Hindawi
Journal of Cardiac Surgery
Volume 2023, Article ID 6983270, 7 pages
https://doi.org/10.1155/2023/6983270

Research Article

Quality of Mitral Valve Surgery Does Not Differ by Hospital Volume in New Jersey

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Received 16 November 2022; Revised 21 February 2023; Accepted 27 May 2023; Published 14 June 2023

Academic Editor: Pradeep Narayan

Background and Aim of the Study. To investigate if mitral valve (MV) surgery quality differs by hospital volume in New Jersey (NJ). *Methods*. Using the NJ State Inpatient Database, patients ≥18 years undergoing MV repair or replacement from 2016–2019 were identified. Centers were considered high-volume if they performed more than 50 mitral operations annually. Baseline characteristics and outcomes (in-hospital mortality, seven-day readmission, hospital length of stay (LOS), and postoperative complications) were evaluated for the population and by center volume. Subanalysis by center volume within each procedure was conducted. *Results*. Among 2,560 mitral operations, MV replacement (92.3% ($n = 2{,}362$)) was performed more often than repair. High- (4) and low-volume (15) centers performed 1,180 (46.1%) and 1,380 (53.9%) mitral surgeries, respectively. Charlson Comorbidity Indices did not differ by center volume, including in subgroup analyses. Low-volume centers had higher rates of Hispanic patients, low-income patients, and readmission rates. High-volume centers had more transfers, urgent/emergent admissions, higher rates of in-hospital mortality, and longer LOS. Postoperative complications did not differ by volume. The MV replacement cohort reflected many of the differences seen in the total population, in addition to seeing higher rates of heart failure at high-volume centers and stroke at low-volume centers. Within MV repairs, significantly more Hispanic patients presented to low-volume centers and high-volume centers had longer LOS. Multivariable analysis indicated that hospital volume was not correlated to in-hospital mortality for the total population and within each procedure. *Conclusions*. MV replacement is performed more frequently than repair. Hospital volume is not correlated with MV surgical quality, and more representative quality measures are needed.

1. Introduction

Mitral valve (MV) dysfunction is an age-related disease process [1] that affects greater than 9.3% of the population over the age of 75 [2] and leads to irreversible remodeling of the heart if left untreated [1, 3]. Surgical MV repair has lower rates of perioperative and long-term mortality than replacement in appropriate candidates [4, 5]. However, the high level of expertise required to perform MV repair [6] and achieve such outcomes has led to the establishment of mitral centers of excellence. Numerous definitions of such centers exist [6–8] with many common aspects: a multidisciplinary team, advanced cardiac imaging, and high mitral surgery volume. Hospital volume has been of particular interest as a proxy for quality of care [9]; however, some studies suggest that the volume-outcome relationship is not a sufficient indicator of the quality of care that a center provides [9]. Geographic and socioeconomic factors can limit access to high volume centers, and thus, the benefit of care at these centers should be defined.

While there have been nationwide studies of volume-outcome relationships favoring high-volume hospitals for

MV surgery [10, 11], the state-level correlation between volume and outcomes has not been investigated. In particular, patterns of care and outcomes for MV surgery within the state of New Jersey (NJ) have yet to be established. This large-database, population-based study aims to investigate NJ intrastate heterogeneity in outcomes of patients undergoing surgical MV operations when stratifying centers by total annual volume of MV surgery.

2. Materials and Methods

2.1. Data Source. The State Inpatient Databases (SIDs) are part of a family of databases developed for the Healthcare Cost and Utilization Project (HCUP) from the Agency for Healthcare Research and Quality. The NJ SID contains a census of inpatient discharge information on all patients, regardless of payer, discharged from hospitals in NJ [12]. Variables extracted from the NJ SID for this study include demographic information, admission type, ICD-10-CM diagnosis codes, ICD-10-PCS procedure codes, hospital length of stay (LOS), discharge disposition, transfer information, and 7-day readmission status. The SID contains a data element titled "present-on-admission" to distinguish presenting comorbidities from postoperative complications. Hospitals are assigned an HCUP hospital identification number, which was used to determine hospital volume. This study was deemed exempt from review by the Institutional Review Board at Rutgers Robert Wood Johnson Medical School.

