Outside Facility Transfer Is Associated With Frequent Disposition to Rehabilitation Following Transcatheter Aortic Valve Replacement

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ABSTRACT

Introduction: Significant variability exists in disposition practices to non-home facilities following transcatheter aortic valve replacement (TAVR). Increased spending due to Post Acute Care Transfer (PACT) policies has led hospitals to scrutinize patient disposition following hospital discharge. We sought to examine the impact of admission origin on rehabilitative services use following TAVR.

Methods: The National Inpatient Sample was queried for TAVR procedures between 2012-2014. We further isolated patients who were discharged to a rehabilitation facility (skilled nursing facility, intermediate care facility, or other rehabilitation facility) stratified by admission origin. Multivariable logistic regression was used to determine independent predictors for disposition to a rehabilitation facility.

Results: A total of 12,175 TAVR patients were discharged to rehabilitation facilities. This included 10,520 patients (86.4%) who were admitted from home, 1,255 patients (10.3%) who were transferred from an acute care hospital, and 355 patients (2.9%) who were transferred from another health facility at the time of admission. Patients transferred from an acute hospital had higher inpatient costs ($77,092 vs. $66,507 and $64,861) and longer length of stay (17.2 vs. 11.6 and 10.6 days; all $p < 0.05$) compared to those transferred from a non-acute facility and those not transferred, respectively. Weekend admission (odds ratio [OR]= 1.78, 95% confidence interval [CI]: 1.11 to 2.84; p=0.017), non-elective admission (OR= 8.23, 95% CI: 4.15 to 13.16; p<0.001), and transfer from a non-acute facility (OR 4.32, 95% CI: 1.74 to 10.67; p=0.002) were independent predictors for disposition to a rehabilitation facility.

Conclusions: Admission origin appears to impact the likelihood of requiring rehabilitation services following TAVR, independent of academic status and patient comorbidities. Drivers propagating non-home discharge, such as weekend transfers from non-acute facilities and non-elective cases, should be investigated to optimize hospital resource utilization under current PACT policies.

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INTRODUCTION

Transcatheter aortic valve replacement (TAVR) has emerged as an established treatment option for the management of symptomatic severe aortic stenosis in in-operable, high-risk, and intermediate-risk patients [1-3]. Given the inherent medical complexity of this patient population, unplanned 30-day readmission rates are frequent (ranging from 14-21%) and have been shown to contribute negatively towards patient outcomes and healthcare costs [4-6]. Furthermore, the majority of readmissions after TAVR are often secondary to non-cardiac etiologies, including respiratory failure, infection and bleeding [7].

In light of the significant burden associated with readmissions following TAVR, heightened attention has been focused on analyzing risk factors for readmission at hospital, state and federal levels. In fact, 30-day readmission rates is an established quality performance metric per the Centers for Medicare and Medicaid services (CMS). Consequently, there are several ongoing efforts to develop novel strategies for reducing readmissions [8]. A specific focus involves efforts to increase discharges to home versus rehabilitation facilities such as skilled nursing facilities (SNF), whenever possible.

The implications of discharge destination have been described in prior studies and are significant for both clinical and economic reasons; in particular, discharge to SNF is an independent predictor of 30-day readmission [4]. Moreover, increased spending due to Post Acute Care Transfer (PACT) policies has led hospitals to scrutinize patient disposition following discharge. However, significant variability exists in disposition practices to non-home facilities following TAVR [9,10]. While patient-related and hospital-based risk factors for non-home discharge are established, the impact of origin of admission on ultimate disposition remains unknown, but is relevant in understanding pre-hospital drivers that predict post-TAVR disposition. In this study, we sought to examine the impact of admission origin on use of rehabilitative services following TAVR.

METHODS

Data Source

The National Inpatient Sample (NIS) is derived from the Healthcare Utilization Project and is the largest inpatient, publicly-available, all-payer database based on administrative claims [11]. The repository consists of a 20% sample of de-identified information on patient demographics, comorbidities, in-hospital outcomes including length of stay (LOS), costs, and discharge disposition from approximately 1,000 non-federal hospitals. When nationally weighted, the data represent more than 35 million discharges annually.

