Outcomes for Mitral Valve Surgery Among Medicare Fee-for-Service Beneficiaries, 1999 to 2008

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Background—Mitral valve surgery in older adults carries with it substantial morbidity and mortality risks, yet there are a paucity of national surveillance data. Therefore, we sought to determine trends in hospitalization rate, readmission, and mortality among Medicare fee-for-service (FFS) patients undergoing mitral valve surgery.

Methods and Results—Inpatient Medicare standard analytic files were used to identify 100% of FFS patients aged ≥65 years who underwent mitral valve surgery between 1999 and 2008. We constructed a denominator file from Medicare administrative data to report hospitalization rates for mitral valve surgery (total and isolated) per 100 000 beneficiary-years. For isolated mitral valve surgery, 30-day readmission, 30-day mortality, and 1-year mortality outcomes were ascertained through corresponding inpatient and vital status files, and risk-standardized rates were calculated adjusting for age, sex, race, and comorbidities. During 1999 to 2008, the overall rate of mitral valve surgery per 100K beneficiary-years declined (56/100K to 51/100K), and the proportion of patients undergoing mitral valve repair (versus replacement) increased (24.7% to 46.9%, P<0.001). For isolated mitral valve surgery, there were significant declines in risk-adjusted 30-day mortality (8.1% to 4.2%, P<0.001 for trend) and 1-year mortality (15.3% to 9.2%, P=0.003 for trend) and a slight decline in risk-adjusted 30-day readmission (23.0% to 21.0%, P=0.035 for trend) over the study period. Mortality rates decreased in all age, sex, and race subgroups, and among patients undergoing mitral valve repair or replacement, but remained higher among patients aged ≥85 years, women, and nonwhites.


Key Words: elderly • mitral valve • mortality • outcomes research • surgery

Advances in US life expectancy have led to an increasing prevalence of nonrheumatic valvular heart disease.1,2 Degenerative or ischemic mitral valve disease (most often regurgitation) is one of the most common of these conditions in older US adults; moderate or severe mitral regurgitation is present in up to 1 of 11 individuals aged 75 years or older.2 Mitral valve surgery (repair or replacement) remains the only definitive therapy to improve prognosis in selected patients.3 Recent studies have reported that the risk of in-hospital mortality after mitral valve surgery has been decreasing over time, possibly due to improved operative techniques4 and postoperative care.5 Although these reports are encouraging, there are several limitations and gaps in current knowledge. First, in-hospital mortality results may be biased by trends toward earlier discharge home or transfers to other facilities over time.6–8 Standardizing mortality measurement over a 30-day follow-up period reduces this potential for confounding6 and has been used as a benchmark in studies of other cardiac procedures such as coronary artery bypass grafting (CABG).9 In addition, 30-day hospital readmission and 1-year mortality have not been assessed nationally.

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John A. Dodson, MD, has been selected as a finalist for the Quality of Care and Outcomes Research Young Investigator Award.

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In this study, we sought to determine national trends in procedure rates and outcomes for mitral valve surgery between 1999 and 2008. We assess trends by age, sex, and race, as well as by state. We used data from 100% of Medicare fee-for-service (FFS) beneficiaries undergoing mitral valve surgery over the 10-year time period with standardized follow-up intervals of 30 days and 1 year. These data can inform patients about outcomes after surgery, serve as a national benchmark for older patients undergoing mitral valve surgery and address whether there are disparate outcomes among demographic subgroups or geographic regions that can be targeted for improvement.

WHAT IS KNOWN

- Mitral valve surgery is associated with substantial morbidity and mortality in older adults.
- Single-center studies have reported a decline over time in mortality after mitral valve surgery.

WHAT THE STUDY ADDS

- Among a national sample of Medicare fee-for-service beneficiaries ≥65 years of age, 30-day and 1-year mortality after isolated mitral valve surgery declined significantly from 1999 to 2008.
- Risk-adjusted 30-day readmission also declined, although to a smaller degree.
- Mortality rates remained higher in women and blacks across all years; in 2008, women and blacks were 16% and 15% more likely to die 1 year after mitral valve surgery, compared with men and whites, respectively.
- Rates of mitral valve repair increased from one-quarter to nearly one-half of all mitral valve surgeries over the study period.
- Among states and territories, 29 of 52 experienced a significant decline in mortality, whereas mortality rates in the remainder were unchanged.

