Comparison of Sex-Based Differences in Home or Nonhome Discharge Utilization of Rehabilitative Services and Outcomes Following Transcatheter Aortic Valve Implantation in the United States

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Sex-based differences in outcomes have been shown to affect caregiving in medical disciplines. Increased spending due to postacute care transfer policies has led hospitals to further scrutinize patient outcomes and disposition patterns after inpatient admissions. We examined sex-based differences in rehabilitative service utilization after transcatheter aortic valve implantation (TAVI). We queried all TAVI discharges in the National Inpatient Sample database from 2012 to 2014 (n = 40,900). Thirteen thousand eight hundred fifteen patients were discharged to home and 12,175 patients were discharged to rehabilitation facility; those not discharged routinely or to a rehabilitation facility were excluded. Patients with nonhome discharges were older (83.3 vs 79.0 years) and female (58.3% vs 37.7%) with a greater number of chronic conditions (9.91 vs 9.03) and number of Elixhauser co-morbidities (6.5 vs 5.8, all $p < 0.05$). Nonhome discharge patients also had a significantly longer length of stay (LOS) (11.3 days vs 5.3 days) and higher hospitalization costs ($66,246 vs $48,710, all $p < 0.001$) compared to home-discharged patients. Overall in-hospital mortality for female patients who underwent TAVI was higher compared to males (4.6% vs 3.6%, $p < 0.05$). On multivariable logistic regression, female sex was an independent predictor for disposition to rehabilitation facilities after TAVI (odds ratio 2.17; 95% confidence interval: 1.88 to 2.50; $p < 0.001$). Other independent predictors for females discharged to rehabilitation included the presence of rheumatoid arthritis and collagen vascular disease, body mass index greater than 30 kg/m^2, depression, and sum of Elixhauser co-morbidities (all $p < 0.001$). In conclusion, nonhome discharge TAVI patients added LOS and hospital costs compared to home discharge TAVI patients, and female sex was one of the major predictors despite the lower co-morbidities. **(Am J Cardiol 2019;123:1983−1991)**

Aortic stenosis is a public health burden with a prevalence of approximately 2.5%, ranging from 0.7% in younger populations to 12.5% to 13.3% in the elderly in the United States.[1,2] Transcatheter aortic valve replacement (TAVI) has emerged as a valued alternative to surgical aortic valve replacement (SAVR) in high-risk, inoperable, and intermediate-risk patients with aortic stenosis.[3,4] Few studies have examined sex-based differences in TAVI outcomes and found an increased incidence of vascular and bleeding complications in women, despite having similar or even lower operative risk and rate of in-hospital adverse outcomes.[5-7] Although sex-based differences in outcomes can affect caregiving, little is known about how these tendencies affect disposition and utilization of rehabilitative facilities after TAVI. In the present era, Medicare's postacute care transfer (PACT) policies have been an impetus for hospitals to scrutinize patient outcomes and readmissions, with preference for home discharge over rehabilitation. With rising healthcare costs, it is important to identify TAVI patients who require postdischarge care to minimize unnecessary utilization of healthcare resources. Thus, we sought to examine sex-based differences in in-hospital mortality, disposition tendency, and utilization of rehabilitative services after TAVI procedure.

Methods

The National Inpatient Sample (NIS) database is the largest publicly available all-payer administrative claims-based database in the United States, with de-identified patient discharge information from approximately 1,000

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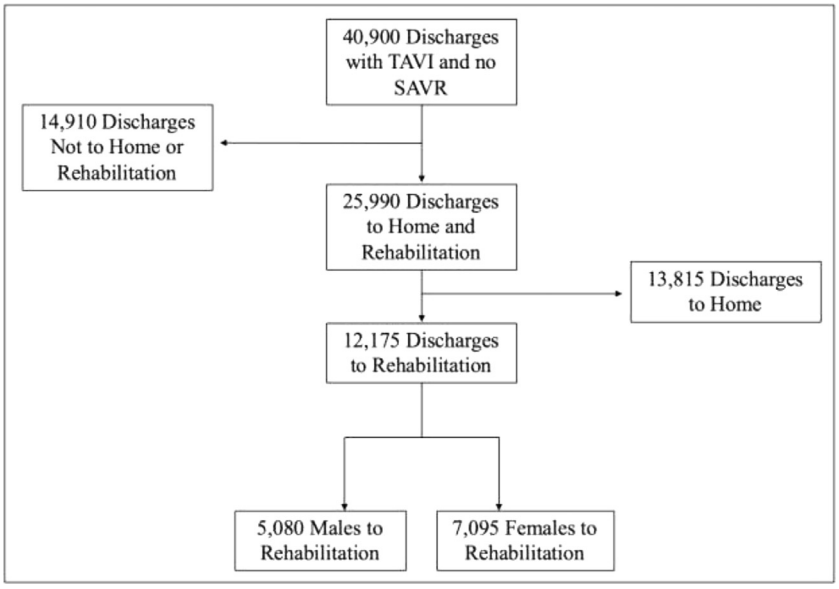

