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Original Article

In-hospital Outcomes and the Impact of Transfer Status in Nonelective vs Elective Transcatheter Aortic Valve Replacement

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ABSTRACT

Background: Nonelective transcatheter aortic valve replacement (TAVR) requires additional research to be fully understood.

Methods: Using the National Inpatient Sample database (2016-2019), we conducted a retrospective cohort study comparing nonelective vs elective TAVR. The primary outcome of interest was the in-hospital mortality rate among patients undergoing nonelective TAVR, compared to that among patients undergoing elective TAVR. We matched patients in a greedy nearest-neighbor 1:1 model and multivariable logistic regression, which was adjusted for demographics,

RÉSUMÉ

Contexte : Le remplacement valvulaire aortique par cathéter (RVAC) d'urgence nécessite plus de recherche pour être bien compris.

Méthodologie : À partir de la base de données National Inpatient Sample (2016-2019), nous avons réalisé une étude rétrospective de cohortes comparant le RVAC non urgent et le RVAC d'urgence. Celle-ci avait pour principal critère d'évaluation la comparaison du taux de mortalité à l'hôpital chez les patients soumis à un RVAC d'urgence à celui noté chez ceux qui subissent un RVAC non urgent. Nous avons apparié les patients selon le modèle du plus proche

Transcatheter aortic valve replacement (TAVR) is being used increasingly as a treatment for symptomatic severe aortic stenosis.[1-5] Some of the current benefits of TAVR vs surgical aortic valve replacement include less procedural invasiveness, and in high-risk surgical patients, lower rates of postoperative major bleeding and atrial fibrillation.[1-5] However, most of these studies are conducted on patients undergoing elective TAVR. Nonelective TAVR is studied less frequently, and additional research is required to fully understand its clinical context. From 2011 to 2016, approximately 10% of all TAVRs performed were nonelective urgent or emergent TAVR.[6] Recent literature comparing the outcomes of nonelective vs elective TAVR reveals significantly higher 30-day and 1-year mortality rates and steeper in-hospital costs with nonelective TAVRs.[7-11] To our knowledge, information on the impact of transfer status from non-acute-care and acute-care centres, in analyses of these 2 cohorts, remains limited.[12-16] Hence, the purpose of this study was to compare the most recent in-hospital outcomes, hospitalization trends, and the impact of transfer status on mortality for patients who underwent nonelective vs elective TAVR, using a nationally representative database. We hypothesized that patients undergoing nonelective TAVR, irrespective of transfer status, had increased odds of suffering in-hospital mortality, compared to elective admissions.

Methods

This retrospective cohort study compared the short-term, in-hospital outcomes of patients undergoing nonelective vs elective TAVR between 2016 and 2019. Patients were selected from the National Inpatient Sample (NIS) database, which is a stratified sample of all-payer inpatient hospital stays in the US. Annually, the NIS data contain approximately 7

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hospital factors, and comorbidities, and was used to compare mortality in our matched cohort.

Results: Each cohort had 4389 patients in each cohort. When adjusted for age, race, sex, and comorbidities, nonelective TAVR patients had 1.99 times higher odds of suffering in-hospital mortality compared to elective admissions (adjusted odds ratio 1.99, 95% confidence interval: 1.42-2.81; $P < 0.001$). When separated by transfer status, nonelective patients admitted as regular hospital admissions or transferred from other acute-care centres also had higher odds of suffering in-hospital mortality compared to elective admissions.

Conclusions: Our findings illustrate that nonelective TAVR patients are a vulnerable population that require additional medical support in the acute-care setting. As the demand for TAVR increases, further discussions regarding access to healthcare in underserved regions, the national physician shortage, and the future of the TAVR industry are imperative.

voisin, avec un rapport 1:1, et utilisé une régression logistique multivariée, ajustée en fonction des caractéristiques démographiques, des facteurs hospitaliers et des affections concomitantes, pour comparer le taux de mortalité dans les cohortes appariées.

