In-Hospital Outcomes of Transcatheter Aortic Valve Implantation in Patients With Mitral Valve Stenosis

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Little is known about the outcome of patients with mitral stenosis (MS) who underwent transcatheter aortic valve implantation (TAVI). Therefore, we sought to evaluate the potential impact of MS on the outcome of patients who underwent TAVI using the US national cohort. Using weighted data from the National Inpatient Sample database between 2011 and 2015, we identified patients who had undergone a TAVI as a primary procedure. Patients with MS diagnosis were compared with those without MS. Univariate and multivariate logistic regression analyses were performed for the outcomes of in-hospital mortality and postprocedural complications. Outcomes were also stratified by the type to TAVI (endovascular vs transapical). A total of 62,110 patients underwent TAVI (mean age 81 ± 8.72, 47.4% females, and 3.7% African-Americans) and 887 patients had MS (1.43%). Patients with concomitant MS had higher in-hospital mortality (5.1% vs 3.5% adjusted odds ratio [aOR] 1.455; 95% confidence interval [CI] 1.059 to 2.001, p = 0.021), major adverse cardiac events (9.0% vs 7.1% aOR 1.297; 95% CI 1.012 to 1.663, p = 0.040), major bleeding (16.3% vs 12.1% aOR 1.303; 95% CI 1.067 to 1.593, p = 0.010), cardiac complications (21.8% vs 16.0% aOR 1.536; 95% CI, 1.300 to 1.815, p < 0.001), and acute myocardial infarction (4.5% vs 2.8% aOR 1.783; 95% CI 1.249 to 2.545, p = 0.007) when compared with patients without MS. In conclusion, MS is an independent risk factor for mortality and morbidity after TAVI procedure for patients with severe aortic stenosis. **(Am J Cardiol 2019;123:1510−1516)**

Transcatheter aortic valve implantation (TAVI) is now the standard of care for patients with severe aortic valve stenosis (AS) who are at high and intermediate risk for surgical aortic valve replacement.[1−5] The coexistence of mitral stenosis (MS) and aortic stenosis (AS) is far from being exceptional in surgical aortic valve replacement. Current registries suggest a prevalence of 11.6% of MS in patients who underwent TAVI.[6] In 1 study, 17% of patients referred for aortic valve replacement were found to have MS [7] with double valve surgery associated with higher operative mortality and lower long-term survival rates compared with those who underwent isolated aortic valve replacement.[7,8] Furthermore, the risk of thromboembolism is higher in patients who underwent double valve replacement compared with patients who underwent isolated aortic valve replacement.[9] Furthermore, the presence of mitral annular calcification was associated with a higher overall and cardiac mortality, along with postprocedural morbidity.[10] Although mitral regurgitation has been an established risk factor for increased morbidity and mortality in TAVI patients,[11,12] there are limited data regarding the outcome of TAVI patients with concomitant aortic stenosis and MS. Therefore, we sought to evaluate the impact of MS on the in-hospital outcome of patients who underwent TAVI using the National Inpatient Sample (NIS).

Method

Using the NIS database from 2011 to 2015, we performed a retrospective analysis. The NIS is a publicly available identified database of hospital discharges in the United States, containing data from approximately 8 million hospital stays that were selected using a complex probability sampling design and the weighting scheme recommended by the Agency for Healthcare Research and Quality which is intended to represent all discharges from nonfederal hospitals. Each record includes 1 primary diagnosis and up to 24 secondary diagnoses from 2011 to 2014 and up to 29 secondary diagnoses from 2014 to 2015. After weighing the data, we identified 62,110 adult patients who had undergone TAVI as a primary procedure using the International Classification of Disease, Ninth Edition, Clinical Modification (ICD-9-CM) codes (35.05 and 35.06), of which 887 patients with MS diagnosis (regardless of etiology) using

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See page 1515 for disclosure information.

