Impact of Economic Status on Utilization and Outcomes of Transcatheter Aortic Valve Implantation and Mitraclip

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Data on the impact of economic status on Transcatheter aortic valve implantation (TAVI) and MitraClip (MC) is lacking. Patients who underwent TAVI and/or MC during 2012 to 2017 were identified in the Nationwide Readmission Database and divided by zip code estimated income quartile into 4 groups (Q1 to Q4). The utilization of TAVI and/or MC was defined as the number of TAVIs and/or MCs over all admissions with an aortic and/or mitral valve disease (AVD and/or MVD) and represented per 1,000 admissions. A total of 168,853 patients underwent TAVI; 20.6% in Q1, 26.3% in Q2, 27.3% in Q3, and 25.8% in Q4, while 15,387 patients underwent MC; 22% in Q1, 26.2% in Q2, 26.3% in Q3, and 25.5% in Q4. The annual utilization of TAVIs and/or MCs increased over the study period and was generally lower with lower income. In 2012, TAVI was performed for 8.2, 8.8, 10.8, and 11.3 per 1,000 AVD admissions in Q1, Q2, Q3, and Q4, respectively. In 2017, TAVI was performed for 54.1, 65.1, 68.6, and 71 per 1,000 AVD admissions in Q1, Q2, Q3, and Q4, respectively. In 2014, MC was performed for 1.6, 2.1, 1.8, and 1.9 per 1,000 MVD admissions in Q1, Q2, Q3, and Q4, respectively. In 2017, MC was performed for 5.6, 6.5, 8, and 8 per 1,000 MVD admissions in Q1, Q2, Q3, and Q4, respectively. In-hospital mortality, stroke, and 30-day readmissions were generally comparable across groups. Lower-income patients may be underrepresented among patients undergoing TAVI and MC despite comparable outcomes. Further studies are needed to examine the etiologies behind these disparities and identify targeted strategies for its mitigation. **(Am J Cardiol 2021;142:116−123)**

In light of recent emerging evidence from the landmark PARTNER-3, EVOLUT, and COAPT trials, demand for FDA-approved valvular interventions (AVIs): Transcatheter aortic valve implantation (TAVI) and MitraClip (MC), is expected to grow. Socioeconomic disparities in the utilization and outcomes of cardiovascular interventions are well established.[1−4] However, data on whether such disparities exist in the expanding field of valvular heart disease interventions is largely lacking. Although no literature exists on the impact of economic status (ES) on MC utilization and outcomes, a few small studies have suggested that ES disparities influence access to and outcomes of TAVI.[5,6] Yet, no large-scale studies have examined ES impact on the use and outcomes of structural heart disease interventions. Understanding these disparities, if present, is an essential step towards eradicating socioeconomic inequalities in healthcare, a well-emphasized objective of the Institute of Medicine and the Healthy People 2010 agenda of the United States Department of Health and Human Services.[7,8] As such, we sought to investigate the impact of ES (measured by household income) on the utilization and outcomes of approved valvular heart disease interventions: TAVI and MC, using a large nationwide database.

Methods

We performed a retrospective cohort study after the STROBE checklist and using the Nationwide Readmissions Database (NRD) released by the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality.[9] NRD is a nationally representative database of hospital admissions in United States (US) non-federal hospitals. It includes up to 17 million discharges each year in up to 27 states, accounting for about 57% of all hospitalizations in the US, and providing discharge weights that can be used to provide the national US estimates.[10] This study was exempt by our Institutional Review Board committee.

We used a weighted estimate of NRD to include patients who underwent TAVI between January 2012 and December 2017, and patients who underwent MC between January 2014 and December 2017. The appropriate ICD-9

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See page 123 for disclosure information.

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(International Classification of Diseases-9th Edition-Clinical Modification) and ICD-10 procedure codes were used for this selection. Supplementary Table 1 describes the codes used for this analysis. Patients with unknown income were excluded; 2,250 and 184 patients who underwent TAVI and Mitraclip, respectively.