Résultats : Chaque cohorte comportait 4 389 patients. Après correction pour tenir compte de l'âge, de l'origine ethnique, du sexe et des affections concomitantes, nous avons constaté que le risque des patients ayant subi un RVAC d'urgence de mourir à l'hôpital était 1,99 fois plus élevé que celui des patients chez qui un RVAC non urgent a été effectué (rapport des risques ajustés : 1,99; intervalle de confiance à 95 % : 1,42 à 2,81; $p < 0,001$). De plus, les patients chez qui l'intervention a été pratiquée d'urgence courraient également un risque plus élevé de décéder à l'hôpital que ceux soumis à un RVAC non urgent, qu'ils aient été admis directement à l'hôpital ou transférés d'autres centres de soins de courte durée.

Conclusions : Nos conclusions montrent que les patients ayant subi un RVAC d'urgence forment une population vulnérable qui requiert un soutien médical supplémentaire dans un milieu de soins de courte durée. Comme la demande pour des RVAC augmente, d'autres discussions sur l'accès aux soins de santé dans les régions mal desservies, la pénurie nationale de médecins et l'avenir de l'industrie du RVAC s'imposent.

million hospital stays—when adjusted for discharge weight, this amounts to an estimate of more than 35 million hospitalizations nationally.[17] Each identified discharge record includes one primary diagnosis and up to 29 secondary diagnoses, using the International Classification of Diseases, Tenth Edition, Clinical Modification (ICD-10-CM). The year 2016 was chosen as the beginning of the study period, as this was the first full calendar year for ICD-10-CM code usage.[17]

Hospitalized patients aged at least 18 years were our demographic of interest. Transfer status was determined using the NIS data element "TRAN_IN." Patients were admitted as either regular hospital admissions or transfers from acute or non-acute care centres. Elective or nonelective admissions were determined using the NIS data element "ELECTIVE." Using ICD-10-CM codes, we then identified hospitalizations with a primary diagnosis of aortic stenosis and a primary procedure of TAVR. The specific ICD-10-CM codes that were included are as follows: I35.0 for aortic stenosis; and 02RF37H, 02RF37Z, 02RF38H, 02RF38Z, 02RF3JH, 02RF3JZ, 02RF48Z, 02RF4JZ, and 02RF4KZ for TAVR. The primary outcome of interest was the in-hospital mortality rate among patients undergoing nonelective TAVR, compared to that of patients undergoing elective TAVR. The secondary study outcomes included mortality by race, postoperative complications, length of stay, and total cost to the hospital.

In our unmatched cohort, regular Student t tests were performed to compare normally distributed continuous variables; Pearson χ^2 tests were used to compare categorical variables. We then utilized logistic regression to calculate a propensity score based on the following: patient demographics (race, sex, age, and health insurance); hospital factors (region, location, and bed number); and comorbidities (acute decompensated heart failure, hypertension, atrial fibrillation, coronary artery disease, prior myocardial infarction, chronic kidney disease, type 2 diabetes mellitus, obesity, and chronic obstructive pulmonary disease). Covariate balance was evaluated by standardized mean difference (SMD), with a standardized mean difference of < 0.1 deemed acceptable. We then conducted 1:1 greedy nearest-neighbor matching to match nonelective TAVR patients with elective TAVR patients, based on propensity scores. The caliper was set at 0.2.

Multivariable logistic regression, adjusted for demographics, hospital factors, and comorbidities, was used to compare mortality in our matched cohort. The adjustment consisted of demographics (race, sex, age, and health insurance), hospital factors (region, location, and bed number) and comorbidities (acute decompensated heart failure, hypertension, atrial fibrillation, coronary artery disease, prior myocardial infarction, chronic kidney disease, type 2 diabetes mellitus, obesity, and chronic obstructive pulmonary disease). The final effect size is reported as an odds ratio (OR) for binary variables, and as median with interquartile range (IQR) for continuous variables. We set the threshold for significance at $P < 0.05$, and our analysis was 2-tailed. All analyses were performed using STATA, version 17 (StataCorp, College Station, TX).

