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Impact of Race on Mitral Procedure Selection and Short-Term Outcomes of Patients Undergoing Mitral Valve Surgery

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ABSTRACT

Background: Racial disparity with respect to mitral valve (MV) surgery has been documented; however, previous reports have been limited by small numbers, focus on patients undergoing MV replacement only, or comparison of African-American patients to white patients. Using more recent data from the largest all-payer database in the United States, we examined whether type of mitral procedure performed was influenced by race and whether racial differences exist in baseline characteristics and short-term outcomes of patients undergoing mitral repair or replacement for MV disease.

Methods: Using the 2005-2007 National Inpatient Sample (NIS) Database, we identified patients ≥ 30 years of age who underwent MV repair or replacement, excluding ischemic and congenital MV disease. Patients were stratified into 4 racial groups: whites, African-Americans, Hispanics, and others. The 4 groups were compared with respect to baseline characteristics, type of MV procedure (repair versus replacement), and short-term outcomes.

Results: Non-whites comprised 22.3% (7818 out of 35,074) of the patients and were generally younger, more often on Medicaid and from urban locations, and more often presented on an urgent/emergent basis. African-Americans and Hispanics tended to be less affluent and have a higher Charlson comorbidity index. MV repair was performed in 45.8% of the patients overall. The racial groups differed significantly with respect to the proportion of patients receiving repair. Hispanics were 2 times more likely to have MV replacement compared to whites (odds ratio [OR] = 2.06, 95% confidence interval [CI] = 1.52-2.80, P = .0001), and African-Americans were more than 1.5 times more likely to have replacement compared to whites (OR = 1.69, 95% CI = 1.35-2.11). Following adjustment for baseline characteristics, there was no difference with respect to race for in-hospital mortality or likelihood of repair, but differences between groups persisted for length of stay and discharge location. African-Americans and Hispanics were more likely than whites to have a prolonged hospitalization.

Conclusions: African-Americans and Hispanics present for MV surgery with worse preoperative profiles and undergo mitral repair less often compared to whites. Although in-hospital mortality was not influenced by race, African-Americans and Hispanics had a more protracted hospital course even following adjustment. The disparity in mitral procedure selection among racial groups was present only prior to adjustment for important baseline characteristics. Nevertheless, this racial difference reflects current reality in surgical practice and identifies an important area for future improvement in the care of patients with valvular heart disease.

INTRODUCTION

Race has been previously identified as a risk factor for adverse outcomes after coronary artery surgery [Hartz 2001; Cooper 2009]. Differences in comorbidities, extent and severity of coronary artery disease, health insurance, socioeconomic status, access to higher quality cardiac surgeons, differences in process of care, and physician perceptual bias and stereotyping have been identified as possible reasons for this disparity [Jacobi 2007; Mukamel 2007; Castellanos 2009]. Although some have suggested that socioeconomic position and not race per se can explain these findings [Koch 2010], some treatment bias in coronary surgery with respect to race has been documented [Kaul 2005; Mukamel 2007]. Compared to white patients, African-American patients receive fewer coronary revascularization procedures [Kaul 2005], including coronary artery bypass graft surgery (CABG) [Mukamel 2007].

Racial disparity with respect to mitral valve (MV) surgery has received little attention. Taylor et al examined the relationship between race and morbidity and mortality after aortic and MV replacement using data from the Society of Thoracic Surgeons (STS) database from 1999 to 2002 [Taylor 2005]. Patients with mitral repair were not included in this analysis. More recently, DiGiorgi et al published data on 123 African-American patients undergoing MV surgery over a 10-year period and contrasted their disease presentation and surgical outcomes to those of white patients [DiGiorgi 2008]. Using more recent data from the largest all-payer database in the

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US, we examined whether type of mitral procedure performed was influenced by race and whether racial differences exist in baseline characteristics and short-term outcomes of patients undergoing mitral repair or replacement for MV disease.

