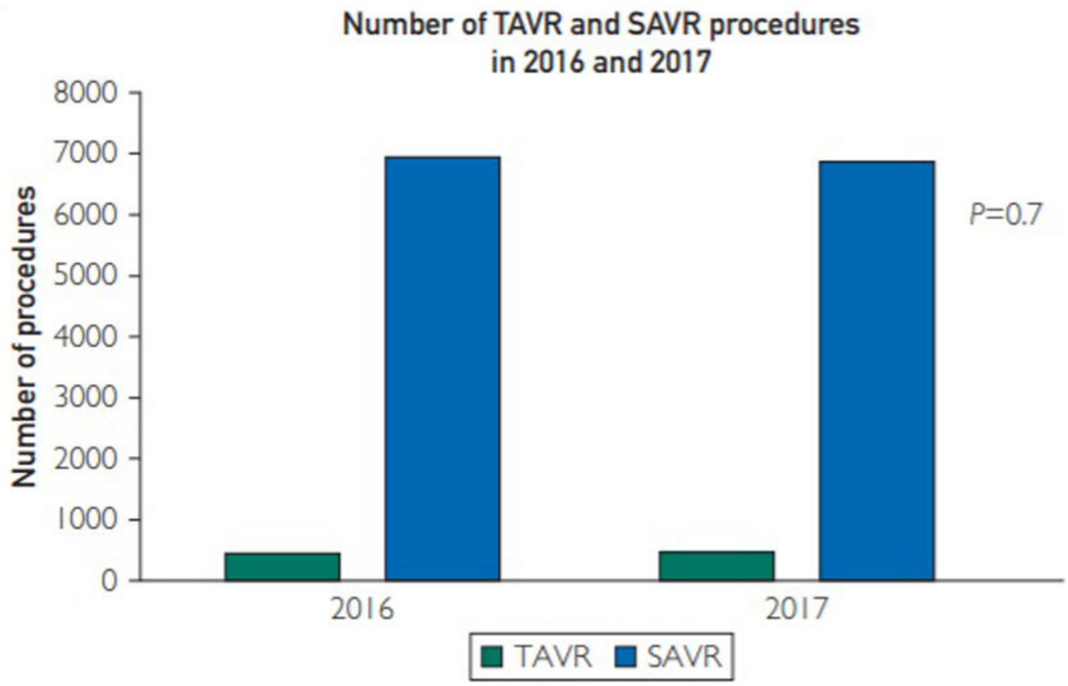

FIGURE 2.

Number of TAVR and SAVR in 2016 and 2017. SAVR = surgical aortic valve replacement; TAVR = transcatheter aortic valve replacement.

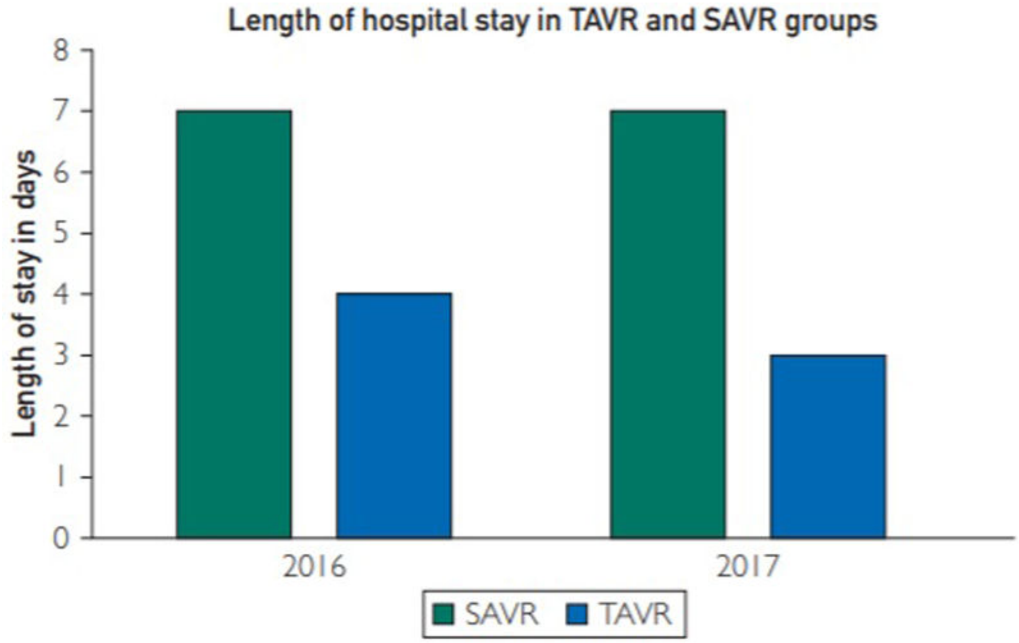

FIGURE 3.