Results

Among the 160,290 patients who met our inclusion criteria, 22,745 (16.5%) underwent nonelective inpatient TAVR (Table 1). In our unmatched cohort, nonelective patients were more racially diverse, less likely to have Medicare (89.3% vs 90.3%, $P < 0.001$), and more likely to be treated in urban teaching hospitals (92.7% vs 89.4%, $P = 0.001$; Table 1). In terms of comorbidities, nonelective TAVR patients had higher rates of decompensated heart failure (47.2% vs 25.4%, $P < 0.001$), atrial fibrillation (35.5% vs 33.3%, $P < 0.001$), and chronic kidney disease (36.9% vs 29.9%, $P < 0.001$), but they had decreased rates of coronary artery disease (59.8% vs 63.0%, $P < 0.001$), chronic obstructive pulmonary disease (18.2% vs 19.3%, $P < 0.001$), hypertension (18.3% vs 26.0%, $P < 0.001$), obesity (13.1% vs 16.4%, $P < 0.001$),

Table 1. Baseline characteristics of nonelective and elective TAVR patients before propensity-score matching

Characteristics	Nonelective TAVR	Elective TAVR	*P*
n	22,745	137,545	
Age, y, mean	79.8	79.7	0.56
Sex			0.46
Male	12,533 (55.1)	75,100 (54.6)	
Female	10,213 (44.9)	62,445 (45.4)	
Race			< 0.001
Asian	341 (1.5)	1651 (1.2)	
Black	1205 (5.3)	4952 (3.6)	
Hispanic	1569 (6.9)	5777 (4.2)	
Native American	68 (0.3)	413 (0.3)	
Other	455 (2.0)	5914 (4.3)	
White	18,605 (81.8)	121,865 (88.6)	
Median household income, quartile ($ range)			0.14
1 (1−47,999)	5027 (22.1)	28,334 (20.6)	
2 (48,000−60,999)	5550 (24.4)	35,487 (25.8)	
3 (61,000−81,999)	6232 (27.4)	36,862 (26.8)	
4 (82,000+)	5936 (26.1)	36,862 (26.8)	
APR-DRG mortality score* (rating)			
0−1 (minor)	1205 (5.3)	15,680 (11.4)	
2 (moderate)	6778 (29.8)	69,873 (50.8)	
3 (major)	10,031 (44.1)	44,702 (32.5)	
4 (extreme)	4731 (20.8)	7290 (5.3)	
Payer status			< 0.001
Medicare	20,311 (89.3)	124,203 (90.3)	
Medicaid	455 (2.0)	1238 (0.9)	
Private insurance	1410 (6.2)	9353 (6.8)	
Self-pay	159 (0.7)	550 (0.4)	
No charge	0 (0)	0 (0)	
Other	409 (1.8)	2201 (1.6)	
Hospital region			< 0.001
Northeast	6141 (27.0)	31,360 (22.8)	
Midwest or North Central	3230 (14.2)	33,836 (24.6)	
South	8347 (36.7)	45,527 (33.1)	
West	5027 (22.1)	26,821 (19.5)	
Hospital location and teaching status			0.001
Rural	91 (0.4)	1513 (1.1)	
Urban non-teaching	1569 (6.9)	13,067 (9.5)	
Urban teaching	21,085 (92.7)	122,965 (89.4)	
Hospital size per number of beds			0.14
Small	1615 (7.1)	8940 (6.5)	
Medium	3958 (17.4)	28,059 (20.4)	
Large	17,172 (75.5)	100,545 (73.1)	
Comorbidities			
Atrial fibrillation	8065 (35.5)	45,780 (33.3)	< 0.001
Coronary artery disease	13,610 (59.8)	86,695 (63.0)	< 0.001
Chronic kidney disease	8385 (36.9)	41,085 (29.9)	< 0.001
COPD	4145 (18.2)	26,585 (19.3)	< 0.001
Decompensated heart failure	10,740 (47.2)	34,960 (25.4)	< 0.001
Hypertension	4160 (18.3)	35,800 (26.0)	< 0.001
Obesity	2990 (13.1)	22,565 (16.4)	< 0.001
Previous myocardial infarction	1915 (8.4)	13,575 (9.9)	< 0.001
Type 2 diabetes mellitus	3765 (16.6)	27,035 (19.7)	< 0.001

Values are n (%), unless otherwise indicated.