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Table 1
Baseline characteristics stratified by presence of mitral stenosis

Variable	Mitral stenosis Yes (n = 887)	Mitral stenosis No (n = 61,233)	p value
Age (mean ± SD)	79.10 ± 9.87	81.02 ± 8.70	<0.001
Women	65.6 (%)	47.2 (%)	<0.001
			<0.001
White	85.5 (%)	87.4 (%)	
Black	7.9 (%)	3.9 (%)	
Hispanic	2.4 (%)	4.0 (%)	
Asian or pacific islander	1.8 (%)	1.1 (%)	
Native American	0.0 (%)	0.2 (%)	
Other	2.4 (%)	3.4 (%)	
Elective hospitalization	75.0 (%)	76.6 (%)	0.599
Primary expected payer			0.012
Medicare	90.4 (%)	90.1 (%)	
Medicaid	1.7 (%)	1.1 (%)	
Private insurance	7.3 (%)	7.0 (%)	
Self-pay	0.6 (%)	0.5 (%)	
No charge	0.0 (%)	0.0 (%)	
Other	0.0 (%)	1.3 (%)	
Median household income (percentile)			0.230
0 to 25 percentiles	21.0 (%)	19.9 (%)	
26 to 50 percentiles	24.8 (%)	23.3 (%)	
51 to 75 percentiles	25.9 (%)	28.8 (%)	
76 to 100 percentiles	28.2 (%)	28.0 (%)	
Bed size			0.914
Small	4.5 (%)	4.8 (%)	
Medium	17.5 (%)	17.7 (%)	
Large	78.9 (%)	77.5 (%)	
Location/teaching status			0.300
Rural	1.1 (%)	0.7 (%)	
Urban nonteaching	8.8 (%)	9.5 (%)	
Urban teaching	90.1 (%)	89.8 (%)	
Hospital region			<0.001
Northeast	21.3 (%)	25.4 (%)	
Midwest	20.3 (%)	22.3 (%)	
South	34.9 (%)	33.8 (%)	
West	23.4 (%)	18.5 (%)	
TAVI access			
Endovascular access	86.5 (%)	84.3 (%)	0.076
Transapical access	13.5 (%)	15.9 (%)	0.055
Comorbidities			
Hypertension	74.6 (%)	80.5 (%)	<0.001
Diabetes, uncomplicated	34.9 (%)	29.2 (%)	<0.001
Diabetes, complicated	7.3 (%)	6.0 (%)	0.107
Hyperlipidemia	55.7 (%)	65.4 (%)	<0.001
Smoking	2.8 (%)	3.2 (%)	0.486
Atrial fibrillation	41.6 (%)	44.2 (%)	0.127
Prior stroke	14.1 (%)	13.1 (%)	0.385
Carotid disease	6.8 (%)	7.4 (%)	0.446
Coronary artery disease	57.9 (%)	68.9 (%)	<0.001
Deficiency anemia	30.1 (%)	24.8 (%)	<0.001
Rheumatoid arthritis/ collagen vascular disease	6.2 (%)	4.7 (%)	0.039
Congestive heart failure	9.6 (%)	8.4 (%)	0.205
Chronic pulmonary disease	36.6 (%)	33.0 (%)	0.024
Coagulopathy	20.2 (%)	22.3 (%)	0.128
Hypothyroidism	25.8 (%)	20.3 (%)	<0.001
Liver disease	3.4 (%)	2.6 (%)	0.150
Lymphoma	0.6 (%)	1.3 (%)	0.051
Fluid and electrolyte disorders	30.4 (%)	25.1 (%)	<0.001
Metastatic cancer	0.0 (%)	0.4 (%)	0.057
Obesity	16.9 (%)	14.7 (%)	0.069
Paralysis	2.3 (%)	1.7 (%)	0.233
Psychosis	0.6 (%)	1.8 (%)	0.007
Renal failure	38.3 (%)	35.7 (%)	0.117
Peripheral arterial disease	34.4 (%)	29.2 (%)	0.001
Pulmonary circulation disorders	5.6 (%)	2.6 (%)	<0.001

(*continued*)

Table 1 (***Continued***)

the codes (394.0 and 396.0). Patients with concomitant mitral valve repair were excluded. Using the Clinical Classification Software codes provided by the Healthcare Cost and Utilization Project and the Elixhauser Comorbidity Index, co-morbidities were appointed via ICD-9 codes. Supplemental Table 1 identifies co-morbidities from the Elixhauser co-morbidity index,[13] and ICD-9 codes used for other co-morbidities and in-hospital outcomes. Institutional board review approval is not required as the NIS is a publicly available database.