Figure 1. Flow chart of patient inclusion and exclusion criteria.

nonfederal hospitals from 45 states. It contains clinical and resource utilization information (e.g., admission cost) and represents 20% of US inpatient hospitalizations. When weighted, they estimate more than 35 million discharges annually.

We retrospectively isolated all TAVI discharges between 2012 and 2014 in the NIS database (Figure 1). All adult patients who underwent TAVI were identified using *International Classification of Diseases, Ninth Revision, Clinical Modification* procedures codes and stratified based on disposition location (Supplementary Table e1). We excluded patients who underwent SAVR during the same hospital admission. Categories of patient disposition included home, rehabilitation facility (skilled nursing facility [SNF], intermediate care facility [ICF], or any other rehabilitative facility), transfer to a short-term hospital, home healthcare, against medical advice, and death. Those not discharged to home or to a rehabilitation facility were excluded from the analysis. Commonly accepted as comprehensive co-morbidity measures for large administrative inpatient databases, Elixhauser co-morbidities were utilized as single categories and as an index to serve as an indicator for frailty.[8,9] The Charlson Co-morbidity Index, which was calculated using *International Classification of Diseases, Ninth Revision, Clinical Modification* codes, attaches weights to common co-morbid medical conditions to summarize the co-morbidity burden for a patient.[10] The primary outcome was disposition location after TAVI. Secondary outcomes included patient co-morbidities, operative characteristics, and in-hospital, postoperative complications. Hospitalization costs, hospital bed size, location/teaching status, ownership status, and region were also examined.

Continuous variables are expressed as a mean with standard deviation and compared using *Student's t tests*. Categorical variables are presented as number and percentages, and compared using chi-square tests. Survey data analysis

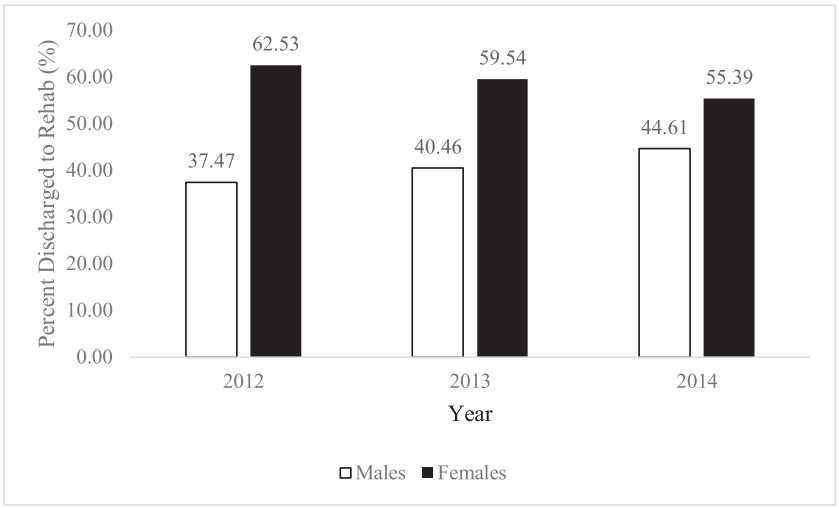

Figure 2. Disposition to rehabilitation following TAVI. TAVI = transcatheter aortic valve implantation.

tools were utilized to generate weighted national estimates and variances that accounted for weighting, clustering of outcomes within hospitals, and sampling variation across strata (region and year).

Univariate analysis and multivariable logistic regression using survey procedures were first used to determine independent predictors for disposition to SNF, ICF, or other rehabilitative facility. Since female sex was an independent predictor, we determined independent predictors for nonhome discharge in female patients using a stepwise backward selection model. The results are presented as odds ratios (OR) and 95% confidence intervals (CI). Established best practices for weighting and statistical analysis of the NIS were followed.[11] All analyses were conducted using STATA Version 13.1 (StataCorp LP, College Station, TX) with an alpha level of $p \leq 0.05$ as the criterion for significance.