APR-DRG, All Patient Refined-Diagnosis Related Group; COPD, chronic obstructive pulmonary disease; TAVR, transcatheter aortic valve replacement.

* APR-DRG scores are calculated from discharge billing codes and based on discharge diagnosis, preexisting medical conditions, and age.

prior myocardial infarction (8.4% vs 9.9%, $P < 0.001$), and type 2 diabetes mellitus (16.6% vs 19.7%, $P < 0.001$; Table 1). Patients undergoing nonelective TAVR were more likely to have concurrent mitral regurgitation (5.8% vs 5.1%, $P < 0.001$) and tricuspid regurgitation (1.8% vs 1.4%, $P < 0.001$).

After nearest-neighbor propensity-score matching, 4389 patients were in each cohort. In our nonelective TAVR cohort, 3078 (70.1%) were admitted as regular hospital admissions, 1184 (27.0%) were admitted as acute-care transfers, and 127 (2.9%) were admitted as non-acute-care transfers. All 4389 patients in our elective TAVR cohort were admitted as regular hospital admissions. Nonelective TAVR patients tended to be younger (aged 79.8 years vs 80.2 years), have lower median household income, and have higher average All Patient Refined-Diagnosis Related Group (APR-DRG) mortality scores, which are calculated from discharge billing codes and based on discharge diagnosis, preexisting medical conditions, and age (Table 2). Nonelective TAVR patients still had lower rates of Medicare enrollment (89.4% vs 90.8%), but higher rates of being treated in hospitals with a small number of beds (6.9% vs 4.8%; Table 2). A total of 2108 nonelective TAVR

Table 2. Baseline characteristics of non-elective and elective TAVR patients after propensity-score matching

Characteristic	Nonelective	Elective	Standardized mean differences
n	4389	4389	
Age, y, mean	79.8	80.2	0.027
Sex			0.014
Male	2410 (54.9)	2360 (53.8)	
Female	1979 (45.1)	2029 (46.2)	
Race			0.002
Asian	64 (1.5)	67 (1.5)	
Black	233 (5.3)	193 (4.4)	
Hispanic	303 (6.9)	257 (5.9)	
Native American	14 (0.3)	23 (0.5)	
Other	187 (4.3)	206 (4.7)	
White	3588 (81.8)	3643 (83.0)	
Median household income, quartile ($ range)			0.023
1 (1−47,999)	944 (21.9)	894 (20.6)	
2 (48,000−60,999)	1052 (24.5)	1100 (25.4)	
3 (61,000−1,999)	1175 (27.3)	1136 (26.2)	
4 (82,000+)	1131 (26.3)	1209 (27.9)	
APR-DRG mortality score* (rating)			0.414
0−1 (minor)	235 (5.4)	333 (7.6)	
2 (moderate)	1311 (29.9)	1865 (42.5)	
3 (major)	1932 (44.0)	1834 (41.8)	
4 (extreme)	911 (20.8)	357 (8.1)	
Payer status			0.031
Medicare	3924 (89.4)	3987 (90.8)	
Medicaid	88 (2.0)	49 (1.1)	
Private insurance	269 (6.1)	260 (5.9)	
Self-Pay	28 (0.6)	22 (0.5)	
No charge	4 (0.1)	0 (0)	
Other	76 (1.7)	71 (1.6)	
Hospital region			0.007
Northeast	1204 (27.4)	1048 (23.9)	
Midwest or North Central	624 (14.2)	891 (20.3)	
South	1629 (37.1)	1582 (36.0)	
West	932 (21.2)	868 (19.8)	
Hospital location and teaching status			0.003
Rural	18 (0.4)	23 (0.5)	
Urban non-teaching	279 (6.4)	264 (6.0)	
Urban teaching	4092 (93.2)	4102 (93.5)	
Hospital size per number of beds			0.030
Small	303 (6.9)	212 (4.8)	
Medium	767 (17.5)	838 (19.1)	
Large	3319 (75.6)	3339 (76.1)	
Comorbidities			
Atrial fibrillation	1555 (35.4)	1537 (35.0)	0.005
Coronary artery disease	2631 (59.9)	2591 (59.0)	0.001
Chronic kidney disease	1624 (37.0)	1609 (36.7)	0.003
COPD	789 (18.0)	755 (17.2)	0.036
Decompensated heart failure	2108 (48.0)	2090 (47.6)	0.010
Hypertension	801 (18.3)	828 (18.9)	0.015
Obesity	572 (13.0)	561 (12.8)	0.018
Previous myocardial infarction	371 (8.5)	346 (7.9)	0.012
Type 2 diabetes mellitus	724 (16.5)	692 (15.8)	0.007

