








ORIGINAL RESEARCH

Same-Day Discharge After Transcatheter Aortic Valve Implantation: Insights from the Nationwide Readmission Database 2015 to 2019

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BACKGROUND: There is a paucity of data on the feasibility of same-day discharge (SDD) following transcatheter aortic valve implantation (TAVI) at a national level.

METHODS AND RESULTS: This study used data from the Nationwide Readmission Database from the fourth quarter of 2015 through 2019 and identified patients undergoing TAVI using the claim code 02RF3. A total of 158 591 weighted hospitalizations for TAVI were included in the analysis. Of the patients undergoing TAVI, 961 (0.6%) experienced SDD. Non-SDDs included 65 814 (41.5%) patients who underwent TAVI who were discharged the next day, and 91 816 (57.9%) discharged on the second or third day. The 30-day readmission rate for SDD after TAVI was similar to non-SDD TAVI (9.8% versus 8.9%, $P=0.31$). The cumulative incidence of 30-day readmissions for SDD was higher compared with next-day discharge (log-rank $P=0.01$) but comparable to second- or third-day discharge (log-rank $P=0.66$). At 30 days, no differences were observed in major or minor vascular complications, heart failure, or ischemic stroke for SDD compared with non-SDD. Acute kidney injury, pacemaker implantation, and bleeding complications were lower with SDD. Predictors associated with SDD included age <85 years, male sex, and prior pacemaker placement, whereas left bundle-branch block, right bundle-branch block, second-degree heart block, heart failure, prior percutaneous coronary intervention, and atrial fibrillation were negatively associated with SDD.

CONCLUSIONS: SDD following TAVI is associated with similar 30-day readmission and complication rates compared with non-SDD. Further prospective studies are needed to assess the safety and feasibility of SDD after TAVI.

Key Words: same-day discharge ■ transcatheter aortic valve implantation ■ transcatheter aortic valve replacement

Transcatheter aortic valve implantation (TAVI) has emerged as the treatment of choice for many patients with symptomatic severe aortic stenosis across the spectrum of surgical risk.^{1–3} Compared with surgical aortic valve replacement, TAVI is associated with a similar risk of mortality and morbidity

and a shorter length of stay.^{4–6} More recently, a minimalist approach to TAVI has been adopted to minimize length of stay and resource use.^{7,8} The 3M TAVR (Multidisciplinary, Multimodality, but Minimalistic Approach to Transfemoral Transcatheter Aortic Valve Replacement) study used a standardized and

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CLINICAL PERSPECTIVE

What Is New?

- Same-day discharge transcatheter aortic valve implantation is rarely performed but appears safe with similar 30-day readmission rates compared with non-same-day discharge (ie, next day and second or third day) after transcatheter aortic valve implantation.
- Hospitalization costs were significantly lower for patients experiencing same-day discharge compared with next-day discharge and second- or third-day discharge after transcatheter aortic valve implantation.

What Are the Clinical Implications?

- Same-day discharge after transcatheter aortic valve implantation appears to be safe in selected patients.

Nonstandard Abbreviations and Acronyms

| | |
|----------------|---|
| NDD | next-day discharge |
| non-SDD | non-same-day discharge |
| NRD | Nationwide Readmission Database |
| PPM | permanent pacemaker |
| ScD/TDD | second- or third-day discharge |
| SDD | same-day discharge |
| TAVI | transcatheter aortic valve implantation |

optimized clinical pathway to achieve a safe next-day discharge for patients undergoing TAVI.⁹ Despite these advances, there is limited evidence on the necessary length of stay and monitoring required following TAVI.

Because of the paucity of evidence on real-world trends and outcomes of patients undergoing TAVI based on discharge length, our study assessed the safety of same-day discharge (SDD) using contemporary real-world data from the National Readmission Database (NRD).

METHODS

Study Data

The NRD is a database sponsored by the Agency for Healthcare Research and Quality. The Healthcare Cost and Utilization Project maintains data on approximately 35 million annual weighted discharges from 28 states representing 59.7% of the US population and 58.7% of inpatient hospitalizations. The NRD is an all-payer database that captures all in-hospital

stays with nationally representative readmission rates. For tracing readmissions within a calendar year, each patient is assigned a unique identifier code, which is randomly generated to protect their privacy. The days to event variable in the NRD are used to capture readmissions within a calendar year and cannot track readmissions across different years.¹⁰ Observations with a cell count <11 are reported as <11 in the NRD. Given the deidentified nature of the database, institutional review board approval and informed consent were not required for this study. NRD is publicly available. The data analyzed from the NRD for this study are available upon request.

Study Design and Data Selection

International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) claims were used to identify patients undergoing TAVI using O2RF3 from the fourth quarter of 2015 through 2019 (Table S1). The NRD contains data on the total inpatient charges billed by a hospital, which differ from the actual cost that includes the total expense for hospital services. To further estimate total hospital cost, the Healthcare Cost and Utilization Project provides a cost-to-charge ratio with hospital-specific ratios (ie, weighted hospital averages). Cost information used for the cost-to-charge ratio is collected by the Centers for Medicare and Medicaid Services from participating hospitals with some imputation of missing values.¹¹ For our study, the provided adjusted cost of hospital care was calculated by multiplying the total charges from the NRD and the cost-to-charge ratio. Total hospitalization costs were adjusted for inflation to January 2020 using the Bureau of Labor Statistics Consumer Price Index.¹²

Index hospital admissions were defined as patients undergoing TAVI and discharged alive without missing variables necessary for identifying readmissions (ie, length of stay, mortality, or days-to-event variables). Index admissions were categorized based on calendar year from January to November. Because readmissions cannot be tracked across calendar years in the NRD, December admissions were excluded to analyze 30-day readmissions. Patients who left against medical advice or were transferred to another rehabilitation facility were excluded. A readmission was defined as any patient being rehospitalized within 30-days of discharge. In patients with multiple 30-day readmissions, only the first hospitalization was included in the analysis. We also excluded patients who were discharged 4 or more days after the procedure. A flowchart of the study is shown in [Figure 1](#).

Study End Point

The primary outcome was 30-day readmission after TAVI. Secondary outcomes included 30-day complications and associated hospitalization costs.