MATERIALS AND METHODS

Database

The National Inpatient Sample (NIS) is a stratified probability sample of inpatient discharges from roughly 20% of hospital admissions in the US. To minimize sampling bias, the NIS is stratified by geographic region, urban versus rural location, teaching status, and hospital bed size. The database is compiled by the Healthcare Cost and Utilization Project funded by the Agency for Healthcare Research and Quality. It contains de-identified patient data including up to 15 procedure and 15 diagnostic codes according to the International Classification of Diseases, Ninth Edition, Clinical Modification (ICD-9-CM). The NIS is the largest all-payer database and is used for analysis of trends in healthcare utilization, access, charges, quality, and outcomes for both research and policy making [HCUP Databases 2010].

Sample Selection

The 2005-2007 NIS was searched to identify patients who underwent MV repair or replacement (ICD-9-CM codes 35.12, 35.23, and 35.24). Patients were excluded if they were < 30 years of age or had closed heart valvuloplasty, congenital heart disease, coronary revascularization, excision of ventricular aneurysm or partial ventriculectomy, replacement of thoracic aorta, aortic fenestration, other valvular repair or replacement (except tricuspid), heart transplantation, and missing race information. Patients with concomitant tricuspid valve repair or replacement, Maze procedure, and atrial septal defect (ASD)/ patent forman ovale (PFO) closure were not excluded. Patients were stratified into 4 racial groups: whites, African-Americans, Hispanics, and all others, with the last group including Asian/Pacific Islanders, Native Americans, and others (unspecified data element).

Statistical Analysis

Chi-square tests of independence and analyses of variance (ANOVAs) were used to compare the groups on baseline characteristics. Follow-up comparisons were performed when the overall test was statistically significant. Descriptive statistics including percents, means, medians, and interquartile ranges are reported. Logistic regression was used to examine the relationship between race and each of the outcomes. Odds ratios are reported for each group relative to whites. Length of stay (LOS) was initially examined as a continuous outcome, but because it was not evenly distributed, it was subsequently dichotomized using a median split and is presented throughout the paper in this manner. Logistic regression was used to assess whether racial differences in the utilization of repair and replacement were still observed after adjusting for the following baseline characteristics: age, gender, urban residency, Medicare and Medicaid status, elective admission status, income quartile, and Charlson comorbidity index. Linearity in the logit scale for continuous variables was assessed using quantiles. Non-linear covariates were categorized using quartiles and entered into the logistic regression model with the utilization of dummy variables. When examining the

Table 1. Characteristics of Patients Undergoing Mitral Valve Surgery from 2005 to 2007

	Overall	White	African-American	Hispanic	All Others	*P*
Number of patients	35,074	27,256 (77.7%)	2937 (8.4%)	2471 (7.0%)	2410 (6.9%)	
Age, y: mean, median (interquartile range)	62.1, 63 (53-73)	63.3, 64 (54-74)	55.6, 54 (47-65)	59.1, 60 (49-70)	59.5, 59 (50-70)	.0001
Age ≥ 65	45.5%	49.1%	26.9%	37.0%	36.6%	.0001
Female	51.0%	48.7%	65.1%	57.9%	53.6%	.0001
Urban	85.7%	83.1%	92.2%	96.2%	95.2%	.0001
Medicare	46.0%	48.7%	37.4%	38.1%	34.3%	.0001
Medicaid	6.2%	3.4%	14.3%	23.0%	10.8%	.0001
Income					.0001	
First quartile	21.0%	17.4%	45.1%	37.8%	15.3%	
Second quartile	21.1%	21.4%	21.9%	20.9%	16.4%	
Third quartile	25.5%	26.1%	20.0%	24.2%	26.0%	
Fourth quartile	32.4%	35.1%	13.0%	17.1%	42.0%	
Charlson Index: mean, median (interquartile range)	1.05, 1 (0-2)	0.96, 1 (0-1)	1.65, 1 (1-2)	1.37, 1 (0-2)	0.96, 1 (0-1)	.0001
Admission Status					.0001	
Elective	61.3%	64.6%	44.3%	52.8%	52.7%	
Urgent/Emergent	38.7%	35.4%	55.7%	47.2%	47.3%	

relationship between race and short-term outcomes stratified by procedure type (repair versus replacement), adjusted odds ratios were computed for the groups after controlling for baseline characteristics. Results were considered statistically significant for $P < .05$. All analyses were performed using SAS version 9.2 to perform the appropriate weighting to reflect the stratified sampling scheme used in the NIS (SAS Institute Inc., Cary, NC, USA).

