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No mental illness impact on post-aortic valve replacement patients' new-onset atrial fibrillation

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Abstract

Aim: The mental illness (MEI) impact upon risk-adjusted first-time aortic valve replacement (AVR) or repeat AVR (r-AVR) outcomes is unknown. Comparing patients with and without new-onset postoperative atrial fibrillation or atrial flutter (POAF/AFL), this retrospective cohort investigation evaluated if MEI impacted patients' risk-adjusted AVR/r-AVR outcomes.

Methods: Using de-identified New York Statewide Planning and Research Cooperative System (administrative) database reports, multivariable logistic regression models compared post-procedural POAF/AFL, 30-day readmission, and composite (i.e., 30-day operative mortality or morbidity) endpoints between MEI and non-MEI patients.

Results: From 2005-2018, there were 36,947 first-time AVR patients and 242 r-AVR patients; of these, 13.18% AVR (n = 4,868) and 16.94% r-AVR (n = 41) patients had preprocedural MEI diagnoses. Compared to non-MEI patients, MEI patients had increased rates of transcatheter *vs.* surgical procedures and higher pre-procedural risks including alcoholism, illegal drug use, tobacco product use, suicidal ideation, or other comorbidities (e.g., valvular disease, atherosclerotic disease, hypertension obesity, and anemia); they were younger, female, and non-Black/non-Hispanic, and had non-commercial (e.g., government or self-pay) insurance. Contrasted to non-MEI patients, MEI patients had no different risk-adjusted new onset of POAF (AVR P = 0.575; r-AVR P = 0.497), 30-day readmission (AVR P = 0.163; r-AVR P = 0.486), and mortality/morbidity composite (AVR P = 0.848; r-AVR P = 0.295) rates.

Conclusions: Despite MEI patients' inherent higher pre-procedural AVR/r-AVR risk, no differences in the MEI *vs.* non-MEI risk-adjusted POAF/AFL, 30-day readmission, or composite rates were found; however, MEI patients more frequently were selected to receive transcatheter rather than open surgical procedures.

Keywords: Aortic stenosis, aortic valve replacement, surgical aortic valve replacement, transcatheter aortic valve replacement, valve-in-valve, repeat surgical aortic valve replacement, atrial fibrillation, mental illness, depression, anxiety

INTRODUCTION

The prevalence of symptomatic aortic stenosis (AS) increases with age[1]. Since 2012, an alternative to traditional surgical aortic valve replacement (SAVR) is FDA-approved transcatheter aortic valve replacement (TAVR)[2]. In 2021, the aortic valve replacement (AVR)-related in-hospital mortality rates reported for SAVR and TAVR procedures were estimated at 0.7% and 2.2%, respectively[3,4].

For a repeated AVR (r-AVR) procedure, in-hospital mortality rates range between 2.3% and 17.6%[5]. Reported r-AVR risk factors including female gender, history of coronary artery disease, and lower creatinine clearance have been found to be independent predictors of early mortality[6].

A novel preoperative risk factor that has not yet been well studied, however, is a mental illness diagnosis. For patients with pre-existing mental illness, moreover, little is known about the utilization of TAVR in this context and whether the traditional reluctance to offer a SAVR to complex patients has been overcome[7]. To address this knowledge gap, the current study utilized the New York State Statewide Planning and Research Cooperative System (SPARCS) administrative health care encounter-based database to evaluate the impact of a preoperative mental illness diagnosis upon AVR and r-AVR patients' postprocedural outcomes[8].

METHODS

The New York state's SPARCS mandatory billing database

With mandatory reporting required since 1979, the New York SPARCS administrative database was used for this study[8]. SPARCS represents a comprehensive, all payer, administrative database documenting all inpatient and outpatient care, ambulatory surgery, and emergency room care provided at New York State's non-federal healthcare facilities. For each healthcare encounter, SPARCS identifies the care received by each patient, including their demographic/socioeconomic profile, clinical outcomes (e.g., in-hospital death), and resources used (e.g., hospital length of stay).

This study's primary mortality endpoint - 30-day operative mortality - was based on the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database's (ACSD) published definition, which reports both in-hospital death and out-of-hospital deaths occurring within 30 days of the surgical procedure; this STS ACSD definition is independent of the cause of death. For each SPARCS encounter, billing codes (e.g., ICD 9, ICD 10, CPT5 codes) were available to classify each patient's diagnoses and procedures performed. As death is not a billable event, no billing-related details could be used to reliably assess the cause of death[9-11]. Moreover, due to the inherent nature of the SPARCS publicly available database, it is not possible to link this de-identified database to external death certificate information. Unfortunately, no cause of death information was separately reported within the SPARCS database; SPARCS database dictionary details can be found online[12].