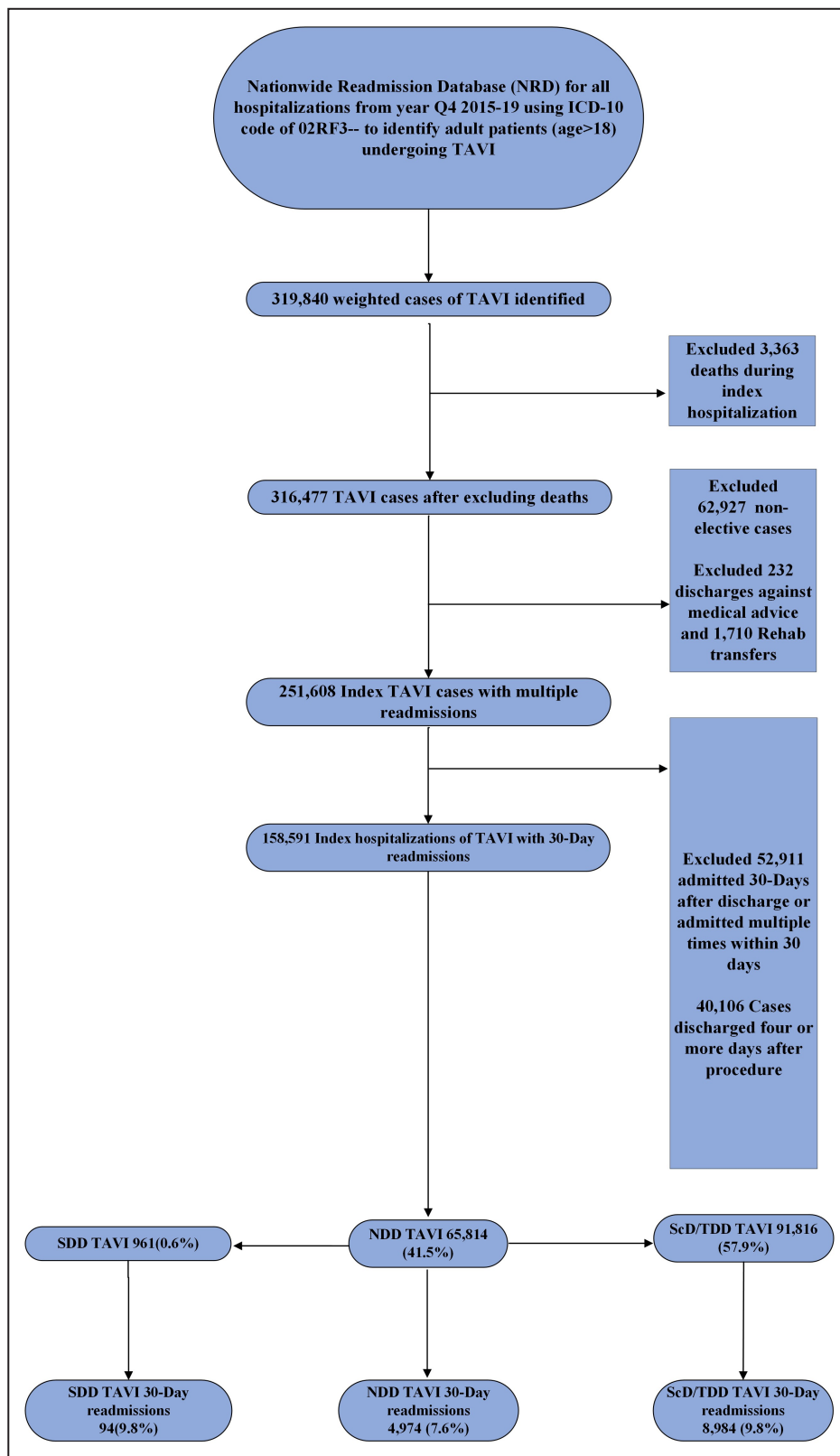


Figure 1. Study flowchart.
 ICD-10 indicates *International Classification of Disease, Tenth Revision*; NDD, next-day discharge; NRD, Nationwide Readmission Database; ScD/TDD, second- or third-day discharge; SDD, same-day discharge; and TAVI, transcatheter aortic valve implantation.

Statistical Analysis

Categorical variables were presented as frequencies and percentages, and continuous variables were reported as a median with an interquartile range. Baseline characteristics were compared using Pearson χ^2 and Fisher exact tests for categorical variables and Mann-Whitney U test for continuous variables. The log-rank test was used to compare the timing of readmissions within 30 days after TAVI discharge between SDD and non-SDD, which included next-day discharge (NDD) and second- or third-day discharge (ScD/TDD). A multivariate logistic regression model was developed using the enter method to analyze predictors of SDD adjusting for age, sex, baseline comorbidities, hospital characteristics, and insurance status (Table 1). A second logistic regression model was also developed to assess the 30-day readmission and complication rates for SDD compared with the non-SDD, NDD, and ScD/TDD groups using the same aforementioned variables for adjustment. For trend analysis, binary logistic regression adjusted for age and sex was used to calculate a trend P value.

Data obtained from the NRD were complete for all reported variables, except for primary expected payer and disposition. Total missing data were 0.1%. The only variables with missing data from the NRD were primary expected payer and disposition. A missing value analysis was performed using the Little test, which demonstrated that missing data were completely random. For primary expected payer and disposition, the missing data were 0.1% ($n=199$) and $<0.1\%$ ($n\leq 11$), respectively, and were recategorized manually as other/unknown. All of the remaining variables contained complete data from the NRD. For all analyses, a 2-tailed P value of <0.05 was considered statistically significant. All statistical analyses were performed using SPSS version 27 (IBM, Armonk, NY) and R version 3.6 (R Foundation for Statistical Computing, Vienna, Austria). Both descriptive statistics and regression models were created using SPSS by using sample weights. The R survival package was used for computing cumulative incidences.¹³ The R survey package was used for the weighted analysis of the data in R.¹⁴ Because of the complex survey design of the NRD, sample weights, strata, and clusters were applied to raw data (descriptive and regression analysis) to generate national estimates for all analyses.

RESULTS

Baseline Characteristics of the Study Population

A total of 158 591 weighted hospitalizations for TAVI were included in the analysis. Of the patients undergoing TAVI, 961 (0.6%) underwent SDD. Non-SDD

discharges included 65 814 (41.5%) patients who underwent NDD and 91 816 (57.9%) discharged as ScD/TDD. SDD TAVI was performed predominantly in large metropolitan teaching hospitals (85.5%) compared with metropolitan nonteaching hospitals (14.1%). Baseline patient and hospital characteristics are shown in Table 1.

Thirty-Day Outcomes, Temporal Trends in Length of Stay, and Hospital Costs

The 30-day readmission rate for SDD after TAVI was similar to non-SDD TAVI (9.8% versus 8.9%, $P=0.31$). The cumulative incidence of 30-day readmission after SDD was also similar compared with non-SDD (log-rank $P=0.30$) (Figure 2A). However, the cumulative incidence of 30-day readmissions for SDD was higher compared with NDD (log-rank $P=0.01$) but comparable to ScD/TDD (log-rank $P=0.66$) (Figure 2B and 2C). Acute kidney injury, permanent pacemaker (PPM) implantation, and bleeding complications at 30 days were lower with SDD TAVI compared with other groups (Table 2). In an adjusted analysis (Table 3), no differences were observed in 30-day readmission, major or minor vascular complications, acute kidney injury requiring dialysis, heart failure, or ischemic strokes between SDD and non-SDD TAVI. However, acute kidney injury, new PPM implantation, and bleeding complications were significantly lower with SDD compared with NDD TAVI. The 30-day readmission rate was higher for SDD TAVI compared with NDD TAVI (Table S2) and comparable with ScD/TDD TAVI (Table S3). Over the study period, NDD increased from 18.1% to 54.4% ($P\leq 0.01$), whereas ScD/TDD decreased from 81.1% to 44.9% ($P\leq 0.01$) (Figure 3). The rate of SDD did not change over the study period ($P=0.60$) (Figure 3). Adjusted hospitalization costs were significantly lower for patients undergoing SDD TAVI compared with NDD TAVI (\$36 235 versus \$45 875, $P=0.04$) and ScD/TDD TAVI (\$36 235 versus \$49 770, $P\leq 0.01$) (Figure 4 & Table 2).