Results

21,400 were males and 19,500 females underwent TAVI from 2012 to 2014. Overall in-hospital mortality for female patients who underwent TAVI was higher compared to males (4.6% vs 3.6%, $p < 0.05$). From this cohort, 13,815 patients were discharged to home and 12,175 patients were discharged either a SNF, ICF, or other rehabilitation facility (Table 1). Compared to home-discharged patients, patients discharged to rehabilitation facilities were older and female, with a greater number of chronic conditions including a higher burden of atrial fibrillation, chronic pulmonary disease, renal failure, and number of Elixhauser co-morbidities (all $p < 0.05$). Nonhome discharged patients were also less likely to be admitted electively, and more likely to be transferred-in from another hospital or use the emergency department (all $p < 0.001$).

Nonhome discharge patients were more likely to undergo TAVI procedures trans-apically (26.6% vs 14.4%) and experience cardiogenic shock (3.9% vs 1.2%), cardiac arrest (4.2% vs 1.4%), transient ischemic attack (TIA)/stroke (6.2% vs 0.7%), acute myocardial infarction (3.9% vs 2.1%), major bleeding (17.7% vs 9.2%), and acute kidney injury (27.0% vs 9.8%) compared home-discharged patients (Table 1). However, the proportion of patients discharged to rehabilitative facilities did not differ by hospital teaching status (teaching vs nonteaching) or hospital size (all $p > 0.05$). Nonhome discharge patients also had a significantly longer length of stay (LOS) (11.3 days vs 5.3 days) and higher hospitalization costs ($66,246 vs $48,710, all $p < 0.001$) compared to home-discharged patients.

Of the 12,175 discharges to rehabilitative services, there were 7,095 (58.3%) female and 5,080 (41.7%) male patients, with a trend toward higher prevalence for females (Table 2; Figure 2). Compared to males, females had a lower Charlson Co-morbidity Index and incidence of co-morbidities, such as coronary artery disease, previous history of coronary artery bypass grafting, and renal failure (all $p < 0.05$). However, there were no significant differences in age, race, and median household income quartiles between these patients.

In terms of operative characteristics, males were more likely to have received a trans-femoral, trans-aortic, or subclavian approach to TAVI. In comparison, the trans-apical approach to TAVI was more frequently utilized in females compared with males (all $p < 0.01$; Table 3). Males had a higher incidence of bleeding (20.4% vs 15.9%; $p = 0.013$) and acute kidney injury (31.7% vs 23.7%; $p < 0.001$) although there were no sex-based differences in other major in-hospital cardiac complications, hospital-level factors, hospital LOS, and hospitalization cost.

Female sex was an independent predictor for disposition to rehabilitation facilities after TAVI (OR 2.17; 95% CI: 1.88 to 2.50; $p < 0.001$; Table 4). Independent predictors for females discharged to rehabilitation included the presence of rheumatoid arthritis and collagen vascular disease (OR 3.37, 95% CI: 2.02 to 5.60), hypothyroidism (OR 2.47; 95% CI 1.89 to 3.22) body mass index greater than 30 kg/m^2 (OR 2.12; 95% CI: 1.54 to 2.92), depression (OR 1.54; 95% CI: 1.05 to 2.24), and sum of Elixhauser co-morbidities (OR 1.14; 95% CI: 1.06 to 1.22; all $p < 0.001$). TAVI approach, cardiopulmonary bypass use, and patient age did not predict disposition to rehabilitation after surgery (all $p > 0.05$).

Discussion

In this large database analysis, we examined disposition tendencies and utilization to rehabilitation services after TAVI. We found that in patients who went to rehabilitation, the proportion of females that were sent to a rehabilitative facility after TAVI was higher than the proportion of males, despite the females having fewer co-morbidities and a higher overall in-hospital mortality. Our multivariable analysis concluded female sex as an independent predictor for postoperative disposition to rehabilitation after TAVI. Considering these findings, female patients may need more preparation preoperatively or more objective-perioperative assessments to reduce the number of nonhome discharges.

Sex-based differences in TAVI outcomes have been reported in contemporary studies and are of increasing interest to clinicians. For instance, in a recent TAVI meta-analysis by Conrotto et al, female patients had more frequent major vascular complications and/or major life-threatening events despite having a lower co-morbidity burden.[5] Similarly, Kodali et al performed a secondary analysis of the randomized and nonrandomized portions of the PARTNER trial to examine sex-specific differences in outcomes after TAVI. Despite having a higher incidence of bleeding and vascular complications, females had a lower 1-year mortality rate than males, contrary to findings reported after SAVR, although in-hospital mortality was not assessed.[6]