Ethical oversight -CORIHS exemption as "not human subjects" research

At Stony Brook University, the Office of the Vice President for Research's Office of Research Compliance staff coordinate research project ethical oversight and approvals. Specific to this SPARCS database study, only de-identified summary reports were generated by the Stony Brook University Biostatistical Consulting Core (BCC) lab staff. Thus, the Stony Brook University Committee on Research in Human Subjects' Institutional Review Board (CORIHS IRB) office granted a "not human study" research (NHSR) written exemption for this study [IRB 2022-00375].

Observational study design

Using the SPARCS database records from 2005-2018, this retrospective, observational cohort study compared outcomes such as POAF and 30-day readmission rates after both AVR and r-AVR procedures for patients with and without a preoperative mental illness diagnosis. To ensure completeness of this observational study's administrative data reporting, the pre-established, STROBE evidence-based medicine report criteria were utilized[13]. To identify opportunities to reduce this observational study's potential risk for bias, moreover, the Newcastle Ottowa scale for cohort studies was utilized[14].

Patient population: study inclusion and exclusion criteria

To date, little is known about the MEI impact upon AVR or r-AVR patients; thus, eligible SPARCS adults (age > 18 years) undergoing AVR and r-AVR procedures were extracted based on ICD9/ICD10 hospital billing codes [Supplementary Table 1]. To assure 30-day complete follow-up, only New York State adult residents with either first-time aortic valve replacement (AVR) or repeat aortic valve replacement (r-AVR) from January 2005 to November 2018 were extracted; by utilizing only New York State residents' records, challenges with out-of-state care provided were minimized.

To identify the subgroup of patients with new-onset POAF/AFL, all records for patients with a prior two-year history of atrial fibrillation or flutter, Maze procedure, pacemaker implantation, or defibrillation prior to their first-time, non-emergent AVR or subsequent r-AVR procedure were excluded from the definition of "new onset" atrial fibrillation. Additionally, all records for pediatric patients (i.e., < 18 years of age) were excluded.

Study definitions: major mental illness diagnoses

A preoperative major mental illness (MEI) diagnosis was used as this study's independent variable; thus, this was the basis for study comparisons of MEI *vs.* non-MEI records. For this purpose, mental illness was defined broadly [Supplementary Table 1] to include patients with a diagnosis of depression (and related disorders such as adjustment disorder, adjustment disorder with depressed mood, *etc*. based on ICD codes), post-traumatic stress disorder (PTSD) and related disorders, generalized anxiety, alcohol-induced mental disorders, obsessive-compulsive disorder, bipolar disorder, schizophrenia, mild cognitive impairment, and dementia were selected as patients with preoperative mental illness, based on ICD codes contained in the SPARCS database. Recorded in SPARCS, these MEI diagnoses were based on the Diagnostic and Statistical Manual of Mental Disorders (DSM) and audited independently by government agencies (e.g., Medicare and Medicaid) to ensure billing accuracy[15].

Preprocedural risk factors

Upon admission, patients' risk factors were assessed and recorded; these risk factors included their demographics/socioeconomic status (i.e., age, race, ethnicity, sex, insurance status, *etc*.), pre-procedural clinical diagnoses, historical cardiac-related diagnoses, historical cardiac-related procedures performed, and other patient health-related risk factors (e.g., smoking status). Over the past two years, patients' profiles for their study-based AVR or r-AVR encounters were compared to their historical encounters within the past two years; using a two-year look-back period, therefore, the new diagnoses and procedures performed were differentiated from the historical diagnoses and procedures performed to differentiate comorbidities *vs.* complications. Additionally, other patient risk information was assessed, such as calculating patient's baseline comorbidity complexity. As an example, the Elixhauser comorbidity scores mortality and 30-day readmission were calculated; these standardized comorbidity score algorithms were used to summarize a patient's comorbidity burden for these study-specific endpoints[16].

Outcome measures

The primary study has three clinical endpoints, including new onset post-procedural atrial fibrillation or flutter (i.e., POAF/AFL), 30-day readmission (READMIT), and a composite endpoint (MM) comprised of major morbidity and 30-day operative mortality based upon the Society of Thoracic Surgeons [STS] definitions used in the Adult Cardiac Surgery Database (ACSD).