2.1.1. Patients and Variables. We conducted a retrospective cohort study using ICD-10-PCS codes to identify all records from 2016 through 2019 for patients ≥18 years old who underwent surgical MV repair (ICD-10-PCS: 02QG0ZZ) or replacement (ICD-10-PCS: 02RG07Z, 02RG08Z, 02RG0JZ, and 02RG0KZ). Transcatheter mitral procedures were excluded. The NJ SID does not allow discernment of full sternotomy versus minimally invasive approaches. Patients were excluded if they underwent both MV repair and replacement during one hospital visit due to lack of granularity allowing evaluation of circumstances leading to multiple operations. Patients who underwent concurrent procedures (e.g., coronary artery bypass grafting (CABG) with mitral valve operation) were included but not specifically identified. Patients were stratified by hospital mitral volume of their providing center: high- or low-volume centers were defined by their annual performance of ≥50 or <50 mitral operations, respectively. The threshold of 50 mitral operations was chosen based on qualifications for mitral centers of excellence from recent guidelines [6, 7].

Baseline characteristics included age, sex, ethnicity (Hispanic versus non-Hispanic), socioeconomic status, comorbid medical conditions, admission type, and mitral valve pathology. Socioeconomic status was estimated based on median household income of the patient's home zip code corresponding to the year of discharge; income quartiles were then defined within the state. Comorbidities included atrial fibrillation, chronic ischemic heart disease, chronic kidney disease (CKD), chronic obstructive pulmonary disease (COPD), conduction blocks, diabetes mellitus, heart failure, hypertension, infective endocarditis, liver disease, peripheral vascular disease, and stroke. Only diagnoses present on admission were included. ICD-10-CM codes corresponding to the evaluated comorbidities are detailed in Supplemental Table 1a. The variables available in the NJ SID do not allow for evaluation of risk indices such as EuroSCORE or the STS score. We have instead included a Charlson Comorbidity Index (CCI) as a risk score, which is a validated risk index tool especially for administrative databases [13]. We evaluated admission type, defined as either urgent/emergent or elective. A subanalysis was conducted comparing in hospital mortality for elective cases and for urgent/emergent cases. Diagnosis of MV regurgitation, MV stenosis, chronic rheumatic MV disease, and MV prolapse present-on-admission were used to designate MV pathology. Corresponding ICD-10-CM codes are detailed in Supplemental Table 1b.

The primary outcomes of the study were in-hospital mortality, seven-day readmission to the same facility, and hospital LOS. Secondary outcomes included postoperative complications of new onset atrial fibrillation, AV block, heart failure, acute kidney injury, and stroke: only diagnoses that were not present on admission were considered. Corresponding ICD-1-CM codes are detailed in Supplemental Table 1c.

2.2. Statistical Analysis. Baseline characteristics, CCIs, and primary and secondary outcomes are reported for the whole population, by the overall mitral volume cohort, and secondarily stratified by mitral volume cohorts within each procedure. Continuous variables are reported as medians with interquartile ranges (IQR) and compared using the Mann–Whitney statistical test. Categorical variables are reported as frequencies (n) and proportions (%) and compared using chi-squared or Fisher's exact tests. Multivariable regression was used to assess the association between hospital volume and in-hospital mortality for the entire population and within each procedure. Factors controlled for include gender, race, case status (elective vs. urgent/emergent), and CCI. Age was not controlled for because it is included in the CCI. These variables were chosen based on clinical judgment and previous studies investigating factors impacting mortality [14]. $p < 0.05$ was considered statistically significant. Statistical analysis was performed using StataMP 17 Statistical Software.

3. Results

3.1. Total Population. A total of 2,560 patients ≥18 years old underwent open mitral valve surgery in NJ and met inclusion criteria between 2016 and 2019, of which 198 (7.7%) underwent MV repair and 2,362 (92.3%) underwent MV replacement. There were 3.75 times more low-volume (15) than high-volume (4) hospitals. Low-volume hospitals performed a range of 10 to 196 mitral surgeries, whereas high-volume hospitals performed a range of 226 to 345 mitral surgeries over the 4-year study period. High-volume hospitals performed 46.1% ($n = 1{,}180$) of the mitral operations identified.