Sex-based differences in disposition have been reported in other surgical specialties but with discordant findings. Several studies in vascular and spinal surgery patients analyzed the various determinants of postoperative discharge, and found that sex was not a major prognostic factor.[12,13] In contrast, Devon et al examined postoperative disposition amongst elderly patients who underwent colorectal surgery and concluded that older female patients had a 33% higher risk of not being discharged home compared with older male patients.[14] In our study, we found significant sex-based differences in disposition to nonhome facilities after

Table 1
Baseline patient demographics, co-morbidities, admission characteristics of patients following TAVI stratified by discharge location

Variable	TAVI patient hospitalizations with home discharge (n = 13,815)	TAVI patient hospitalizations with discharge to SNF, ICF, other rehab (n = 12,175)	p value
Patient demographics			
Age (years)	79.0 ± 9.8	83.3 ± 6.7	<0.001*
Women	5,210 (37.7%)	7,095 (58.3%)	<0.001*
White	11,140 (86.9%)	9,820 (87.9%)	
Black	540 (4.2%)	395 (3.5%)	
Hispanic	530(4.1%)	350 (3.1%)	
Asian or Pacific Islander	30 (0.2%)	20 (0.2%)	
Other	400 (3.1%)	460 (4.1%)	
Median household income quartile, percentile			<0.001*
0-25th	3,205 (23.7%)	2,400 (20.0%)	
26-50th	3,610 (26.7%)	2,815 (23.5%)	
51-75th	3,510 (30.0%)	3,255 (27.2%)	
76-100th	3200 (23.7%)	3,520 (29.4%)	
Number of chronic conditions	9.00 (2.9%)	9.9 (2.9%)	<0.001*
Co-morbidities			
Atrial fibrillation	5,345 (38.7%)	6,155 (50.6%)	<0.001*
Smoking	4,405 (31.9%)	2,815 (23.1%)	<0.001*
Prior TIA/stroke	10,450 (75.6%)	8,500 (69.8%)	<0.001*
Dyslipidemia	9,540 (69.1%)	7,240 (59.5%)	<0.001*
Known coronary artery disease	10,055 (72.8%)	7,920 (65.1%)	<0.001*
Prior myocardial infarction	2,385 (17.3%)	1,660 (13.6%)	<0.001*
Prior coronary bypass	3,785 (27.4%)	1,990 (16.3%)	<0.001*
Prior PCI	2,915 (21.1%)	2,085 (17.1%)	<0.001*
Carotid artery disease	1,025 (7.4%)	865 (7.1%)	0.677
Prior PPM	1,370 (9.9%)	1,330 (10.9%)	0.255
Prior ICD	485 (3.5%)	255 (2.1%)	0.003*
Alcohol abuse	175 (1.3%)	110 (0.9%)	0.210
Iron deficiency anemia	3,060 (22.2%)	3,495 (28.7%)	<0.001*
Rheumatoid arthritis/collagen vascular diseases	625 (4.5%)	665 (5.5%)	0.097
Chronic blood Loss anemia	150 (1.1%)	180 (1.5%)	0.180
CHF	1,650 (11.9%)	1,555 (12.8%)	0.400
Chronic pulmonary disease	4,385 (31.7%)	4,195 (34.5%)	0.039*
Coagulopathy	2,500 (18.1%)	3,290 (27.0%)	<0.001*
Depression	825 (6.0%)	1,075 (8.8%)	<0.001*
Diabetes, uncomplicated	4,190 (30.3%)	3,460 (28.4%)	0.137
Diabetes with chronic complications	765 (5.5%)	775 (6.4%)	0.200
HTN, uncomplicated and complicated	11,265 (81.6%)	9,440 (77.5%)	0.002*
Hypothyroidism	2,720 (19.7%)	2,605 (21.4%)	0.126
Fluid and electrolyte disorders	2,450 (17.7%)	4,185 (34.4%)	<0.001*
Other neurological disorders	675 (4.9%)	1,030 (8.5%)	<0.001*
Obesity	1,995 (14.4%)	1,720 (14.1%)	0.746
Peripheral vascular disorders	3,975 (28.8%)	3,545 (29.1%)	0.803
Psychoses	110 (0.8%)	320 (2.6%)	<0.001*
Pulmonary circulation disorders	470 (3.4%)	465 (3.8%)	0.424
Renal failure	4,505 (32.6%)	4,705 (38.6%)	<0.001*
Solid tumor without metastasis	300 (2.2%)	180 (1.5%)	0.050
Weight loss	310 (2.24%)	1,030 (8.5%)	<0.001*
Charlson co-morbidity index	2.8 ± 1.8	3.0 ± 1.7	<0.001*
Number of elixhauser co-morbidities	5.8 ± 1.9	6.5 ± 2.0	<0.001*
Admission characteristics			
Elective admission	11,220 (81.3%)	8,545 (70.2%)	<0.001*
Emergency department use	310 (2.2%)	685 (5.6%)	<0.001*
Transfer status			<0.001*
Not transferred in	13,110 (95.6%)	10,520 (86.7%)	
Transferred from different acute care hospital	520 (3.8%)	1,255 (10.4%)	
Transferred from another type of health facility	85 (0.6%)	355 (2.9%)	