Values are n (%), unless otherwise indicated.

APR-DRG, All Patient Refined-Diagnosis Related Group; COPD, chronic obstructive pulmonary disease; TAVR, transcatheter aortic valve replacement.

* APR-DRG scores are calculated from discharge billing codes and are based on discharge diagnosis, preexisting medical conditions, and age.

patients (48.0%) also presented with decompensated heart failure, compared to 2090 elective TAVR patients (47.6%; Table 2). Additionally, 1305 nonelective TAVR patients (29.7%) had concurrent mitral regurgitation, compared to 1330 elective TAVR patients (30.3%). A total of 395 nonelective TAVR patients (9.0%) had concurrent tricuspid regurgitation, compared to 365 elective TAVR patients (8.3%).

When adjusted for age, race, sex, and comorbidities, nonelective TAVR patients had 1.99 times higher odds of suffering in-hospital mortality, compared to elective TAVR admissions (adjusted odds ratio [aOR] 1.99, 95% confidence interval [CI]: 1.42-2.81; $P < 0.001$). Our nonelective cohort was also separated by transfer status. Nonelective TAVR patients who were transferred from other acute-care centres had 2.12 times higher odds of suffering in-hospital mortality, compared to elective TAVR admissions (aOR 2.12, 95% CI: 1.21-3.71; $P = 0.01$; Fig. 1). Nonelective TAVR patients who were admitted as regular hospital admissions had 2.18 times higher odds of suffering in-hospital mortality, compared

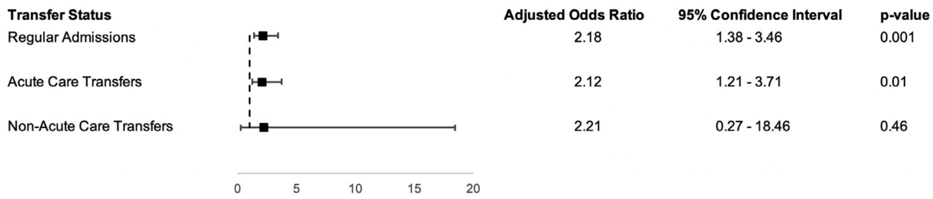

Figure 1. The effect of transfer status on mortality in nonelective, compared to elective, transcatheter aortic valve replacement patients after propensity-score matching.

to elective TAVR admissions (aOR 2.18, 95% CI: 1.38-3.46; $P = 0.001$; Fig. 1). No significant difference occurred in mortality for nonelective TAVR patients who were transferred from non-acute-care centres vs elective TAVR patients ($P = 0.46$; Fig. 1). When separated by race, White (2.2% vs 1.1%, $P < 0.001$) and Hispanic (4.6% vs 1.6%, $P = 0.04$) patients had a higher mortality rate in the nonelective TAVR cohort (Fig. 2; Table 3).