Table 1: Baseline characteristics and comorbidities of patients undergoing mitral valve repair and replacement in New Jersey by high- and low-volume centers.

	Total population ($N = 2,560$)	High volume ($N = 1,180$)	Low volume ($N = 1,380$)	p value
Baseline characteristics				
Age median (IQR)	68 (58, 76)	69 (58,76)	67 (58, 75)	0.07
Female n (%)	1,268 (49.5)	590 (50.0)	678 (49.1)	0.65
Hispanic n (%)	323 (12.6)	118 (10.0)	205 (14.9)	<0.001
Transfer into facility	498 (19.5)	291 (24.7)	207 (15.0)	<0.001
Socioeconomic status n (%)				<0.001
25th percentile	717 (28.0)	305 (25.8)	412 (29.9)	
50th percentile	668 (26.1)	268 (22.7)	400 (29.0)	
75th percentile	626 (24.5)	323 (27.4)	303 (22.0)	
100th percentile	536 (20.9)	280 (23.7)	256 (18.6)	
Comorbidities n (%)				
Atrial fibrillation	1,169 (45.7)	550 (46.6)	619 (44.9)	0.37
Chronic ischemic heart disease	1,474 (57.6)	696 (59.0)	778 (56.4)	0.18
Chronic kidney disease	610 (23.8)	286 (24.2)	324 (23.5)	0.65
Chronic obstructive pulmonary disease	592 (23.1)	282 (23.9)	310 (22.5)	0.39
Conduction blocks	147 (5.7)	66 (5.6)	81 (5.9)	0.76
Diabetes mellitus	755 (29.5)	362 (30.7)	393 (28.5)	0.22
Heart failure	1,416 (55.3)	623 (52.8)	793 (57.5)	0.02
Hypertension	1,985 (77.5)	910 (77.1)	1,075 (77.9)	0.64
Infective endocarditis	293 (11.4)	131 (11.1)	162 (11.7)	0.61
Liver disease	121 (4.7)	43 (3.6)	78 (5.7)	0.02
Peripheral vascular disease	137 (5.4)	72 (6.1)	65 (4.7)	0.12
Stroke	75 (2.9)	35 (3.0)	33 (2.4)	0.37

The median age of the overall cohort was 68 (IQR: 58,76) years with 49.5% ($n = 1,268$) female and 12.6% ($n = 323$) Hispanic patients. Transfers from another acute care hospital to the facility performing surgery comprised 19.5% ($n = 498$) of the total population. Patients of the lowest income quartile comprised the greatest proportion of the population (28.0% ($n = 717$)). Majority of the population presented with comorbid chronic ischemic heart disease (57.6% ($n = 1,474$)), heart failure (55.3% ($n = 1,416$)), or hypertension (77.5% ($n = 1,985$)). High rates of comorbid atrial fibrillation (45.7% ($n = 1,169$)), CKD (23.1% ($n = 591$)), COPD (23.1% ($n = 692$)), and diabetes mellitus (29.5% ($n = 755$)) were also seen. Comorbid conduction block, infective endocarditis, liver disease, peripheral vascular disease, or prior stroke were seen in less than 15% of patients (Table 1). The median CCI of the population was 4 (IQR 3, 6) points, corresponding to an estimated 53% chance 10-year survival.

Within the population, 53.9% ($n = 1,380$) presented as an urgent/emergent admission, while 45.9% ($n = 1,176$) presented electively. MV regurgitation was the most common presenting MV pathology (47% ($n = 1,204$)), while MV stenosis (3.1% ($n = 3.1\%$)), chronic rheumatic MV disease (8.7% ($n = 223$)), and MV prolapse (5.6% ($n = 143$)) were less common. In-hospital mortality was 6.1% ($n = 156$), of which most presented in an urgent/emergent state (64.7% [$n = 101$]). The median LOS was 12 days (IQR: 8, 19) with a 7-day readmission rate of 4.3% ($n = 109$). Postoperative complications were uncommon in the population, with acute kidney injury being the most common (29.8% ($n = 763$)).