Study Population and Outcomes

We retrospectively identified all TAVR discharges using *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) procedures codes between 2012-2014. We further isolated patients who were discharged to a rehabilitation facility (the rehab cohort - SNF, intermediate care facility (ICF) or any other rehabilitative facility) following their TAVR procedure (**Supplement Table 1**). We excluded all patients who underwent both surgical aortic valve replacement (SAVR) and TAVR during the same hospitalization.

Our primary outcome of interest was disposition tendency to a rehabilitation facility. Secondary outcomes were inpatient costs, LOS and in-hospital outcomes: complete heart block, cardiogenic shock and cardiac arrest. Elixhauser comorbidities, which are a common measure of comprehensive comorbidities for large administrative inpatient databases, were utilized as single categories and as an index to serve indirectly as an indicator for frailty [12,13]. The Charlson Comorbidity Index, which was calculated using ICD-9-CM codes, was used to summarize the comorbidity burden for an individual [14]. Hospital-specific variables such as hospital size, location, teaching status, region and ownership were also queried.

Statistical Methods

Survey procedures were applied to (1) generate national estimates and variances using given probability weights and (2) to account for clustering of outcomes by sampling unit (i.e. hospital) and sampling variation by region and year, as described previously [15,16]. Differences in patient demographics, comorbidities, in-hospital and hospital-level factors between the rehab cohort versus home discharge cohort were compared using univariate analysis. Costs were calculated using hospital charges and cost-to-charge ratios in US dollars [17]. Within the rehab cohort, we further compared preoperative, in-hospital, and hospital-level factors by admission origin. The 3 comparison groups were (1) not transferred (i.e. coming from home) (2) transferred from acute care hospital and (3) transferred from another health facility.

Continuous variables are expressed as a mean with standard deviation and were compared using Generalized Wald tests. Categorical variables are presented as number and percentages and were compared using Chi-squared tests. We also developed a stepwise, backward-selection, multivariable logistic regression model to determine independent predictors for disposition to a rehabilitation facility following TAVR. Covariates with a p-value <0.05 were kept in the model; those that crossed this threshold were manually trimmed in the final iteration of the model until all remaining covariates met the significance level. These results are presented as odds ratios (OR) and 95% confidence intervals (CI). All analyses were conducted using STATA Version 13.1 (StataCorp LP, College Station, TX) survey procedures with an alpha level of p≤0.05 as the criterion for significance.

RESULTS

Characteristics and Outcomes Stratified by Discharge Disposition

A total of 40,900 patients met inclusion criteria. Of these, 12,175 patients were discharged to a rehabilitation facility (i.e. the rehab cohort; **Table 1**). The rehab cohort was significantly older, more likely female, and had a higher number of chronic conditions (such as atrial fibrillation, prior pacemaker placement, renal failure) compared to the home discharge

Table 1: Preoperative Factors, Hospital Characteristics, and In-Hospital Outcomes of TAVR Patients Stratified by Discharge Disposition.