The primary outcome of the study was in-hospital mortality. The secondary outcomes were in-hospital complications which included hemorrhage requiring blood transfusion, vascular complications (injury to blood vessels, accidental puncture, injury to retroperitoneum, other vascular complications, and vascular complications requiring surgery), cardiac complications (iatrogenic cardiac complications, hemopericardium, cardiac tamponade, and pericardiocentesis), permanent pacemaker implantation, conversion to open-heart surgery, respiratory complications (postprocedural pneumothorax, postprocedural pulmonary edema, pulmonary collapse, prolonged mechanical ventilation >96 hours, and tracheostomy), postprocedural stroke, and acute kidney injury. All procedure-related complications were identified using appropriate ICD-9-CM codes (Supplementary Table 1).

The data was expressed as weighted mean values ± standard deviation, and frequencies were denoted in percentages according to the presence or absence of MS. Independent *t* tests were used for the comparison of continuous variables measurements, while chi-square test for categorical variables. Weighted values of patient level observations were generated to produce a nationally representative estimate of the entire US population of hospitalized patients. Univariable and multiple logistic regressions were used to study the association between the MS and the primary and secondary outcomes after TAVI. The regression models were adjusted for demographics (age, race, and gender), urgency of TAVI (elective vs emergent), included Elixhauser co-morbidities (other than valvular disorders), other relevant co-morbidities (atrial fibrillation, smoking, carotid artery disease, coronary artery disease, previous stroke, and dyslipidemia), TAVI access (endovascular or

transapical), patient insurance, socioeconomic status, and hospital characteristics. Linear regression models were used to assess the length of stay (LOS). Log transformation of LOS was used to adjust for positively skewed data. We performed a subgroup analysis by further stratifying patients for TAVI access for all outcomes. To further explore our findings, we performed multivariate logistic regression for the predictors of having MS in patients who underwent TAVI. For the trend analysis, Cochrane-Armitage test was used to determine the presence of a linear trend in MS rates in patients who underwent TAVI during the studied years. p value of less than 0.05 was considered statistically significant. SPSS version 25 software (IBM Corp, Armonk, New York) was used for all statistical analyses.

Results

During the study period, a total of 62,110 patients underwent TAVI (mean age 81 ± 8.72, 47.4% females, and 3.7% African-Americans). We identified 887 patients with MS (1.43%) and compared them with 61,233 (98.57%) patients without MS. Patients in the MS group were younger (79.10 vs 81.02, p <0.001) more females (65.6% vs 47.2%) and African-American patients (7.9% vs 3.9%) (p <0.001 for both). Furthermore, the MS group had a lower burden of several co-morbidities including hypertension, coronary artery disease and hyperlipidemia (p <0.001). However, other co-morbid conditions such as diabetes mellitus (DM), chronic pulmonary disease, peripheral vascular disease (PAD) and pulmonary circulation disorders were more prevalent in the MS group. Baseline characteristics stratified by MS status is described in Table 1.

In patients who underwent TAVI, and using multivariate logistic regression, female gender, black patients, complicated and uncomplicated DM, fluid and electrolyte disorders, PAD, pulmonary circulation disorders, and renal failure were identified as predictors of having MS (p ≤ 0.049 for all). Female gender and pulmonary circulation disorders had the highest odds of having MS (odds ratio [OR] 2.178; 95% confidence interval [CI] 1.862 to 2.547, p <0.001), (OR 2.319; 95% CI 1.589 to 3.384, p <0.001), respectively (Table 3). Younger patients were more likely to have MS (OR 0.979; 95% CI 0.971 to 0.988, p <0.001). Using the Cochrane-Armitage method, there was a statistically significant linear increase in the rate of MS patients who underwent TAVI from 1.0% to 1.6% between the years of 2011 and 2014 (p <0.001) (Figure 3).

Following adjustment for baseline covariates, patients with MS had a statistically significant higher in-hospital mortality compared with the non-MS group after adjusting for patients' demographics, TAVI access, urgency, co-morbidities, patient insurance, socioeconomic status, and hospital characteristics (5.1% vs 3.5% adjusted odds ratio [aOR], 1.455; 95% CI 1.059 to 2.001, p = 0.021) (Figure 1). Furthermore, MS patients had a statistically significant higher major adverse cardiac events (9.0% vs 7.1% aOR 1.297; 95% CI 1.012 to 1.663, p = 0.040), major bleeding (16.3% vs 12.1% aOR 1.303; 95% CI 1.067 to 1.593, p = 0.010), cardiac complications (21.8% vs 16.0% aOR 1.536; 95% CI 1.300 to 1.815, p <0.001), and acute myocardial infarction (AMI) (4.5% vs 2.8% aOR 1.783; 95% CI 1.249 to 2.545, p = 0.007) when compared with non-MS patients. Interestingly, MS patients had statistically significant lower vascular complications when compared with non-MS patients (2.3% vs 3.7% aOR 0.487; 95% CI 0.308 to 0.768, p = 0.002) (Figure 2). Risk-adjusted linear regression for LOS demonstrated no statistically significant difference in LOS between MS and non-MS groups (p = 0.553). The