The STS definitions for 30-day operative mortality and major morbidity were established in 1979. This endpoint included in-hospital deaths and all post-discharge deaths occurring within 30 days. For the MM composite, records with either the STS-defined 30-day operative mortality (i.e., death in-hospital or within 30 days of surgery) or STS-defined set of major complications were identified; major complications included repeat procedures (i.e., including repeat procedures for bleeding or impaired valve functionality), perioperative stroke, new renal failure requiring dialysis, deep sternal wound infection (i.e., mediastinitis), or prolonged use of ventilation (i.e., greater than 48 h on a ventilator)[17]. Following October 15, 2015, new ICD-10 complication codes were also used to differentiate STS major complications from pre-AVR patient comorbidities.

The READMIT endpoint was evaluated based on the time from the date of discharge to the admission date for a subsequent encounter. Secondary patient outcomes included AVR-relevant complications (e.g., bleeding, stroke, and myocardial infarction) and the primary outcomes' sub-components (i.e., STS-defined 30-day operative death and the five major STS complications as secondary outcomes).

Statistical analyses

All analyses were performed using SAS 9.4 by an institutional data analytics team (the Stony Brook University School of Medicine's Biostatistical Consulting Core [BCC] lab). The BCC team's data extraction and analysis tasks occurred from January 2021 to July 2022. Statistical analyses included both bivariate comparisons and multivariable logistic regression analyses. For categorical variables, bivariate comparisons used chi-square tests with exact P-values from Monte Carlo simulation to examine the relationship between categorical variables (e.g., polychotomous, or dichotomous baseline patient risk factors such as sex, race, ethnicity, insurance, *etc.*) and study endpoints (i.e., POAF, 30-day readmission, and the MM composite)[18]. Correspondingly, Welch t-tests compared the unadjusted marginal differences in relationships between continuous variables (e.g., age, Elixhauser readmission score, Elixhauser mortality score) and study endpoints (i.e., POAF, 30-day readmission, and the MM composite)[19].

For multivariable logistic regression analyses, a stepwise descending selection approach was used[20]. To initially identify potential model eligible variables, the literature on cardiovascular surgery and mental illness was reviewed. These literature-based variables were screened using bivariate comparisons ($P < 0.10$) with each study endpoint, verifying the clinical appropriateness of these findings' directionality. To prevent potential collinearity, model eligible variables were further refined based on selecting only one domain-specific variable for model inclusion. The final set of endpoint-specific model eligible variables were entered into multivariable logistic regression equations predicting the three primary endpoints: (i.e., POAF, 30-day readmission, and the MM composite).

To assure this study's final logistic regression models were robust, sensitivity analyses were conducted to evaluate the impact of an additional mental health propensity variable; this variable was designed to evaluate the likelihood of mentally ill patients receiving an AVR procedure[21].

For all analyses performed, a protocol-driven statistical significance threshold was pre-established at $P < 0.05$; however, all raw *P*-values are reported for ease of interpretation. In understanding the logistic regression findings, an odds ratio (OR) > 1.00 indicated that a risk factor had an adverse outcome impact, while an OR < 1.00 indicated a protective outcome effect. For all analyses, SAS 9.4 (SAS Institute Inc., Cary, NC) was used.

RESULTS

From 2005 to 2018, 74,892 patients underwent an AVR procedure in New York State (SPARCS reporting mandated by law). After removing records that were missing a unique patient identifier ($n = 193$), unknown gender ($n = 1$), or duplicate records ($n = 23$), there were 74,675 records; of these, there were 73,945 first-time AVR procedures. Within these first-time AVR patients' records, the patients < 18 years old ($n = 190$) or those admitted emergently ($n = 15,925$) were excluded. Additionally, patient records ($n = 20,883$) were excluded due to a prior history of aortic dissections and/or a concomitant/history of prior coronary artery bypass graft surgery, thoracic aortic aneurysm repair or mitral valve repair/replacement procedures. Following these exclusions, 36,947 patients remained with a first-time, non-emergent aortic valve replacement-only procedure. Of these patients, 62.22% ($n = 22,989/36,947$) underwent a SAVR procedure; 37.78% ($n = 13,958/36,947$) underwent a TAVR procedure [Figure 1].