Length of hospital stay in TAVR and SAVR groups in days. SAVR = surgical aortic valve replacement; TAVR = transcatheter aortic valve replacement.

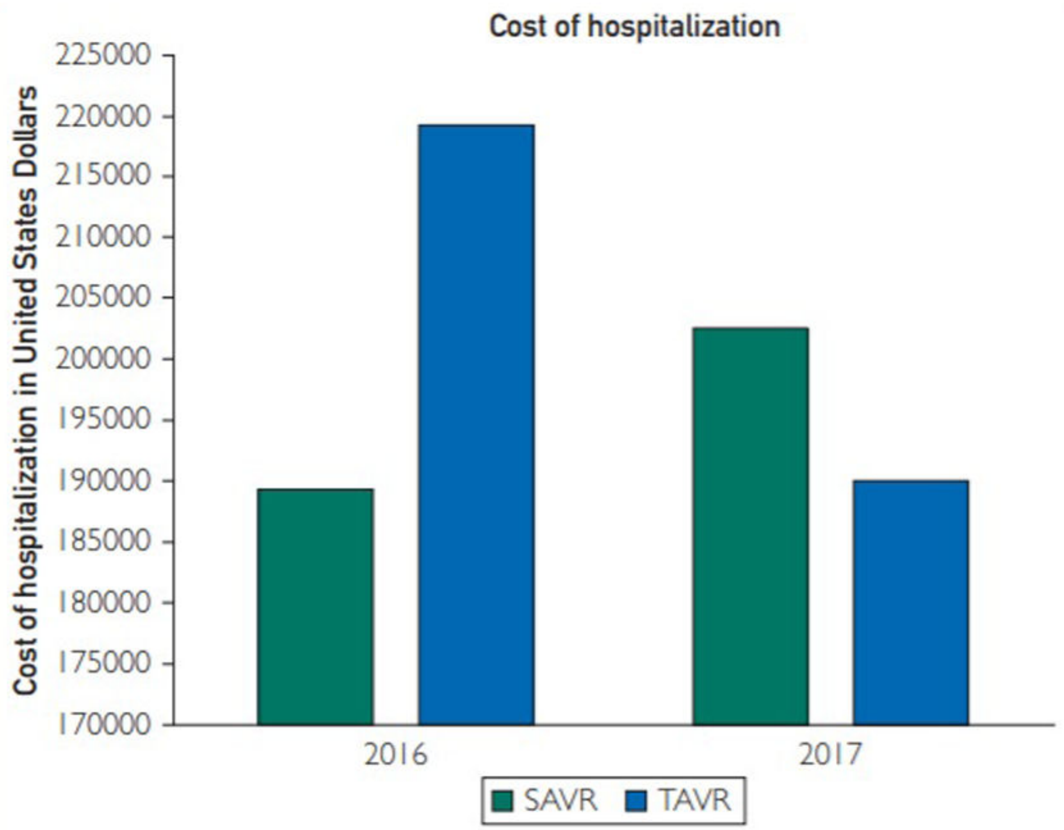

FIGURE 4.
Cost of hospitalization in TAVR and SAVR groups in US dollars. SAVR = surgical aortic valve replacement; TAVR = transcatheter aortic valve replacement.

TABLE 1.

Basic Characteristics of the Patients Who Underwent TAVR and SAVR Before and After Propensity Matching