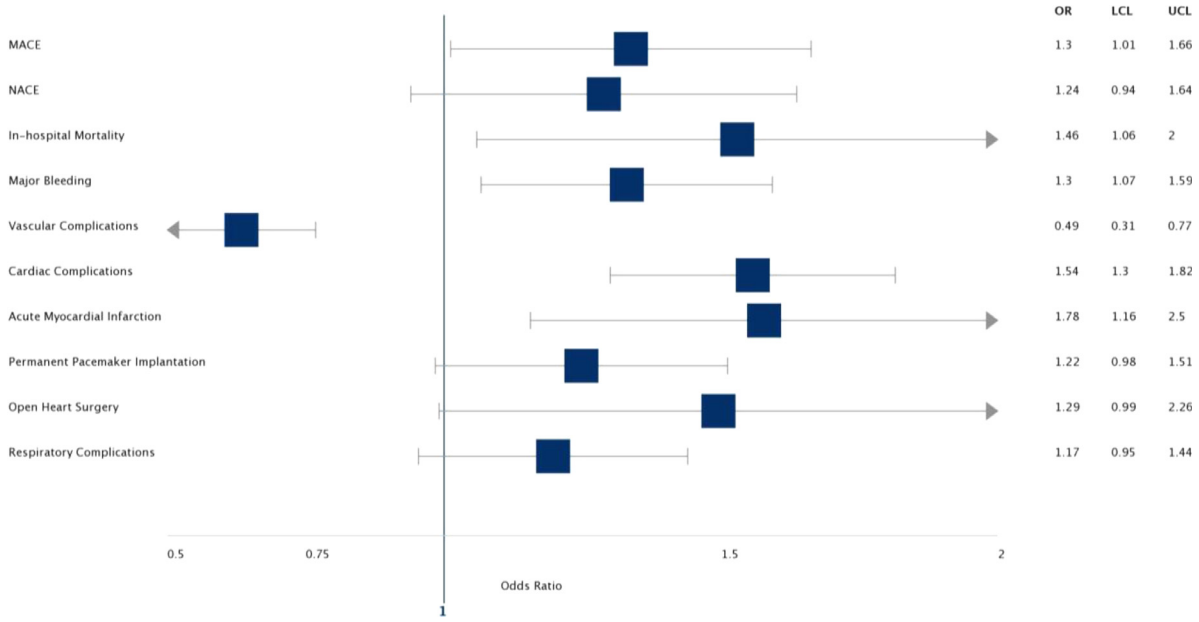

Figure 1. Multivariate logistic regression of the outcomes of transcatheter aortic valve implantation in patients with mitral stenosis compared with those without mitral stenosis.

OR = odds ratio; LCL = lower confidence level; MACEs = major adverse cardiovascular events; NACEs = net adverse cardiovascular events; UCL = upper confidence level.