(*continued*)

Table 1 (***Continued***)

Variable	TAVI patient hospitalizations with home discharge (n = 13,815)	TAVI patient hospitalizations with discharge to SNF, ICF, other rehab (n = 12,175)	p value
Operative characteristics			
Trans-femoral, trans-aortic or subclavian approach	11,845 (85.7%)	8,965 (73.6%)	<0.001*
Trans-apical approach	1,990 (14.4%)	3,235 (26.6%)	<0.001*
Cardiopulmonary bypass	980 (7.1%)	1,040 (8.5%)	0.093
Percutaneous cardiopulmonary bypass	80 (0.6%)	145 (1.2%)	0.018*
In-hospital outcomes			
Complete heart block	1,085 (7.9%)	1,435 (11.8%)	<0.001*
Cardiogenic shock	160 (1.2%)	480 (3.9%)	<0.001*
Cardiac arrest	190 (1.9%)	515 (4.2%)	<0.001*
TIA/stroke	95 (0.7%)	750 (6.2%)	<0.001*
Acute myocardial infarction	285 (2.1%)	470 (3.9%)	<0.001*
Major bleeding	1,275 (9.2%)	2,160 (17.7%)	<0.001*
Acute kidney injury	1,355 (9.8%)	3,290 (27.0%)	<0.001*
Hospital characteristics			
Census division of hospital			<0.001*
New England	255 (1.9%)	790 (6.5%)	
Middle Atlantic	1,560 (11.%3)	3,005 (24.7%)	
East North Central	1,865 (13.5%)	1,835 (15.1%)	
West North Central	1,155 (8.4%)	1,015 (8.3%)	
South Atlantic	2,575 (18.6%)	2,040 (16.8%)	
East South Central	1,225 (8.9%)	820 (6.7%)	
West South Central	2,005 (14.5%)	790 (6.5%)	
Mountain	940 (6.%8)	670 (5.5%)	
Pacific	2,235 (16.2%)	1,210 (9.9%)	
Bed size of hospital			0.371
Small	770 (5.6%)	585 (4.8%)	
Medium	2,050 (14.8%)	2,010 (16.5%)	
Large	10,995 (79.6%)	9,580 (78.7%)	
Location/teaching status of hospital			0.869
Rural	80 (0.6%)	75 (0.6%)	
Urban nonteaching	1,555 (11.3%)	1,300 (10.7%)	
Urban teaching	12,180 (88.2%)	10,800 (88.7%)	
Region of hospital			<0.001*
Northeast	1,815 (13.1%)	3,795 (31.%2)	
Midwest or North Central	3,020 (21.9%)	2,850 (23.4%)	
South	5,805 (42.0%)	3,650 (30.0%)	
West	3,175 (23.0%)	1,880 (15.4%)	
Control/ownership of hospital			0.025*
Government, nonfederal	1,320 (9.6%)	930 (7.6%)	
Private, not-profit	11,220 (81.2%)	10,370 (85.2%)	
Private, invest-own	1,275 (9.2%)	875 (7.2%)	
Length of stay	5.3 (4.2%)	11.3 (8.7%)	<0.001*
Cost (US dollars)	48,710 (19,881)	66,246 (35,401)	<0.001*

Abbreviations: TAVI = transcatheter aortic valve implantation; CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention; PPM = permanent pacemaker; ICD = implantable cardioverter defibrillator; CHF = congestive heart failure; HTN = hypertension; TIA = transient ischemic attack; AMI = acute myocardial infarction, SNF = skilled nursing facility, ICF = intermediate care facility.

Continuous variables are presented as mean (SD) unless otherwise noted as median (IQR); categorical variables are summarized as n (%).

* p value ≤0.05 was considered statistically significant.

TAVI, with females having an increased risk compared to males, despite the former having fewer co-morbidities. These sex-based differences existed despite similar rates of major in-hospital cardiac complications, hospital-level factors, and LOS between the 2 sexes.