The study was granted exempt status by our Institutional Review Board.

RESULTS

Baseline Characteristics

The baseline characteristics of patients undergoing MV surgery are presented in Table 1. Whites comprised 77.7% of the patients; 8.4% were African-Americans, 7.0% were Hispanics, and all others accounted for the remaining 6.9%. There was a significant difference in mean age at presentation as a function of race. Compared to whites, the rest of the groups were significantly younger. African-Americans were also significantly younger than Hispanics. Whites were less likely to be female than non-whites. African-Americans and Hispanics were less affluent than the other 2 groups. Non-whites were more likely to be on Medicaid (14.3% of African-Americans, 23.0% of Hispanics, and 10.8% of all others, compared to 3.4% of whites, $P = .0001$) and more often came from urban locations and presented on an urgent/emergent basis. African-Americans and Hispanics had a higher mean Charlson comorbidity index compared to whites and all others.

Operative Data

Mitral repair was performed in 45.8% of the patients overall. The racial groups differed significantly with respect to the proportion of patients receiving repair (35.6% of African-Americans, 31.2% of Hispanics, 48.3% of whites, and 44.3% of all others, $P = .0001$). Data on mitral procedure selection with respect to race are presented in Table 2 as odds ratios relative to whites. Hispanics were nearly twice as likely to undergo replacement compared to whites (OR = 2.06, 95% CI = 1.52-2.80). African-Americans were also significantly more likely to undergo replacement compared to whites (OR = 1.69, 95% CI = 1.35-2.11).

Concomitant procedure data are presented in Table 3. Among patients who underwent mitral repair, 6.7%

Table 2. Mitral Procedure Selection: Likelihood of Mitral Valve Replacement Relative to Whites

	Overall	White	African-American	Hispanic	All Others	*P*
Number of patients	35,074	27,256 (77.7%)	2937 (8.4%)	2471 (7.0%)	2410 (6.9%)	
Mitral valve replacement	54.2%	1.00	1.69 (1.35-2.11)	2.06 (1.52-2.80)	1.18 (0.82-1.69)	.0001

Table 3. Concomitant Procedure Odds Ratios (95% Confidence Intervals) for Patients Undergoing Mitral Valve Repair and Replacement

	Mitral Repair					
	All Repair	White	African-American	Hispanic	All Others	*P*
Number of patients	16,061	13,175 (82.0%)	1047 (6.5%)	771 (4.8%)	1068 (6.6%)	
Maze	24.9%	1.00	0.65 (0.46-0.90)	0.70 (0.43-1.14)	0.93 (0.68-1.28)	.0510
Tricuspid repair	6.7%	1.00	2.59 (1.75-3.84)	1.75 (1.01-3.04)	1.14 (0.65-2.01)	.0001
Tricuspid replacement	<0.4%†	1.00	1.60 (0.20-12.92)	‡	3.48 (0.75-16.24)	.2742
IABP*	2.4%	1.00	2.60 (1.31-5.14)	2.91 (1.42-5.96)	0.84 (0.23-3.00)	.0016
Pacemaker	6.1%	1.00	1.26 (0.71-2.26)	1.13 (0.61-2.08)	0.81 (0.47-1.41)	.6654
	Mitral Replacement					
	All Replacement	White	African-American	Hispanic	All Others	*P*
Number of patients	19,013	14,081 (74.1%)	1890 (9.9%)	1700 (8.9%)	1342 (7.1%)	
Maze	26.6%	1.00	0.47 (0.34-0.65)	0.85 (0.63-1.14)	0.99 (0.76-1.29)	.0001
Tricuspid repair	5.1%	1.00	1.80 (1.18-2.74)	1.77 (1.11-2.83)	1.76 (1.09-2.84)	.0031
Tricuspid replacement	1.9%	1.00	2.43 (1.30-4.55)	2.47 (1.26-4.85)	2.39 (1.18-4.84)	.0110
IABP	7.0%	1.00	1.08 (0.71-1.63)	0.93 (0.50-1.71)	0.90 (0.44-1.86)	.9002
Pacemaker	12.4%	1.00	1.00 (0.75-1.33)	1.15 (0.83-1.58)	0.81 (0.54-1.22)	.6767

*IABP indicates intra-aortic balloon pump.