	Home Discharge Cohort	Rehab Discharge Cohort	
Variable	**(n=13,815)**	**(n=12,175)**	**P-Value**
Demographics			
Age	79.0 (9.8)	83.3 (6.7)	<0.01*
Female	5,210 (37.7)	7,095 (58.3)	<0.01*
Race			0.09
White	11,140 (86.8)	9,820 (87.9)	
Black	540 (4.2)	395 (3.5)	
Hispanic	530 (4.1)	350 (3.1)	
Asian or Pacific Islander	190 (1.5)	125 (1.1)	
Native American	30 (0.2)	20 (0.2)	
Other	400 (3.1)	460 (4.1)	
Median Household Income Quartile, percentile			<0.01*
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)	<0.01*
Comorbidities			
Atrial Fibrillation	5,345 (38.7)	6,155 (50.6)	<0.01*
Smoking	4,405 (31.9)	2,815 (23.1)	<0.01*
Prior TIA/Stroke	10,450 (75.6)	8,500 (69.8)	<0.01*
Dyslipidemia	9,540 (69.1)	7,240 (59.5)	<0.01*
Known Coronary Artery Disease	10,055 (72.8)	7,920 (65.1)	<0.01*
Prior Myocardial Infarction	2,385 (17.3)	1,660 (13.6)	<0.01*
Prior CABG	3,785 (27.4)	1,990 (16.3)	<0.01*
Prior PCI	2,915 (21.1)	2,085 (17.1)	<0.01*
Carotid Artery Disease	1,025 (7.4)	865 (7.1)	0.68
Prior PPM	1,370 (9.9)	1,330 (10.9)	0.26
Prior ICD	485 (3.5)	255 (2.1)	<0.01*
Alcohol Abuse	175 (1.3)	110 (0.9)	0.21
Deficiency Anemia	3,060 (22.2)	3,495 (28.7)	<0.01*
Rheumatoid Arthritis/ Collagen Vascular Diseases	625 (4.5)	6,65 (5.5)	0.1
Chronic Blood Loss Anemia	150 (1.1)	180 (1.5)	0.18
CHF	1,650 (11.9)	1,555 (12.8)	0.4
Chronic Pulmonary Disease	4,385 (31.7)	4,195 (34.5)	0.04*
Coagulopathy	2,500 (18.1)	3,290 (27.0)	<0.01*
Depression	825 (6.0)	1,075 (8.8)	<0.01*
Diabetes, Uncomplicated	4,190 (30.3)	3,460 (28.4)	0.14
Diabetes with Chronic Complications	765 (5.5)	775 (6.4)	0.2
HTN, Uncomplicated and Complicated	11,265 (81.6)	9,440 (77.5)	<0.01*
Hypothyroidism	2,720 (19.7)	2,605 (21.4)	0.13
Fluid and Electrolyte Disorders	2,450 (17.7)	4,185 (34.4)	<0.01*
Other Neurological Disorders	675 (4.9)	1030 (8.5)	<0.01*
Obesity	1,995 (14.4)	1,720 (14.1)	0.75
Peripheral Vascular Disorders	3,975 (28.8)	3,545 (29.1)	0.8
Psychoses	110 (0.8)	320 (2.6)	<0.01*
Pulmonary Circulation Disorders	470 (3.4)	465 (3.8)	0.42
Renal Failure	4,505 (32.6)	4,705 (38.6)	<0.01*
Solid Tumor Without Metastasis	300 (2.2)	180 (1.5)	0.05
Weight Loss	310 (2.2)	1030 (8.5)	<0.01*
Charlson Comorbidity Index	2.8 (1.8)	3.0 (1.7)	<0.01*
Number of Elixhauser Comorbidities	5.8 (1.9)	6.5 (2.0)	<0.01*
Admission Characteristics			
Elective Admission	11,220 (81.3)	8,545 (70.2)	<0.01*
Emergency Department use	310 (2.2)	685 (5.6)	<0.01*
Transfer Status			<0.01*
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)	
Operative Characteristics			

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Trans-femoral, Trans-aortic or Subclavian approach	11,845 (85.7)	8,965 (73.6)	<0.01*
Trans-apical approach	1,990 (14.4)	3,235 (26.6)	<0.01*
Cardiopulmonary Bypass	980 (7.1)	1,040 (8.5)	0.09
Percutaneous Cardiopulmonary Bypass	80 (0.6)	145 (1.2)	0.02*
In-Hospital Outcomes			
Complete Heart Block	1,085 (7.9)	1,435 (11.8)	<0.01*
Cardiogenic Shock	160 (1.2)	480 (3.9)	<0.01*
Cardiac Arrest	190 (1.9)	515 (4.2)	<0.01*
Length of Stay	5.3 (4.2)	11.3 (8.7)	<0.01*
Cost (US Dollars)	48,710 (19,881)	66,246 (35,401)	<0.01*
Hospital Characteristics			
Census Division of Hospital			<0.01*
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	1155 (8.4)	1,015 (8.3)	
South Atlantic	2,575 (18.6)	2,040 (16.8)	
East South Central	1225 (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			0.37
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			0.87
Rural	80 (0.6)	75 (0.6)	
Urban nonteaching	1,555 (11.3)	1300 (10.7)	
Urban teaching	12,180 (88.2)	10800 (88.7)	
Region of Hospital			<0.01*
Northeast	1,815 (13.1)	3795 (31.2)	
Midwest or North Central	3,020 (21.9)	2850 (23.4)	
South	5,805 (42.0)	3650 (30.0)	
West	3,175 (23.0)	1880 (15.4)	
Control/ Ownership of Hospital			0.03*
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)	