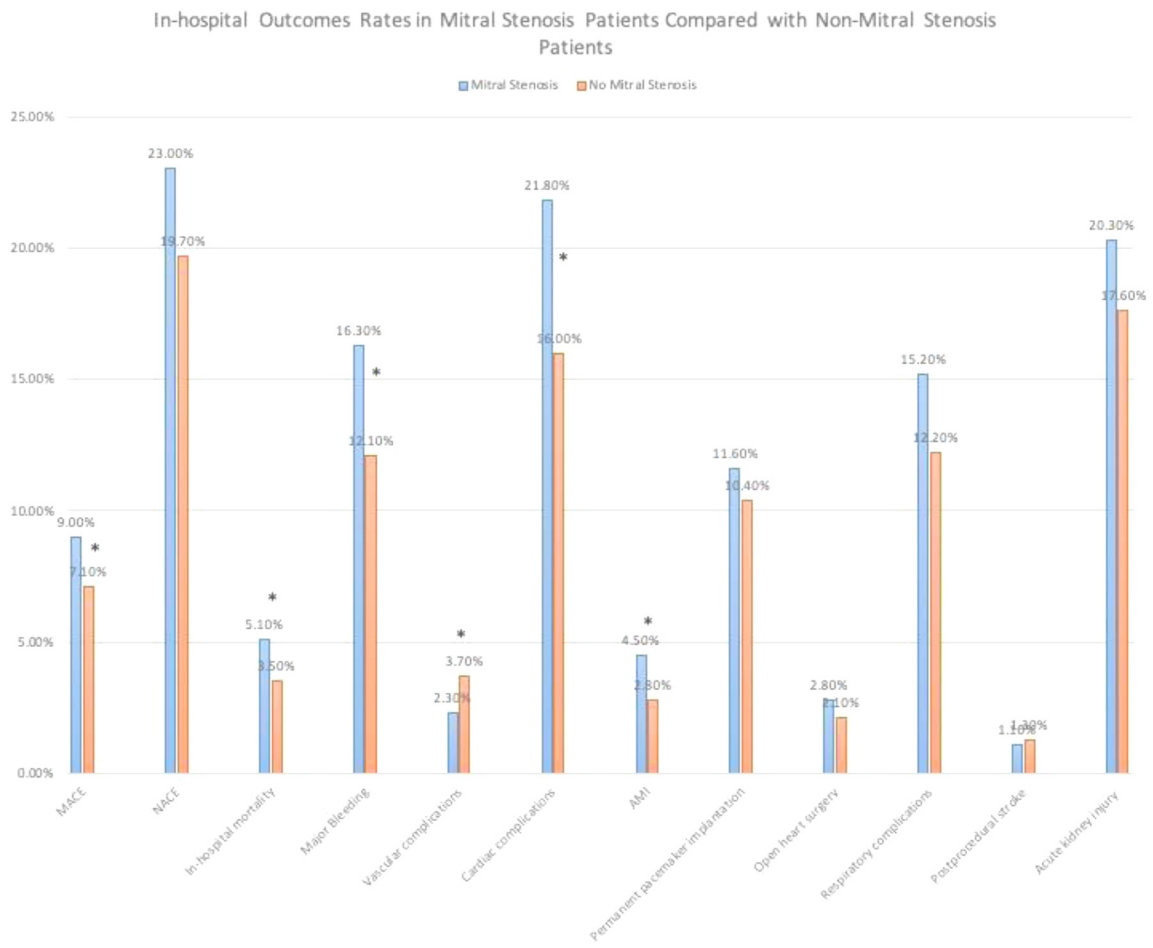

Figure 2. In-hospital outcomes rates in mitral stenosis patients compared with nonmitral stenosis patients who underwent transcatheter aortic valve implantation. AMI = acute myocardial infarction; MACEs = major adverse cardiovascular events; NACEs = net adverse cardiovascular events.
*Indicates statistical significance.