†Unreportable per National Inpatient Sample (NIS) reporting guidelines.

‡Indicates a zero count for this category, analysis performed in exclusion.

Table 4. Hospital Outcome Odds Ratios (95% Confidence Intervals) Stratified by Procedure Type

	Mitral Repair					
	All Mitral Repair	White	African-American	Hispanic	All Others	*P*
In hospital death	1.53%	1.00	2.24 (0.82-6.09)	2.09 (0.47-9.25)	1.80 (0.75-4.30)	.2480
Length of stay ≥ 8 days	38.8%	1.00	2.06 (1.50-2.83)	2.57 (1.83-3.61)	1.15 (0.88-1.50)	.0001
Routine disposition	87.4%	1.00	0.98 (0.63-1.52)	0.93 (0.52-1.66)	0.96 (0.60-1.53)	.9939
	Mitral Replacement					
	All Mitral Replacement	White	African-American	Hispanic	All Others	*P*
In hospital death	5.46%	1.00	0.97 (0.59-1.59)	0.85 (0.51-1.41)	0.64 (0.33-1.24)	0.5848
Length of stay ≥ 8 days	68.0%	1.00	1.91 (1.49-2.44)	1.54 (1.13-2.08)	1.31 (0.99-1.73)	.0001
Routine disposition	77.8%	1.00	0.96 (0.74-1.25)	1.64 (1.10-2.44)	1.58 (1.11-2.24)	.0110

underwent a concomitant tricuspid repair. African-Americans (OR = 2.59, 95% CI = 1.75-3.84) and Hispanics (OR = 1.75, 95% CI = 1.01-3.04) were more likely to undergo concomitant tricuspid repair relative to whites, and there was no difference among groups with respect to concomitant tricuspid replacement and Maze. Overall, 2.4% of patients in the repair group required intra-aortic balloon pump (IABP) placement, with African-Americans (OR = 2.60, 95% CI = 1.31-5.14) and Hispanics (OR = 2.91, 95% CI = 1.42-5.96) more than twice as likely to receive IABP compared to whites. There was no significant difference in pacemaker placement between groups.

Among patients who underwent mitral replacement, concomitant tricuspid repair was performed in 5.1% of patients, and tricuspid replacement was done in 1.9%. Compared to whites, the other 3 racial groups were more likely to undergo tricuspid repair or replacement. Concomitant Maze procedure was performed less in African-Americans than whites (OR = 0.47, 95% CI = 0.34-0.65), Hispanics (OR = 0.55, 95% CI = 0.36-0.84), or all others (OR = 0.47, 95% CI = 0.32-0.69). Compared to the repair group, patients undergoing mitral replacement had higher incidence of IABP placement (2.4% versus 7.0%) and pacemaker insertion (6.1% versus 12.4%), but there was no difference for these procedures among the racial subsets undergoing mitral replacement.

Hospital Outcome

Overall hospital mortality was 3.66%. Discharge to home with or without home healthcare services was similar among the racial groups. Mean LOS was longer for African-Americans, Hispanics, and all others compared to whites (15.1 days, 14.6 days, and 12.8 days, respectively, compared to 11.2 days). Because of the skewed distribution of LOS, we compared patients using the median split value to dichotomize LOS. Compared to whites, African-Americans and Hispanics were more than twice as likely to have LOS ≥ 8 days.

Hospital outcomes stratified by procedure type are shown in Table 4. As expected, in-hospital mortality for patients undergoing mitral repair was lower compared to those with replacement (1.53% versus 5.46%). In addition, hospital mortality was similar among the racial groups for both the repair and replacement subsets. There were significant differences among the racial groups when looking at LOS ≥ 8 days both for the repair and replacement groups. African-Americans (OR = 2.06, 95% CI = 1.50-2.83) and Hispanics (OR = 2.57, 95% CI = 1.83-3.61) undergoing mitral repair were significantly more likely to have prolonged hospitalization compared to whites. Similarly, African-Americans (OR = 1.91, 95% CI = 1.49-2.44) and Hispanics (OR = 1.54, 95% CI = 1.13-2.08) undergoing replacement were more likely to have a prolonged LOS compared to whites. Among patients undergoing repair, there was no significant difference among racial groups with respect to routine disposition status, but following mitral replacement, Hispanics and the all others group were more likely to be discharged home than whites and African-Americans.