Several reasons could explain why females were more likely to be discharged to rehabilitation compared to males. First, we postulate that patient-level factors not captured in NIS played a significant role in influence disposition decisions. In a recent study, reduced improvement in exercise capacity and failure to improve during a 6-minute walk test after TAVI by 20% in females was independently associated with all-cause mortality and cardiovascular death.[15] Likewise, a meta-analysis of 149 studies and 8,176 participants found adherence to cardiac rehabilitation sessions was significantly lower in females versus males.[16] Second, female patients underwent more trans-apical TAVI, likely due to the smaller caliber and increased tortuosity of

Table 2
Baseline patient demographics, co-morbidities, admission characteristics for patients with disposition rehabilitative services following TAVI stratified by gender

Variable	Male TAVI patients to rehabilitative facilities (n = 5,080 hospitalizations)	Female TAVI patients to rehabilitative facilities (n = 7095 hospitalizations)	p value
Patient demographics			
Age (years)	83.4 ± 6.6	83.2 ± 6.7	0.400
White	4,150 (89.4%)	5,670 (86.8%)	0.114
Black	105 (2.3%)	290 (4.4%)	0.134
Hispanic	150 (3.2%)	200 (3.1%)	0.872
Asian or Pacific Islander	70 (1.5%)	55 (0.8%)	0.675
Native American	5 (0.1%)	15 (0.2%)	0.782
Other	160 (3.5%)	300 (4.6%)	0.486
Median household income quartile, percentile			0.162
0-25th	880 (17.6%)	1,520 (21.8%)	
26-50th	1,205 (24.1%)	1,610 (23.0%)	
51-75th	1,365 (27.3%)	1,890 (27.0%)	
76-100th	1,550 (31.0%)	1,970 (28.2%)	
Number of chronic conditions	10.2 (2.9%)	9.71 (3.0%)	0.002*
Co-morbidities			
Atrial fibrillation	2,635 (51.9%)	3,520 (49.6%)	0.334
Smoking	1,565 (30.8%)	1,250 (17.6%)	<0.001*
Prior TIA/stroke	815 (16.0%)	955 (13.5%)	0.128
Dyslipidemia	3,095 (60.9%)	4,145 (58.4%)	0.280
Known coronary artery disease	3,740 (73.6%)	4,090 (57.7%)	<0.001*
Prior myocardial infarction	745 (14.7%)	690 (9.7%)	0.003*
Prior CABG	1,250 (24.6%)	740 (10.4%)	<0.001*
Prior PCI	905 (17.8%)	1,180 (16.6%)	0.496
Carotid artery disease	340 (6.7%)	525 (7.4%)	0.568
Prior PPM	630 (12.4%)	700 (9.9%)	0.068
Prior ICD	200 (3.9%)	55 (0.7%)	<0.001*
Alcohol abuse	95 (1.9%)	15 (0.2%)	<0.001*
Deficiency anemia	1,410 (27.8%)	2,085 (29.4%)	0.464
Rheumatoid arthritis/collagen vascular diseases	140 (2.8%)	525 (7.4%)	<0.001*
Chronic blood loss anemia	80 (1.6%)	100 (1.4%)	0.779
CHF	660 (13.0%)	895 (12.6%)	0.807
Chronic pulmonary disease	1,840 (36.2%)	2,355 (33.2%)	0.180
Coagulopathy	1,490 (29.3%)	1,800 (25.4%)	0.051
Depression	355 (7.00%)	720 (10.2%)	*0.018
Diabetes, uncomplicated	1,460 (28.7%)	2,000 (28.2%)	0.809
Diabetes with chronic complications	380 (7.5%)	395 (5.6%)	0.122
HTN, uncomplicated and complicated	3,915 (77.1%)	5,525 (77.9%)	0.687
Hypothyroidism	695 (13.7%)	1,910 (26.9%)	<0.001*
Fluid and electrolyte disorders	1,690 (33.3%)	2,495 (35.2%)	0.390
Other neurological disorders	470 (9.3%)	560 (7.9%)	0.288
Obesity	530 (10.4%)	1,190 (16.8%)	<0.001*
Peripheral vascular disorders	1,555 (30.6%)	1,990 (28.1%)	0.267
Psychoses	120 (2.4%)	200 (2.8%)	0.511
Pulmonary circulation disorders	175 (3.5%)	290 (4.1%)	0.445
Renal failure	2,465 (48.5%)	2,240 (31.6%)	<0.001*
Solid tumor without metastasis	115 (2.3%)	65 (0.9%)	0.026
Weight loss	430 (8.5%)	600 (8.5%)	0.995
Charlson co-morbidity index	3.4 ± 1.7	2.8 ± 1.7	<0.001*
Number of elxihauser co-morbidities	6.5 ± 2.0	6.5 ± 2.0	0.913
Admission characteristics			
Elective admission	3,520 (69.4%)	5,025 (70.9%)	0.495
Emergency department use	390 (7.7%)	530 (7.5%)	0.622
Transfer status			0.813
Not transferred in	4,345 (86.1%)	6,175 (87.2%)	
Transferred from different acute care hospital	545 (10.8%)	710 (10.0%)	
Transferred from another type of health facility	155 (3.1%)	200 (2.8%)	