In terms of operative complications, nonelective TAVR patients were more likely to have intraoperative cardiac arrest (odds ratio [OR] 1.61, 95% CI: 1.07-2.43; $P = 0.02$), postoperative acute respiratory failure (OR 1.91, 95% CI: 1.40-2.63; $P < 0.001$), postoperative cardiogenic shock (OR 2.16, 95% CI: 1.30-3.61; $P = 0.003$), and postoperative pneumothorax (OR 1.97, 95% CI: 1.08-3.61; $P = 0.03$; Table 4). Our 2 cohorts did not differ in regard to intraoperative cerebral infarction (OR 1.81, 95% CI: 0.50-6.60; $P = 0.37$), postoperative cardiac arrest (OR 1.62, 95% CI: 0.92-2.87; $P = 0.10$), postoperative cerebral infarction (OR 1.26, 95% CI: 0.88-1.81; $P = 0.21$), postoperative heart failure (OR 1.15, 95% CI: 0.40-3.36; $P = 0.80$), or postoperative hypotension (OR 0.93, 95% CI: 0.68-1.27; $P = 0.66$; Table 4). Additionally, nonelective TAVR patients had an average length of stay of 7.9 days (median, 6 days; IQR, 3-11 days), compared to 3.0 days for elective admissions (median, 2 days; IQR, 1-3 days). Nonelective TAVR patients also were more likely to be discharged to a skilled-nursing or intermediate-care facility (23.7% vs 9.9%, $P < 0.001$) and had higher mean hospital costs ($276,455.40 vs $203,902.50, $P < 0.001$).

Discussion

Our study illustrates that patients undergoing nonelective TAVR had higher odds of inpatient mortality. compared to elective TAVR patients. Even when separated by transfer status, patients transferred from an acute-care centre and those admitted as regular hospital admissions had higher odds of inpatient mortality when undergoing nonelective compared to elective TAVR. Patients undergoing nonelective TAVR were more likely to have intraoperative cardiac arrest, postoperative acute respiratory failure, postoperative cardiogenic shock, and postoperative pneumothorax.

Previous studies have explored why nonelective TAVR patients are more likely to suffer in-hospital mortality. The presumed explanation is that patients undergoing nonelective TAVR have more decompensated aortic stenosis.[13,18] According to Kolte et al., patients undergoing nonelective TAVR had worse aortic valve disease and presented with worse New York Heart Association functional class status and left ventricular ejection fraction.[6] In both our unmatched and matched cohorts, nonelective TAVR patients had higher rates of decompensated heart failure, concurrent tricuspid regurgitation, and APR-DRG mortality scores. Although the reason

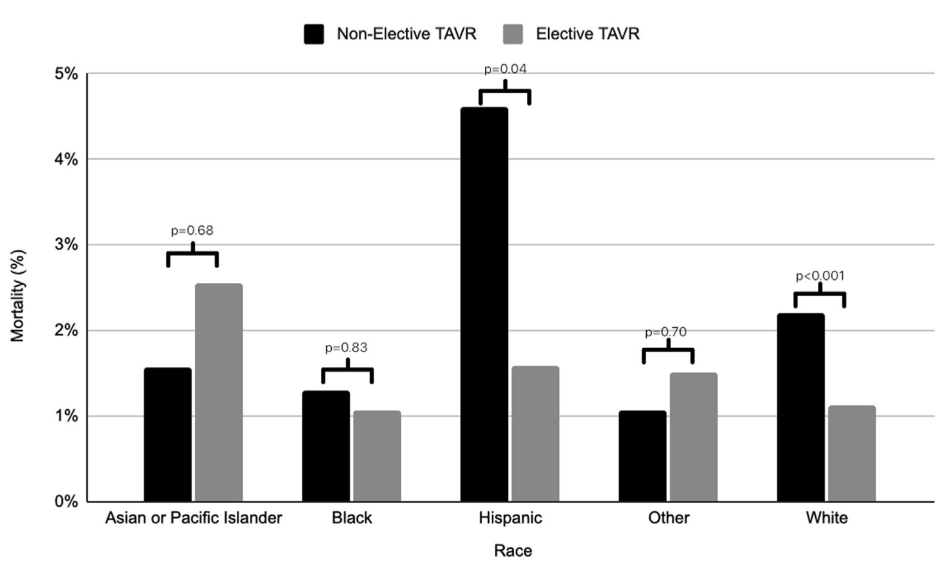

Figure 2. Mortality in nonelective and elective transcatheter aortic valve replacement (TAVR) patients, stratified by race after propensity-score matching.

