Ethnic and Gender Disparities in the Uptake of Transcatheter Aortic Valve Replacement in the United States

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ABSTRACT

Introduction: Little is known about ethnic and gender disparities for transcatheter aortic valve replacement (TAVR) procedures in the United States.

Methods: We queried the Nationwide Inpatient Sample (NIS) database (2011–2014) to identify patients who underwent TAVR. We described the temporal trends in the uptake of TAVR procedures among various ethnicities and genders.

Results: Our analysis identified 39,253 records; 20,497 (52.2%) were men and 18,756 (47.8%) were women. Among all TAVRs, 87.2% were Caucasians, 3.9% were African Americans (AA), 3.7% were Hispanics, and 5.2% were of other ethnicities. We found a significant rise in the trend of TAVRs in all groups: in Caucasian men (coefficient = 0.946, \( p < 0.001 \)), Caucasian women (coefficient = 0.985, \( p < 0.001 \)), AA men (coefficient = 0.940, \( p < 0.001 \)), AA women (coefficient = 0.864, \( p < 0.001 \)), Hispanic men (coefficient = 0.812, \( p = 0.001 \)), Hispanic women (coefficient = 0.845, \( p < 0.001 \)). Hence, the uptrend was most significant among Caucasian women, and relatively least significant among Hispanic men. Multivariate regression analysis was conducted to evaluate in-hospital mortality among different groups after adjusting for demographics and baseline characteristics. After multivariable regression for baseline characteristics overall, the in-hospital mortality per 100 TAVRs was highest among Hispanic men 5.5%, followed by Caucasian women 5.0%, Hispanic women 4.6%, AA women 3.7%, AA men 3.4%, and Caucasian men 3.38% (adjusted \( p \) value = 0.004).

Conclusions: In this observational study, we demonstrated that there is evidence of ethnic and gender differences in the overall uptake and adjusted mortality of TAVRs in the United States.

Keywords: Gender disparities; Racial disparities; Transcatheter aortic valve replacement
Transcatheter aortic valve replacement (TAVR) emerged as an alternative to surgical replacement for patients with severe aortic stenosis [1–3]. However, little is known about ethnic and gender disparities for TAVR procedures in the United States. This study aimed to evaluate the temporal changes in the uptake of TAVR procedures among the major ethnic groups.

Using the Nationwide Inpatient Sample (NIS) database years 2011–2014, we identified patients who underwent TAVR procedures using International Classification of Diseases procedure code-9; (trans-femoral 35.05 and trans-apical 35.06). Using linear logistic regression analysis, we described the temporal trends in number of TAVR procedures and mortality among various ethnicities and genders. Effect sizes were expressed using co-efficient of regression. Multivariable regression analysis was conducted to compare in-hospital mortality among different study groups. The model included the following variables: age, hypertension, diabetes mellitus, congestive heart failure, chronic lung disease, chronic kidney disease (CKD), obesity, anemia, hypothyroidism, liver disease, fluid/electrolyte abnormalities, peripheral vascular disease, pulmonary circulation disorders, smokers, history of PCI, history of coronary artery bypass grafting, prior MI, and access route for TAVR.

From 2011 to 2014, 42,189 records underwent TAVR. After excluding records with missing data regarding ethnicity (2936), the final cohort included 39,253 records; 20,497 (52.2%) were men and 18,756 (47.8%) were women. Among all TAVRs, 34,229 (87.2%) were Caucasians, 1527 (3.9%) were African Americans (AA), 1471 (3.7%) were Hispanics and 2027 (5.2%) were of other ethnicities. Among Caucasians, 18,023 (52.7%) were men and 16,206 (47.3%) were women, among AA ethnicity 589 (38.6%) were men and 937 (61.4%) were women, while among Hispanics 825 (56.1%) were men and 646 (43.9%) were women. Baseline characteristics for different study groups are outlined in Table 1.