We obtained Medicare denominator files from 1999 to 2008 which contained information about patients’ eligibility and enrollment in Medicare. Death was determined through the corresponding CMS vital status file (which included in-hospital and out-of-hospital mortality). Patients were excluded if they were <65 years of age, or resided outside of the 50 US states, the District of Columbia, or Puerto Rico.

Patient Characteristics and Comorbidities

We examined characteristics of patients undergoing mitral valve surgery across strata of age (65–74, 75–84, ≥85 years), sex, and race (white, black, other). Race was determined from the Medicare denominator file and was patient-reported. Comorbidities were drawn from those used for profiling hospitals by the CMS 30-day mortality measures for acute myocardial infarction,10 heart failure,11 and pneumonia12 They were identified from secondary diagnosis codes recorded at time of discharge from hospitalization for mitral valve surgery (which did not represent a potential complication) as well as primary or secondary diagnosis codes of all inpatient hospitalizations up to 1 year before hospitalization for surgery. Hospital length of stay (LOS) was calculated as the difference between the discharge and admission dates. We also reported the presurgery LOS, defined as the difference between the procedure and admission dates. If a discharge or procedure date was same as the date of admission, then LOS was 1.

Primary Outcomes

There were 3 main outcomes: hospitalization for surgery, mortality, and readmission. For each year, hospitalization for surgery was calculated by dividing the total number of mitral valve surgeries performed (numerator) by the total accumulated person-years of time (denominator). Because in a given year some beneficiaries were in Medicare FFS for less than 12 months, the denominator was calculated as the total number of months enrolled or at risk, converted to person-years. All rates are reported per 100,000 person-years. We further determined the proportion of patients undergoing mitral valve repair or receiving bioprosthetic or mechanical valves, and the proportion undergoing isolated mitral valve surgery.

For the 30-day and 1-year mortality outcomes, we identified all hospitalizations for mitral valve surgery that occurred in a given year; if a patient had more than 1 mitral valve surgery during the year, 1 hospitalization was selected at random, consistent with methods used to calculate CMS publicly reported mortality measures for acute myocardial infarction,10 heart failure,11 and pneumonia12 The 30-day and 1-year mortality rates were calculated as the percentage of patients who died within 30 days and 1 year, respectively, from the date of procedure.

To generate 30-day readmission rates we calculated the percentage of patients who were discharged alive, not transferred to another acute care hospital, and readmitted to any hospital within 30 days of discharge for the index mitral valve surgery, consistent with the CMS publicly reported measures.13–15 With respect to the procedure rates, we reported trends in both patients undergoing any mitral valve surgery and the subgroup who underwent isolated mitral valve surgery. For the mortality and readmission outcomes we focused on the subgroup of patients undergoing isolated mitral valve surgery to avoid confounding by changes in higher-risk concomitant operations (eg, CABG, aortic valve replacement) over time.

Statistical Analysis

To analyze whether changes over time in the primary outcomes (mitral valve surgery rate, mortality rate, and readmission rate) were statistically significant, we used the Mantel-Haenszel χ² test. We also used this test in demographic subgroups (age, sex, and race) that were prespecified.