Abbreviations: TAVR, transcatheter aortic valve replacement; 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.

cohort (all $p<0.001$). These patients were also less likely to be admitted electively and more likely to be transferred in preoperatively (13.3% vs. 4.4%; $p<0.001$). Proportionally, more patients in the rehab cohort underwent the trans-apical TAVR approach (26.6% vs. 14.4%, $p<0.01$) compared to the home discharge cohort.

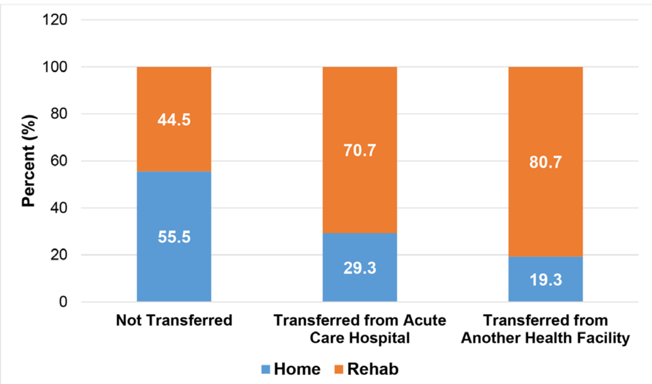

Figure 1: Proportion of Discharges to Rehabilitation Facilities Following TAVR by Preoperative Admission Origin.

In terms of postoperative outcomes, the rehab cohort had a higher incidence of complete heart block, cardiogenic shock and cardiac arrest, and significantly longer inpatient LOS and costs compared to the home discharge cohort (all $p<0.01$; **Table 1**). After stratifying the cohort by admission origin, TAVR patients who were transferred from another health facility or an acute care facility had significantly higher proportions of discharges to rehabilitation facilities postoperatively compared to patients not transferred (80.7% and 70.7% vs. 44.5%; all $p<0.01$; **Figure 1**).

Characteristics and Outcomes of Rehab Cohort Stratified By Admission Origin

Of the 12,175 patients in the rehab cohort, 10,520 patients (86.4%) were admitted from home, 1,255 patients (10.3%) were transferred from an acute care hospital, and 355 patients (2.9%) were transferred from another health facility (**Table 2**). In general, patient age, sex, and comorbidity profile of patients did not vary by admission origin (all $p>0.05$). But patients who were transferred from an acute care hospital were more likely to be admitted over the weekend compared to patients who were not transferred (17.9% vs 5.4%; global $p<0.01$).

Although major in-hospital cardiac complications and other hospital-level factors did not vary by admission origin (all $p>0.05$), patients who were transferred from acute care hospital had significantly longer LOS (17.2 vs 10.6 days and 11.6 days; $p<0.01$) and higher admission costs ($77,092 vs $64,861 and

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$66,507; *p* <0.01) compared to those not transferred and those transferred from another facility, respectively.

Table 2: Preoperative Factors, Hospital Characteristics, and In-Hospital Outcomes of TAVR Rehab Cohort Stratified by Admission Origin.