For these 36,947 patient records, the patients with a subsequent SAVR/TAVR (r-AVR) procedure occurring beyond 30 days following their first AVR-related operation ($n = 627$) were identified. Of these, 385 patient records were excluded due to concomitant coronary artery bypass graft surgery, thoracic aortic aneurysm repair, and/or mitral valve repair/replacement. Representative of the redo procedural population, 242 patient records with r-AVR were analyzed; this included 70.25% redo-SAVR ($n = 170/242$) and 29.75% ViV-TAVR ($n = 72/242$) [Figure 1].

Patient demographics and risk factors

In the AVR population, the overall MEI rate was lower for TAVR (41.82%; $n = 2,036/4,868$) *vs.* for SAVR (58.18%; $n = 2,832/4,868$), $P < 0.001$, see Table 1. There were 57.11% of women in the MEI subgroup compared to 43.00% in the non-MEI subgroup ($P < 0.001$). Non-MEI patients were more frequently reported to be of Black race (4.71%; $n = 1,511/32,079$) and Hispanic race (4.73%; $n = 1517/32,079$) compared to MEI patients. MEI patients were younger than non-MEI patients (72.88 ± 13.11 years *vs.* 74.28 ± 12.79 years, $P < 0.001$). After evaluating the proportion of urgent *vs.* elective patient procedures, no significant differences were found in the MEI patients' admission status. For details of baseline demographics, see Table 1.

As seen in Table 2, in the r-AVR population, there was a higher MEI rate in patients undergoing redo-SAVR (60.98%) compared to the patients undergoing ViV-TAVR (39.02%; $P = 0.154$). Compared to non-MEI patients, there were more women in the MEI subgroup (53.66% *vs.* 31.84%, $P = 0.008$). Patients with MEI diagnoses were more likely to undergo an elective procedure compared to an urgent one (87.80% *vs.* 12.20%, $P = 0.040$); however, patients' age, race, insurance, and ethnicity were not found to be significant r-SAVR *vs.* ViV-TAVR treatment selection factors for this r-AVR population.

Table 1. First-time SAVR and TAVR patients' characteristics with and without mental illness

		Overall			
Variable	**Level**	**Total (*N* = 36,947)**	**With mental illness (*N* = 4,868, 13.18%)**	**Without mental illness (*N* = 32,079, 86.82%)**	***P*-value***
Surgery type	SAVR	62.22%	58.18%	62.84%	< 0.0001
	TAVR	37.78%	41.82%	37.16%	
Type of admission	Elective	82.23%	82.25%	82.23%	0.9685
	Urgent	17.77%	17.75%	17.77%	
Gender	Female	44.86%	57.11%	43.00%	< 0.0001
	Male	55.14%	42.89%	57.00%	
Age	Unit = year	74.09 ± 12.82	72.88 ± 13.11	74.28 ± 12.76	< 0.0001
Race	Black	4.39%	2.26%	4.71%	< 0.0001
	Other	95.61%	97.74%	95.29%	
Ethnicity	Hispanic	4.60%	3.74%	4.73%	0.0021
	Other and unknown	95.40%	96.26%	95.27%	
Insurance	Commercial	26.94%	25.51%	27.15%	0.0164
	Medicaid, medicare, and other	73.06%	74.49%	72.85%	
Tobacco/smoking	No	65.43%	59.22%	66.37%	< 0.0001
	Yes	34.57%	40.78%	33.63%	
Elixhauser mortality index		10.74 ± 10.47	8.67 ±10.85	11.05 ± 10.38	< 0.0001
Elixhauser readmission index		19.88 ± 15.09	23.56 ± 15.32	19.32 ± 14.98	< 0.0001

For continuous variables, the mean +/- std were reported; For categorical variables, *P*-values were based on chi-squared test with exact *P*-value from Monte Carlo simulation; For continuous variables, *P*-values were based on Welch's *t*-test.

Table 2. Redo-SAVR and ViV-TAVR patients' characteristics with and without mental illness