Variable, n	Unmatched cohort SAVR (13,805)	Unmatched cohort TAVR (915)	Unmatched cohort *P* value	Propensity-matched cohort SAVR (1390)	Propensity-matched cohort TAVR (915)	Propensity-matched cohort *P* value
Age median (IQR)	64 (54–72)	78 (68–85)	<.001	74 (67–80)	78 (68–85)	<.001
Female	3685 (26.7)	265 (29.0)	0.14	400 (28.8)	265 (29.0)	.92
Race						
White	9740 (74.1)	770 (84.2)	<.001	1165 (83.8)	770 (84.2)	.61
African American	1585 (12.1)	75 (8.2)		105 (7.6)	75 (8.2)	
Hispanic	920 (7.0)	25 (2.7)		35 (2.5)	25 (2.7)	
Other	895 (6.8)	45 (4.9)		85 (6.1)	45 (4.9)	
Elective admission	9695 (70.6)	630 (69.6)	<.001	925 (66.5)	630 (68.9)	.25
Concomitant coronary artery bypass graft surgery	3205 (23.2)	0(0)	<.001	-	-	-
Comorbidities						
Bicuspid aortic valve	555 (4.02)	0	<.001	-	-	-
Alcohol abuse	455 (3.3)	NA	<.001	15 (1.1)	NA	.18
Anemia	1655 (12.0)	260 (28.4)	<.001	275 (19.8)	260 (28.4)	.01
Congestive heart failure	5730 (41.5)	730 (79.8)	<.001	1060 (76.3)	730 (79.8)	.047
Collagen vascular disease	435 (3.2)	30 (3.3)	.83	45 (3.2)	30 (3.3)	.97
Chronic pulmonary disease	2655 (19.2)	230 (25.1)	<.001	320 (23.0)	230 (25.1)	.24
Coronary heart disease	5965 (43.2)	575 (62.8)	<.001	830 (59.7)	575 (62.8)	.13
Cerebrovascular disease	1070 (7.8)	75 (8.2)	.63	130 (9.4)	75 (8.2)	.34
Coagulopathy	5320 (38.5)	220 (24.0)	<.001	410 (29.5)	220 (24.0)	.004
Diabetes with no complications	1180 (8.5)	135 (14.8)	<.001	160 (11.5)	135 (14.8)	.02
Diabetes with complications	1020 (7.4)	115 (12.6)	<.001	160 (11.5)	115 (12.6)	.44
Hypertension	8180 (59.3)	410 (44.8)	<.001	560 (40.3)	410 (44.8)	.03
Hypothyroidism	1465 (10.6)	165 (18.0)	<.001	220 (15.8)	165 (18.0)	.17
Liver disease	230 (1.7)	35 (3.8)	<.001	55 (4.0)	35 (3.8)	.87
Obesity	2310 (16.7)	110 (12.0)	<.001	170 (12.2)	110 (12.0)	.88
Peripheral vascular disease	5440 (39.4)	200 (21.9)	<.001	350 (25.2)	200 (21.9)	.07
Smoking	1835 (13.3)	55 (6.0)	<.001	80 (5.8)	55 (6.0)	.80

Variable, n	Unmatched cohort			Propensity-matched cohort		
	SAVR (13,805)	TAVR (915)	*P* value	SAVR (1390)	TAVR (915)	*P* value
Renal failure	2265 (16.4)	365 (39.9)	<.001	465 (33.5)	365 (39.9)	.002
Weight loss	525 (3.8)	40 (4.4)	.39	70 (5.0)	40(4.4)	.46
Census region						
New England	520 (3.8)	45 (4.9)	.01	60 (4.3)	45 (4.9)	.008
Mid-Atlantic	2265 (16.4)	120 (13.1)		250 (18.0)	120 (13.1)	
East North Central	2370 (17.2)	115 (12.6)		165 (11.9)	115 (12.6)	
West North Central	905 (6.6)	85 (9.3)		100 (7.2)	85 (9.3)	
South Atlantic	2530 (18.3)	175 (19.1)		245 (17.6)	175 (19.1)	
East South Central	1025 (7.4)	85 (9.3)		145 (10.4)	85 (9.3)	
West South Central	1295 (9.4)	95 (10.4)		130 (9.4)	95 (10.4)	
Mountain	990 (7.2)	60 (6.6)		125 (9.0)	60 (6.6)	
Pacific	1905 (13.8)	135 (14.8)		170 (12.2)	135 (14.8)	
Urban or rural						
Rural	265 (1.9)	15 (1.6)	.32	30 (2.2)	15(1.6)	.66
Urban, nonteaching	1720 (12.5)	100 (10.9)		155 (11.2)	100(10.9)	
Urban, teaching	11,820 (85.6)	800 (87.4)		1205 (86.7)	800(87.4)	
Hospital size						
Small	1235 (8.9)	35 (3.8)	<.001	80 (5.8)	35 (3.8)	.07
Medium	2650 (19.2)	165 (18.0)		225 (16.2)	165 (18.0)	
Large	9920 (71.9)	715 (78.1)		1085 (78.1)	715(78.1)	
Primary payer						
Medicare/Medicaid	7945 (57.7)	780 (85.2)	<.001	1120 (80.6)	780 (85.2)	<.001
Private insurance	5200 (37.8)	110 (12.0)		235 (16.9)	110 (12.0)	
Self-pay	310 (2.3)	<11 (<1)		0	<11 (<1)	
Other	315 (2.3)	20 (2.2)		35 (2.5)	20 (2.2)	
Median household Income for patient ZIP code						
0 to 25th percentile	3380 (25.0)	190 (21.2)	.02	250 (18.0)	190 (20.8)	0.23
26th to 50th percentile	3255 (24.1)	230 (25.7)		340 (24.5)	235 (25.7)	
51st to 75th percentile	3330 (24.6)	210 (23.5)		370 (26.6)	220 (24.0)	
76th to 100th percentile	3550 (26.3)	265 (29.6)		430 (30.9)	270 (29.5)	

IQR = Interquartile range; NA = values <11 (as this cannot be reported per Healthcare Cost and Utilization Project recommendation); SAVR = surgical aortic valve replacement; TAVR = transcatheter aortic valve replacement.