Table 3. Total population and number of deaths stratified by race after propensity-score matching

Race	Nonelective patient total	Nonelective death total	Elective patient total	Elective death total	*P*
Asian or Pacific Islander	64 (1.5)	1 (1.6)	78 (1.8)	2 (2.6)	0.68
Black	233 (5.3)	3 (1.3)	189 (4.3)	2 (1.1)	0.83
Hispanic	303 (6.9)	14 (4.6)	253 (5.8)	4 (1.6)	0.04
Other	187 (4.3)	2 (1.1)	199 (4.5)	3 (1.5)	0.70
White	3588 (81.8)	79 (2.2)	3643 (83.0)	41 (1.1)	< 0.001

Values are n (%), unless otherwise indicated.

for this decompensated aortic stenosis is multifactorial, one possibility is that nonelective TAVR patients did not have as close provider follow-up as elective TAVR patients. This difference may be due to a variety of reasons, such as poor healthcare literacy, access to a healthcare provider, and proximity to a facility that has the resources to perform TAVR. Consequently, their aortic stenosis and other chronic medical conditions may not be as medically optimized prior to undergoing intervention, causing longer hospital stays and higher rates of discharge to a skilled-nursing or intermediate-care facility.[13]

Another contributing factor for increased nonelective TAVR mortality is that patients who undergo nnonelective TAVR may have more concomitant comorbidities. According to Kolte et al., hypoxia, immunocompromised status, atrial fibrillation, and elevated baseline creatinine level are all predictors of higher mortality in patients undergoing nonelective TAVR.[6] Our data reaffirm this notion, as nonelective TAVR patients had higher rates of atrial fibrillation, decompensated heart failure, chronic kidney disease, and tricuspid regurgitation in both our unmatched and matched cohorts.

Currently, the literature on how transfer status, specifically between acute-care centres, impacts TAVR patients is limited. Unfortunately, increased acute-care transfer mortality is a multifaceted problem. One major component is the lack of access to healthcare, an issue that is more prominent in underserved regions. As of 2020, approximately 60 million people reside in rural America and depend on local hospitals for medical care.[19,20] However, 161 rural hospitals have closed since 2005, and as of February 2019, an additional 673 rural hospitals were at risk of closing.[19,20] Factors that have contributed to rural hospital closures include costly medications, workforce shortages, and inadequate reimbursements.[21] Furthermore, TAVR programs are located predominantly in urban tertiary-care centres and are less likely to expand into lower socioeconomic regions, such as rural America.[22] This distribution leads patients in lower socioeconomic regions to seek care routinely at rural hospitals that do not have the financial means to provide specialized procedures such as TAVR. These challenges force patients receiving care from rural hospitals to be transferred to specific tertiary-care centres for further management. Additionally, the specific tertiary-care centre also matters, as hospitals that have a higher volume of urgent or emergent TAVR procedures have improved in-hospital outcomes.[23] Thus, this delay in medical care and variability in TAVR volume status among hospitals can negatively impact a patient's outcome.

In the setting of an increasing world population, concern is rising regarding a global physician shortage, as this may further exacerbate the strains on access to healthcare. This pattern is further exemplified in the US. A study by the US Census Bureau estimated a 34.2% increase in the population aged 65 years or older from 2010 to 2020, which corresponded to a growth of 13,787,044 individuals.[24] The Association of American Medical Colleges (AAMC) predicts that the US population will grow from 328 million in 2019 to 363 million in 2034, with a 42.4% increase in those aged 65 years or older.[25] As our population grows, the demand for TAVR will continue to increase as well. A meta-analysis conducted by Osnabrugge et al. showed the prevalence of aortic stenosis and severe aortic stenosis among those aged 75 years or older in North America and Europe to be 12.4% and 3.4%, respectively.[26] Unfortunately, the Association of American Medical Colleges also predicts a shortage of between 3800 and 13,400 physicians in medical specialties,