Predictors of SDD

Independent predictors of SDD TAVI included age <85 years (odds ratio [OR], 1.18 [95% CI, 1.03–1.36]; $P=0.03$), male sex (OR, 1.23 [95% CI, 1.08–1.41]; $P\leq 0.01$), and prior PPM (OR, 1.34 [95% CI, 1.11–1.63]; $P\leq 0.01$). Whereas left bundle-branch block (OR, 0.65 [95% CI, 0.52–0.81]; $P\leq 0.01$), right bundle-branch block (OR, 0.63 [95% CI, 0.43–0.92]; $P=0.02$), second-degree heart block (OR, 0.15 [95% CI, 0.03–0.81]; $P=0.03$), heart failure (OR, 0.84 [95% CI, 0.73–0.96]; $P\leq 0.01$), prior percutaneous coronary intervention (OR, 0.74 [95% CI, 0.62–0.89]; $P\leq 0.01$), and atrial fibrillation (OR, 0.80 [95% CI, 0.69–0.94]; $P=0.01$) were negative predictors for SDD TAVI (Figure 5).

Table 1. Baseline and Hospital Characteristics of the Study Population

| Variable | SDD, n=961 | NDD, n=65 814 | ScD/TDD, n=91 816 | Total non-SDD, n=157 630* | P value† |
|--|-------------|---------------|-------------------|---------------------------|----------|
| Age, y, median (IQR) | 80 (75–85) | 80 (74–85) | 81 (75–86) | 81 (75–86) | <0.01 |
| Female sex | 371 (38.6) | 26 320 (40.0) | 42 927 (46.8) | 69 247 (43.9) | <0.01 |
| Charlson Comorbidity Index, median (IQR) | 7 (5–8) | 7 (6–8) | 7 (6–8) | 7 (6–8) | <0.01 |
| Anemia | 29 (3.0) | 1775 (2.7) | 3186 (3.5) | 4961 (3.1) | 0.81 |
| Heart failure | 634 (66.0) | 46 061 (70.0) | 65 245 (71.1) | 111 306 (70.6) | <0.01 |
| Coagulopathy | 80 (8.3) | 3285 (5.0) | 9064 (9.9) | 12 349 (7.8) | 0.57 |
| COPD | 241 (25.1) | 16 168 (24.6) | 25 704 (28.0) | 41 872 (26.6) | 0.31 |
| Coronary artery disease | 675 (70.3) | 44 371 (67.4) | 63 977 (69.7) | 108 349 (68.7) | 0.32 |
| Cerebrovascular disease | 80 (8.4) | 5862 (8.9) | 8754 (9.5) | 14 616 (9.3) | 0.31 |
| Diabetes | 174 (18.1) | 11 243 (17.1) | 15 914 (17.3) | 27 157 (17.2) | 0.47 |
| Hypertension | 837 (87.1) | 58 314 (88.6) | 82 500 (89.9) | 14 0813 (89.3) | 0.03 |
| Liver disease | 21 (2.2) | 1661 (2.5) | 2517 (2.7) | 4178 (2.7) | 0.37 |
| Obesity | 177 (18.4) | 12 672 (19.3) | 18 145 (19.8) | 30 817 (19.5) | 0.37 |
| Peripheral vascular disease | 151 (15.8) | 11 167 (17.0) | 17 922 (19.5) | 29 089 (18.5) | 0.03 |
| Chronic kidney disease | 286 (29.8) | 19 022 (28.9) | 31 313 (34.1) | 50 335 (31.9) | 0.15 |
| End stage renal disease | 24 (2.5) | 1665 (2.5) | 3214 (3.5) | 4878 (3.1) | 0.29 |
| Smoking | 47 (4.9) | 2990 (4.5) | 3828 (4.2) | 6819 (4.3) | 0.39 |
| Weight loss | <11 (<1.1)‡ | 469 (0.7) | 1457 (1.6) | 1926 (1.2) | 0.09 |
| Prior CABG | 180 (18.7) | 11 555 (17.6) | 16 743 (18.2) | 28 297 (18.0) | 0.53 |
| Prior MI | 127 (13.2) | 7771 (11.8) | 11 370 (12.4) | 19 141 (12.1) | 0.31 |
| Prior pacemaker | 120 (12.5) | 7839 (11.9) | 7922 (8.6) | 15 761 (10.0) | 0.01 |
| Prior stroke | 122 (12.7) | 9102 (13.8) | 13 213 (14.4) | 22 315 (14.2) | 0.21 |
| Prior PCI | 166 (17.3) | 13 459 (20.5) | 18 980 (20.7) | 32 439 (20.6) | 0.01 |
| Mitral stenosis | <11 (<1.1)‡ | 343 (0.5) | 543 (0.6) | 886 (0.6) | 0.06 |
| Atrial fibrillation | 224 (23.4) | 16 847 (25.6) | 26 151 (28.5) | 42 998 (27.3) | <0.01 |
| Left bundle-branch block | 88 (9.1) | 6572 (10.0) | 14 730 (16.0) | 21 302 (13.5) | <0.01 |
| Right bundle-branch block | 29 (3.0) | 2443 (3.7) | 4626 (5.0) | 7069 (4.5) | 0.03 |
| First-degree heart block | 52 (5.4) | 2746 (4.2) | 5665 (6.2) | 8411 (5.3) | 0.92 |
| Second-degree heart block | <11 (<1.1)‡ | 367 (0.6) | 1097 (1.2) | 1465 (0.9) | <0.01 |
| Primary expected payer | | | | | |
| Medicare | 871 (90.8) | 58 630 (89.3) | 84 069 (91.6) | 14 2693 (90.6) | 0.94 |
| Medicaid | <11 (<1.1)‡ | 657 (1.0) | 810 (0.9) | 1466 (0.9) | |
| Private insurance | <11 (<1.1)‡ | 211 (0.3) | 240 (0.3) | 9986 (6.3) | |
| Self-pay | 61 (6.3) | 4790 (7.3) | 5151 (5.6) | 444 (0.3) | |
| Other, uncategorized or missing | 20 (2.1) | 1523 (2.3) | 1526 (1.7) | 3049 (1.9) | |
| Hospital bed size | | | | | |
| Small | 47 (4.8) | 3080 (4.7) | 5316 (5.8) | 8395 (5.3) | |
| Medium | 217 (22.5) | 13 704 (20.8) | 20 046 (21.8) | 33 750 (21.4) | 0.61 |
| Large | 698 (72.6) | 49 031 (74.5) | 66 454 (72.4) | 11 5485 (73.3) | |
| Hospital teaching status | | | | | |
| Metropolitan nonteaching | 135 (14.1) | 5898 (9.0) | 10 955 (11.9) | 17 894 (11.4) | <0.01 |
| Metropolitan teaching | 824 (85.7) | 59 351 (90.2) | 79 782 (86.9) | 137 606 (87.3) | |
| Nonmetropolitan hospital | <11 (<1.1)‡ | 566 (0.9) | 1078 (1.2) | 2131 (1.4) | |

CABG, coronary artery bypass grafting; COPD, chronic obstructive pulmonary disease; IQR, interquartile range; MI, myocardial infarction; NDD, next-day discharge; Non-SDD, non-same-day discharge; PCI, percutaneous coronary intervention; ScD/TDD, second- or third-day discharge; and SDD, same-day discharge.