3.1.1. High-versusLow-Volume Centers. The average patient age was 69 (IQR: 58, 76) and 67 years (IQR 58, 75) at high- and low-volume centers, respectively ($p = 0.072$), with similar proportions of female patients. Low-volume centers saw more Hispanic patients and patients below the 50th income percentile. High-volume centers had significantly more transfers into the providing facility (Table 2). Rates of comorbid heart failure and liver disease were greater at low-volume centers. All other comorbidities were similar between high- and low-volume centers (Table 1). Additionally, CCI scores did not differ between high- and low-volume centers (4 [3, 6] vs. 4 [3, 6]; $p = 0.868$).

High-volume centers saw significantly more urgent/emergent cases than elective cases when compared to low-volume centers. More patients with MV regurgitation and chronic rheumatic MV disease presented to low-volume centers. Patients with MV stenosis or prolapse did not present differently based on volume cohorts (Table 2).

High-volume centers had greater unadjusted in-hospital mortality. However, when controlling for gender, race, case status, and CCI, hospital volume was not correlated with in-hospital mortality ($p = 0.084$). This was also demonstrated in the case status subgroup analysis. There were no statistically significant differences in in-hospital mortality between high- and low-volume centers in patients who presented electively centers (5.6% ($n = 25$) vs. 4.0% ($n = 29$); $p = 0.209$) or urgent/emergently (8.1% ($n = 59$) vs. 6.5% ($n = 42$); $p = 0.249$). LOS was longer at high-volume centers (13 [8, 20] vs. 11 [7, 18]; $p < 0.001$), while readmission rates were greater at low-volume centers. Postoperative complications did not significantly differ between high- and low-volume centers (Figure 1).

Table 2: Admission types and mitral valve pathology of patients undergoing mitral valve repair and replacement in New Jersey as a whole population and stratified by high- and low-volume centers.

	Total population ($n = 2{,}560$)	Mitral valve repair ($N = 198$)			Mitral valve replacement ($n = 2{,}362$)		
		High volume ($n = 54$)	Low volume ($n = 144$)	p value	High volume ($n = 1{,}126$)	Low volume ($n = 1{,}236$)	p value
Admission type n (%)				0.64			<0.001
Urgent/emergent	1,380 (53.9)	23 (42.6)	56 (38.9)		707 (62.8)	594 (48.1)	
Elective	1,176 (45.9)	31 (57.4)	88 (61.1)		418 (37.1)	639 (51.7)	
MV pathology n (%)							
MV regurgitation	1,204 (47.0)	39 (72.2)	107 (74.3)	0.77	470 (41.7)	570 (46.1)	0.03
MV stenosis	79 (3.1)	0	0	—	41 (3.6)	37 (3.0)	0.38
Chronic rheumatic MV disease	223 (8.7)	0	**	0.38	84 (7.5)	134 (10.8)	0.005
MV prolapse	143 (5.6)	**	17 (11.8)	0.89	57 (5.1)	63 (5.1)	0.97

MV: mitral valve. **total number ≤10, and exact values are removed for patient privacy.

3.1.2. MV Repair and Replacement by Volume. A subanalysis was conducted comparing high- to low-volume centers stratified by the procedure type: MV replacement or MV repair.

In patients who underwent MV replacement, differences in baseline characteristics and admission type reflected those seen in the total population (Table 3). CCI scores did not differ between high- and low-volume centers (4 [3, 6] vs. 4 [3, 6], $p = 0.901$). In patients who underwent MV replacement, a significantly higher proportion of those with MV stenosis presented to low-volume centers. There were no other differences in MV pathology (Table 2). Subanalysis of the MV replacement population demonstrated findings similar to those seen in the whole population. These differences included longer LOS at high-volume centers, greater rates of in-hospital mortality at high-volume centers, and greater rates of readmission at low-volume centers. While no significant differences between high- and low-volume centers were seen in postoperative complications in total population, the MV replacement subpopulation saw greater rates of heart failure at high-volume centers ($p = 0.025$) and greater rates of stroke at low-volume centers ($p = 0.046$) (Table 4). Multivariable regression indicated that when controlling for gender, race, case status, and CCI, hospital volume was not correlated with in-hospital mortality ($p = 0.075$).

