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RESEARCH LETTER

Outcomes of Cancer Patients Undergoing Transcatheter Aortic Valve Replacement

Transcatheter aortic valve replacement (TAVR) has evolved as a first-line treatment modality for patients with symptomatic aortic stenosis (AS). The proportion of patients with cancer who require TAVR has gradually increased, with a prevalence close to 4% (1). Although surgical aortic valve replacement (SAVR) has been a long-standing treatment option for AS patients, cardiac surgery in cancer patients carries an increased risk of infection, conduction abnormalities, bleeding, and post-procedural intensive care requirement (2). As a less-invasive option, TAVR is therefore promising. Limited data have assessed the short- and long-term outcomes of cancer patients, and there are no data regarding readmissions in this population. We investigated a large, representative, nationwide cohort to evaluate the feasibility and short-term outcomes of TAVR in this group.

The Nationwide Readmission Database (NRD) is a database created by the Agency for Healthcare Research and Quality for the Healthcare Cost and Utilization Project that encompasses weighted estimates of one-half of the total hospitalizations in the United States (3). We used this registry to retrospectively select patients who were admitted between January 2012 and September 2015 and underwent TAVR using the appropriate International Classification of Diseases-9th Revision procedure codes (35.05 and 35.06). Among included patients, we assessed for the presence of a malignancy using the International Classification of Diseases-9th Revision diagnoses codes (140.X to 209.X). We performed chi-square tests for categorical variables and Mann-Whitney *U* tests for continuous variables to evaluate comorbidities and outcomes, as well as multivariable logistic regression analyses to assess mortality predictors after adjusting for age, sex, and all comorbidities (**Table 1**). All regression models were multivariable, and results were presented as odds ratio (OR) with 95% confidence interval (CI). All statistical analyses were performed using SPSS version 26 (IBM, Armonk, New York) for the weighted values of observations as provided by the NRD to measure national estimates. A 2-sided value of $p < 0.05$ was set for statistical significance. NRD data are anonymized and considered nonhuman subject research; thus, institutional review board approval was not required.

A total of 63,352 patients underwent TAVR and were included, of which 2,850 (4.5%) had a malignancy. Cancer patients were more likely to have an underlying cardiomyopathy (10.8% vs. 8.8%; $p < 0.001$), and heart failure (11.2% vs. 8.9%; $p < 0.001$), but less likely to have hypertension, atrial fibrillation, diabetes mellitus, dyslipidemia, chronic lung disease, and other comorbidities (**Table 1**).

Post-procedural outcomes, including all-cause in-hospital mortality, stroke, bleeding, and permanent pacemaker implantation, did not differ in patients with and without cancer (**Table 1**). However, cancer patients were more likely to develop acute kidney injury (17.9% vs. 16.2%; $p = 0.023$), and to be readmitted within 30 days of discharge (20.2% vs. 17.4%; $p < 0.001$). After adjusting for age, sex, and all comorbidities mentioned in **Table 1**, there remained no difference in all-cause in-hospital mortality (OR: 0.873 [95% CI: 0.715 to 1.066]; $p = 0.183$), but there was a higher likelihood of 30-day readmission (OR: 1.21 [95% CI: 1.09 to 1.34]; $p < 0.001$). Mortality rates were similar irrespective of stage or site of cancer. When analyzed specifically by site, only patients with colorectal (OR: 3.66 [95% CI: 2.30 to 5.82]; $p < 0.001$), urinary/bladder (OR: 1.87 [95% CI: 1.17 to 2.98]; $p = 0.009$), and uterine (OR: 5.03 [95% CI: 2.33 to 10.89]; $p < 0.001$) cancers were associated with the increased risk of 30-day readmission, when compared with patients without cancer. The most common cause for readmission in both groups was heart failure, followed by infections and sepsis.