*Non-SDD includes both NDD and ScD/TDD cohorts.

†P value compared SDD with non-SDD.

‡As per Healthcare Cost and Utilization Project regulations, observations with a cell count <11 were reported as <11.

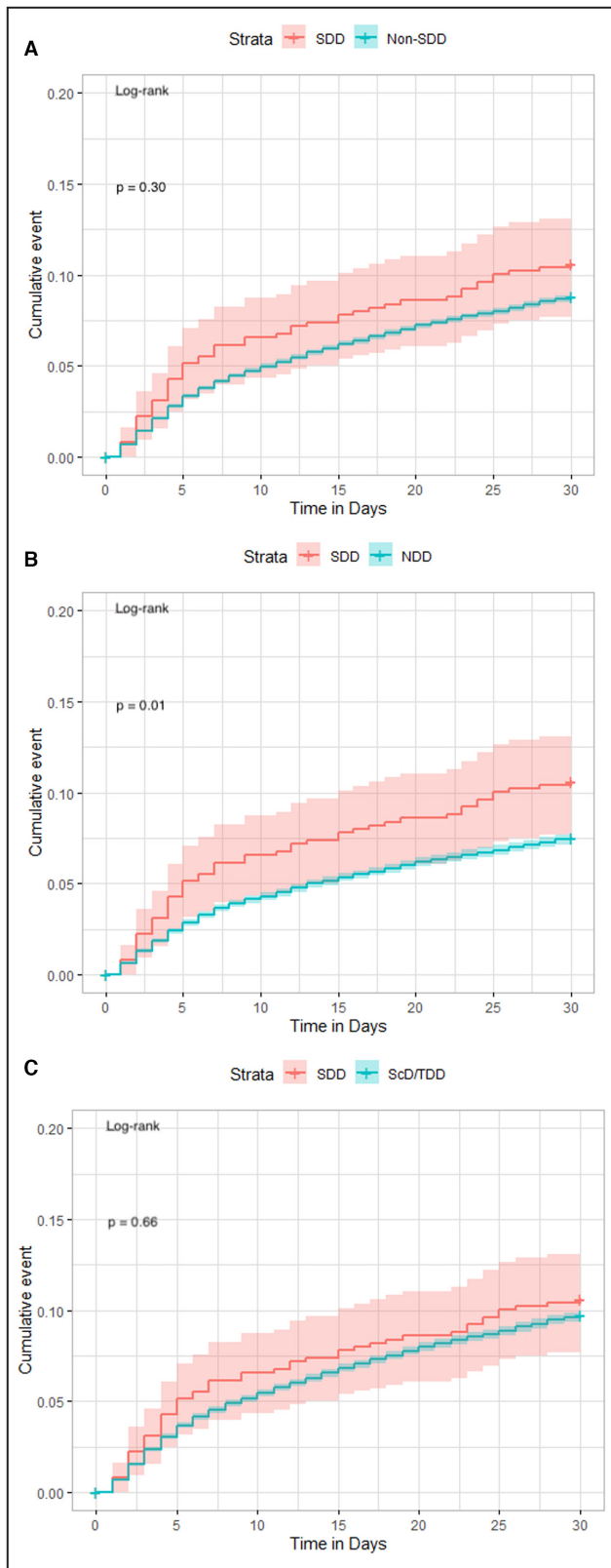


Figure 2. Cumulative incidence of 30-day readmissions stratified by the day of discharge following TAVI.

A, The cumulative rate of readmission rates for SDD TAVI is comparable with non-SDD as shown by the cumulative incidence function log-rank test ($P=0.30$). **B**, The cumulative rate of readmission rates for SDD TAVI is higher compared with NDD as shown by the cumulative incidence function log-rank test ($P=0.01$). **C**, The cumulative rate of readmission rates for SDD TAVI is comparable with ScD/TDD as shown by the cumulative incidence function log-rank test ($P=0.66$). NDD, next-day discharge; Non-SDD, non-same-day discharge; ScD/TDD, second- or third-day discharge; SDD, same-day discharge; and TAVI, transcatheter aortic valve implantation.

(39.7%) were secondary to cardiac causes that included heart failure, cardiac arrhythmias, valvular disorders, acute coronary syndrome, pericarditis, and conduction disturbances. The most common cardiac cause was heart failure ($n=4260$; 30.3%). Among the noncardiac causes, a respiratory cause ($n=1602$; 11.4%) was the most frequent cause of readmission and included hypoxic respiratory failure, pneumothorax, pleural effusion, pneumonia, and need for mechanical ventilation. No differences were observed in the rates of cardiac and noncardiac causes for 30-day readmission following TAVI between SDD and non-SDD groups (Table S4).

DISCUSSION

Our study on 30-day readmissions using a nationally representative TAVI population revealed the following: (1) The 30-day readmission rates were similar between SDD and non-SDD (ie, NDD and ScD/TDD) TAVI. (2) Independent predictors for SDD included age <85 years, male sex, prior PPM, and the absence of a left bundle-branch block, right bundle-branch block, second-degree heart block, heart failure, prior percutaneous coronary intervention, or atrial fibrillation. (3) SDD was not associated with an increase in 30-day readmission, major or minor vascular complications, heart failure, or ischemic strokes, but acute kidney injury, new PPM implantation, and bleeding were lower compared with non-SDD TAVI. (4) SDD is rare following TAVI and its use has not changed significantly over time, whereas the use of NDD after TAVI has increased significantly over the study period. (5) Hospitalization costs for SDD TAVI were significantly lower compared with NDD and ScD/TDD TAVI.