Patients were divided based on their income into 4 groups: Q1; 0 to 25th percentile income, Q2; 26th to 50th percentile income, Q3; 51st to 75th percentile income, and Q4; 76th to 100th percentile income. Income data was reported in NRD based on the estimated median household income of residents in the patient's ZIP Code. As these estimates change every year, the income ranges for income groups changed every year and are provided in Supplementary Table 2 for included years.[11] We also estimated the utilization of TAVI and MC in each income group. TAVI utilization was defined as the number of TAVI procedures in an income group over the number of all admissions with an aortic valve disease in this income group and was represented per 1,000 admissions with aortic valve disease. Similarly, MC utilization was defined as the number of MC procedures in an income group over the number of all admissions with a mitral valve disease in this income group and was represented per 1,000 admissions with mitral valve disease.

The following baseline variables were collected in the study population: age, gender, primary expected payer, diabetes mellitus (DM), hypertension, renal failure, dyslipidemia, congestive heart failure, obesity, history of stroke, smoking, alcohol abuse, and drug abuse. We also looked at admission details including all-cause in-hospital mortality, in-hospital stroke, in-hospital acute myocardial infarction (AMI), in-hospital acute kidney injury (AKI), the requirement of post-procedural permanent pacemaker (PPM) implantation, and the requirement of post-procedural blood transfusion. All patients were followed for at least 30 days after discharge after the procedure for any hospital readmission. In-hospital outcomes and all-cause 30-day readmission rates were compared between income groups. We also assessed baseline predictors of in-hospital stroke, in-hospital mortality, and 30-day readmission.

Categorical variables were presented as numbers and percentages and were compared using Fisher's exact test. Continuous variables were presented as median (interquartile range) compared using 1-way ANOVA or the like Kruskal-Wallis H test. Temporal trends of utilization were assessed by calculating the annual percentage change (APC) for utilization in each group, using the Joinpoint regression software of the National Cancer Institute.[12] The Joinpoint Regression software uses *t*-tests to determine if APCs were statistically significant from zero. Predictors of in-hospital stroke, in-hospital mortality, and 30-day readmission were examined using multiple logistic regression models. All variables of patient characteristics were included as covariates in the multivariable analyses. All tests were 2-sided with a significance level of 0.05. All statistical analyses were conducted using IBM SPSS Statistics, version 26 (IBM Corp., Armonk, NY).

Results

Our study included 168,853 patients who underwent TAVI. Of the 168,853 patients identified, 20.6% were in the Q1 income group, 26.3% in the Q2 group, 27.3% in the Q3 group, and 25.8% in the Q4 group. Most patients in all groups were on Medicare. High-income patients were less likely to have DM, hypertension, renal failure, heart failure, and obesity, but more likely to have dyslipidemia and atrial fibrillation (Table 1). The overall utilization of TAVI was 28.8, 34.3, 36.3, and 36.7 per 1,000 admissions with aortic valve disease in the Q1, Q2, Q3, and Q4 groups respectively.

Throughout the study period, the number of TAVI procedures performed every year was lowest in the Q1 group. The number of TAVI procedures performed in each group every year increased over the study period; in Q1 group (APC = 46.57%, 95% CI [37.26 to 56.51], $p < 0.001$), in Q2 group (APC = 54.46%, 95% CI [42.22 to 67.76], $p < 0.001$), in Q3 group (APC = 49.51%, 95% CI [40.04 to 59.63], $p < 0.001$), and in Q4 group (APC = 42.30%, 95% CI [33.00 to 52.25], $p < 0.001$) (Figure 1).