Current guidelines recommend TAVR to be performed in patients with a life expectancy >12 months (4). However, it is seldom possible to predict the life expectancy of cancer patients, and successful treatment of AS may allow for more intensive cancer treatment modalities, which in turn could affect survival. In many cases, symptomatic AS may be the

rate-limiting step in cancer management. Thus, a multidisciplinary decision-making team of interventionalists and oncologists is warranted. A recent multicenter study comparing 222 cancer patients with 2,522 "no-cancer" patients undergoing TAVR showed that the 2 groups had similar 30-day outcomes, and 1-year mortality was higher in individuals with advanced cancer (5). The novelty of our study lies in the reporting of higher readmission rates in such patients, as well as the observation that certain types of cancers were more commonly associated with early readmission, most notably from heart failure and infection. These summative findings support that TAVR in cancer patients is appropriate on a case-by-case basis, and that optimal post-procedural cardiovascular rehabilitation as well as careful observation for post-procedural infections may result in overall better outcomes.

Our study is not without limitations. There is a paucity of information with respect to patient-level data regarding cancer treatments, as well as other unaccounted comorbidities and causes of death. Being an administrative database, it relies on physician/hospital reporting of outcomes. In addition, because of the retrospective nature of the analysis, it is not possible to differentiate active malignancies from history of malignancy. Information on dates of in-hospital outcomes and post-discharge out-of-hospital mortality are not recorded in NRD, which prohibits conducting a competing risk analysis for in-hospital outcomes or readmission. It is noteworthy that our comparator arm represents a high-surgical risk population, as TAVR in intermediate- and low-risk patients obtained approval in 2016 and 2019, respectively. It would be interesting to see how this affects the findings of future trials, especially those that also address the question of quality of life, which is an important consideration in decision-making in advanced cancer patients undergoing palliative therapy.

TABLE 1 Baseline Characteristics and Outcomes of TAVR Patients With and Without Cancer (n = 63,352)

	Cancer (n = 2,849)	No Cancer (n = 60,503)	p Value
Age, yrs	83 (76–87)	83 (77–88)	
Sex			<0.001
Male	1,748 (61.4)	31,549 (52.1)	
Female	1,101 (38.6)	28,954 (47.9)	
Cancer stage			
Localized/regional	2,675 (93.9)		
Metastatic	175 (6.1)		
Cancer site			
Prostate cancer	388 (13.6)		
Breast cancer	147 (5.1)		
Leukemia/lymphoma	1,476 (51.8)		
Lung cancer	206 (7.2)		
Colorectal cancer	92 (3.2)		
Urinary bladder cancer	102 (3.6)		
Uterine corpus cancer	27 (0.9)		
Other cancers	413 (14.5)		
Comorbidities			
Hypertension	2,098 (73.6)	48,489 (80.1)	<0.001
Atrial fibrillation	1,139 (40)	26,706 (44.1)	<0.001
Cardiomyopathy	309 (10.8)	5,317 (8.8)	<0.001
Diabetes mellitus	849 (29.8)	21,324 (35.2)	<0.001
Heart failure	320 (11.2)	5,413 (8.9)	<0.001
Previous MI	326 (11.4)	6,830 (11.3)	0.811
Carotid artery disease	157 (5.5)	4,150 (6.9)	0.005
Dyslipidemia	1,472 (51.7)	35,906 (59.3)	<0.001
Chronic lung disease	868 (30.5)	20,261 (33.5)	0.001
Renal failure	1,010 (35.5)	21,758 (36)	0.589
Obesity	308 (10.8)	9,720 (16.1)	<0.001
Smoking	760 (26.7)	16,239 (26.8)	0.845
Alcohol abuse	47 (1.6)	638 (1.1)	0.004
Outcomes			
Length of stay, days	6 (4–11)	6 (3–9)	<0.001
In-hospital mortality	107 (3.8)	2,300 (3.8)	0.954
In-hospital stroke	58 (2)	1,438 (2.4)	0.257
Post-procedural blood transfusion	709 (24.9)	12,830 (21.2)	<0.001
In-hospital acute kidney injury	509 (17.9)	9,826 (16.2)	0.023
Permanent pacemaker implantation	291 (10.2)	6,380 (10.5)	0.594
30-day readmission*	494 (20.2)	9,018 (17.4)	<0.001
30-day in-hospital mortality*	27 (1.1)	585 (1.1)	0.988

Values are median (interquartile range) or n (%). *For 30-day readmission rates, we excluded patients who died within index hospitalization and patients who were discharged in December each year (and September 2015) to allow for at least 30 days of follow-up for all patients.

MI = myocardial infarction; TAVR = transcatheter aortic valve replacement.

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