Trends in mortality among the geriatric population undergoing Surgical aortic valve replacement (SAVR) and potential racial disparities: a 20-year perspective via the National (Nationwide) Inpatient Sample

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https://doi.org/10.26599/1671-5411.2024.07.002

ABSTRACT

Background   Racial disparities in cardiovascular conditions are well documented. Whether similar race-based discrepancies in health outcomes also exist among elderly patients undergoing surgical aortic valve replacement (SAVR) for aortic stenosis remains understudied.

Methods   We abstracted data from the National (Nationwide) Inpatient Sample over a 20-year period from 2001 to 2020 using specific ICD-9 and ICD-10 codes. We included patients aged ≥ 60 and ≤ 80 years with races recorded as White, African American, or Hispanic at the time of their hospitalization for surgery. We analyzed and reported the baseline characteristics, risk-adjusted in-hospital mortality, and complications stratified by race.

Results   Of 420,181 patients studied, 90.0% identified as White, 4.0% as African American and 6.0% as Hispanic. Despite a decrease in overall in-hospital mortality rates from 3.8% between 2001-2005 to 1.8% between 2016-2020, African Americans had higher odds of all-cause in-hospital deaths compared to Whites (aOR = 1.390, $P < 0.001$). Additionally, they were more likely to experience cardiogenic shock (aOR = 1.241, $P < 0.001$) and acute kidney injury (aOR = 1.314, $P < 0.001$) as well as more likely to require organ support such as IABP use (aOR = 1.336, $P < 0.001$) or invasive mechanical ventilation (aOR = 1.342, $P < 0.001$). Interestingly, African Americans were less likely to report events of acute ischemic stroke compared to Whites (aOR = 0.852, $P < 0.001$).

Conclusions   Despite a reassuring reduction in overall in-hospital mortality rates of geriatric patients undergoing SAVR for aortic stenosis, racial disparities in health outcomes remain pervasive with minorities more likely to report higher in-hospital morbidity and mortality.

The perennity of racial and ethnic disparities in healthcare delivery and outcomes is well-documented.[1] These challenges remain pervasive nearly 38 years since the publication of the Heckler report, which demonstrated how racial disparities are linked to higher mortality

among minorities and stressed the importance of implementing measures to advance health equity.[2,3] Contemporary studies have similarly highlighted poorer outcomes among African Americans and Hispanics following hospitalization across a spectrum of cardiovascular conditions, including aortic valve interventions and myocardial infarction.[1,4-6] In carefully selected patients with aortic stenosis, surgical aortic valve replacement (SAVR) remains the preferred modality of valve intervention despite the introduction of transcatheter aortic valve replacement (TAVR).[7] A recent analysis by McNeely, *et al.*[1] reported several complications, such as higher readmission rates, among African Americans undergoing SAVR who were covered by Medicare between 2011 and 2013. Meanwhile, in their study spanning a 7-year period, Erinne *et al.* found no differences in short-term mortality risks between Whites, African Americans, and Hispanics following SAVR.[8] To date, studies pertaining to race-based disparities in outcomes among patients undergoing SAVR for aortic stenosis have involved relatively small cohorts. To address this paucity in literature, we performed a retrospective observational study, using healthcare data covering two decades collected in one of the largest databases of medical records in the United States (US).

METHODS

Data Source

Our retrospective observational study was carried out via the 2001-2020 National (Nationwide) Inpatient Sample (NIS). The NIS stands out as the biggest all-payer inpatient record from the US, which is available for public access in de-identified form. It is one of the multiple publications developed by the Healthcare Cost and Utilization Project (HCUP) and the Agency for Healthcare Research and Quality (AHRQ). It involves more than 1000 hospitals across more than 40 US states over time. While it covers an estimated 20% of all hospital records, the use of year-specific weights allows users to produce national estimates for more than 97% of the US population, with over 35 million records per year.[9-12]

The database relies on the International Classific-

ation of Diseases, 9th Revision, and 10th Revision (ICD-9 and ICD-10) codes to identify multiple comorbidities, diagnoses, and procedures. Other patient and hospital characteristics are also included in the various files released by HCUP.[9,10]

Study Population, Variables, Outcomes, and Statistical Analysis

Our study sample contained patients in the age range ≥ 60 years and ≤ 80 years. Patients with a primary procedure for SAVR (ICD 9: 3521, 3522, ICD10: 02RF0JZ, 02RF07Z, 02RF08Z, 02RF0KZ) and a co-existing diagnosis of aortic stenosis (ICD 9: 3950, 3952, 4241, 7463, ICD 10: I060, I062, I350, I352, Q230) were sampled. We excluded all patients of races other than White, African American, or Hispanic from our sample. We compared the presence of multiple comorbidities and characteristics (patient and hospital) between the three groups.[13-23] To examine potential differences among categorical variables (e.g., sex, race, primary payer form, and comorbidities), we used Pearson's Chi-square tests, while ANOVA/ Kruskal-Wallis tests were used for continuous variables.