The utilization of TAVI also increased in all income groups over the study timeframe with rates of TAVI utilization being persistently higher with higher income. Notably, the gap in utilization of TAVI between income groups appears to be widening with time. In 2012, TAVI was performed for 8.2, 8.8, 10.8, and 11.3 per 1,000 admissions with aortic valve disease in the Q1, Q2, Q3, and Q4 groups respectively. On the other hand, in 2017, TAVI was performed for 54.1, 65.1, 68.6, and 71 per 1,000 admissions with aortic valve disease in the Q1, Q2, Q3, and Q4 groups respectively (Figure 1).

Rates of in-hospital mortality, in-hospital stroke, and 30-day readmission were not significantly different between income groups. However, patients in the Q4 group were most likely to get post-procedural blood transfusion and PPM, and patients with lower income were more likely to develop in-hospital AKI and AMI (Table 1).

After adjusting for age, gender, atrial fibrillation, history of stroke and/or TIA, DM, hypertension, renal failure, dyslipidemia, congestive heart failure, obesity, smoking, and drug abuse, the Q1 group did not have a different in-hospital stroke risk when compared with other groups, and the predictors of in-hospital stroke included older age, female gender, atrial fibrillation, history of stroke/TIA, and drug abuse (Figure 2) (Supplementary Table 3). However, Q2 and Q3 groups had a lower risk of in-hospital mortality compared with the Q1 group; OR = 0.871, 95%CI [0.795 to 0.955], $p = 0.003$, and OR = 0.891, 95%CI [0.814 to 0.976], $p = 0.013$, respectively (Figure 2). Other predictors of in-hospital mortality included atrial fibrillation, renal failure, heart failure, in-hospital stroke, and requiring postprocedural blood transfusion (Supplementary Table 4). Risk of 30-day readmission did not change between income groups and predictors of 30-day readmission included atrial fibrillation, history of stroke and/or TIA, DM, renal failure, heart failure, drug abuse, in-hospital stroke, and requiring post-procedural blood transfusion (Figure 2) (Supplementary Table 5).

Our study included 15,387 patients who underwent MC, of which 22% were in the Q1 income group (APC = 55.33%, 95% CI [19.72 to 101.53], $p = 0.02$), 26.2% in the Q2 group (APC = 46.23%, 95% CI [24.70 to 71.48], $p = 0.01$), 26.3% in the Q3 group (APC = 59.85%,

Table 1
Patients who underwent TAVI between 2012 and 2017 (n = 168,853) divided by income