The 30-day readmissions rates following TAVI have been assessed in prior studies.^{15–20} All-cause 30-day readmission rates following TAVI range between 9% and 18% (Hannan et al [18.8%],¹⁶ Holmes et al [17.4%],¹⁷ Franco et al [14.6%],¹⁸ Dodson et al [17%],¹⁹ Sanchez et al [9.2%]²⁰). A prior study of TAVI performed between January 2014 through November 2014 using the NRD reported a 30-day readmission rate of 17.9% after

Causes of 30-Day Readmissions Following TAVI

Of the total readmissions ($n=14\ 052$), 8467 (60.3%) were attributable to noncardiac causes, and 5586

Table 2. Thirty-Day Readmission Rates, Clinical Outcomes, and Hospital Costs Following Transcatheter Aortic Valve Implantation

| Outcomes | SDD, n=961 | NDD, n=65 814 | P value* | ScD/TDD, n=91 816 | P value† | Total non-SDD, n=157 630 | P value‡ |
|--|---------------------------|---------------------------|----------|---------------------------|----------|---------------------------|----------|
| 30-day readmission rates | 94 (9.8) | 4974 (7.6) | 0.01 | 8984 (9.8) | 0.98 | 13 959 (8.9) | 0.31 |
| Acute kidney injury | 27 (2.8) | 1753 (2.7) | 0.78 | 5231 (5.7) | <0.01 | 6984 (4.4) | 0.02 |
| Acute kidney injury requiring dialysis | <11 (<1.1)§ | 39 (0.1) | 0.45 | 141 (0.2) | 0.22 | 180 (0.1) | 0.31 |
| Major vascular complications | <11 (<1.1)§ | 399 (0.6) | 0.09 | 1330 (1.4) | 0.29 | 1728 (1.1) | 0.87 |
| Minor vascular complications | <11 (<1.1)§ | 226 (0.3) | 0.35 | 784 (0.9) | 0.26 | 1010 (0.6) | 0.64 |
| Permanent pacemaker | 41 (4.2) | 2442 (3.7) | 0.37 | 8575 (9.3) | <0.01 | 11 017 (7.0) | <0.01 |
| Heart failure | 265 (27.6) | 18 636 (28.3) | 0.61 | 24 348 (26.5) | 0.46 | 42 984 (27.3) | 0.83 |
| Ischemic stroke | <11 (<1.1)§ | 371 (0.6) | 0.05 | 857 (0.9) | 0.73 | 1227 (0.8) | 0.36 |
| Bleeding requiring transfusion | 14 (1.5) | 1075 (1.6) | 0.67 | 3389 (3.7) | <0.01 | 4464 (2.8) | 0.01 |
| Cost of hospitalization, median (IQR) | 36 235 (35 710–38 031) | 45 875 (39 194–57 541) | 0.04 | 49 770 (40 293–62 990) | <0.01 | 48 504 (39 971–61 395) | <0.01 |

IQR, interquartile range; NDD, next-day discharge; non-SDD, non-same day discharge; ScD/TDD, second- or third-day discharge; and SDD, same-day discharge.

*Compares SDD with NDD.

†Compares SDD with ScD/NDD.

‡Compares SDD with total non-SDD.

§As per Healthcare Cost and Utilization Project regulations, observations with a cell count <11 were reported as <11.

TAVI.¹⁵ Our study demonstrates that 30-day TAVI re-admission rates have improved significantly over time, where the 30-day readmission rate from the fourth quarter of 2015 through 2019 for our study population was 8.9%.²¹ Our estimates of the 30-day readmission rate are consistent with a study using the STS/ACC TVT Registry (Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy Registry) from 2015 to 2017, which reported an all-cause 30-day readmission rate of 9.2%.²⁰

Prior studies have demonstrated the safety and feasibility of early discharge (ie, 1–2 days) following TAVI.^{9,22–24} Despite these advances, a major limiting factor for early discharge following TAVI is the

management of atrioventricular conduction disturbances and the potential need for in-hospital or late PPM implantation.^{25,26} Our study demonstrated that patients undergoing TAVI with a preexisting PPM were more likely to undergo SDD compared with patients without a PPM. Patients with a preexisting PPM do not require monitoring for atrioventricular conduction disturbances and may represent an ideal cohort to consider SDD. Patients undergoing TAVI with left bundle-branch block, right bundle-branch block, and second-degree heart block were more likely to be discharged on the second and third day following TAVI compared with SDD; likely because of a need for further rhythm monitoring for potential PPM implantation

Table 3. Adjusted and Unadjusted 30-Day Outcomes Following Transcatheter Aortic Valve Implantation for Same-Day Discharge Compared With Non-Same-Day Discharge (Next-Day Discharge and Second- or Third-Day Discharge)

| Outcomes | Unadjusted analysis | | Adjusted analysis* | |
|--------------------------------|------------------------|---------|---------------------|---------|
| | Unadjusted OR (95% CI) | P value | Adjusted OR (95%CI) | P value |
| 30-day readmission | 1.12 (0.90–1.38) | 0.34 | 1.19 (0.96–1.48) | 0.11 |
| Acute kidney injury | 0.62 (0.43–0.92) | 0.02 | 0.64 (0.44–0.95) | 0.03 |
| Major vascular complications | 0.95 (0.51–1.77) | 0.99 | 0.95 (0.50–1.79) | 0.87 |
| Minor vascular complications | 0.81 (0.34–1.96) | 0.79 | 0.82 (0.34–1.99) | 0.66 |
| Permanent pacemaker | 0.59 (0.43–0.81) | <0.01 | 0.64 (0.46–0.88) | 0.01 |
| Heart failure | 1.02 (0.88–1.17) | 0.86 | 1.13 (0.97–1.33) | 0.12 |
| Ischemic stroke | 1.34 (0.72–2.50) | 0.46 | 1.42 (0.74–2.70) | 0.29 |
| Bleeding requiring transfusion | 0.51 (0.31–0.86) | 0.01 | 0.54 (0.32–0.91) | 0.02 |

OR indicates odds ratio.

*Logistic regression model adjusted for age, sex, anemia, heart failure, coagulopathy, chronic obstructive pulmonary disease, coronary artery disease, cerebrovascular disease, diabetes, hypertension, liver disease, obesity, peripheral vascular disease, chronic kidney disease, end-stage renal disease, smoking, weight loss, prior coronary artery bypass graft, prior myocardial infarction, prior pacemaker, prior stroke, prior percutaneous coronary intervention, mitral stenosis, atrial fibrillation, left bundle-branch block, right bundle-branch block, insurance status, hospital size, and hospital teaching status.

