Hospital volume, mitral repair rates, and mortality in mitral valve surgery in the elderly: An analysis of US hospitals treating Medicare fee-for-service patients

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ABSTRACT

Background: The volume-outcome relationship has been suggested as a quality metric in mitral valve surgery and would be particularly relevant in the elderly because of their greater burden of comorbidities and higher perioperative risk.

Methods and Results: The study included 1239 hospitals performing mitral valve surgery on Medicare beneficiaries from 2000 through 2009. Only 9% of hospitals performed more than 40 mitral operations per year, 29% performed 5 or less, and 51% performed 10 or less. Mitral repair rates were low; 22.7% of hospitals performed 1 or less, 65.1% performed 5 or less, and only 5.6% performed more than 20 mitral repairs per year in those aged 65 years or more. Repair rates increased with increasing volume of mitral operations per year: 5 or less, 30.5%; 6 to 10, 32.9%; 11 to 20, 34.9%; 21 to 40, 38.8%; and more than 40, 42.0% ($P = .0001$). Hospitals with lower volume had significantly higher adjusted operative mortality compared with hospitals performing more than 40 cases per year: 5 or less cases per year, odds ratio (OR) 1.58 (95% confidence interval [CI], 1.40-1.78); 6 to 10 cases per year, OR 1.29 (95% CI, 1.17-1.43); 11 to 20 cases per year, OR 1.17 (95% CI, 1.07-1.28); 21 to 40 cases per year, OR 1.15 (95% CI, 1.05-1.26). Hospitals with lower mitral repair rates had an increased likelihood of operative mortality relative to the top quartile: lowest quartile, OR 1.31 (95% CI, 1.20-1.44); second quartile, OR 1.18 (95% CI, 1.09-1.29); and third quartile, OR 1.14 (95% CI, 1.05-1.24). Long-term mortality beyond 6 months was also higher in low-volume hospitals: 5 or less cases year, hazard ratio (HR) 1.11 (95% CI, 1.06-1.18); 6 to 10 cases per year, OR 1.06 (95% CI, 1.02-1.10) compared with hospitals performing more than 40 cases per year.

Conclusions: Most hospitals perform few mitral valve operations on elderly patients. Greater volume of mitral procedures was associated with higher repair rates. Both greater volume of mitral procedures and increasing mitral repair rates were associated with decreased mortality. (J Thorac Cardiovasc Surg 2015;149:762-8)

Operative mortality and mitral repair rates

	OR	95%LL	95%UL	p-value
Hosp annual MV volume ≤5*	1.58	1.40	1.78	
Hosp annual MV volume >5-10*	1.29	1.17	1.43	0.0001
Hosp annual MV volume >10-20*	1.17	1.07	1.28	
Hosp annual MV volume >20-40*	1.15	1.05	1.26	
* versus >40 / year				
Repair rate - 1st quartile**	1.31	1.20	1.44	
Repair rate - 2nd quartile**	1.18	1.09	1.29	0.0001
Repair rate - 3rd quartile**	1.14	1.05	1.24	
** versus top quartile				
	Repair rate (%)			
Hosp annual MV volume ≤5	30.5			
Hosp annual MV volume >5-10	32.9			
Hosp annual MV volume >10-20	34.9			
Hosp annual MV volume >20-40	38.8			
Hosp annual MV volume >40	42.0			

Odds ratios for adjusted operative mortality along with mitral valve repair rates.

Central Message

The majority of hospitals perform few mitral valve operations. Greater mitral procedural volume was associated with lower adjusted mortality, higher long-term survival, and higher repair rates. Lower hospital mitral repair rates were also independently predictive of higher mortality.

Author Perspective

Prior studies have found a relationship between volume and outcomes in cardiac surgery. We found that valve repair rates and mortality vary by hospital annual mitral procedure volume and that the majority of hospitals have a limited experience in treating elderly patients with mitral valve disease. We found a significant increase in mitral repair rates and a decrease in mortality as a function of hospital annual mitral procedure volume. Our findings support and extend prior reports suggesting that instituting specific volume thresholds for hospitals wishing to perform mitral valve surgery may lead to improved surgical outcomes.

See Editorial Commentary pages 769-70.

Supplemental material is available online.

The management of elderly patients with mitral valve disease is complex. Options include medical management of heart failure symptoms and surgical intervention, consisting of either mitral repair or replacement. We recently found that outcomes after mitral surgery in the Medicare population are much better than previously reported; survival for those who underwent repair was similar to the age- and gender-matched US population.[1] Despite these favorable outcomes, mitral replacement is much more common in the elderly.[2] Hospitals vary dramatically in the number of mitral valve operations performed.

Previous studies have investigated the relationship between volume and outcome in mitral valve surgery.[3,4] Using data from the Society of Thoracic Surgeons (STS) database, Gammie and colleagues[3] analyzed data from

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Received for publication April 8, 2014; revisions received Aug 27, 2014; accepted for publication Aug 31, 2014; available ahead of print Oct 24, 2014.