Baseline characteristics of all patients who underwent MV repair were similar between cohorts except for a higher proportion of Hispanic patients presenting to low-volume centers (Table 3). CCI scores did not differ between high- and low-volume centers (3 [2, 5] vs. 4 [2, 5]; $p = 0.888$). There were no significant differences in the admission type in patients undergoing MV repair. No patients presenting with MV stenosis underwent repair; most patients who underwent MV repair presented with MV regurgitation at both high- and low-volume centers (Table 2). High-volume centers had longer LOS; there were no other significant differences in outcomes between high- and low-volume centers. However, low-volume centers tended towards greater rates of postoperative atrial fibrillation, heart failure, and renal failure (Table 4.). Multivariable regression indicated that when controlling for gender, race, case status, and CCI, hospital volume was not correlated with in-hospital mortality ($p = 0.935$).

4. Discussion

Our analysis of a large statewide database demonstrated the high frequency with which MV replacement is performed in comparison to repair. Low-volume centers were much more numerous throughout the state and thus cumulatively treated roughly equal numbers of patients as high-volume centers. Low-volume centers care for Hispanic patients and patients with low household incomes more frequently than high-volume centers. Patient risk, defined by CCI scores, did not differ by center volume in the total population nor the repair and replacement subgroups. Outcomes after MV replacement were not statistically different between low- and high-volume hospitals. No clear volume-outcome association was seen in the MV replacement subgroup, whereas outcomes were similar between high- and low-volume centers when examining MV repair alone. Despite higher rates of in-hospital mortality at high-volume centers, in-hospital mortality was not correlated with hospital volume when controlling for baseline characteristics, case status, and CCI.

There were evident disparities in access to high-volume centers based on race and socioeconomic status. We hypothesize that this difference may be due to geographic distances and convenience of near-by hospitals. Low-volume hospitals are 3.75 times more numerous throughout the state of NJ and thus are more likely to be frequented by marginalized groups who may experience geographic and transportation barriers. Further, previous studies have demonstrated that in areas of high segregation, minority patients tend to present to hospitals of lower quality more frequently, possibly due to feelings of unwelcomeness at the hospital [15]. This underscores the critical component of patient care, physician referral. Patients with low health literacy are unlikely to know of and understand interhospital differences, and thus the referring physician must be aware of mitral centers of excellence so that their care can be optimized [6]. The physician must consider the needs of the

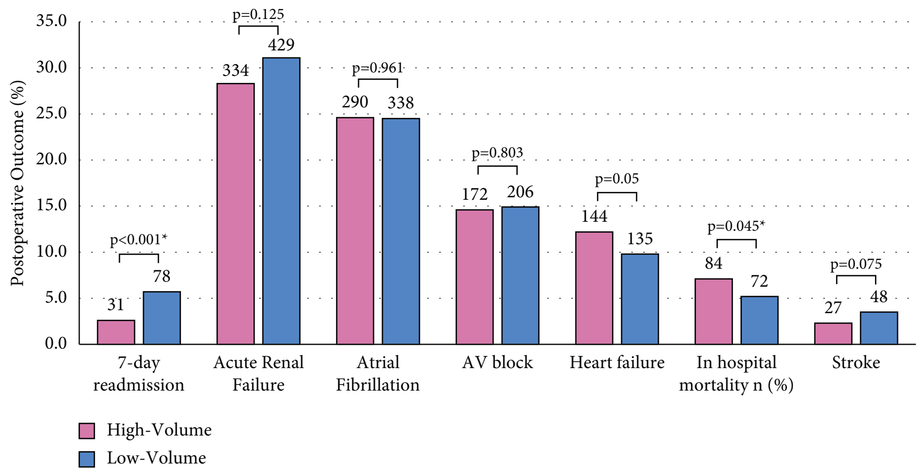

Figure 1: Outcomes of patients who underwent open mitral valve surgery in New Jersey stratified by high- and low-volume centers. AV: atrioventricular. *indicates statistical significance.

Table 3: Baseline characteristics and comorbidities of patients undergoing mitral valve repair and replacement in New Jersey stratified by high- and low-volume centers within each procedure.