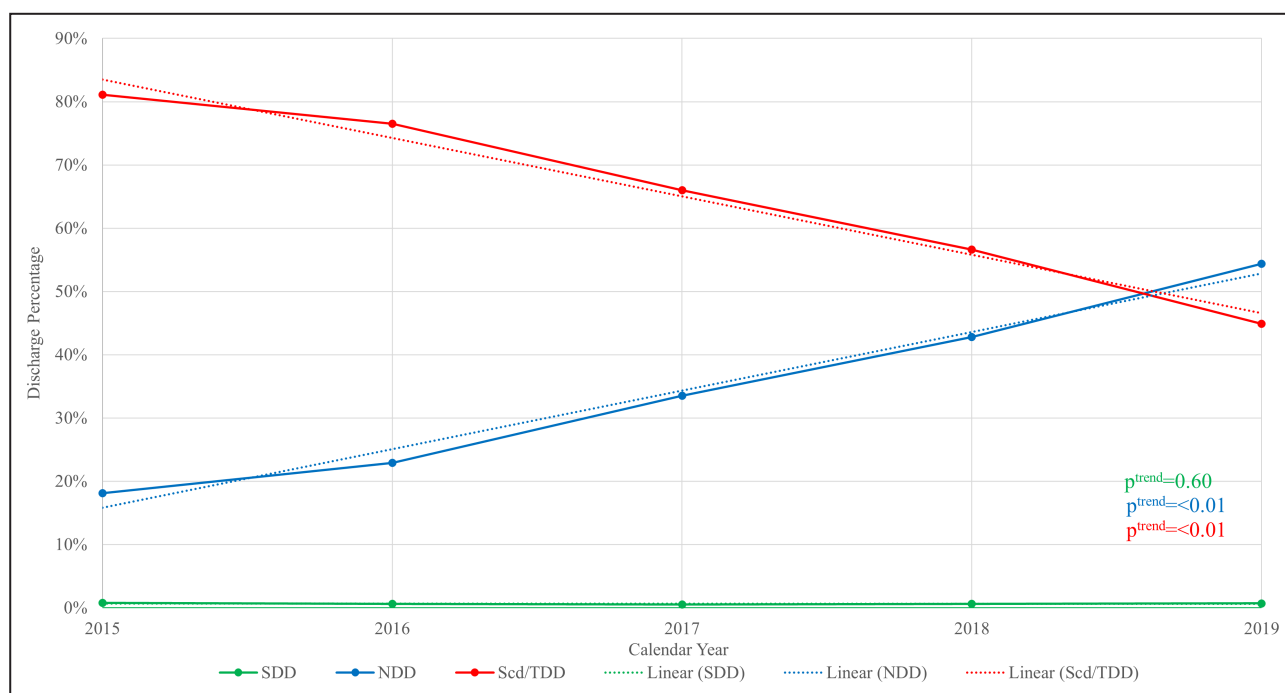


Figure 3. Temporal trends of SDD TAVI vs next-day and second- or third-day discharge TAVI from 2015* to 2019 NDD, next-day discharge; ScD/TDD, second- or third-day discharge; SDD, same-day discharge; and TAVI, transcatheter aortic valve implantation. *quarter four of 2015

during the index admission. Prior studies demonstrated a higher rate of PPM implantation in patients undergoing TAVI with a preexisting bundle-branch block^{27–29} and may represent a cohort of patients where SDD may not be feasible.

Other clinical predictors of SDD TAVI included younger age, male sex, and the absence of atrial fibrillation, which have previously been identified as favorable predications for NDD following TAVI.^{6,30} Male sex has been associated with fewer vascular and bleeding complications compared with female sex, resulting in shorter lengths of stay following TAVI and may increase the feasibility of SDD.³¹ Heart failure is the most common cardiac cause of readmission following TAVI.^{15,32} In our study, preexisting heart failure was a negative predictor for SDD TAVI and may limit its use in these patients. Further study is needed to determine which clinical factors predict the safety and feasibility of SDD TAVI.

SDD TAVI significantly reduces hospitalization costs compared with NDD and ScD/TDD. During the COVID-19 pandemic, several prospective studies were conducted to facilitate SDD following structural interventions to minimize the risk for COVID-19 exposure.^{25,33,34} To address the constraints placed on the health care system during the COVID-19 pandemic, the Post-Transcatheter Aortic Valve Replacement Using a Standardized Clinical Pathway (PROTECT TAVR) multicenter study demonstrated the safety and

feasibility of SDD TAVI and suggests its potential use during times of crisis.³⁵ The study provided an SDD clinical pathway that excluded patients with preexisting bundle-branch blocks.³⁵ Excluding patients with a preexisting bundle-branch block is consistent with our reported findings that patients with a right bundle-branch block or left bundle-branch block are not ideal candidates for SDD-TAVI. Similarly, a single-center study performed SDD-TAVI in 22.1% (n=114) of patients who underwent TAVI in 2020.³⁶ Taken together with our study findings, this suggests the potential for broader use of SDD-TAVI in the post-COVID-19 era. SDD TAVI in highly selected patients based on clinical judgement has the potential to reduce health care costs and minimize hospital resource use. Moreover, SDD can increase patient satisfaction, and its safety has been previously reported with percutaneous left atrial appendage closure³⁷ and elective percutaneous coronary intervention.^{38–40}

During the study period (ie, the fourth quarter of 2015 through 2019), rates of SDD TAVI remained constant, whereas NDD TAVI increased significantly from 18.1% to 54.4%. The use of a minimalist approach for TAVI, including a growing trend in the use of conscious sedation, have contributed to shorter lengths of stay and procedural-related complications following TAVI.^{9,41,42} According to the recent STS/ACC TVT Registry, the use of conscious sedation increased from 33% in 2016 to 64% in 2019 and is associated