		Overall			
Variable	**Level**	**Total (*N* = 242)**	**With mental illness (*N* = 41)**	**Without mental illness (*N* = 201)**	***P*-value***
Surgery type	Redo-SAVR	70.25%	60.98%	72.14%	0.1542
	ViV-TAVR	29.75%	39.02%	27.86%	
Type of admission	Elective	75.21%	87.80%	72.64%	0.0404
	Urgent	24.79%	12.20%)	27.36%	
Gender	Female	35.54%	53.66%	31.84%	0.0078
	Male	64.46%	46.34%	68.16%	
Age	Unit = year	64.91 ± 14.87	64.78 ± 15.60	64.94 ± 14.76	0.9521
Race	Black	8.68%	4.88%	9.45%	0.3980
	Other	91.32%	95.12%	90.55%	
Ethnicity	Hispanic	7.85%	7.32%	7.96%	1.0000
	Other and unknown	92.15%	92.68%	92.04%	
Insurance	Commercial	39.67%	31.71%	41.29%	0.2528
	Medicaid, medicare, and other	60.33%	68.29%	58.71%	
Tobacco/smoking	No	63.22%	43.90%	67.16%	0.0049
	Yes	36.78%	56.10%	32.84%	
Elixhauser mortality index		13.06 ± 10.95	9.54 ± 12.23	13.78 ± 10.55	0.0434
Elixhauser readmission index		23.93 ± 15.36	27.54 ±16.56	23.19 ± 15.04	0.1262

For continuous variables, the mean +/- std were reported; For categorical variables, *P*-values were based on chi-squared test with exact *P*-values from Monte Carlo simulation; For continuous variables, *P*-values were based on Welch's *t*-test.

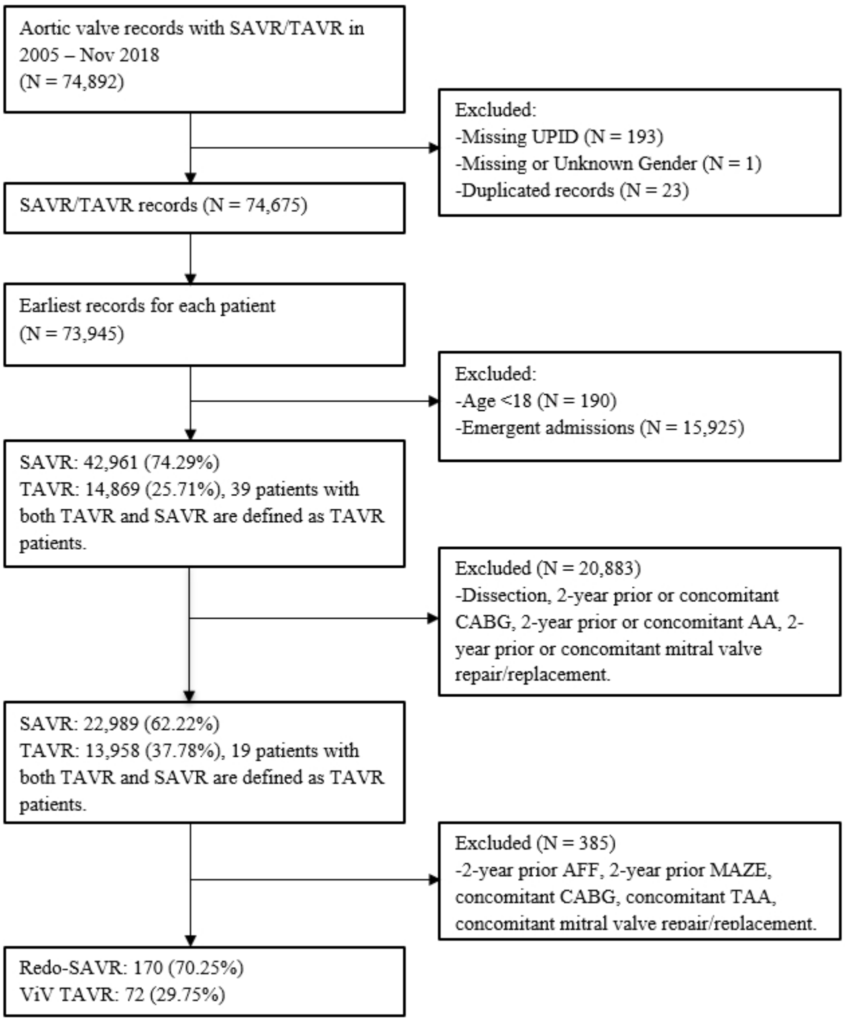

Figure 1. Flow diagram for SAVR, redo-SAVR, TAVR, and ViV-TAVR patients with exclusion criteria.

Patient mental illness distribution

For first-time aortic valve replacements, 13.18% (*n* = 4,868) patients had a pre-existing MEI within the two years of pre-procedure. Of these [see Table 3], the most prevalent MEI diagnoses included depression (53.37%, *n* = 2,598/4,868), anxiety (25.74%, *n* = 1,253/4,868), or schizophrenia (25.18%, *n* = 1,226/4,868). Other pre-procedural major mental illness diagnoses (such as dementia (8%, *n* = 389/4,868), mild cognitive impairment (1%, *n* = 49/4,868), bipolar disorder (1%, *n* = 49/4,868), obsessive-compulsive disorder (0%), alcohol-induced mental disorder (1% = 49/4,868), or PTSD/PTSD-related disorders (2%, *n* = 97/4,868) were less frequently observed.