Methods

Data Source and Coding

We used National Claims History files from the Centers for Medicare and Medicaid Services (CMS) to identify all hospitalizations for Medicare FFS beneficiaries between January 1, 1999, and December 31, 2008. Each record included information on patient demographics (age, sex, and race); admission, procedure, and discharge dates; discharge disposition; and up to 10 discharge diagnoses and 6 procedures (which were coded according to the International Classification of Diseases, Ninth Revision, Clinical Modification [ICD-9-CM]). We defined hospitalization for mitral valve surgery as any of the following ICD-9-CM codes: 35.12 (mitral valve repair), 35.23 (bioprosthetic mitral valve replacement), or 35.24 (mechanical mitral valve replacement). We further defined a subgroup of patients undergoing “isolated mitral valve surgery” by excluding patients with the following coexisting codes: CABG (36.10–36.17, 36.19), aortic valve repair/replacement (35.11, 35.21, 35.22), tricuspid valve repair/replacement (35.14, 35.27, 35.28), endocarditis (421.0, 421.1, 421.9), or cardiogenic shock (785.1).
To estimate the national trend in mitral valve surgery rates over time, we calculated the total number of all hospitalizations for mitral valve surgery and the total person-years in each state by year for 18 demographic combinations—representing three age categories (65–74, 75–84, and 85 years), 2 sex categories, and 3 race categories (white, black, other). We then fitted a generalized linear mixed effects model with a Poisson link function and state-specific random intercepts, adjusting for age, sex, and race. The log-transformed total person-years value was used as an offset in the model to obtain the expected number of hospitalizations. To estimate the national trend in mortality (30-day and 1-year) and readmission rates over time, we fitted a linear mixed effects model with a logit link function and state-specific random intercepts, adjusting for patient covariates from previously validated mortality models10–12 including age, sex, race, and 21 comorbidities available from administrative coding. Analyses of trends for the risk-standardized outcomes were performed by including dummy time variables representing subsequent years in the models. Specifically, using the baseline year (1999) as the reference year, we calculated the risk-adjusted incidence rate ratio for hospitalization and the risk-adjusted odds ratio for mortality and readmission in each subsequent year. We used the method of Zhang and Yu16 to convert odds ratio values obtained from the mixed-effects modeling to relative risk estimates. We then used the derived relative risk values to calculate risk-adjusted mortality and readmission rates for each year.

To evaluate the state-specific changes in mitral valve surgery and 1-year mortality rates during the study period, we calculated both the 1999 and the 2008 risk-standardized rates for mitral valve surgery hospitalization and mortality for each of the 50 states, the District of Columbia, and Puerto Rico. We used the nonparametric bootstrap method to generate 3000 samples with replacement to obtain the 95% confidence interval for the state-specific change estimates between 1999 and 2008. We reported the number of states within each Census region that were similar, higher, or lower when compared with the null hypothesis (of zero change). Using bootstrapping samples, we also calculated the probability that the state-specific change was greater than the null hypothesis.

All analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC). A probability value of <0.05 (2-sided test) was considered statistically significant. To facilitate data presentation, patient characteristics were reported in 2-year intervals over the study period. Institutional review board approval was

### Table 1. Characteristics of Patients Hospitalized for Mitral Valve Surgery (Total), 1999 to 2008

| Year            | Age (SD) | Female | White | Black | Other | Congestive heart failure | Prior myocardial infarction | Unstable angina | Coronary artery disease | Hypertension | Stroke | Cerebrovascular disease | Peripheral vascular disease |
|-----------------|----------|--------|-------|-------|-------|--------------------------|----------------------------|---------------------------|----------------------|------------------------|----------------|--------|------------------------|-----------------------------|
| 1999 to 2000    | 74.8 (5.4) | 55.4%  | 93.0% | 3.8%  | 3.2%  | 30.1%                  | 5.5%                        | 5.5%                     | 52.1%              | 44.3%                  | 1.3%   | 3.6%  | 5.1%                  |
| 2001 to 2002    | 74.9 (5.5) | 54.7%  | 92.4% | 4.5%  | 3.2%  | 29.2%                  | 5.5%                        | 4.7%                     | 52.9%              | 49.1%                  | 1.3%   | 3.5%  | 5.3%                  |
| 2003 to 2004    | 75.1 (5.7) | 52.6%  | 91.7% | 4.5%  | 3.7%  | 29.2%                  | 5.5%                        | 4.0%                     | 52.7%              | 50.2%                  | 1.2%   | 3.4%  | 6.1%                  |
| 2005 to 2006    | 75.1 (5.8) | 51.2%  | 91.3% | 4.8%  | 3.9%  | 28.3%                  | 4.9%                        | 3.3%                     | 49.9%              | 49.5%                  | 1.4%   | 3.0%  | 5.9%                  |
| 2007 to 2008    | 75.2 (6.0) | 50.6%  | 91.3% | 4.7%  | 4.0%  | 28.2%                  | 5.1%                        | 2.9%                     | 49.0%              | 52.1%                  | 1.6%   | 3.2%  | 5.9%                  |

COPD indicates chronic obstructive pulmonary disease.