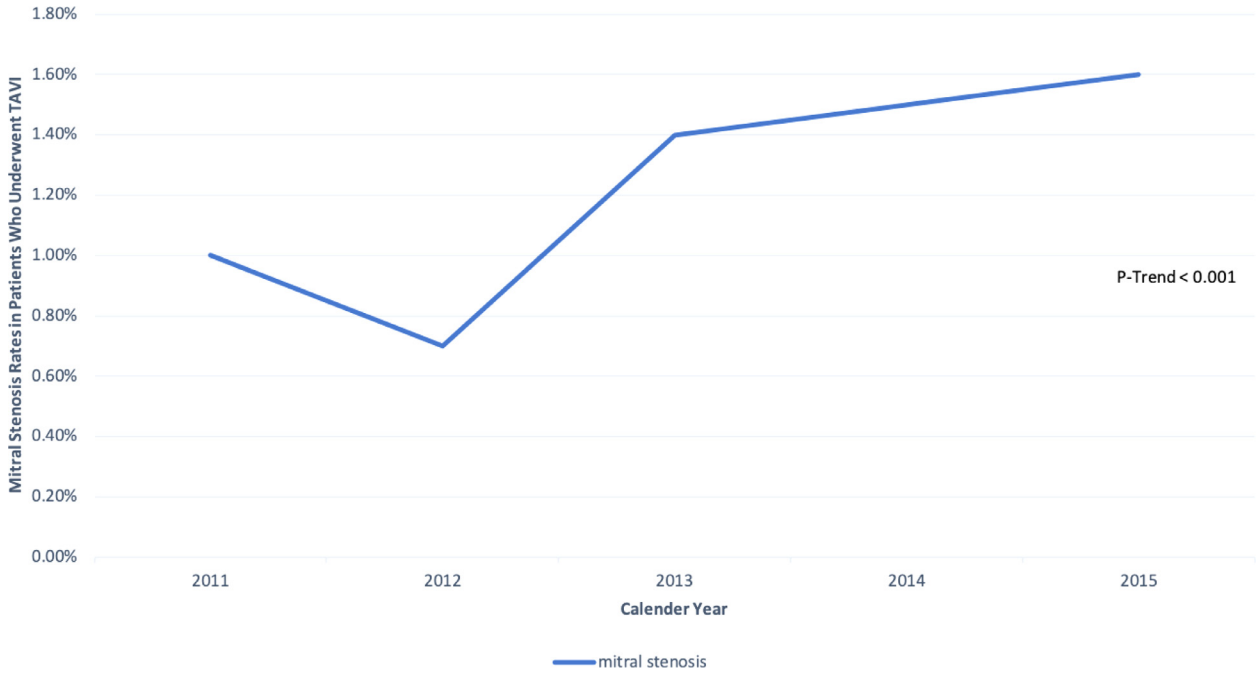

Figure 3. Trends in mitral stenosis rates in patients who underwent transcatheter aortic valve implantation.
TAVI = transcatheter aortic valve implantation.

Table 2
Multivariate logistic regression of the in-hospital outcomes of mitral stenosis patients who underwent TAVI when compared with those without mitral stenosis

Outcome	MS	Non-MS	UOR (95% CI) MS (when compared with no MS)	aOR (95% CI) MS (when compared with no MS)	Unadjusted p value	Adjusted p value
Overall	887	61,233				
Endovascular	767	51,614				
Transapical	120	9,738				
MACE	9.0 (%)	7.1 (%)	1.296 (1.028-1.634)	1.297 (1.012-1.663)	0.028	0.040
Endovascular	8.5 (%)	6.8 (%)	1.264 (0.978-1.633)	1.240 (0.940-1.637)	0.073	0.128
Transapical	12.5 (%)	8.7 (%)	1.507 (0.874-2.601)	1.759 (0.994-3.111)	0.140	0.052
NACE	23.0 (%)	19.7 (%)	1.216 (1.039-1.424)	1.090 (0.917-1.295)	0.015	0.330
Endovascular	23.4 (%)	19.8 (%)	1.233 (1.041-1.459)	1.183 (0.993-1.410)	0.015	0.060
Transapical	20.8 (%)	19.4 (%)	1.094 (0.702-1.705)	0.981 (0.615-1.564)	0.702	0.935
In-hospital mortality	5.1 (%)	3.5 (%)	1.474 (1.088-1.995)	1.455 (1.059-2.001)	0.012	0.021
Endovascular	4.6 (%)	3.2 (%)	1.444 (1.025-2.034)	1.495 (1.016-2.095)	0.035	0.041
Transapical	8.3 (%)	5.2 (%)	1.666 (0.866-3.202)	1.629 (0.809-3.277)	0.126	0.172
Length of stay (iQR), (days)	5 (4-9)	5 (3-9)				0.553
Endovascular	5 (4-8)	5 (3-8)				0.389
Transapical	7.50 (5.25-13.50)	7 (5-12)				0.573
Major bleeding	16.3 (%)	12.1 (%)	1.404 (1.172-1.681)	1.303 (1.067-1.593)	<0.001	0.010
Endovascular	16.8 (%)	12.3 (%)	1.443 (1.192-1.747)	1.329 (1.072-1.684)	<0.001	0.009
Transapical	12.5 (%)	11.5 (%)	1.104 (0.640-1.903)	NA	0.723	NA
Vascular complications	2.3 (%)	3.7 (%)	0.601 (0.385-0.938)	0.487 (0.308-0.768)	0.025	0.002
Endovascular	2.6 (%)	3.9 (%)	0.652 (0.417-1.019)	0.515 (0.325-0.816)	0.060	0.005
Transapical	0.0 (%)	2.4 (%)	NA	NA	NA	NA
Cardiac complications	21.8 (%)	16.0 (%)	1.461 (1.243-1.716)	1.536 (1.300-1.815)	0.082	<0.001
Endovascular	20.6 (%)	15.8 (%)	1.379 (1.155-1.645)	1.462 (1.217-1.757)	<0.001	<0.001
Transapical	29.2 (%)	16.8 (%)	2.042 (1.373-3.038)	1.756 (1.156-2.668)	<0.001	0.008
Acute myocardial infarction	4.5 (%)	2.8 (%)	1.669 (1.211-2.300)	1.783 (1.249-2.545)	0.002	0.001
Endovascular	4.6 (%)	2.8 (%)	1.683 (1.194-2.372)	1.700 (1.156-2.502)	0.003	0.007
Transapical	4.2 (%)	2.7 (%)	1.591 (0.644-3.929)	2.203 (0.820-5.919)	0.314	0.117
Permanent pacemaker implantation	11.6 (%)	10.4 (%)	1.129 (0.918-1.389)	1.219 (0.984-1.512)	0.250	0.070
Endovascular	12.1 (%)	11.1 (%)	1.100 (0.884-1.369)	1.204 (0.960-1.511)	0.392	0.109
Transapical	8.3 (%)	6.6 (%)	1.297 (0.675-2.490)	1.280 (0.652-2.516)	0.435	0.473
Open heart surgery	2.8 (%)	2.1 (%)	1.379 (0.923-2.061)	1.292 (0.858-1.946)	0.116	0.220
Endovascular	3.3 (%)	2.1 (%)	1.560 (1.043-2.335)	1.497 (0.991-2.260)	0.031	0.055
Transapical	0.0 (%)	1.8 (%)	NA	NA	<0.001	NA
Respiratory complications	15.2 (%)	12.2 (%)	1.290 (1.073-1.552)	1.172 (0.954-1.440)	0.007	0.131
Endovascular	12.4 (%)	10.4 (%)	1.218 (0.981-1.513)	0.957 (0.747-1.226)	0.074	0.827
Transapical	33.3 (%)	22.0 (%)	1.777 (1.212-2.606)	1.874 (1.254-2.801)	0.003	0.002
Postprocedural stroke	1.1 (%)	1.3 (%)	0.864 (0.461-1.617)	0.623 (0.302-1.287)	0.647	0.201
Endovascular	0.7 (%)	1.3 (%)	0.503 (0.208-1.217)	0.412 (0.158-1.071)	0.128	0.069
Transapical	4.2 (%)	1.4 (%)	3.116 (1.252-7.753)	1.612 (0.278-9.345)	0.015	0.594
Acute kidney injury	20.3 (%)	17.6 (%)	1.194 (1.013-1.408)	1.016 (0.836-1.235)	0.035	0.871
Endovascular	16.3 (%)	16.3 (%)	0.999 (0.824-1.212)	0.705 (0.558-0.891)	0.995	0.003
Transapical	45.8 (%)	24.2 (%)	2.645 (1.842-3.799)	3.769 (2.502-5.676)	<0.001	<0.001