Table 4. Postoperative complications after propensity-score matching

Outcomes	Nonelective TAVR	Elective TAVR	OR (95% CI)	*P*
Intraoperative				
Cardiac arrest	29 (0.7)	14 (0.3)	1.61 (1.07−2.43)	0.02
Cerebral infarction	3 (0.1)	4 (0.1)	1.81 (0.50−6.60)	0.37
Postoperative				
Acute kidney injury	4 (0.1)	3 (0.1)	1.86 (0.61−5.71)	0.28
Acute respiratory failure	50 (1.1)	35 (0.8)	1.91 (1.40−2.63)	< 0.001
Cardiac arrest	15 (0.3)	7 (0.2)	1.62 (0.92−2.87)	0.10
Cardiogenic shock	20 (0.5)	9 (0.2)	2.16 (1.30−3.61)	0.003
Cerebral infarction	36 (0.8)	20 (0.5)	1.26 (0.88−1.81)	0.21
Fever	6 (0.1)	6 (0.1)	0.76 (0.32−1.77)	0.52
Heart failure	4 (0.1)	7 (0.2)	1.15 (0.40−3.36)	0.80
Hypertension	6 (0.1)	5 (0.1)	1.13 (0.47−2.71)	0.78
Hypotension	45 (1.0)	39 (0.9)	0.93 (0.68−1.27)	0.66
Hypothyroidism	27 (0.6)	35 (0.8)	0.90 (0.62−1.32)	0.59
Intestinal obstruction	1 (0)	0 (0)	1.21 (0.14−10.35)	0.86
Pneumothorax	14 (0.3)	11 (0.3)	1.97 (1.08−3.61)	0.03

Values are n (%), unless otherwise indicated.

CI, confidence interval; OR, odds ratio; TAVR, transcatheter aortic valve replacement.

such as cardiology, in the same timeframe.[25] This population growth and increased demand for TAVR, in conjunction with the physician shortage, will continue to exacerbate the disparities in access to healthcare.

Our study has some limitations. Use of the NIS database carries an inherent risk of miscoded diagnoses. Data such as the severity of aortic stenosis, left ventricular ejection fraction, imaging results, route of access, type of transcatheter valve placed, procedure details, medications given, readmission rate, and outcomes after discharge were also not available. Concomitant coronary artery disease, mitral regurgitation, and tricuspid regurgitation also were inadequately captured in the NIS database, and whether any of these conditions also were addressed during the index admission was not analyzed. The aforementioned clinically relevant variables can be confounding factors, which may have affected our study results. We also are unable to confirm if the rationale for determining whether a patient is undergoing an elective or a nonelective procedure is consistent throughout the hospitals in our dataset. Our data showed that when patients were separated by race, only White and Hispanic patients had higher odds of suffering mortality in nonelective TAVR. However, both our original dataset and propensity-matched cohorts consisted of predominantly White patients. Other races having less representation creates the possibility of a type II error. Finally, of the 22,745 nonelective TAVR patients in our dataset, only 4389 (19.2%) were included in our final analysis. These patients were selected based on the propensity scores we calculated, which can cause a selection bias. Such a bias has the potential to affect the generalizability of our results, as the patients selected can change based on the variables used to calculate the propensity score.

Conclusion

In our nationally representative sample of inpatient hospitalizations across the US, patients undergoing nonelective TAVR had higher odds of suffering in-hospital mortality, compared to elective TAVR admissions. Even when separated by transfer status, patients transferred from an acute-care centre and those admitted as regular hospital admissions had higher odds of inpatient mortality when undergoing nonelective, compared to elective, TAVR. Additional research should be conducted on TAVR outcomes by race, and on how to improve the safety of nonelective TAVR. As the demand for TAVR increases, further discussions regarding access to healthcare in underserved regions, the national physician shortage, and the future of the TAVR industry are imperative.

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Ethics Statement

The research reported has adhered to the relevant ethical guidelines.

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Disclosures

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