*Includes hemiplegia, paraplegia, paralysis, and functional disability.
obtained through the Yale University Human Investigation Committee, and the requirement for informed consent was waived based on the nature of the study. Beneficiary confidentiality was protected through a data use agreement with CMS.

### Results

#### Patient Characteristics

Characteristics of the study sample are shown in Table 1. Between 1999 and 2008, the mean age of patients undergoing mitral valve surgery increased slightly from 74.8 to 75.2 years, the percentage of female patients decreased from 55.4% to 50.6%, and the percentage of nonwhite patients increased from 7.0% to 8.7%. The prevalence of most comorbidities remained relatively stable, although there were increases in renal failure (3.8% to 11.0%) and in hypertension (44.3% to 52.1%).

### Hospitalization for Mitral Valve Surgery

Table 2 presents the hospitalization rates for total and isolated mitral valve surgery per 100,000 person-years over time. The hospitalization rate for total mitral valve surgery increased slightly from 56/100K in 1999 to 59/100K in 2002, and subsequently declined to 51/100K in 2008 ($P<0.001$). The percentage of patients undergoing either mitral valve repair or bioprosthetic replacement increased from 1999 to 2008 (24.7% to 46.9% and 23.8% to 33.0% respectively, $P<0.001$ for both trends); correspondingly, the percentage of patients undergoing mechan-
ich mitral valve replacement decreased (51.5% to 20.1%, \( P<0.001 \)) (Table 2 and Figure 1). Over time, rates decreased in patients aged 65 to 74 years and increased in patients aged \( \geq 85 \) years; thus, patients \( \geq 85 \) years of age constituted a greater percentage of the total mitral valve surgery population in 2008 than in 1999 (12.7% versus 8.8%, \( P<0.001 \)). Men were more likely to undergo mitral valve surgery than women in all years (in 2008: 59/100K for men, 44/100K for women). In addition, white patients were more likely to undergo mitral valve surgery than patients of black or other race across all years.

As shown in Table 2, the performance of isolated mitral valve surgery declined slightly over time as well (23/100K in 1999 versus 20/100K in 2008, \( P<0.001 \)). As a proportion of total mitral valve surgery, isolated mitral valve surgery remained relatively stable (41.1% in 1999 versus 39.2% in 2008). Similar to total mitral valve surgery, patients aged \( \geq 85 \) years constituted a greater proportion of patients receiving isolated mitral valve surgery in 2008 than in 1999 (12.0% versus 7.5%). In contrast to total mitral valve surgery, men and women underwent isolated mitral valve surgeries at similar rates (in 2008: males, 20/100K; females, 19/100K). Whites were more likely than nonwhites to undergo isolated mitral valve surgery (in 2008: whites, 21/100K; blacks, 13/100K; others, 12/100K).

### Primary Outcomes

Outcomes of 30-day readmission, 30-day mortality, and 1-year mortality were analyzed for the subgroup of patients undergoing isolated mitral valve surgery, to reduce the potential for confounding by temporal changes in concomitant operations that may have affected readmission and mortality risk. Among patients undergoing isolated mitral valve surgery, there was a slight decline in the observed 30-day readmission rate (22.9% in 1999 versus 21.9% in 2008, \( P<0.001 \)) and more substantial declines in the 30-day mortality rate (8.1% in 1999 versus 6.0% in 2008, \( P<0.001 \)), and 1-year mortality rate (15.3% in 1999 versus 12.5% in 2008, \( P<0.001 \)) (Table 3).

In subgroup analyses, there were no major declines in 30-day readmission from 1999 to 2008 among nonwhites (black race: 25.7% to 25.3%; other race: 24.4% to 28.6%) or women (24.2% to 24.0%). For 30-day and 1-year mortality, significant declines were observed among all subgroups of age, sex, and race, although overall 1-year mortality rates remained higher among patients aged \( \geq 85 \) years, women, and nonwhites across all years.

After adjustment for demographics and comorbidities, the declines in 30-day mortality (8.1% to 4.2%, \( P<0.001 \) for trend), 1-year mortality (15.3% to 9.2%, \( P=0.003 \) for trend) and 30-day readmission (23.0% to 21.0%, \( P=0.035 \) for trend) over the study period remained statistically significant (Figure 2).