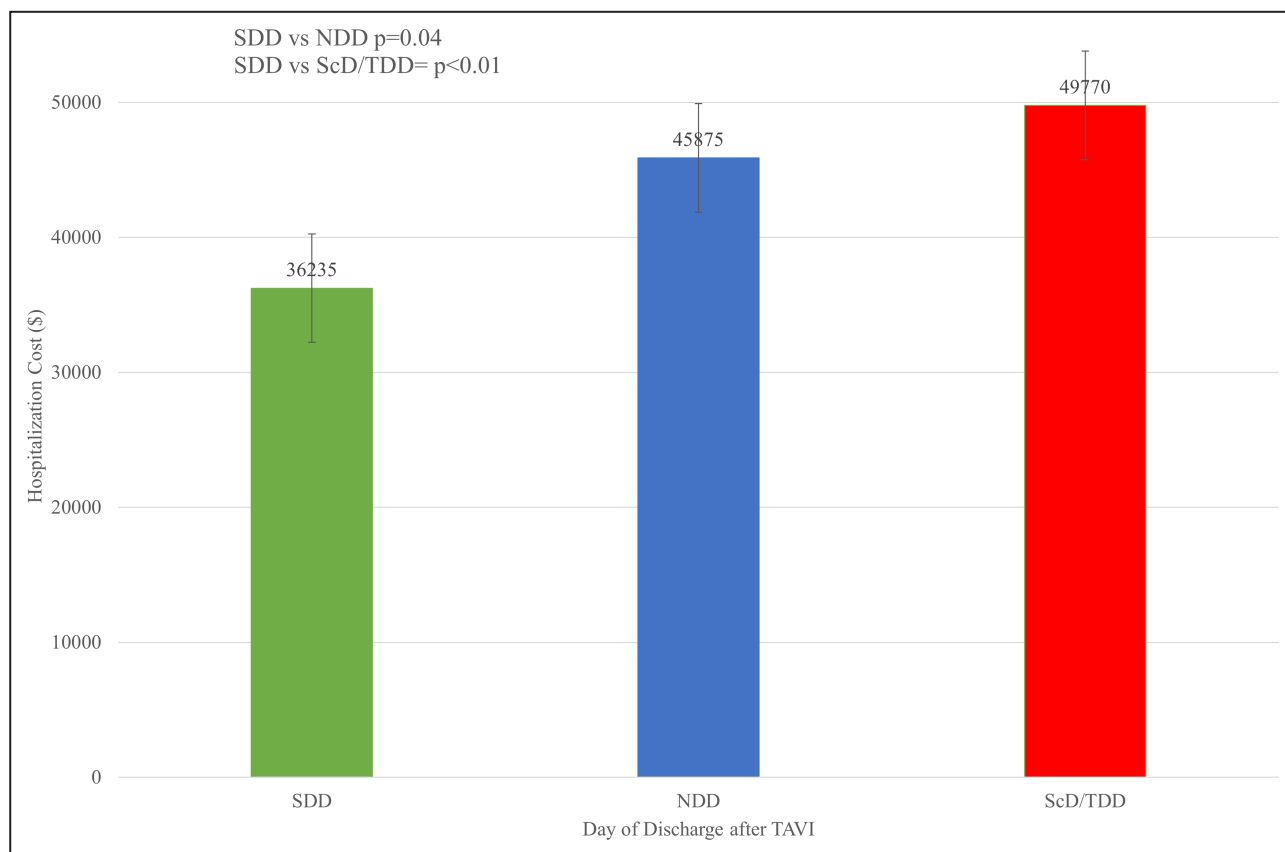


Figure 4. Estimated hospital costs of SDD TAVI compared with NDD and ScD/TDD TAVI.

Bar chart comparing median hospitalization costs of SDD, NDD, and ScD/TDD TAVI. *P* values were computed using the Mann-Whitney *U* test. NDD, next-day discharge; ScD/TDD, second or third-day discharge; SDD, same-day discharge; and TAVI, transcatheter aortic valve implantation.

with improved outcomes, namely lower mortality, compared with general anesthesia.⁴³ Additionally, the use of smaller sheath sizes for TAVI have reduced vascular complications⁴⁴ and has the potential to promote earlier ambulation and discharge. Operator experience is also an important determinant of outcomes with TAVI. The STS/ACC TVT Registry demonstrated that higher TAVI volumes were associated with lower mortality, vascular, and bleeding complications.⁴⁵ Similar results were also observed in a New York State Registry study of 8771 TAVI procedures, where increased operator volume was associated with lower rates of mortality and stroke.⁴⁶

Study Limitations

The NRD is an administrative claims-based database that uses discharge *ICD-10-CM* codes to reflect hospitalizations in the United States. Although procedural codes are less prone to error, coding errors for TAVI cannot be excluded. Like any observational retrospective study, any association from this study cannot imply causation and conclusions are purely hypothesis-generating for future studies. Because of the inherent shortcomings

of the NRD, certain data surrounding the TAVI procedure are not available, including the type of transcatheter valve used, clinical setting of the procedure, success of the procedure, echocardiographic data, and postprocedural management (ie, medical therapy). Additionally, the relatively small sample size of SDD TAVI may be underpowered to detect a significant difference in 30-day readmission and/or complication rates.

CONCLUSIONS

SDD following TAVI was performed rarely in the United States in the pre-COVID-19 era and was associated with similar readmission rates compared with non-SDD TAVI (i.e., NDD or ScD/TDD). Furthermore, hospitalization costs for SDD TAVI were significantly lower compared with NDD and ScD/TDD TAVI. Our analysis provides some initial data on the safety of SDD in a limited number of patients following TAVI. Larger prospective studies are needed to assess the safety and feasibility of SDD TAVI and identify reliable clinical and procedural characteristics to determine potential candidates for SDD TAVI.

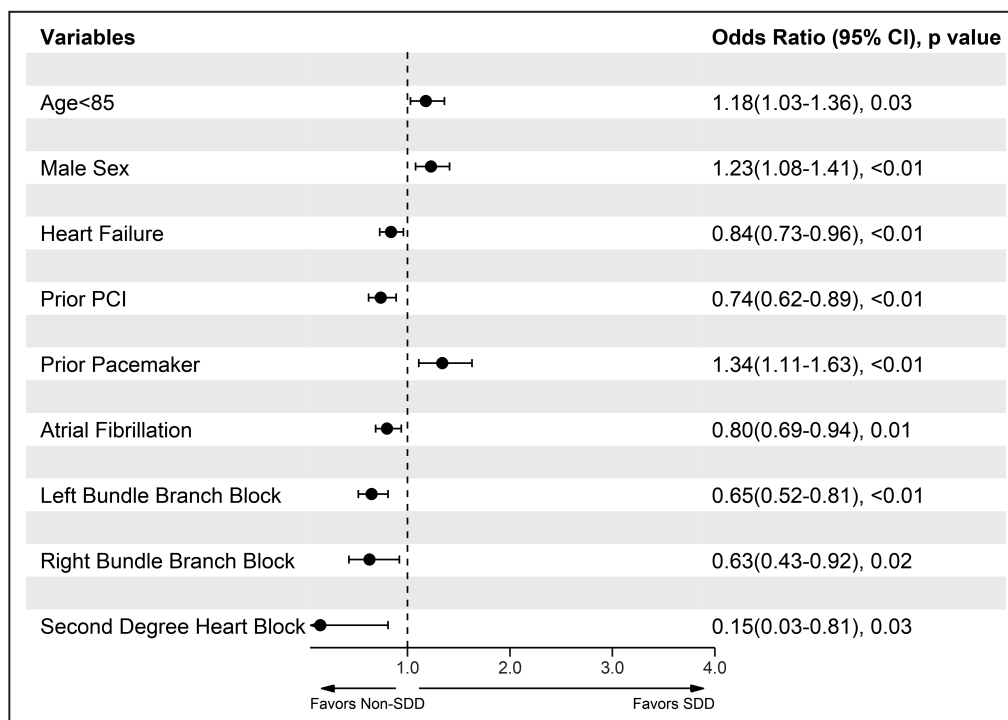


Figure 5. Clinical predictors of SDD following TAVI.

Forest plot illustrating independent adjusted predictors of same-day discharge developed from a multivariate logistic regression model with the enter method. Non-SDD, non-same-day discharge; PCI, percutaneous coronary intervention; SDD, same-day discharge; and TAVI, transcatheter aortic valve implantation.