The primary outcome of our study was all-cause in-hospital mortality in the three race-based groups, and our secondary outcomes included prevalence of complications, defined as cardiogenic shock, cardiac arrest, acute kidney injury (AKI), events of acute myocardial infarction (AMI), acute ischemic stroke (AIS), as well as use of Extracorporeal Membrane Oxygenation (ECMO), Intra-Aortic Balloon Pump (IABP), or invasive mechanical ventilation. We estimated the trends in mortality rates between the three groups across the 20 years of our study. Moreover, the differences in outcomes between the groups were analyzed using multivariable logistic regression to adjust for the effect of confounders and reported using adjusted odds ratios (aOR) and 95% Confidence (95% CI).

Ethical Consideration

To comply with the data provider, information was not released or disclosed in cases where the number of observations (i.e., individual discharge records) in any given cell of tabulated data was less than 11. Since the database was provided in de-identified form, our study was exempted from Insti-

tutional Review Board (IRB), ethics committee approvals, and informed consent.[9,10]

Statistical Software

The analyses were performed using SPSS 29.0 (IBM Corp, Armonk, NY, USA) and STATA 18.0 (Stata Corporation, College Station, TX, USA).

RESULTS

Baseline Characteristics and Comorbidities

Overall, our cohort comprised 42,0181 patients between the ages 60-80 years, undergoing SAVR following a diagnosis of aortic stenosis between 2001-2020. Most patients were racially classified as Whites (377,985 cases, 90.0%), with ethnic minorities comprising of 16,902 (4.0%) African Americans, and 25,294 (6.0%) Hispanics.

There were several differences observed between our three cohorts. African Americans had a higher weekend admission rate (7.2%) than Hispanics (6.1%) and Whites (4.5%, P-value < 0.01). The primary payer of all three groups was Medicare, and Hispanics showed the highest prevalence of Medicaid users (8.6% $vs.$ 1.2% in Whites, and 4.5% in African Americans) among the three groups. Around 69.7% of Whites, 79.1% of African Americans, and 69.7% of Hispanics (P-value < 0.01) in our study were treated in urban-teaching centers across the United States.

The prevalence of co-existing comorbidities differed between the groups. African Americans had a higher prevalence of hypertension (73.3% in African Americans $vs.$ 66.2% in Whites and 69.0% in Hispanics, P < 0.01), chronic kidney disease (CKD) (24.8% in African Americans $vs.$ 10.8% in Whites and 12.0% in Hispanics, P < 0.01), history of drug abuse (1.5% in African Americans $vs.$ 0.5% in Whites and 0.5% in Hispanics, P < 0.01), prior myocardial infarction (6.6% in African Americans $vs.$ 6.5% in Whites and 6.1% in Hispanics, P < 0.01), obesity (19.6% in African Americans $vs.$ 18.7% in Whites and 18.1% in Hispanics, P value < 0.01), and higher mean Charlson Comorbidity Index (CCI) score 2.20 ± 2.36 in African Americans than Whites 1.55 ± 1.59 and Hispanics 1.62 ± 2.05 (P < 0.01). Meanwhile, Whites reported more cases of dyslip-

idemia (58.7% in Whites $vs.$ 52.5% in African Americans and 56.2% in Hispanics, P < 0.01), smoking (31.6% in Whites $vs.$ 28.9% in African Americans and 25.9% in Hispanics, P < 0.01), family history of CAD (5.6% in Whites $vs.$ 3.7% in African Americans and 4.0% in Hispanics, P < 0.01), alcohol abuse (2.3% in Whites $vs.$ 2.0% in African Americans and 2.0% in Hispanics, P < 0.01), and Chronic Obstructive Pulmonary Disease (COPD, 16.9% in Whites $vs.$ 15.9% in African Americans and 12.5% in Hispanics, P < 0.01), while Hispanics had more patients with diabetes (43.3% in Hispanics $vs.$ 31.3% in Whites and 41.2% in African Americans, P < 0.01) and cirrhosis (1.6% in Hispanics vs. 1.0% in Whites and 1.1% in African Americans, P < 0.01), (Table 1).