Abbreviations: aOR = adjusted odds ratio; IQR − interquartile range; MS = mitral stenosis; MACEs = major adverse cardiovascular events; NACEs = net adverse cardiovascular events; TAVI = transcatheter aortic valve implantation; uOR = unadjusted odds ratio. Unadjusted odds ratios are displayed given low event rate. NA indicates odds ratio could not be calculated due to an event rate of 0 (%).

rates of permanent pacemaker placement, respiratory complications, postprocedural stroke, and conversion open heart surgery were comparable in both groups (Table 2).

Upon further stratifying the analysis by TAVI access, patients with MS who underwent endovascular TAVI had statistically significant higher in-hospital mortality (aOR 1.495; 95% CI 1.016 to 2.095, p = 0.041), major bleeding (aOR 1.329; 95% CI 1.072 to 1.593, p = 0.009), cardiac complications (aOR 1.462; 95% CI 1.217 to 1.757, p <0.001), AMI (aOR 1.700; 95% CI 1.156 to 2.502, p = 0.007). In addition, MS patients who underwent transapical TAVI had statistically significant higher cardiac complications (aOR 1.756; 95% CI 1.1156 to 2.668, p = 0.008), respiratory complications (aOR 1.874; 95% CI 1.254 to 2.801, p = 0.002), and acute kidney injury (aOR 3.769; 95% CI 2.502 to 5.676, p <0.001) when compared with non-MS patients.