Abbreviations: TAVI = transcatheter aortic valve implantation; CABG = coronary artery bypass grafting; PCI = percutaneous coronary intervention; PPM = permanent pacemaker; ICD = implantable cardioverter defibrillator; CHF = congestive heart failure; HTN = hypertension; TIA = transient ischemic attack; AMI = acute myocardial infarction.

Continuous variables are presented as mean (SD) unless otherwise noted as median (IQR); categorical variables are summarized as n (%).

* p value ≤0.05 was considered statistically significant.

Table 3
In-hospital outcomes and hospital characteristics for patients with disposition rehabilitative services following TAVI stratified by gender

Variable	Male TAVI patients to rehabilitative facilities (n = 5,080 hospitalizations)	Female TAVI patients to rehabilitative facilities (n = 7,095 hospitalizations)	p value
Operative characteristics			
Trans-femoral, trans-aortic or subclavian approach	3,935 (77.5%)	5,030 (70.9%)	0.002*
Trans-apical approach	1,155 (22.7%)	2,080 (29.3%)	0.002*
Cardiopulmonary bypass	435 (8.6%)	605 (8.5%)	0.978
Percutaneous cardiopulmonary bypass	60 (1.8%)	85 (1.2%)	0.970
In-hospital outcomes			
Complete heart block	570 (11.2%)	865 (12.2%)	0.504
Cardiogenic shock	200 (3.9%)	280 (4.0%)	0.992
Cardiac arrest	250 (4.9%)	265 (3.7%)	0.218
TIA/stroke	310 (6.1%)	440 (6.2%)	0.931
AMI	240 (4.%7)	230 (3.2%)	0.103
Major bleeding	1,035 (20.4%)	1,125 (15.9%)	0.013*
Acute kidney injury	1,610 (31.7%)	1,680 (23.7%)	<0.001*
Hospital characteristics			
Census division of hospital			0.373
New England	290 (5.7%)	500 (7.1%)	
Middle Atlantic	1,170 (23.0)	1,835 (25.9%)	
East North Central	800 (15.8%)	1,035 (14.6%)	
West North Central	485 (9.6%)	530 (7.5%)	
South Atlantic	875 (17.2%)	1,165 (16.4%)	
East South Central	330 (6.5%)	490 (6.9%)	
West South Central	280 (5.5%)	510 (7.2%)	
Mountain	315 (6.2)	355 (5.0%)	
Pacific	535 (10.5%)	675 (9.5%)	
Bed size of hospital			0.484
Small	250 (4.9%)	355 (4.7%)	
Medium	785 (15.5%)	1,225 (17.3%)	
Large	4,045 (79.6%)	5,535 (78.0%)	
Location/teaching status of hospital			0.458
Rural	25 (0.5%)	50 (0.7%)	
Urban nonteaching	590 (11.6%)	710 (10.0%)	
Urban teaching	4,465 (87.9%)	6,335 (89.3%)	
Region of hospital			0.123
Northeast	1,460 (28.7%)	2,335 (32.9%)	
Midwest or North Central	1,285 (25.3%)	1,565 (22.1%)	
South	1,485 (29.2%)	2,165 (30.5%)	
West	850 (16.7%)	1,030 (14.5%)	
Control/ownership of hospital			0.852
Government, nonfederal	390 (7.7%)	540 (7.6%)	
Private, not-profit	4,305 (84.8%)	6,065 (85.5%)	
Private, invest-own	385 (7.6%)	490 (6.9%)	
Length of stay	11.6 ± 0.4	11.1 ± 0.3	0.368
Cost (US dollars)	67,329 ± 1847	65,478 ± 1315	0.344

Abbreviations: TAVI = transcatheter aortic valve implantation; TIA = transient ischemic attack; AMI = acute myocardial infarction.
Continuous variables are presented as mean (SD) unless otherwise noted as median (IQR); categorical variables are summarized as n (%).
* p value ≤0.05 was considered statistically significant.

femoral vessels for percutaneous access, although our multivariable analysis did not predict TAVI approach as a predictor for nonhome discharge. Last, we suspect that social status, which is not captured in the NIS, plays a role in the disposition. With longer life expectancy in females, elderly females tend to be widowed and live alone.[17] They may have altered the destination after discharge, although, further research is warranted to assess the impact of marriage status on disposition tendencies. A recent study using the Michigan Health and Retirement Study data sheds some light on this issue, as the investigators found adults who were divorced, separated, or widowed had 40% greater odds of developing a new functional disability during the first 2 years after cardiac surgery.[18] Another study by Gordon and Rosenthal found that the odds of nursing home diagnosis and in-hospital mortality were 2.3 times higher for unmarried surgical patients compared with their married counterparts.[19] Thus in both studies, marital status was a predictor of functional recovery.