Primary and Secondary Outcome

Trends in Mortality

Between 2001-2020, the mortality rates among Whites, African Americans, and Hispanics decreased as illustrated in Table 2 and Figure 1 (P_{trend} < 0.01). The overall mortality rates also dropped from 3.8% between 2001-2005 to 1.8% between 2016 and 2020.

Outcomes

Several racial disparities in outcomes were observed in our sample. Compared to Whites, African Americans and Hispanics reported higher odds of cardiogenic shock, IABP use, and need for invasive mechanical ventilation use. In addition, African Americans also had higher odds of events of Acute Kidney Injury (AKI), Extracorporeal Membrane Oxygenation (ECMO) use, and all-cause in-hospital death than Whites, while Hispanics showed no differences ($vs.$ Whites). We also found that African Americans and Hispanics had lower odds of reporting ischemic stroke during their hospitalization as compared to Whites (Table 3). Finally, the mean length of stay among African Americans (11.53 days) was longer as compared to Whites (9.17 days) and Hispanics (10.17 days, P < 0.01) (Table 1).

DISCUSSION

To our knowledge, our retrospective study is the first to investigate the racial differences in elderly

Table 1   Adults aged 60-80 years with aortic stenosis, undergoing SAVR in the United States between 2001-2020.

	White (*n* = 377,985) (%)	Black (*n* =16,902) (%)	Hispanic (*n* =25,294) (%)	*P*-value
Weekend admission	4.5	7.2	6.1	< 0.01
Female	35.4	45.5	39.2	< 0.01
Primary payer form				< 0.01
Medicare	76.4	73.3	66.6	
Medicaid	1.2	4.5	8.6	
Private	20.2	18.6	19.4	
Hospital				< 0.01
Rural	2.9	1.5	1.0	
Urban non-teaching	27.4	19.4	29.3	
Urban teaching	69.7	79.1	69.7	
Age ≥ 70 yrs	60.7	52.4	54.4	< 0.01
Comorbidities				
Hypertension	66.2	73.3	69.0	< 0.01
Dyslipidemia	58.7	52.5	56.2	< 0.01
Smoking	31.6	28.9	25.9	< 0.01
Diabetes	31.3	41.2	43.3	< 0.01
CKD	10.8	24.8	12.0	< 0.01
Family history of CAD	5.6	3.7	4.0	< 0.01
Peripheral vascular disease	10.1	11.5	9.5	< 0.01
Cirrhosis	1.0	1.1	1.6	< 0.01
Alcohol abuse	2.3	2.0	2.0	< 0.01
Drug abuse	0.5	1.5	0.5	< 0.01
Prior myocardial infarction	6.5	6.6	6.1	0.025
Obesity	18.7	19.6	18.1	< 0.01
COPD	16.9	15.9	12.5	< 0.01
Mean CCI score	1.55 ± 1.99	2.20 ± 2.36	1.62 ± 2.05	< 0.01
CCI ≥ 3	19.0	32.0	21.0	< 0.01
Complications and outcomes				
Cardiogenic shock	2.9	4.4	3.6	< 0.01
IABP use	2.9	4.3	3.6	< 0.01
Acute kidney injury	14.0	23.4	15.3	< 0.01
Acute ischemic stroke	5.6	5.5	4.5	< 0.01
Cardiac arrest	1.7	2.2	1.8	< 0.01
Use of invasive mechanical ventilation	8.0	12.2	9.9	< 0.01
ECMO use	0.1	0.3	0.2	< 0.01
Acute myocardial infarction	4.8	6.2	6.5	< 0.01
Died	2.6	4.2	3.0	< 0.01
Mean length of stay (LOS)(days)	9.17 ± 7.35	11.53 ± 9.23	10.17 ± 8.49	< 0.01

Data are presented as mean ± SD or % unless other indicated. CAD: coronary artery disease; CKD: chronic kidney disease; COPD: chronic obstructive pulmonary disease; SAVR: surgical aortic valve replacement.

AS patients undergoing SAVR over two decades. The major findings showed that: (1) the mortality rates in all three races decreased over the years, (2) differences in comorbidities and characteristics exis-
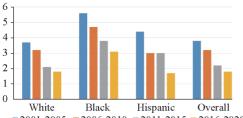
Table 2 Trends in mortality among adults aged 60-80 undergoing SAVR in the United States.

Year	2001-2005	2006-2010	2011-2015	2016-2020
White	3.70%	3.20%	2.10%	1.80%
Black	5.60%	4.70%	3.80%	3.10%
Hispanic	4.40%	3.00%	3.00%	1.70%
Overall	3.8%	3.2%	2.2%	1.8%

SAVR: surgical aortic valve replacement.

Figure 1 The mortality rates between 2001-2020.

ted between the three groups, and (3) racial disparities impact the risk of several in-hospital complications following SAVR.