From 2011 to 2014, there was an increase in TAVRs in Caucasian men from 493 in the 2011 quarter (q)4 to 2470 in 2014-q4 with a significant change of trend (coefficient = 0.946, \( p < 0.001 \)), and in Caucasian women from 381 in 2011-q4 to 2280 in 2014-q4 (coefficient = 0.985, \( p < 0.001 \)). Among AA men, TAVRs increased from 11 in 2011-q4 to 85 in 2014-q4 (coefficient = 0.940, \( p < 0.001 \)), and in AA women TAVRs increased from 37 in 2011-q4 to 140 in 2014-q4 (coefficient = 0.864, \( p < 0.001 \)). In Hispanic men, there was an increase in TAVRs from 11 in 2011-q4 to 100 in 2014-q4 (coefficient = 0.812, \( p = 0.001 \)), while in Hispanic women, TAVRs increased from 11 in 2011-q4 to 90 in 2014-q4 (coefficient = 0.845, \( p < 0.001 \)) (Fig. 1). Hence, the uptrend was most significant among Caucasian women, and relatively least significant among Hispanic men.

Multivariate regression analysis was conducted to evaluate in-hospital mortality among different groups after adjusting for demographics and baseline characteristics. Overall, the in-hospital mortality per 100 TAVRs was highest among Hispanic men 5.5% (45/825), followed by Caucasian women 5.0% (804/15,402), Hispanic women 4.6% (30/646), AA women 3.7% (35/937), AA men 3.4% (20/589), and Caucasian men 3.38% (610/18,023) (adjusted \( p \) value = 0.004). Temporal changes in the in-hospital mortality among different groups are outlined in Fig. 1. Overall, there was no significant change in the trends, despite some numerical differences along the years.

In this observational study, we demonstrated that there is evidence of ethnic and gender differences in the overall uptake of TAVRs in the US. According to the United States Census Bureau, AA and Hispanics represent 13% and 17.1% of the general population, respectively [5]. However, in our study, they only represented 3.9% and 3.7% of the TAVR procedures, respectively. We have demonstrated a significant uptrend in the number of TAVRs in all groups, which was most significant in Caucasian women, and least in Hispanic men. Data from the Society of Thoracic Surgeons/American College of Cardiology Transcatheter Valve Therapy (TVT) have reported ethnic differences in the uptake of TAVRs in the United States [4]. In their report including 26,378 TAVRs from 2012 to 2014, the majority were Caucasians (93.8%) and AA represented only 3.8% of all TAVRs [4]. The present study extends our
knowledge by examining other ethnicities and evaluating gender differences as well. Further, we demonstrated ethnic and gender disparities in the adjusted in-hospital mortality rate, which was highest among Hispanic men followed by Caucasian women.

The background for ethnic disparities in the uptake of TAVR is multi-factorial. Socio-economic status and insurance coverage play important roles in preventing certain groups from receiving TAVRs. Reports from the United States Census Bureau suggested higher rates of non-insurance among minorities; reaching 10.5% in AA and 16% among Hispanics compared with 6.3% among Caucasians [5]. Cultural differences may also play a role, with reports of higher propensities to refuse invasive treatments among some minorities compared to Caucasians [6]. Importantly, minorities have been underrepresented in major clinical trials and specifically for TAVR [1].

This analysis is limited by the data source, which is an administrative database, and liable to documentation errors. Also, the NIS provides only data related to the index hospitalization, with no available long-term data. Being an