In the context of TAVI, our findings are timely and relevant given the existing Medicare PACT policies and their implications on hospital reimbursements. Implemented to

Table 4
Independent predictors for disposition to rehabilitative facilities following TAVI

Variable	Odds ratio	Standard error	95% confidence interval		p value
Years	1.090	0.006	1.078	1.101	<0.001*
Elective	1.602	0.178	1.288	1.993	<0.001*
Female	2.171	0.158	1.881	2.504	<0.001*
Length of stay	1.219	0.019	1.181	1.257	<0.001*
Number of chronic conditions	1.064	0.015	1.035	1.094	<0.001*
Transfer in	1.488	0.207	1.133	1.954	0.004*
All patient refined DRG: risk of mortality subclass	1.573	0.104	1.383	1.791	<0.001*
All patient refined DRG: severity of illness subclass	0.763	0.046	0.678	0.86	<0.001*
Depression	1.421	0.193	1.090	1.854	0.010*
Hypertension (uncomplicated and complicated)	0.732	0.068	0.610	0.877	0.001*
Paralysis	2.919	0.803	1.702	5.006	<0.001*
Psychoses	3.181	1.137	1.579	6.410	0.001*

* p value ≤0.05 was considered statistically significant.

limit Medicare spending growth, PACT policies mandate a reduction in hospital payment when patients are discharged to qualifying postacute care settings earlier than national averages. From a financial standpoint, hospitals lose between $500,000 to $700,000 in annual revenue, a figure that exceeds the average loss from more publicized pay-for-performance initiatives such as the Hospital Readmissions Reduction, Hospital-Acquired Conditions, and Inpatient Value-Based Purchasing Programs combined—yet many health systems remain unaware of its impact.[20,21] Although TAVI does not fall under these specific metrics yet, we suspect that its growth due to widespread adoption and increasing disposition tendency to rehabilitation may likely drive subsequent inclusion in the years ahead. Based on our findings, we recommend establishing hospital-wide care standards for PACT associated diagnoses that minimize postoperative acute care utilization to an "as needed" bases and maximize home discharge, without compromising on the quality of care delivered.

Management of TAVI patients with complex histories or co-morbidities can be challenging. In this regard, our findings emphasize the integral role of a multidisciplinary heart team to ensure appropriate use of hospital resources postdischarge. This would include educating engaged family members on postoperative care needs and greater care-coordination with resources, such as physical therapy, to avoid nonhome discharge. Proactive, targeted rehabilitation of patients at risk for nonhome discharge may be an appealing area for quality improvement and may provide an opportunity to create robust preoperative prediction tools.[22] Together, we believe that these strategies may help hospitals avoid PACT penalties and reduce unnecessary resource utilization, time away from home, and ultimately reduce sex-based differences in postoperative care.

There are limitations of our study. The NIS is derived from hospital claims data without access to patients' medical records and is subject to the shortcomings of other administrative datasets. Inconsistencies related to coding may overestimate or underestimate the sex-based differences in disposition tendencies and utilization, although the Healthcare Cost and Utilization Project (HCUP) quality control measures should minimize these discrepancies. Moreover, NIS precludes detailed assessment of patient presentation, indication for surgery or rehabilitation, details of TAVI procedure, and Society of Thoracic Surgeons (STS) risk scores, which may help explain some of these disposition tendencies. We also could not determine the type of anesthesia (general vs conscious sedation) despite its importance in postoperative recovery and LOS. Given the nature of the database, frailty was difficult to assess formally. Surrogate measures such as Charlson Co-morbidity Index and sum of Elixhauser co-morbidities were utilized.

In conclusion, using a national database, we examined sex-based differences in in-hospital outcomes, disposition tendencies, and utilization of rehabilitation services after TAVI. Our prediction model showed female sex is an independent predictor for disposition to rehabilitative facilities after TAVI. These finding should be placed in the larger growing context of sex-based disparities in delivering health care and should be further explored to inform future quality and reimbursement models involving TAVI PACT policies.

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Supplementary materials

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