The higher prevalence of hypertension, prior MI, and CKD among African Americans seen in our study correlated with the recent findings from the American Heart Association, whereby African Americans were more prone to hypertension and its

Table 3 Outcomes of patients aged 60-80 years undergoing SAVR*.

	P-value	aOR	Lower 95% CI	Upper 95% CI
Adjusted odds ratio of cardiogenic shock				
Black	< 0.001	1.241	1.147	1.342
Hispanic	< 0.001	1.172	1.091	1.258
Adjusted odds ratio of IABP use				
Black	< 0.001	1.336	1.235	1.445
Hispanic	< 0.001	1.140	1.062	1.224
Adjusted odds ratio of acute kidney injury				
Black	< 0.001	1.314	1.259	1.371
Hispanic	0.284	1.022	0.982	1.063
Adjusted odds ratio of acute ischemic stroke				
Black	< 0.001	0.852	0.795	0.913
Hispanic	< 0.001	0.784	0.736	0.834
Adjusted odds ratio of cardiac arrest				
Black	0.010	1.152	1.035	1.283
Hispanic	0.617	0.975	0.884	1.076
Adjusted odds ratio of invasive mechanical ventilation				
Black	< 0.001	1.342	1.277	1.411
Hispanic	< 0.001	1.219	1.166	1.275
Adjusted odds ratio of ECMO use				
Black	< 0.001	1.769	1.287	2.431
Hispanic	0.058	1.355	0.990	1.856
Adjusted odds ratio of acute myocardial infarction				
Black	0.460	1.026	0.958	1.099
Hispanic	< 0.001	1.245	1.177	1.316
Adjusted odds ratio of all-cause mortality				
Black	< 0.001	1.390	1.281	1.507
Hispanic	0.103	1.067	0.987	1.154

*White as reference. ECMO: extracorporeal membrane oxygenation; SAVR: surgical aortic valve replacement; IABP: intra-aortic balloon pump.

multiple cardiovascular and renal sequelae.[24] Moreover, we found a higher prevalence of obesity among African Americans, reflecting the findings of prior studies that have consistently shown a disproportionately increased rate amongst this cohort.[25] Similarly, the higher prevalence of smoking observed among Whites correlated with a higher prevalence of COPD, echoing a well-recognized association.[26] A previous study across all age groups of the US adult population by Umpierrez *et al.* also found that Hispanics were 1.9 times more likely to be diagnosed with diabetes than Whites.[27] Although our patient cohort consisted only of patients aged 60 to 80 years, Hispanics still demonstrated the highest prevalence of diabetes.

Our study established that the trends in mortality in all three groups have decreased over the last 20 years. This is not surprising given the earlier access to care, better availability of diagnostic techniques, evidence-based consensus on follow-up intervals and thresholds for intervention as well as improvements in surgical techniques and post-operative rehabilitation facilities. These factors contribute to a lower in-patient mortality rate not only for SAVR but also for other cardiac interventions, such as TAVR.[28,29] In a smaller study of 1855 SAVR patients involving data for the state of New York, Qian *et al.* also found that the mortality rate dropped from 2.36% in 2011 to 0.97% in 2018.[30]

Our results add to the current scholarly discourse on the impact of race on disparities in short- and long-term health outcomes affecting patients in the United States. Relative to White individuals, African American patients are more likely to experience cardiogenic shock, cardiac arrest, acute kidney injury and acute ischemic stroke during their hospitalizations for SAVR. As a result, the use of organ support techniques such as IABP, ECMO and invasive mechanical ventilation was higher among African Americans. Not surprisingly, the risk of in-hospital mortality was also higher among African American patients compared to Whites and Hispanics. Hispanics were noted to be more vulnerable than their White peers to cardiogenic shock, AMI, IABP use, events of AIS, and use of invasive mechanical ventilation. While the higher CCI score seen among African Americans and Hispanics as compared to Whites put them at a greater risk of such complications, concerns of racial disparities at level of access-

ibility to care, impact of insurance coverage, engagement and follow-up with their physicians, economic disparities, and factors influencing their decisions to undergo SAVR cannot be excluded. Additional studies, providing a broader framework, can help investigate these potential factors as a way of driving changes to reduce the impact of the racial burden.[31,32]

Conclusion

Our study involving hospital data from 2001-2020 showed that despite decreasing mortality rates in elderly patients undergoing SAVR in the United States, multiple racial disparities were present, which led to poorer outcomes in African Americans and Hispanic patients. Further studies and initiatives to help reduce such disparities and provide equal availability of care are warranted.

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