	Mitral valve repair ($N = 198$)			Mitral valve replacement ($N = 2,362$)		
	High volume ($n = 54$)	Low volume ($n = 144$)	p value	High volume ($n = 1,126$)	Low volume ($n = 1,236$)	p value
Baseline characteristics						
Age median (IQR)	66 (57, 76)	66 (57, 74)	0.82	69 (58, 76)	67.5 (58, 75)	0.096
Female n (%)	20 (37.0)	51 (35.4)	0.83	570 (50.6)	627 (50.7)	0.98
Hispanic n (%)	**	25 (17.4)	0.01	116 (10.3)	180 (14.6)	0.002
Transfer into facility	11 (20.4)	13 (9.0)	0.09	280 (24.9)	194 (15.7)	<0.001
Socioeconomic status n (%)			0.68			<0.001
25th percentile	**	34 (23.6)		295 (26.2)	278 (30.6)	
50th percentile	12 (22.2)	39 (27.1)		256 (22.7)	361 (29.2)	
75th percentile	14 (25.9)	29 (20.1)		309 (27.4)	274 (22.2)	
100th percentile	17 (31.5)	42 (29.1)		263 (23.4)	214 (17.3)	
Comorbidities n (%)						
Atrial fibrillation	22 (40.7)	55 (38.2)	0.74	528 (46.9)	564 (45.6)	0.54
Chronic ischemic heart disease	29 (53.7)	81 (56.3)	0.75	667 (59.2)	697 (56.4)	0.16
Chronic kidney disease	11 (20.4)	25 (17.4)	0.63	270 (24.0)	285 (23.1)	0.60
Chronic obstructive pulmonary disease	**	30 (20.8)	0.72	275 (24.4)	299 (24.2)	0.90
Conduction blocks	**	**	0.49	62 (5.5)	74 (6.0)	0.62
Diabetes mellitus	18 (33.3)	37 (25.7)	0.29	344 (30.6)	356 (28.8)	0.35
Heart failure	28 (51.9)	77 (53.5)	0.84	595 (52.8)	716 (57.9)	0.01
Hypertension	43 (79.6)	114 (79.2)	0.94	867 (77.0)	961 (77.8)	0.66
Infective endocarditis	**	**	0.22	127 (11.3)	158 (12.8)	0.26
Liver disease	**	**	1.000	42 (3.7)	74 (6.0)	0.01
Peripheral vascular disease	**	**	1.000	70 (6.2)	60 (4.9)	0.15
Stroke	**	**	0.47	34 (3.0)	32 (2.6)	0.53

**total number ≤10, and exact values are removed for patient privacy.

patient as a whole, including the complexity of disease and social factors, when making a referral.

Despite greater levels of experience at high-volume centers, patients at these centers were found to have longer hospital LOS. While seemingly contradictory, this is in accordance with other national studies [16, 17]. Although not previously explained, we hypothesize that this finding may be due to differences in patient presentation and plan of care. Urgent/emergent admissions and transfers into the facility were more prevalent at high-volume centers, possibly indicating a delay in high-level care. These high acuity cases comprised the majority of the in-hospital mortality and are likely to be more intricate and complicated, thus prolonging hospital LOS. This patient population may also see a high rate of replacement as compared to repair due to the acute nature. Conversely, high-volume centers saw lower rates of 7-day readmission and postoperative stroke. High-volume centers are more likely to have diverse heart teams such as

Table 4: Outcomes of patients undergoing mitral valve repair and replacement in New Jersey as a whole population and stratified by high- and low-volume centers.

	Total population ($N = 2{,}560$)	Mitral valve repair ($N = 198$)			Mitral valve replacement ($N = 2{,}362$)		
		High volume ($n = 54$)	Low volume ($n = 144$)	p value	High volume ($n = 1{,}126$)	Low volume ($n = 1{,}236$)	p value
In hospital mortality n (%)	156 (6.1%)	**	**	1.000	82 (7.3%)	65 (5.3%)	0.042
7-day readmission n (%)	109 (4.3%)	**	**	0.669	28 (2.5%)	75 (6.1%)	<0.001
Length of stay median (IQR)	12 (8, 19)	11 (7, 18)	8 (5, 13)	0.036	13 (8, 20)	12 (7, 18)	<0.001
Postoperative complications n (%)							
Atrial fibrillation	628 (24.5%)	**	31 (21.5%)	0.698	280 (24.9%)	307 (24.8%)	0.987
Atrioventricular block	378 (14.8%)	**	**	1.000	169 (15.0%)	198 (16.0%)	0.498
Heart failure	279 (10.9%)	**	14 (9.7%)	0.73	148 (12.7%)	121 (9.8%)	0.025
Renal failure	763 (29.8%)	**	32 (22.2%)	0.697	324 (28.8%)	297 (24.0%)	0.078
Stroke	75 (2.9%)	**	**	0.472	26 (2.3%)	46 (3.7%)	0.046