To explore the association between type of surgery and the observed mortality trends, we examined the three surgical subgroups. The unadjusted 1-year mortality rate was lowest across all years in patients undergoing mitral valve repair compared with bioprosthetic or mechanical mitral valve replacement (Figure 3). Absolute 1-year mortality from 1999 to 2008 declined the most among patients undergoing mitral valve repair (10.2% to 7.8%, \( P<0.01 \)) but also declined significantly among patients undergoing bioprosthetic mitral valve replacement (18.1% to 17.3%, \( P<0.01 \)). Among patients undergoing mechanical mitral valve replacement, mortality increased from 16.5% in 1999% to 18.2% in 2006 and then declined to 15.2% in 2008 (\( P=0.67 \)).

### Other Outcomes

As shown in Table 3, the overall LOS declined (12.9 days to 12.4 days, \( P<0.01 \)), which was driven by a reduction in presurgery LOS (2.7 days to 2.1 day, \( P<0.01 \)). Over time, in-hospital mortality decreased (8.1% in 1999 to 5.7% in 2008, \( P<0.001 \)), whereas the percentage of patients who were discharged to a nursing home increased (11.9% in 1999 to 16.5% in 2008, \( P<0.001 \)). The proportion of mitral valve surgeries representing a reoperation remained low across all years (from 1999 to 2008: 2.2%, 1.6%, 2.0%, 2.0%, 1.8%, 2.0%, 1.7%, 1.8%, 1.9%, and 2.0%).

### State Variation

State-level changes in rates of hospitalization for mitral valve surgery and 1-year mortality between 1999 and 2008 are shown in Figure 4. The majority of states experienced a decline in hospitalization for mitral valve surgery. The greatest relative decline in hospitalization was seen in Nebraska (−9.0%) and the greatest increase in Hawaii (4.7%). Across states/territories, rates of 1-year mortality either declined or were statistically unchanged. The greatest declines were seen in Puerto Rico (−9.3%), Arizona (−6.4%), and Rhode Island (−6.0%).

### Discussion

We found that over the 10-year period between 1999 and 2008, whereas the overall rate of mitral valve surgery remained relatively constant, the proportion of patients \( \geq 85 \) years of age increased, and rates for whites and men were higher than for other subgroups across all years. In
Table 3. Outcomes Among Patients Undergoing Mitral Valve Surgery (Isolated) in Medicare Fee-for-Service, 1999 to 2008