Only forty-one patients with MEI underwent a redo-SAVR or ViV-TAVR procedure. Of these, most MEI patients were diagnosed with depression (63.41%, *n* = 26/41), schizophrenia (27%, *n* = 11/41), and anxiety-related disorders (24%, *n* = 10/41). Like first-time AVR patients, however, the diagnoses of PTSD/PTSD-related diagnoses (5%, *n* = 2/41), obsessive-compulsive disorder (2%, *n* = 1/41), bipolar disorder (2%, *n* = 1/41), dementia (2%, *n* = 1/41), or mild cognitive impairment (2%, *n* = 1/41) were again relatively rare

Table 3. Preoperative mental illness diagnoses among first-time SAVR and TAVR patients

Mental illness	Percentage of patients with specific mental illness diagnoses (total = 4,868; %)	Percentage of first-time SAVR and TAVR patients (%)
PTSD	0.02	0.20
PTSD-related	0.01	0.10
Depression	0.53	7.03
Anxiety	0.26	3.39
Alcohol-induced mental disorder	0.01	0.12
Obsessive-compulsive disorder	0.00	0.04
Bipolar disorder	0.01	0.19
Schizophrenia	0.25	3.32
Mild cognitive impairment	0.01	0.10
Dementia	0.08	1.08

Definitions: PTSD (post-traumatic stress disorder).

[Table 4]. Additional characteristics and risk factors for MEI patients can be found in [Supplementary Tables 2-13].

Multivariable regression analysis

Post-AVR outcomes

In the AVR population, there were no differences in the POAF rates between MEI patients *vs.* non-MEI patients after holding all other risk factors constant (P = 0.5746). Similarly, there were no 30-day readmission or composite outcome rate differences between MEI patients *vs.* patients without MEI (P = 0.1632 and P = 0.8478, respectively) [Table 5].

On multivariable analysis of the AVR population, patients with a MEI diagnosis had no different POAF rates (AVR, OR = 0.982, 95%CI: 0.920-1.047, P = 0.5746), 30-day readmission rates (AVR, OR = 1.059, 95%CI: 0.977-1.149, P = 0.1632), and 30-day STS composite rates (AVR, OR = 1.010, 95%CI: 0.914-1.116, P = 0.8478) than patients without MEI.

In the set of full multivariable AVR analysis reports (see Supplementary Tables 2-4 respectively), SAVR *vs.* TAVR procedures had high odds ratios reported (POAF OR = 2.16, 95%CI: 2.05-2.28, P < 0.001; READMIT OR = 2.26, 95%CI: 2.10-2.42, P < 0.001; MM OR 1.63 (1.51-1.76, P < 0.001).

Post r-AVR outcomes

In the r-AVR population, there were no differences in the POAF rates between MEI patients *vs.* non-MEI patients (P = 0.4973). Similarly, there were no 30-day readmission or composite rate differences between MEI patients *vs.* patients without MEI, after holding all other risk factors constant (P = 0.4860 and P = 0.2950, respectively) [Table 6].

On multivariable analysis of both r-AVR populations, patients with a MEI diagnosis had no different POAF rates (r-AVR, OR = 1.335, 95%CI: 0.580-3.072, P = 0.4973), 30-day readmission rates (r-AVR, OR = 0.660, 95%CI: 0.206-2.122, P = 0.4860), and 30-day STS composite rates (r-AVR, OR = 0.591, 95%CI: 0.221-1.581, P = 0.2950) than patients without a MEI diagnosis.

Table 4. Preoperative mental illness diagnoses among redo-SAVR and ViV-TAVR patients

Mental illness	Percentage of patients with specific mental illness diagnoses (total = 41; %)	Percentage of redo-SAVR and ViV-TAVR patients (%)
PTSD	0.05	0.83
PTSD-related	0.05	0.83
Depression	0.63	10.74
Anxiety	0.24	4.13
Obsessive-compulsive disorder	0.02	0.41
Bipolar disorder	0.02	0.41
Schizophrenia	0.27	4.55
Mild cognitive impairment	0.02	0.41
Dementia	0.02	0.41

Definitions: PTSD (post-traumatic stress disorder).