IQR: interquartile range. **total number ≤10, and exact values are removed for patient privacy.

inpatient cardiology, electrophysiology, heart failure cardiology, cardiac anesthesia, and cardiac surgery. Experienced personnel may be better able to assess readiness for discharge and rapidly identify and treat conditions, such as atrial fibrillation [18], prior to development of complications, subsequently decreasing 7-day readmission and stroke rates, respectively. The finding of greater rates of in-hospital mortality at high-volume hospitals was not present when controlling for baseline characteristics, case status, and comorbidities, further demonstrating that hospital volume alone does not indicate quality of care. Overall, the mixed outcomes seen after MV replacement suggest that broad view national studies may fail to account for geographic diversity in outcomes.

The outcomes of MV repair did not differ significantly between high- and low-volume centers, apart from longer LOS at high-volume hospitals, a stark contrast to MV replacement outcomes. This curious finding conflicts with prior studies that have shown lower operative [5] and perioperative [4] mortality and higher 10-year survival [5] in MV repair performed on well-selected candidates. In our study, MV repairs were performed at a 1 : 12 ratio to MV replacements, as noted in Tables 2 and 3. The technical expertise required to successfully repair the valve often leads surgeons to choose replacement instead [19], reflected in our finding of the majority (86.4% ($n = 1{,}040$)) of regurgitant valves being replaced. Developing proficiency with the various repair techniques requires substantial exposure to the procedures, hence recommendations for referral to mitral centers of excellence [7]. Recent efforts have focused on developing simulations for MV repair [20, 21] to help surgeons gain experience without the additional concern of extended heart-lung bypass time [20]. These findings further emphasize the geographic variability of the volume-outcome relationship.

Our study is not without limitations. The use of an administrative dataset limits granularity of the analysis, notably identifying etiology of mitral valve disease and identifying specific cardiac risk factors that would allow us to compute an STS score. Furthermore, it may contain clerical and collection errors which we are not able to address. We used the threshold of 50 mitral surgeries per year to define high-vs. low-volume centers based on the current guidelines [6, 7], and it should be noted that a different threshold would likely yield different results. We also acknowledge that this is a study limited to NJ and may not be widely generalizable to other populations. Additionally, our study included but did not specifically identify concurrent procedures which can impact outcomes. Regardless, this is important research because it demonstrates that hospital volume should not be used as an independent indicator of hospital quality as well as the rarity with which MV repair is performed. Studies should be performed in other geographically distinct locations to assess the volume-outcome relationship in other areas.

5. Conclusion

Ultimately, there is an unclear relationship between hospital volume and outcomes in MV repair or replacement. NJ is an example of a microcosm where national trends are not seen when examined more closely, suggesting that the volume-outcome relationship may be geographically diverse than national studies imply. Increased operative experience and specialized training in MV repair are critical for improved patient outcomes at the surgeon level, but more representative quality benchmarks are needed at the hospital level rather than volume alone.

Data Availability

The data were obtained from the Healthcare Cost and Utilization Project (HCUP) from the Agency for Healthcare Research and Quality. Users can purchase the data after completing the HCUP Data Use Agreement and associated training. Data are protected for legal and ethical purposes. More information can be found at the following link: https://www.hcup-us.ahrq.gov/db/state/siddbdocumentation.jsp.

Ethical Approval

This study was deemed exempt from review by the Rutgers Robert Wood Johnson Medical School Institutional Review Board.

Disclosure

MJR discloses financial relationships with Edwards Lifesciences and Abbott Laboratories. LYL discloses a financial relationship with Abbott Laboratories.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

The authors acknowledge Susette Coyle and Marie Macor for their invaluable contribution to this study.

Supplementary Materials

ICD-10-CM codes utilized to determine comorbidities, mitral valve pathology, and postoperative complications for patients undergoing mitral valve surgery in New Jersey from 2016 to 2019. (*Supplementary Materials*)

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