<table>
<thead>
<tr>
<th>Description</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isolated mitral valve surgeries, n</td>
<td>5974</td>
<td>6128</td>
<td>6251</td>
<td>6502</td>
<td>6425</td>
<td>6395</td>
<td>6233</td>
<td>5702</td>
<td>5608</td>
<td>5466</td>
</tr>
<tr>
<td>LOS in days, mean (SD)</td>
<td>12.9</td>
<td>13.3</td>
<td>13.4</td>
<td>13.3</td>
<td>13.4</td>
<td>12.9</td>
<td>12.7</td>
<td>12.6</td>
<td>12.6</td>
<td>12.4</td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>8.1%</td>
<td>7.7%</td>
<td>8.8%</td>
<td>8.4%</td>
<td>7.3%</td>
<td>7.2%</td>
<td>6.3%</td>
<td>6.7%</td>
<td>5.7%</td>
<td>5.7%</td>
</tr>
<tr>
<td>Discharge to nursing home</td>
<td>11.9%</td>
<td>12.6%</td>
<td>12.1%</td>
<td>12.3%</td>
<td>14%</td>
<td>14.6%</td>
<td>14.5%</td>
<td>16.7%</td>
<td>16.0%</td>
<td>16.5%</td>
</tr>
<tr>
<td>Overall outcomes</td>
<td>22.9%</td>
<td>23.8%</td>
<td>23.4%</td>
<td>24.5%</td>
<td>23.5%</td>
<td>23.8%</td>
<td>21.9%</td>
<td>20.2%</td>
<td>21.7%</td>
<td>21.9%</td>
</tr>
<tr>
<td>30-Day readmission</td>
<td>21.8%</td>
<td>22.2%</td>
<td>21.7%</td>
<td>23.7%</td>
<td>22.6%</td>
<td>22.2%</td>
<td>20.2%</td>
<td>19.0%</td>
<td>19.8%</td>
<td>20.0%</td>
</tr>
<tr>
<td>30-Day mortality</td>
<td>6.4%</td>
<td>6.1%</td>
<td>6.4%</td>
<td>6.1%</td>
<td>5.8%</td>
<td>6.1%</td>
<td>4.7%</td>
<td>5.0%</td>
<td>4.2%</td>
<td>4.7%</td>
</tr>
<tr>
<td>One-year mortality</td>
<td>12.2%</td>
<td>11.0%</td>
<td>11.6%</td>
<td>11.4%</td>
<td>11.2%</td>
<td>10.8%</td>
<td>10.3%</td>
<td>10.1%</td>
<td>9.7%</td>
<td>9.6%</td>
</tr>
<tr>
<td>Outcomes by age 65–74 y</td>
<td>23.8%</td>
<td>26.0%</td>
<td>25.6%</td>
<td>25.4%</td>
<td>23.9%</td>
<td>25.1%</td>
<td>23.3%</td>
<td>21.0%</td>
<td>23.4%</td>
<td>23.6%</td>
</tr>
<tr>
<td>30-Day readmission</td>
<td>9.9%</td>
<td>9.5%</td>
<td>11.2%</td>
<td>10.3%</td>
<td>8.7%</td>
<td>8.7%</td>
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<td>7.1%</td>
<td>6.9%</td>
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<tr>
<td>30-Day mortality</td>
<td>18.4%</td>
<td>15.8%</td>
<td>19.8%</td>
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<td>17.7%</td>
<td>17.3%</td>
<td>16.3%</td>
<td>15.5%</td>
<td>15.1%</td>
<td>14.9%</td>
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<tr>
<td>One-year mortality</td>
<td>27.1%</td>
<td>26.8%</td>
<td>27.6%</td>
<td>27.7%</td>
<td>25.6%</td>
<td>23.3%</td>
<td>26.6%</td>
<td>26.7%</td>
<td>28.2%</td>
<td>19.4%</td>
</tr>
<tr>
<td>Outcomes by age 75–84 y</td>
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<td>23.0%</td>
<td>22.5%</td>
<td>27.2%</td>
<td>29.5%</td>
<td>28.9%</td>
<td>28.0%</td>
<td>26.1%</td>
<td>27.3%</td>
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<tr>
<td>30-Day readmission</td>
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<td>17.2%</td>
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<td>30-Day mortality</td>
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<td>One-year mortality</td>
<td>21.0%</td>
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<td>19.7%</td>
<td>17.8%</td>
<td>19.8%</td>
<td>19.3%</td>
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<tr>
<td>Outcomes by sex, male</td>
<td>7.7%</td>
<td>7.1%</td>
<td>8.2%</td>
<td>6.6%</td>
<td>7.0%</td>
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<td>5.5%</td>
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<td>30-Day readmission</td>
<td>15.0%</td>
<td>12.2%</td>
<td>14.9%</td>
<td>13.6%</td>
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<td>13.7%</td>
<td>12.1%</td>
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<td>One-year mortality</td>
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<td>9.2%</td>
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(Continued)
addition, for isolated mitral valve surgery, there were striking declines in 30-day and 1-year mortality across all strata of age, sex, and race. After adjustment for demographics and comorbidities, these trends persisted; relative to 1999, risk-adjusted 30-day mortality declined by 48.1%, and risk-adjusted 1-year mortality declined by 39.9%. Based on the number of hospitalizations for mitral valve surgery over the study period, these results imply that there were about 750 fewer deaths at 30 days and about 1500 fewer deaths at 1 year in 2008 than there would have been had the rates stayed unchanged from 1999. Additionally of note, there was an 8.7% relative reduction in risk-adjusted 30-day readmission.

Our results extend the prior, mainly single-center studies showing improved outcomes after mitral valve surgery over time.4,5,17,18 Our data have the advantage of incorporating outcomes from hospitals which may not have published their data or participated in registries such as the Society of Thoracic Surgeons (STS). These data are important for clinicians and patients considering mitral valve surgery; the likelihood of surviving to both 30 days and 1 year after hospitalization was significantly higher in 2008 than in 1999.