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0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2014.08.084

Abbreviations and Acronyms

BASF = Beneficiary Annual Summary Files
CI = confidence interval
CMS = Centers for Medicare and Medicaid Services
HR = hazard ratio
MEDPAR = Medicare Provider Analysis and Review
NIS = Nationwide Inpatient Sample
OR = odds ratio
STS = Society of Thoracic Surgeons

575 participating hospitals from 2000 to 2003 and found that a higher volume of mitral procedures was associated with lower adjusted operative mortality and increased repair rates.[3] Because the mean age of the patient population included in that report was lower than 65 years, it is unclear if these findings can be extrapolated to older patients. In addition, far fewer hospitals participated in the STS at that time and it is possible that participating hospitals differed from nonparticipating hospitals. A more representative analysis of contemporary treatment in the elderly is needed to support this previously reported volume-outcome relationship.

Birkmeyer and colleagues[4] used the Medicare database to examine the relationship between hospital volume and surgical mortality for a variety of procedures in the United States, including aortic and mitral valve replacement and found an inverse relationship. This methodology was limited by not taking into account the interhospital variability in the proportion of Medicare cases performed (ie, it was assumed that hospitals do not differ in the number of Medicare patients they see) as well as any variability of the proportion of Medicare cases performed at each hospital over time. Moreover, it did not include information on mitral repair, a procedure that has been used with increasing frequency in mitral valve surgery. The purpose of this investigation was to extend these previous efforts by providing a descriptive analysis of the association between hospital volume of mitral procedures, mitral valve repair rates, and mortality in the Medicare population.

METHODS

Data Sources

The data files used for the present study included the Medicare Provider Analysis and Review (MEDPAR) files and corresponding Beneficiary Annual Summary Files (BASF) from 1999 to 2009. The MEDPAR files contain institutional claims for inpatient services covered under Part A. The BASF files contain information on patient demographics, eligibility, enrollment, summarized service utilization and payment, and chronic condition flags for eligible beneficiaries. The Vital Status file for February 2012 was used to calculate long-term survival.

The study was approved by the Institutional Review Board of Southern Illinois University, which waived the requirement for informed consent. In addition, beneficiary confidentiality data was protected through a rigorous data use agreement with Centers for Medicare and Medicaid Services (CMS).

Patient Cohort

All Medicare beneficiaries aged 65 years or older who underwent mitral valve repair (International Classification of Diseases, Ninth Edition, Clinical Modification [ICD-9-CM] code 35.12) or replacement (35.23 or 35.24) from 2000 through 2009 were considered for inclusion. Figure 1 provides a flowchart outlining patient selection for the analysis. The ICD-9 codes used for the exclusions are provided in Table E1. Patients with significant concomitant procedures or other nonvalvular procedures were excluded to more directly assess the relationship between the volume of more straightforward mitral valve operations and outcomes. In addition, to ensure a more complete assessment of patient risk factors, patients were excluded if they did not have 12 months of Medicare Part A and Part B coverage in the year preceding their index admission, or if they had a period of enrollment under a Medicare managed plan at any point in the year before their index admission. Patients with emergency admission status were also excluded from the analysis.

Data Variables

The index admission was defined as the first hospitalization documenting a mitral valve repair or replacement during the 10-year period from 2000 through 2009. Demographic and comorbidity data were obtained from the MEDPAR file, using ICD-9-CM diagnostic codes from both the index admission and any hospitalizations during the 12-month period before the index admission. Operative mortality was defined as hospital or 30-day mortality, whichever was longer, in accordance with the standard STS definition. Long-term mortality was calculated from the Vital Status file for February 2012. Hospital annual volume of mitral procedures was calculated as the average number of mitral valve operations per year, that is, the total number of mitral valve operations paid for by Medicare over the 10-year study period, divided by the number of years that the hospital reported performing mitral valve operations. Thus, if a hospital had claims only in 6 of the 10 years, the total number of claims would be divided by 6. After examining the distribution of annual mitral valve volumes across hospitals, we identified clinically and statistically relevant categories of annual volumes. Similarly, the hospital annual volume of mitral repairs was defined as the average number of mitral valve repairs per year. The average annual mitral repair rates for each hospital were categorized into quartiles of the distribution across the hospitals.

Statistical Analysis

Categorical patient characteristics were compared across the volume groups using the χ^2 test, including observed mitral repair rates. A Cochran-Armitage trend test was used to assess the influence of the volume of mitral procedures on mitral repair rates. In order to account for clustering of patients within hospitals, hierarchical logistic regression was used to model operative mortality. Adjusted odds ratios (ORs) are presented, accounting for the clustering of patients within hospitals, the hospital characteristics of annual volume of mitral valve procedures and mitral valve repair rates, as well as the baseline patient and surgery characteristics. Similarly, Cox proportional hazards models, specifying hospital as a random effect to account for patients being nested within hospitals, were used to examine the impact of patient and hospital characteristics on long-term mortality beyond 6 months. After inspecting mortality curves, we chose to look at the impact of these factors on long-term mortality after the initial 6-month period after surgery because there is a high mortality phase immediately after surgery followed by a fairly constant hazard of death thereafter. Adjusted hazard ratios (HRs) reflecting the relative increase/decrease in the likelihood of death over the follow-up period from more than 6 months to 10 years are presented. All analyses were performed using SAS v 9.3 (SAS Institute Inc, Cary, NC).