Variable	Not Transferred (n=10,520)	Transferred from Acute Care Hospital (n= 1,255)	Transferred from Another Health Facility (n=355)	*P*-Value
Demographics				
Age	83.29 (6.7)	82.91 (6.7)	83.27 (7.0)	0.78
Female	6,175 (58.7)	710 (56.7)	200 (56.3)	0.81
Race				0.01*
White	8560 (88.6)	940 (81.0)	280 (91.8)	
Hispanic	295 (3.1)	40 (3.5)	15 (4.9)	
Median Household Income Quartile for Zip Code				0.77
0-25th percentile	2090 (20.2)	230 (18.6)	70 (20.3)	
26-50th percentile	2415 (23.3)	320 (25.9)	65 (18.8)	
51-75th percentile	2850 (27.5)	300 (24.3)	85 (24.6)	
76-100th percentile	3010 (29.0)	385 (31.2)	125 (36.2)	
Patient Location				0.04*
"Central" counties of metro areas >= 1 million population	2820 (26.9)	255 (20.4)	110 (31.0)	
"Fringe" counties of metro areas >= 1 million population	3000 (28.7)	440 (35.2)	105 (29.6)	
Counties in metro areas of 250,000-999,999 population	2155 (20.6)	185 (14.8)	75 (21.1)	
Counties in metro areas of 50,000-249,999 population	855 (8.2)	70 (5.6)	15 (4.2)	
Micropolitan counties	950 (9.1)	165 (13.2)	25 (7.0)	
Not metropolitan or micropolitan counties	690 (6.6)	135 (10.8)	25 (7.0)	
Comorbidities				
Atrial Fibrillation	5315 (50.5)	605 (48.2)	210 (59.2)	0.34
Deficiency Anemia	2870 (27.3)	490 (39.0)	115 (32.4)	<0.01*
Congestive Heart Failure	1280 (12.2)	205 (16.3)	55 (15.5)	0.14
Chronic Pulmonary Disease	3605 (34.3)	460 (36.7)	120 (33.8)	0.77
Coagulopathy	2945 (28.0)	255 (20.3)	70 (19.7)	0.02
Depression	950 (9.0)	100 (8.0)	25 (7.0)	0.71
Diabetes, Uncomplicated	3020 (28.7)	325 (25.9)	110 (31.0)	0.68
Diabetes with Chronic Complications	680 (6.5)	85 (6.8)	10 (2.8)	0.56
HTN, Uncomplicated and Complicated	8250 (78.4)	895 (71.3)	255 (71.9)	0.05
Fluid and Electrolyte Disorders	3600 (34.2)	445 (35.5)	105 (29.6)	0.7
Neurological Disorders	880 (8.4)	100 (8.0)	45 (12.7)	0.45
Obesity	1475 (14.0)	195 (15.5)	45 (12.7)	0.79
Peripheral Vascular Disorders	3150 (29.9)	305 (24.3)	75 (21.1)	0.13
Renal Failure	3915 (37.2)	635 (50.6)	125 (35.2)	0.01*
Smoking	2460 (23.4)	270 (21.5)	75 (21.1)	0.76
Prior TIA/Stroke	1535 (14.6)	170 (13.6)	60 (16.9)	0.79
Dyslipidemia	6325 (60.1)	680 (54.2)	200 (56.3)	0.26
Known Coronary Artery Disease	6675 (63.5)	880 (70.1)	245 (69.0)	0.13
Prior Myocardial Infarction	1255 (11.9)	130 (10.4)	45 (12.7)	0.84
Prior CABG	1740 (16.5)	155 (12.4)	80 (22.5)	0.14
Prior PCI	1790 (17.0)	195 (15.5)	90 (25.4)	0.25
Carotid Artery Disease	770 (7.3)	70 (5.6)	15 (4.2)	0.57
Prior PPM	1105 (10.5)	180 (14.3)	35 (9.9)	0.3
Prior ICD	205 (2.0)	35 (2.8)	15 (4.2)	0.42
Number of Chronic Conditions	9.8 ± 0.1	10.3 ± 0.2	9.5 ± 0.4	0.1
In-Hospital Outcomes				
Complete Heart Block	1250 (11.9)	140 (11.2)	40 (11.3)	0.96
Cardiogenic Shock	385 (3.7)	85 (6.8)	10 (2.8)	0.13
Length of Stay	10.60 (8.1)	17.16 (10.8)	11.63 (8.9)	<0.01*
Cost (USD $)	64,861 (35,109)	77,092 (36,956)	66,508 (28,607)	<0.01*
Admission and Hospital Factors				
Weekend Admission	570 (5.4)	225 (17.9)	55 (15.5)	<0.01*
Elective Admission	8115 (77.1)	205 (16.3)	200 (56.3)	<0.01*
Bed Size of Hospital				0.21
Small	505 (4.8)	35 (2.8)	40 (11.3)	
Medium	1705 (16.2)	230 (18.3)	55 (15.5)	
Large	8310 (79.0)	990 (79.0)	260 (73.2)	
Location/ Teaching Status of Hospital				0.11