ARTICLE INFORMATION

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Supplemental Material

Tables S1-S4

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SUPPLEMENTAL MATERIAL

Table S1: ICD-10 codes used for the Study

| Variables | ICD-10 |
|---|---|
| Transcatheter Aortic Valve Implantation | 02RF3 |
| Coronary Artery Disease | I251, I257, I258, I259, I255 |
| Heart failure | I09.9, I11.0, I13.0, I13.2, I25.5, I42.0, I42.5–I42.9, I43.x, I50.x, P29.0 |
| Peripheral vascular Disease | I70.x, I71.x, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9 |
| Cerebrovascular disease | G45.x, G46.x, H34.0, I60.x–I69.x |
| Chronic pulmonary disease | I27.8, I27.9, J40.x–J47.x, J60.x–J67.x, J68.4, J70.1, J70.3 |
| Diabetes Mellitus | E10.0, E10.1, E10.6, E10.8, E10.9, E11.0, E11.1, E11.6, E11.8, E11.9, E12.0, E12.1, E12.6, E12.8, E12.9, E13.0, E13.1, E13.6, E13.8, E13.9, E14.0, E14.1, E14.6, E14.8, E14.9 |
| Chronic Kidney Disease | N18 |
| End-Stage Renal Disease | Z992, N186 |
| Pulmonary circulation disorders | I26.x, I27.x, I28.0, I28.8, I28.9 |
| Peripheral vascular disorders | I70.x, I71.x, I73.1, I73.8, I73.9, I77.1, I79.0, I79.2, K55.1, K55.8, K55.9, Z95.8, Z95.9 |

| | |
|-----------------------------|---|
| Hypertension | I10.x |
| Liver disease | B18.x, I85.x, I86.4, I98.2, K70.x, K71.1, K71.3– K71.5, K71.7, K72.x– K74.x, K76.0, K76.2– K76.9, Z94.4 |
| Coagulopathy | D65–D68.x, D69.1, D69.3– D69.6 |
| Obesity | E66.x |
| Weight loss | E40.x–E46.x, R63.4, R64 |
| Atrial fibrillation | I48 |
| Mitral stenosis | I342, I1050 |
| Prior MI | I252 |
| Prior CABG | Z951 |
| Prior Pacemaker | Z950 |
| Prior Stroke | I69, Z8673 |
| Prior PCI | Z955 |
| First Degree HB | I440 |
| Second Degree HB | I441 |
| Left anterior hemiblock | I444 |
| Left posterior hemiblock | I445 |

| | |
|------------------------------|------------------------|
| Right bundle branch block | I45.1, I45.10, I45.19. |
|------------------------------|------------------------|

| | |
|-----------------------------|-------|
| Left bundle branch block | I44.7 |
|-----------------------------|-------|

Table S2: Adjusted 30-Day Outcomes comparing SDD vs. NDD TAVI

| Outcomes | *Adjusted OR (95% CI) | P value |
|---------------------------------------|------------------------------|----------------|
| 30-Day Readmission | 1.34(1.08-1.66) | <0.01 |
| Acute Kidney Injury | 1.04(0.71-1.53) | 0.84 |
| Major Vascular Complications | 1.72(0.91-3.38) | 0.10 |
| Minor Vascular Complications | 1.56(0.63-3.82) | 0.34 |
| Permanent Pacemaker | 1.13(0.82-1.56) | 0.46 |
| Heart Failure | 1.03(0.88-1.21) | 0.69 |
| Ischemic Stroke | 1.81(0.94-3.45) | 0.07 |
| Bleeding requiring transfusion | 0.89(0.53-1.52) | 0.68 |

SDD: Same-Day Discharge; NDD: Next-Day Discharge; OR: odds ratio; CI: confidence interval. *Logistic regression model adjusted for age, sex, anemia, heart failure, coagulopathy, COPD, coronary artery disease, cerebrovascular disease, diabetes mellitus, hypertension, liver disease, obesity, peripheral vascular disease, chronic kidney disease, end-stage renal disease, smoking, weight loss,

prior CABG, prior MI, prior pacemaker, prior stroke, prior PCI, mitral stenosis, atrial fibrillation, left bundle branch block, right bundle branch block, Insurance status, hospital size, hospital teaching status

Table S3: Adjusted 30-Day Outcomes for SDD vs. ScD/TDD TAVI

| Outcomes | *Adjusted OR (95%CI) | P value |
|---------------------------------------|-----------------------------|----------------|
| 30-Day Readmission | 0.94(0.75-1.16) | 0.55 |
| Acute Kidney Injury | 0.49(0.33-0.72) | <0.01 |
| Major Vascular Complications | 0.70(0.37-1.33) | 0.28 |
| Minor Vascular Complications | 0.61(0.25-1.46) | 0.26 |
| Permanent Pacemaker | 0.47(0.34-0.65) | <0.01 |
| Heart Failure | 1.21(1.03-1.42) | 0.02 |
| Ischemic Stroke | 1.23(0.64-2.37) | 0.53 |
| Bleeding requiring transfusion | 0.42(0.25-0.71) | <0.01 |

SDD: Same-Day Discharge; ScD/TDD: Second- or Third-Day Discharge; OR: odds ratio; CI: confidence interval. *Logistic regression model adjusted for age, sex, anemia, heart failure, coagulopathy, COPD, coronary artery disease, cerebrovascular disease, diabetes mellitus, hypertension, liver disease, obesity, peripheral vascular disease, chronic kidney disease, end-stage renal disease, smoking,

weight loss, prior CABG, prior MI, prior pacemaker, prior stroke, prior PCI, mitral stenosis, atrial fibrillation, left bundle branch block,
right bundle branch block, Insurance status, hospital size, hospital teaching status

Table S4: Reasons for 30-Day Readmissions for SDD, NDD and ScD/TDD

| Outcomes | SDD (n=94) | NDD (n=4974) | P value* | ScD/TDD (n=8984) | P value[†] | Total Non-SDD (n=13958) | P Value[‡] |
|-----------------|------------------------|-------------------------|-----------------|-----------------------------|----------------------------|------------------------------------|----------------------------|
| Cardiac | 41(43.2) | 1981(39.8) | 0.46 | 3564(39.7) | 0.44 | 5545(39.7) | 0.44 |
| Non-Cardiac | 50(53.2) | 2492(50.1) | 0.58 | 4598(51.2) | 0.73 | 7300(52.3) | 0.89 |
| Respiratory | 20(20.9) | 844(17.0) | 0.27 | 1678(18.7) | 0.52 | 2522(18.1) | 0.42 |
| Infection | 15(15.4) | 507(10.2) | 0.08 | 1158(12.9) | 0.40 | 1665(11.9) | 0.25 |
| Renal | <11(<1.1) [§] | 181(3.6) | 0.18 | 273(3) | 0.07 | 665(4.8) | 0.09 |
| Hematological | <11(<1.1) [§] | 269(5.4) | 0.68 | 491(5.5) | 0.71 | 759(5.4) | 0.69 |
| GI | <11(<1.1) [§] | 237(4.8) | 0.80 | 446(5.0) | 0.88 | 683(4.9) | 0.85 |
| Neurological | <11(<1.1) [§] | 454(9.1) | 0.05 | 552(6.1) | 0.24 | 1006(7.2) | 0.13 |
| Other | <11(<1.1) [§] | 501(10.1) | 0.04 | 822(9.1) | 0.06 | 1113(8.0) | 0.12 |

* compares SDD with NDD, † compares SDD with ScD/NDD, ‡ compares SDD with total Non-SDD

§ "As per HCUP regulations, observations with a cell count less than 11 were reported as "<11".

SDD: Same-Day Discharge; NDD: Next-Day Discharge; ScD/TDD: Second- or Third-Day Discharge; Non-SDD: Non-Same-Day Discharge