Adjusted Comparisons

Following adjustment for age, gender, urban residency, Medicare and Medicaid status, admission status, income quartile, and Charlson comorbidity index, the increased likelihood of non-whites to undergo mitral replacement compared to whites was no longer statistically significant. Certain differences with respect to concomitant procedures among the racial groups persisted even following adjustment for baseline characteristics and type of mitral procedure. African-Americans were less likely to receive Maze procedure compared to whites and more likely to undergo concomitant tricuspid valve repair than whites and Hispanics. The racial groups did not differ significantly on in-hospital mortality following adjustment, but differences in LOS persisted. African-Americans and Hispanics were more likely than whites to have LOS ≥ 8 days, and Hispanics were found to be more likely to be discharged home than the all others group.

DISCUSSION

Significant racial variation exists in the baseline characteristics of patients presenting for mitral valve surgery in the US. Non-white patients are younger, less affluent, more often on Medicaid, more often come from urban locations, have more

comorbidities, and more often present urgently and emergently. In our investigation, the Charlson comorbidity index was used for risk adjustment between racial groups in order to avoid the limitation of missing comorbidity data [Deyo 1992]. This index has been validated for use with large administrative databases [D'Hoore 1996]. Despite much younger age at presentation, African-American and Hispanic patients had higher Charlson comorbidity index. This finding may reflect higher prevalence of comorbid conditions, an accelerated disease course in these populations, or lack of access to preventive healthcare/risk modifications strategies. Similar findings have been reported by others [Taylor 2005; DiGiorgi 2008]. DiGiorgi et al examined mitral disease presentation and surgical outcomes in African-American patients compared to white patients undergoing mitral valve surgery by a single surgical group [DiGiorgi 2008]. Although the numbers were much smaller compared to our investigation, African-American patients were found to be younger at presentation but have much worse preoperative risk profiles [DiGiorgi 2008].

The issue of mitral procedure selection deserves special attention. Specifically, racial differences with respect to mitral procedure selection have not been studied. This is of importance considering the advantages of mitral repair over replacement, including lower operative mortality, improved long-term survival, better preservation of early and late ventricular function, fewer valve-related complications, including thromboembolism, endocarditis, anticoagulation-related bleeding events, and late prosthetic dysfunction [Perier 1984; Grossi 1998]. We found that African-Americans and Hispanics were less likely to undergo mitral repair. Others have reported that African-Americans undergo mitral repair less often than whites [DiGiorgi 2008]. Following adjustment for baseline characteristics, race no longer had a statistically significant relationship to type of procedure, suggesting that race may not be an independent determinant of type of mitral procedure received. The preoperative profile of African-Americans and Hispanics may increase the likelihood of these racial groups to present for evaluation to hospitals with less expertise in MV repair. Alternatively, higher Charlson comorbidity index and more urgent/emergent presentation may influence surgeon comfort in attempting mitral repair to correct the disease pathology. Moreover, worse preoperative profiles may be a surrogate for a different disease process, perhaps less suited for repair. It is important to note that this disparity in mitral procedure selection among racial groups was present only prior to adjustment for important baseline characteristics. Nevertheless, this racial difference reflects current reality in surgical practice and identifies an important area for future improvement in the care of patients with valvular heart disease.