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Urban nonteaching	1180 (11.2)	80 (6.4)	30 (8.5)	
Urban teaching	9265 (88.1)	1175 (93.6)	325 (91.6)	
Region of Hospital				0.14
Northeast	3195 (30.4)	470 (37.5)	130 (36.6)	
Midwest or North Central	2530 (24.1)	220 (17.5)	95 (26.8)	
South	3135 (29.8)	415 (33.1)	60 (16.9)	
West	1660 (15.8)	150 (12.0)	70 (19.7)	
Control/ Ownership of Hospital				0.02*
Government, nonfederal	840 (8.0)	70 (5.6)	15 (4.2)	
Private, not-profit	8920 (84.8)	1130 (90.0)	285 (80.3)	
Private, invest-own	760 (7.2)	55 (4.4)	55 (15.5)	

Abbreviations: TAVR, transcatheter aortic valve replacement; 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.

Table 3: Independent Predictors for Postoperative Disposition to a Rehabilitation Facility Following TAVR.

Variable	Odds ratio	95% Confidence Interval		*P*-Value
Admission Day on Weekend	1.78	1.11	2.84	0.02*
Non-Elective	8.23	4.15	13.16	<0.01*
Length of Stay	1.04	1.02	1.07	0.01*
Patient Location: "Central" counties of metro areas ^{3} 1 million population	[reference]			
Patient Location: Micropolitan County	2.57	1.41	4.65	<0.01*
Patient not transferred	[reference]			
Transfer from another health facility	4.32	1.75	10.67	<0.01*

**P*-value ≤ 0.05 was considered statistically significant.

Predictors of Disposition to a Rehabilitation Facility

In our final multivariable regression model, admission day on weekend (OR 1.78, 95% CI: 1.11 to 2.84), non-elective admission (OR 8.23, 95% CI: 4.15 to 13.16) and patient residency/occupancy in a micropolitan county (OR 2.57, 95% CI: 1.41 to 4.65), were independent predictors of disposition to a rehabilitation facility (all *p* <0.05; **Table 3**). Most notably, transfer from another type of health care facility was also found to be associated with increased risk for disposition to a rehabilitation facility after discharge (OR 4.32, 95% CI: 1.75 to 10.67). However, hospital academic status, patient comorbidities and transfer from an acute care facility did not impact the likelihood of discharge to a rehabilitation facility after TAVR.

DISCUSSION

To our knowledge, no prior study has analyzed the impact of preadmission patient location/origin on the risk of requiring post-procedure rehabilitative services following TAVR. This study had several key findings: First, we found that more than 25% of TAVR patients were discharged to a rehabilitation facility, and majority (almost 90%) of them had presented for their procedure from home. Second, although the proportion of patients transferred from another health care facility was small, these patients experienced 4.3-fold higher odds of disposition to a rehabilitation facility following TAVR. Additionally, weekend admission and emergent admission were independently associated with need for rehabilitative services after discharge, regardless of academic practice type or patient comorbidities. These findings emphasize the need to further dissect reasons for patient transfers using a multi-disciplinary approach in order to improve overall patient triage and transitions of care.

Understanding pre-hospital drivers for post-TAVR disposition to a rehabilitation facility are relevant both clinically and economically in the context of readmission. This is because disposition to SNF and prolonged LOS have been found to be associated with increased risk of 30-day readmissions after TAVR [4]. Not surprisingly, our study demonstrated that longer hospitalization was associated with higher risk of discharge to a rehabilitation facility. This finding is in accordance with prior work that has shown that patients with longer intensive care unit stays were more likely to be discharged to an acute care facility versus home [9]. While the reasons for prolonged hospitalization may be multifactorial, they likely represent a combination of patient comorbidity burden or surgical complexity. With the utilization of TAVR likely to expand, we suspect that hospital LOS, in addition to readmission rates, will continue to improve with increasing experience. Nonetheless, these metrics will likely serve as an important benchmark with which to assess hospital performance and to promote value-based, high-quality care especially in the current era of episode-based payments.