TABLE 2.

Clinical Outcomes After the Procedure in TAVR and SAVR Groups: Results for Unadjusted and After Adjustment (Propensity Matching)

Variable	Unadjusted			Adjusted		
	SAVR (13,805)	TAVR (915)	*P* value	SAVR (1390)	TAVR (915)	*P* value
In-hospital mortality	420 (3.0)	25 (2.7)	.60	45 (3.2)	25 (2.7)	.49
Acute kidney injury	2850 (20.6)	210 (23.0)	.10	420 (30.2)	210 (23.0)	<.001
Atrial fibrillation	6370 (46.1)	405 (44.3)	.27	845 (60.8)	405 (44.3)	<.001
Cardiopulmonary resuscitation	165 (1.2)	20 (2.2)	.01	15 (1.1)	20 (2.2)	.03
Cardiogenic shock	1015 (7.4)	70 (7.7)	.74	145 (10.4)	70 (7.7)	.03
Postoperative stroke	165 (1.2)	<11 (<1)	.08	20(1.4)	<11 (<1)	.04
All strokes code	495 (3.6)	15 (1.6)	.01	40 (2.9)	15 (1.6)	.06
Postoperative respiratory complications	1595 (11.6)	45 (4.9)	<.001	120(8.6)	45(4.9)	<.001
Blood transfusion	3080 (22.3)	45 (4.9)	<.001	305 (21.9)	45 (4.9)	<.001
Pacemaker Insertion	1390 (10.1)	180 (19.7)	<.001	160 (11.5)	180 (19.7)	<.001
Pericardial effusion and hemopericardium	555 (4.0)	15 (1.6)	<.001	40 (2.9)	15 (1.6)	.002
Non—ST-segment elevation myocardial infarction	590 (4.3)	65 (7.1)	.02	105 (7.6)	65 (7.1)	0.69
ST-segment elevation myocardial infarction	140 (1.0)	0 (0.0)	.002	20 (1.4)	0	<.001
Percutaneous coronary intervention	45 (0.3)	75 (8.2)	<.001	5 (0.4)	75 (8.2)	<.001
Mechanical ventilation	1440 (10.4)	35 (3.8)	<.001	170 (12.2)	35 (3.8)	<.001
Tracheostomy	210 (1.5)	<11 (<1)	.30	15 (1.1)	<11 (<1)	.98
Gastrostomy	185 (1.3)	15 (1.6)	.45	20 (1.4)	15 (1.6)	.70
Pneumonia	615 (4.5)	20 (2.2)	<.001	65 (4.7)	20 (2.2)	<.001
Pneumothorax	470 (3.4)	<11 (<1)	<.001	50 (3.6)	<11 (<1)	<.001
Septic shock	140 (1.0)	0	.002	25 (1.8)	0	<.001
Vasopressor use	610 (4.4)	<11 (<1)	<.001	55 (4.0)	<11 (<1)	<.001
Pseudoaneurysm	60 (0.4)	15 (1.6)	<.001	<11 (1)	15 (1.6)	<.001
Urinary tract infection	595 (4.3)	15 (1.6)	<.001	85 (6.1)	15 (1.6)	<.001
Discharge status						
Discharged home	10,860 (81.1)	800 (89.9)	<.001	930 (69.1)	800 (89.9)	<.001
Non-home discharges	2525 (18.9)	90(10.1)		415(30.9)	90 (10.1)	
Resource utilization						

Variable	Unadjusted			Adjusted		
	SAVR (13,805)	**TAVR (915)**	***P* value**	**SAVR (1390)**	**TAVR (915)**	***P* value**
Length of stay, median (IQR), days	7 (5–11)	4 (2–9)	<.001	9 (6–13)	4 (2–9)	<.001
Cost of hospitalization, median (IQR) $	195,003 (139,610–290,271)	205,888 (149165–281751)	0.12	212,979 (1,449,970–324,689)	205,888 (149,165–281,751)	.03

Variables used for propensity matching. Selected elixhauser morbidities (alcohol abuse, anemia, congestive heart failure, collagen vascular disease, chronic pulmonary disease, coagulopathy, diabetes with no complications, diabetes with complications, hypertension, hypothyroidism, liver disease, obesity, peripheral vascular disease, renal failure, weight loss); other variables (cerebrovascular disease, coronary heart disease, smoking); and demographics (gender, race, elective admission, census region, urban or rural, hospital size, primary payer, median household Income for patient ZIP code).

IQR = interquartile range; SAVR = surgical aortic valve replacement; TAVR = transcatheter aortic valve replacement.