We also found significant differences between the racial groups with respect to concomitant tricuspid valve surgery. African-Americans and Hispanics had a higher incidence of concomitant tricuspid valve repair and replacement. Whether this reflects longer standing mitral valve disease in the non-white patients is unclear considering the younger age at presentation compared to white patients. This finding may be related to racial differences in disease presentation with respect to age or disease biology. Although within the NIS database it was not possible to determine whether atrial fibrillation was a preoperative condition or a postoperative complication, the finding that African-Americans underwent concomitant Maze procedure much less frequently was intriguing. This was true even after adjustment for baseline characteristics and type of mitral procedure performed (repair versus replacement). Whether this reflects lesser incidence of preoperative atrial fibrillation in African-Americans remains unknown. Others have reported significantly lower incidence of preoperative atrial fibrillation in African-American patients compared to white patients undergoing MV replacement [Taylor 2005]. This finding is difficult to reconcile with the fact that of all racial groups, African-Americans had the highest frequency of concomitant tricuspid repair and replacement, possibly suggesting longer-standing MV disease, of which atrial fibrillation is known to be a frequent complication. Genetic differences in predisposition to atrial fibrillation in the setting of MV disease may exist. Alternatively, unrecognized racial bias may be responsible for this finding [Bridges 2008]. For example, African-Americans with non-ST elevation acute coronary syndrome are less likely than whites to receive many evidence-based treatments, particularly newer or costly ones [Sonel 2005]. African-Americans are less likely to undergo cardiac catheterization and CABG compared to white patients [Kressin 2001]. Non-whites were much more frequently on Medicaid, and it is possible that issues related to reimbursement may have played a role (Medicaid does not consistently reimburse for the Maze procedure in the setting of MV repair and/or replacement). Further studies may be warranted to investigate the rate of utilization of the Maze procedure with respect to race and/or insurance type.

Following adjustment, we found no significant relationship between in-hospital mortality and race. Our results are supported by the work of others [Taylor 2005; DiGiorgi 2008]. However, we observed a significant relationship between race and longer LOS. African-Americans and Hispanics had a more protracted hospital course despite their younger age compared to whites. This may be related to several factors. Both of these groups had more comorbidities, but even after adjustment for baseline characteristics, this difference persisted. Race has been identified as an independent predictor of several postoperative complications by some [Taylor 2005] but not by others [DiGiorgi 2008]. Although hard clinical endpoints such as the ones included in our analysis are difficult to miscode, the limitations of the NIS database did not allow us to reliably compare the incidence of various postoperative complications among racial groups. Furthermore, whether socioeconomic factors may play a part cannot be determined using this data set. However, if true, this may have significant cost implications. Alternatively, non-whites may have slower return to baseline physical state, or their longer LOS may be influenced by more frequent lack of stable home situation.

Our study has several limitations. The NIS is a stratified probability sample of state inpatient databases including data on roughly 20% of hospital admissions in the US. Therefore, our data were weighted to make them more

applicable to the entire in-patient population. The purpose of administrative databases is to gather data for billing purposes, and can be limited by erroneous coding. Moreover, the NIS database does not provide as much clinical detail compared to most notably the STS database. Furthermore, the diagnostic coding for degenerative versus rheumatic valve disease in the NIS database needs to be validated for accuracy before this information is used for clinical comparisons. These unaccounted factors may have influenced the decision to perform mitral repair versus replacement. However, several strengths are noted with respect to data from the NIS compared to the STS database. The NIS uses different sources and methods to acquire data, participation is not voluntary, and sampling is weighted to reflect national averages. It has been suggested that the NIS database may be better suited for evaluating trends because increased participation in the STS database over time may skew reported trends [Barnett 2009]. Furthermore, participating practices in the STS database may differ significantly from non-participating practices [Taylor 2005]. NIS is the largest all-payer database in the US, and some of its limitations are offset by large patient volumes, hard clinical end-points, and the opportunity to explore real world community data, making our findings widely applicable across hospitals in the US.

Comparative studies between the 1990s and the 2000s have demonstrated that racial disparities are decreasing over time [Mukamel 2007]. In-hospital mortality for patients undergoing mitral valve surgery for MV disease in the US is low and similar for all racial groups. The disparity in mitral procedure selection among racial groups was present only prior to adjustment for important baseline characteristics. Nevertheless, this racial difference reflects current reality in surgical practice and identifies an important area for future improvement in the care of patients with valvular heart disease. While the issue of racial disparity in cardiac surgery may be multifactorial, continued scrutiny is necessary to minimize the racial gap.

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