| Table 1 Baseline characteristics among different study groups |
|-------------------------------------------------------------|
| Characteristics     | White females (n = 16,206) | White males (n = 18,023) | AA females (n = 937) | AA males (n = 589) | Hispanic females (n = 646) | Hispanic males (n = 809) | P value |
|---------------------|----------------------------|--------------------------|---------------------|--------------------|--------------------------|--------------------------|---------|
| Hypertension        | 13,006 80.3               | 14,195 78.8             | 788 84.0            | 474 80.5           | 526 81.4                  | 679 82.3                  | < 0.001 |
| Diabetes mellitus   | 5088 31.4                 | 6354 35.3               | 424 45.3            | 240 40.7           | 295 45.7                  | 384 46.6                  | < 0.001 |
| Heart failure       | 2015 12.4                 | 2014 11.2               | 140 14.9            | 80 13.6            | 75 11.6                   | 90 10.9                   | < 0.001 |
| Chronic lung disease| 5300 32.7                 | 6298 34.9               | 269 28.7            | 184 31.2           | 196 30.3                  | 259 31.4                  | < 0.001 |
| CKD                 | 4595 28.4                 | 7248 40.2               | 390 41.6            | 375 63.6           | 196 30.3                  | 400 48.5                  | < 0.001 |
| Obesity             | 2594 16.0                 | 2046 11.4               | 240 25.6            | 80 13.6            | 120 18.6                  | 75 9.1                    | < 0.001 |
| Chronic anemia      | 4436 27.4                 | 4325 24.0               | 343 36.6            | 230 39.0           | 201 31.1                  | 250 30.3                  | < 0.001 |
| Coagulopathy        | 3454 21.3                 | 4539 25.2               | 249 26.6            | 170 28.9           | 160 24.8                  | 290 35.2                  | < 0.001 |
| Hypothyroidism      | 4594 28.3                 | 2514 13.9               | 165 17.6            | 50 8.5             | 155 24.0                  | 105 12.7                  | < 0.001 |
| Chronic liver disease| 373 2.3                  | 462 2.6                 | 20 2.1              | 30 5.1             | 15 2.3                    | 31 3.8                    | < 0.001 |
| Fluid and electrolyte disorders | 4492 27.7 | 4297 23.8 | 333 35.5 | 165 28.0 | 196 30.3 | 210 25.5 | < 0.001 |
| Pulmonary circulation disorders | 680 4.2 | 600 3.3 | 25 2.7 | 45 7.6 | 30 4.6 | 25 3.0 | < 0.001 |
| Tobacco use         | 3268 20.2                 | 6369 35.3               | 160 17.1            | 195 33.1           | 105 16.3                  | 239 29.0                  | < 0.001 |
| History of PCI      | 2638 16.3                 | 3839 21.3               | 95 10.1             | 95 16.1           | 90 13.9                   | 164 19.9                  | < 0.001 |
| History of CABG     | 2033 12.5                 | 5822 32.3               | 55 5.9              | 65 11.0           | 70 10.8                   | 245 29.7                  | < 0.001 |
| Prior myocardial infarction | 1591 9.8 | 2900 16.1 | 80 8.5 | 80 13.6 | 60 9.3 | 85 10.3 | < 0.001 |
| Trans-femoral TAVR  | 12,601 77.8               | 14,933 82.9             | 803 85.6            | 505 85.6          | 476 73.6                  | 571 69.2                  | < 0.001 |
| Trans-apical TAVR   | 3630 22.4                 | 3139 17.4               | 135 14.4            | 85 14.4           | 171 26.4                  | 254 30.8                  | < 0.001 |

CKD chronic kidney disease, AA African American, PCI percutaneous coronary intervention, CABG coronary artery bypass grafting
observation study, there is always potential for selection bias. However, we attempted to reduce allocation bias by conducting multivariable regression analyses. Useful information, such as medications, laboratory data, as well as type of TAVR valves, was unavailable through this database. Further studies are encouraged to identify barriers for uptake of TAVR by minorities, as well as to better specify ethnic and gender differences in outcomes of TAVR procedures.

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**Compliance with Ethics Guidelines.** This article does not contain any studies with human participants or animals performed by any of the authors.

**Data Availability.** All data generated or analyzed during this study are included in this published article/as supplementary information files.

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REFERENCES

1. Smith CR, Leon MB, Mack MJ, Miller DC, Moses JW, Svensson LG, et al. Transcatheter versus surgical aortic-valve replacement in high-risk patients. N Engl J Med. 2011;364(23):2187–98.

2. Leon MB, Smith CR, Mack MJ, Makkar RR, Svensson LG, Kodali SK, et al. Transcatheter or surgical aortic-valve replacement in intermediate-risk patients. N Engl J Med. 2016;374(17):1609–20.

3. Zack CJ, Al-Qahtani F, Kawsara A, Al-Hijji M, Amin AH, Alkhouri M. Comparative outcomes of surgical and transcatheter aortic valve replacement for aortic stenosis in nonagenarians. Am J Cardiol. 2017;119(6):893–9.

4. Holmes DR, Nishimura RA, Grover FL, Brindis RG, Carroll JD, Edwards FH, et al. Annual outcomes with transcatheter valve therapy: from the STS/ACC TVT registry. J Am Coll Cardiol. 2015;66(25):2813–23.

5. U.S. Census Bureau; 2017. https://www.census.gov/data/datasets/2017/demo/popest/nation-detail.html. Accessed April 2019.

6. Groeneveld PW, Kruse GB, Chen Z, Asch DA. Variation in cardiac procedure use and racial disparity among Veterans Affairs Hospitals. Am Heart J. 2007;153(2):320–7.