Table 5. First-time AVR and outcomes in patients with mental illness

Variable	OR (95%CI)	*P*-value
POAF	0.982 (0.920-1.047)	0.5746
30-day readmission	1.059 (0.977-1.149)	0.1632
30-day STS composite rates	1.010 (0.914-1.116)	0.8478

Listed respectively:

New-onset POAF model's statistically significant variables in the model included age, surgery type, type of admission, gender, race, ethnicity, insurance type, history of stroke, bicuspid aortic valve, non-rheumatic aortic stenosis, obstructive sleep apnea, pulmonary hypertension, and Elixhauser Mortality Index. The c-index of this model was 0.658 and the Hosmer and Lemeshow Goodness-of-Fit Test p-value was 0.0001.

30-Day Readmission Model's statistically significant variables in the model included age, surgery type, gender, insurance type, alcohol abuse, tobacco/smoking, stroke, myocardial infarction, bicuspid aortic valve, abdominal aortic aneurysm, non-rheumatic aortic stenosis, leukemia, and Elixhauser Readmission Index. The c-index of this model was 0.633 and the Hosmer and Lemeshow Goodness-of-Fit Test p-value was 0.7041.

30-Day Mortality/Morbidity (MM) composite model's statistically significant variables in the model included age, surgery type, type of admission, insurance type, tobacco/smoking, stroke, bicuspid aortic valve, peripheral vascular disease, abdominal aortic aneurysm, non-rheumatic aortic stenosis, obstructive sleep apnea, leukemia, hypothyroidism, intra-aortic balloon pump, and Elixhauser Mortality Index. The c-index of this model was 0.733 and the Hosmer and Lemeshow Goodness-of-Fit Test p-value was 0.0117.

POAF: Postoperative atrial fibrillation.

Table 6. Redo AVR and outcomes in patients with mental illness

Variable	OR (95%CI)	*P*-value
POAF	1.335 (0.580-3.072)	0.4973
30-day readmission	0.660 (0.206-2.122)	0.4860
30-day STS composite rates	0.591 (0.221-1.581)	0.2950

Listed respectively:

For new-onset POAF model, there were no statistically significant risk factors. The c-index of this model was 0.729 and the Hosmer and Lemeshow Goodness-of-Fit Test p-value was 0.0282.

The only 30-day readmission model's statistically significant variable was cerebral vascular disease. The c-index of this model was 0.645 and the Hosmer and Lemeshow Goodness-of-Fit Test p-value was 0.1790.

The Mortality/Morbidity Composite model's statistically significant variables included race and cerebral vascular disease. The c-index of this model was 0.706 and the Hosmer and Lemeshow Goodness-of-Fit Test p-value was 0.7659.

POAF: Postoperative atrial fibrillation.

Sensitivity analyses: no impact of new mental illness propensity variable

To assure no findings substantively changed, a new sensitivity analyses was run by including a new propensity variable (i.e., the likelihood of mentally ill patients to receive AVR treatment). Although these reports have not been provided herein, the current multivariable models were found to be robust.

DISCUSSION

Multivariable analysis of the SPARCs database records showed no difference in short-term outcomes of MEI New York State adult residents. Given the increased baseline comorbidities and healthcare spending reported in the literature in this population, this result was unexpected[22].

In this SPARCS New York State database analysis, only 9.95% of AVR and 14.05% of r-AVR patients had preoperative MEI diagnoses. This is below the rate of New Yorkers in the general population with MEI reported by the Department of Health. As MEI patients do not appear to receive AVR or r-AVR procedures at the same rates as non-MEI patients, there may be multiple potential explanations for these differential procedural use rates.

For MEI patients, studies have reported lower medication compliance rates and follow-up rates as compared to non-MEI patients[23,24]. Follow-up difficulties with MEI patients may be related to the "revolving door phenomenon," where MEI patients experience a temporary improvement of symptoms following a facility-based treatment, but then stop their facility-based encounters until a relapse episode or a re-hospitalization occurs[25]. Additionally, a MEI diagnosis might preclude patients from being selected or referred for an invasive treatment, such as a surgical procedure. Importantly, MEI patients that are well controlled might present otherwise similarly to patients without a MEI diagnosis. For this SPARCS analysis, the level of detailed diagnostic information available to clinicians for their pre-procedural AVR referral or AVR treatment selection decisions was not documented. Although possibly either a referral for AVR treatment or an AVR treatment selection bias of MEI patients may have occurred, sensitivity analyses run for multivariable analyses that included a MEI treatment propensity variable had no substantive changes.