There are several potential explanations for the reduction in mortality over time. Lower rates of mitral valve replacement may have lead to reductions in the incidence of prosthesis-related complications, the need for reoperation, or severe bleeding due to the necessity of prolonged anticoagulation (in the case of mechanical replacement).19,20 General trends in cardiac surgery may be

Table 3. Continued

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Outcomes by race, black

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Outcomes by race, other

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Overall outcomes (adjusted)

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LOS indicates length of stay.

Figure 2. Trends in risk-adjusted mortality and readmission after isolated mitral valve surgery, 1999 to 2008.
contributing as well, as lower rates of sternal wound infections have been reported, and the duration of postoperative mechanical ventilation is decreasing. Monitoring of provider-specific mortality rates in cardiac surgery and ongoing feedback mechanisms have also been postulated to play a role in improved outcomes. Another potential explanation is that patients are being referred for surgery earlier in their disease course, but we were unable to evaluate this with our available data.

Another important finding in our study is that the risk-adjusted 30-day readmission rate declined over the 10-year study period. This encouraging trend stands in contrast to persistently high readmission rates for heart failure and acute myocardial infarction; systematic efforts to improve outcomes in these conditions have largely failed. Although overall readmission declined, the rate in 2008 was 21.0%, demonstrating that there likely remains significant room for improvement.

Our findings illustrate that several challenges remain in the care of patients undergoing mitral valve surgery. While reductions in 30-day and 1-year mortality rates were seen among all subgroups of patients, 1-year mortality rates and 30-day readmission rates remained higher in nonwhites and women compared with whites and men, respectively, across all years. Previous study results have been mixed with regard to the association of race and sex with outcomes, and data beyond single-center reports are usually limited to short-term results. An analysis of the STS database found that black race was not a significant predictor of early mortality in patients undergoing isolated mitral valve surgery after adjusting for other comorbidities, but blacks had higher rates of postoperative complications including prolonged mechanical ventilation and renal failure. These complications, while not increasing the risk of short-term mortality in the study, may have increased the likelihood of 1-year mortality (which was not captured). In a separate analysis from STS, female sex was associated with an increased likelihood of early mortality after all types of valve surgery combined, but separate data have demonstrated that long-term mortality after mitral valve surgery is similar in women compared with men. The issue is certainly a worthy direction for future investigation.

There are several limitations to the current study. As our analysis was limited to Medicare FFS beneficiaries, we cannot comment on trends in patients <65 years of age, or patients enrolled in Medicare managed care programs. As more patients have migrated into Medicare managed care programs over time, the Medicare FFS population may have changed and therefore affected the observed trends. Although we risk-adjusted for potential confounders, it is possible that changing characteristics of the FFS population were not accounted for by available data. We also did not have information on the etiology of mitral valve disease (eg, ischemic, degenerative), which may have partially accounted for increasing rates of mitral valve repair over time, and may have also influenced the discrepancies in outcomes among demographic subgroups. As we excluded CABG from our isolated mitral valve cohort, it is likely that most patients in this group had degenerative (rather than ischemic) mitral valve disease, although this could not be definitively confirmed in our administrative dataset. We also did not have information on whether, over time, surgeons were better at identifying patients who would do poorly after surgery, which may have led to improved outcomes; however, data from the STS database suggest that comorbidities are increasing (rather than decreasing) over time. Finally, we relied on administrative claims data to obtain comorbidities, which may have been up-coded or down-coded over time.

**Conclusions**

Hospitalization for mitral valve surgery in Medicare FFS beneficiaries has remained relatively stable from 1999 to 2008; however, in 2008 patients ≥85 years of age represented a greater proportion of cases. Risk-adjusted 30-day and 1-year mortality declined significantly over this time period, and declines were seen in all subgroups of age, sex, and race. Despite these encouraging trends, readmission at 30 days in nonwhites and women remained relatively unchanged, and 1-year mortality in nonwhites and women was higher than in whites and men across all years; both of these findings

![Figure 3. 1-year mortality over time in surgical subgroups after isolated mitral valve surgery, 1999 to 2008.](http://circoutcomes.ahajournals.org/doi/figure-pdf/10.1161/CIRCOUTCOMES.108.003348)
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Disclosures

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References


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