What is further alarming is that existing rates of readmission following TAVR are still already high despite contemporary improves in valve design, delivery methods and training.

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According to one study, 24.4% of patients undergo TAVR tend to be re-hospitalized once and 12.5% are re-hospitalized twice within a year post procedure [18]. Other studies have reported even higher rates of 1-year post-TAVR readmission (43.9%), with 14.6% of those readmissions occurring within the first 30 days [7]. For patients undergoing TAVR, who are likely to be medically complex and potentially frail by current eligibility criteria, repeat readmission may not only indicate poor medical prognosis but also arguably represent a poor post-procedure quality of life. Thus, granular assessments of these metrics are integral for quality improvement, cost savings and reduction in preventable readmissions.

In our cohort, non-elective or weekend admissions were also found to be strongly associated with increased discharge to a rehabilitation facility. These patients may represent a high-risk cohort with either more advanced, debilitating disease or poor access that limited their ability to present for management of their disease in an elective fashion. We also found that patients transferred in from an acute care hospital were more likely to be admitted over the weekend and less likely to be admitted electively versus those admitted from home. These patients had a higher prevalence of renal failure and anemia, which further underscores their medical complexity. However, these patient characteristics did not remain statistically significant in our multivariable analysis, and which may likely be due to the small sample size. While prior studies have suggested significant regional variability in discharge from hospitals to SNFs [9], overall it seems reasonable that more medically complex patients requiring emergent or weekend transfer would be at an increased risk for discharge to a rehabilitation center.

While our findings enlighten the implications of contemporary trends in patient disposition, we propose that they can also be implemented to improve the current healthcare landscape. Notably, our finding that patients who were admitted on the weekend and emergently were more likely to be discharged to rehabilitation centers suggests a need to minimize these types of admissions. Although cardiac emergencies necessitating admission for TAVR cannot be eliminated, consideration for earlier transfer for these patients could have presented opportunities for the inpatient teams to circumvent or better optimize the patient for a procedure such that his or her risk of discharge to a rehabilitation facility is as low as possible. Moreover, as cardiac emergencies cannot be eliminated, consideration should be given to policies that would permit removing emergent admissions from analyses for reimbursement. This would ensure that institutions considered transfer hubs, capable of caring for patients in crisis requiring emergent TAVR, are not penalized based upon the patient's discharge disposition or readmission course. These strategies could also be an incentive to improve overall inpatient prognostication, risk stratification, pre-procedure counseling and discharge planning.

Our findings can be placed in the context of existing Medicare PACT policies and their implications on hospital reimbursements. The CMS reduces hospital reimbursements when patients are sent to post-acute care settings earlier than national averages. Hospitals have been quoted to lose between $500,000-$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 Program [19]. Though TAVR 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 care standards for transferred patients following TAVR that maximize home discharge, without compromising on the quality of care delivered.

This study is not without limitations. The NIS uses hospital claims data that are prone to inconsistency with regard to variability in coding practices between institutions. While the database captures patient disposition location, we are unable to assess post-discharge outcomes including readmissions. The NIS also precludes detailed assessment of patient presentation, procedural details, surgical risk (e.g. STS score), and frailty, all of which may have contributed to decisions regarding transfer and disposition. While indirect measures such as the Charlson comorbidity index and summation of Elixhauser comorbidities were evaluated, frailty itself was not formally assessed. It was also impossible to ascertain the exact rationale that led directly to disposition decision making.

In conclusion, this is the first study to specifically examine the impact of pre-hospitalization origin on patient's use of rehabilitation services following TAVR. Admission origin appears to impact the likelihood for discharge to a rehabilitation facility post TAVR, independent of institution type and patient comorbidities. Drivers propagating non-home discharge, such as weekend transfers from non-acute facilities and non-elective cases, should be further investigated. These results stand to decrease hospital resource utilization under current PACT policies, improve risk assessments, and inform pre-

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procedure counseling, which may ultimately enhance overall patient care.

Additional Information:

Supplementary material available to download at :

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