For all three of the multivariable AVR logistic regressions, however, SAVR procedures had statistically significantly higher odds ratios associated with POAF, MM, and READMIT adverse outcomes as compared to TAVR procedures. Independent of a patient's pre-existing MEI status, therefore, treatment type appears to be an important predictor of adverse AVR outcomes. Given these SPARCS study records were extracted from 2005 to 2018, however, this preliminary finding should be re-confirmed by updated longitudinal analyses.

Specifically, TAVR procedures were approved for Medicare payment in 2012 for high-risk patients. In 2016, TAVR procedures received expanded Medicare approval for application to intermediate risk patients. Thus, it was not until after this study's time-period had already ended - in August 2019 - that TAVR procedures were approved for widespread use in low-risk patients[26]. Given these period-specific policy changes, it would not be appropriate to directly report a TAVR *vs.* SAVR procedural comparison. Based on these preliminary findings, additional research appears needed to evaluate differential TAVR *vs.* SAVR utilization in MEI *vs.* non-MEI patients while adjusting for other patient risk factors.

Surprisingly, there were no risk adjusted POAF rate differences between the MEI and non-MEI patients. Given that MEI patients are commonly prescribed anti-psychotics, anti-depressants, anti-anxiolytics, sedatives, opioids, stimulants, and pain management medications that may result in postcardiac surgery arrhythmias, this finding was unexpected.

Consistent with already published literature, this study also found that smokers were less likely to be readmitted to the hospital. This has been documented as the "smoker's paradox," a phenomenon in which the varying age and comorbidities between smokers lead to this unexpected outcome[27,28].

Based on hospital inpatient and outpatient, ambulatory surgery, and emergency room SPARCS records, this study's STS post-procedural outcomes were limited to those occurring within 30 days post-procedure. Several studies, as outlined below, identify MEI as a risk factor for poor long-term postoperative outcomes. Historically, patients with depression and/or anxiety have had worse long-term surgical outcomes compared to the general population. For example, depression was shown to be a risk factor for 10-12-year mortality following coronary artery bypass surgery[29-31]. Aside from increasing rates of postoperative mortality, mental illness also increases the chance of emergency readmission as well as overall greater postoperative pain and worse physical symptoms[32]. Even after a minimally invasive procedure such as TAVR, patients with dementia were seen to have higher rates of in-hospital delirium as well as discharge to rehabilitation facilities[33]. Thus, follow up beyond 30 days may be required to identify any MEI-related risk-adjusted outcome differences.

Limitations

Observational research study designs using administrative databases are inherently limited to the information that is available as well as the potential confounding of unmeasured variables. During this New York State SPARCS analysis, moreover, the lower-than-expected MEI proportion of patients receiving AVR and r-AVR procedures seems suggestive of either a potential differential referral or selection process being applied to MEI patients being evaluated for these cardiac procedures. Given these limitations, therefore, additional research using a larger patient cohort that includes longer-term outcomes now appears warranted to evaluate the post-procedural impacts for this vulnerable, "at risk" MEI patient population.

Conclusion

Multivariable regression analysis of the SPARCS database showed that MEI patients did not have significant differences in their risk-adjusted POAF, 30-day readmissions, and 30-day composite endpoint rates compared to patients without MEI after undergoing AVR and r-AVR. Although MEI patients included younger women with multiple comorbidities, these inherently higher-risk AVR and r-AVR MEI populations did not have significant differences in their risk-adjusted POAF, 30-day readmissions, and 30-day composite endpoint rates. Compared to non-MEI patients, however, MEI patients more frequently received transcatheter rather than open surgical procedures.

DECLARATIONS

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Availability of data and materials

All patient records and data were extracted from the 2005-2018 SPARCS Database. Due to the New York State Department of Health SPARCS Data Use Agreement (DUA) contractual limitations (i.e., concerns regarding patient records being re-identified), no reports contain cells with counts lower than 10 events; thus, only percentages were reported in Tables 1-3.

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Conflicts of interest

All authors declared that there are no conflicts of interest.

Ethical approval and consent to participate

This study received IRB exemption as "not human subjects research" [IRB 2022-00375]. The protocol and IRB written exemption can be found online at: "No Mental Illness Impact on Post-Aortic Valve Replacement Patients' Ne" by Natalie Kolba, Julia Dokko *et al.* (stonybrook.edu).

Consent for publication

Not applicable.

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