Discussion

In our national analysis of TAVI patients, we found that a small proportion (1.4%) to have MS. The rates of

Table 3
The predictors of mitral stenosis in patients who underwent transcatheter aortic valve implantation

Predictor	OR (95% CI)	p Value
Age	0.979 (0.971-0.988)	<0.001
Female gender	2.178 (1.862-2.547)	<0.001
African-American race	1.674 (1.277-2.197)	<0.001
Uncomplicated diabetes	1.375 (1.177-1.606)	<0.001
Complicated diabetes	1.325 (1.001-1.755)	0.049
Fluid and electrolyte disorders	1.182 (1.011-1.383)	0.036
Peripheral vascular disease	1.395 (1.201-1.621)	<0.001
Pulmonary circulation disorders	2.319 (1.589-3.384)	<0.001
Renal failure	1.205 (1.037-1.401)	0.015

Abbreviations: CI = confidence interval; OR = odds ratio.

MS in this population with TAVI have been increasing over time from 1.0% to 1.6%. Furthermore, these patients with MS who undergo TAVI are more likely to be younger, female, African-American and more likely to have DM, PAD, pulmonary circulation disorders, and fluid and electrolyte disorder. Patients who underwent TAVI with MS had higher in-hospital mortality and adverse outcomes compared with patients without MS. These findings suggest that patients with MS who undergo TAVI are a high-risk group, and measure for improving outcomes in this population is needed.

Patients who are referred for a TAVI procedure are often older and have more cardiovascular co-morbidities. Although patients with MS were significantly younger compared with those without MS, they had higher rates of DM, chronic pulmonary disease, pulmonary circulation disorders, PAD, and deficiency anemia. The proposed mechanism for MS-induced LV dysfunction is due to myocardial inflammation that occurs in the acute phase of rheumatic fever, and the chronic hemodynamics changes triggered by change in preloading conditions.[14] Furthermore, MS has been frequently identified as a cause of elevated pulmonary artery pressure and pulmonary hypertension (PH).[15] The changes in the LV preload and PH could explain the elevated risk of cardiac complications and mortality since PH is already known to be an independent risk factor for morbidity and mortality in TAVI patients, which is consistent with our findings.[16]

The recently published work by Jospeh et al.[6] has demonstrated a higher in-hospital mortality in patients with severe MS who underwent TAVI, which supports our findings. In addition, the 1-year mortality and the composite outcome of mortality, stroke, heart failure-related hospitalization, and reintervention of mitral disease were higher in both severe MS and nonsevere MS patients who underwent TAVI. We have added to these findings by demonstrating a higher major adverse cardiac events in MS patients compared with patients without MS. Interestingly, nonsevere MS had no statistically significant difference in in-hospital mortality when compared with patients without MS.

In TAVI, the retrograde aortic approach has increased odds of left ventricular perforation causing pericardial effusions.[17,18] In our study, cardiac complications, including iatrogenic complications and cardiac tamponade, were significantly increased in MS patients compared with non-MS patients. Our population showed a rate of 21.8% in cardiac complications in those with MS compared with 16.0% in patients without MS. The increased risk of cardiac complications could be attributed to the LV dysfunction associated with MS.[14]

Our study showed that 4.5% of MS group suffered a postprocedural myocardial infarction compared with 2.8% in the non-MS group. Even after adjusting for potential cofounder, MS patients had almost 78% increased odds of AMI. Interestingly, previous literature had demonstrated the rate of AMI was comparable between MS and non-MS groups regardless of MS severity.[6]

Given our findings, we suggest a thorough preoperative risk evaluation for MS patients requiring TAVI through hemodynamic evaluation. A possible expansion of hemodynamic assessment, especially in patients with clinical evidence of PH might improve the predictability of the procedural outcomes. The ACC/TAVI in-hospital mortality score has incorporated severe chronic pulmonary disease as predictor for worse outcomes in patients who underwent TAVI.[19] More studies are needed to further identify measures to minimize the procedural risk associated with this high-risk population.

Our study has several limitations as it was a retrospective observational study, which poses a possible selection bias and unmeasured confounding factors. Moreover, the NIS is an administrative database which could be subjected to inaccurate coding and under-reporting of co-morbid diagnoses. In addition, data regarding the severity of MS and other relevant echo parameters were missing. Furthermore, details of the TAVI procedure were not reported such as; the type of device used, anesthesia type, and the amount of contrast used which pose possible cofounding factors.

In conclusion, MS patients had higher in-hospital mortality in patients who underwent TAVI with increased risk of major bleeding, cardiac complications, and acute myocardial infarction. Based on these findings, we propose assessment of hemodynamics before TAVI procedure especially in patients with echocardiographic evidence for MS.

Disclosure

The authors have no conflicts of interest to disclose.

Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.amjcard.2019.02.005.

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