	Percentile income				
Variable	0 -25th	26th to 50th	51st to 75th	76th to 100th	P value
Overall	34,835	44,370	46,007	43,642	
Age (years), median (IQR)	81 (75-86)	82 (76-87)	82 (76-87)	83 (77-88)	<0.001
Sex					<0.001
Men	18,240 (52.4%)	23,722 (53.5%)	24,701 (53.7%)	23,516 (53.9%)	
Women	16,595 (47.6%)	20,648 (46.5%)	21,305 (46.3%)	20,125 (46.1%)	
Primary expected payer					<0.001
Medicare	31,742 (91.2%)	40,504 (91.4%)	41,871 (91.1%)	40,024 (91.8%)	
Medicaid	518 (1.5%)	480 (1.1%)	424 (0.9%)	355 (0.8%)	
Private insurance	1,668 (4.8%)	2,359 (5.3%)	2,801 (6.1%)	2,723 (6.2%)	
Self-pay	180 (0.5%)	155 (0.3%)	209 (0.5%)	195 (0.4%)	
No charge	7 (0.0001%)	13 (0.0001%)	10 (0.0001%)	3 (0.0001%)	
Other	675 (1.9%)	806 (1.8%)	647 (1.4%)	315 (0.7%)	
	Co-morbidities				
Diabetes mellitus	13,205 (37.9%)	15,787 (35.6%)	15,916 (34.6%)	13,956 (32%)	<0.001
Hypertension	29,793 (85.5%)	37,467 (84.4%)	39,002 (84.8%)	36,978 (84.7%)	<0.001
Renal failure	11,829 (34%)	14,807 (33.4%)	14,905 (32.4%)	13,863 (31.8%)	<0.001
Dyslipidemia*	22,638 (65%)	29,347 (66.1%)	30,387 (66.1%)	29,444 (67.5%)	<0.001
Congestive heart failure	26,087 (74.9%)	32,842 (74%)	33,390 (72.6%)	31,064 (71.2%)	<0.001
Atrial fibrillation	11,606 (33.3%)	15,571 (35.1%)	16,460 (35.8%)	16,121 (36.9%)	<0.001
Obesity†	5,894 (16.9%)	7,651 (17.2%)	7,462 (16.2%)	5,731 (13.1%)	<0.001
Stroke/TIA history	4,289 (12.3%)	5,291 (11.9%)	5,755 (12.5%)	5,416 (12.4%)	0.174
Valve surgery history	1,345 (3.9%)	1,605 (3.6%)	1,663 (3.6%)	1,567 (3.6%)	0.07
Smoker	12,246 (35.2%)	15,190 (34.2%)	15,157 (32.9%)	14,991 (34.4%)	0.001
Alcohol abuse	289 (0.8%)	427 (1%)	434 (0.9%)	377 (0.9%)	0.838
Drug abuse	135 (0.4%)	129 (0.3%)	149 (0.3%)	103 (0.2%)	0.001
	Outcomes				
In-hospital mortality	915 (2.6%)	1,044 (2.4%)	1,111 (2.4%)	1,138 (2.6%)	0.776
In-hospital stroke	695 (2%)	923 (2.1%)	964 (2.1%)	937 (2.1%)	0.152
In-hospital acute myocardial infarction	1,133 (3.3%)	1,244 (2.8%)	1,277 (2.8%)	1,229 (2.8%)	0.001
In-hospital acute kidney injury	4,837 (13.9%)	5,969 (13.5%)	6,052 (13.2%)	5,708 (13.1%)	0.001
Post-procedural permanent pacemaker implantation	3,256 (9.3%)	4,586 (10.3%)	4,920 (10.7%)	4,930 (11.3%)	<0.001
Post-procedural blood transfusion	4,217 (12.1%)	4,923 (11.1%)	5,484 (11.9%)	6,484 (14.9%)	<0.001
30-day readmission	4,552 (14.8%)	5,818 (14.8%)	5,972 (14.8%)	5,710 (14.9%)	0.794

* Dyslipidemia is defined as disorders of lipoid metabolism (specific codes are present in Supplementary Table 1).
† Obesity is defined as overweight, obese, and/or having BMI 30 or higher (specific codes are present in Supplementary Table 1).

95% CI [11.61 to 128.93], p = 0.03), and 25.5% in the Q4 group (APC = 49.64%, 95% CI [-1.69 to 127.79], p = 0.05). The median age at MC was 78 years, 80 years, 81 years, and 82 years in the Q1, Q2, Q3, and Q4 groups, respectively. Most patients in all groups were on Medicare−a federal program that provides health coverage for patients 65+ or under 65 and have a disability, regardless of income. A small minority of patients were on Medicaid− a state and federal program that provides health coverage for patients with very low income. High-income patients were less likely to have DM, hypertension, renal failure, heart failure, and obesity, but more likely to have atrial fibrillation (Table 2). The overall utilization of MC was 3.7, 4.6, 4.9, and 5.1 per 1,000 admissions with mitral valve disease in the Q1, Q2, Q3, and Q4 groups respectively.

Throughout the study period, the number of MC procedures performed every year was lowest in the Q1 group. The number of MC procedures performed in each group every year increased over the study period; from 355 procedures in 2014 to 1,324 in 2017 in the Q1 group, from 498 procedures in 2014 to 1,535 procedures in 2017 in the Q2 group, from 382 procedures in 2014 to 1,662 procedures in 2017 in Q3 group, and from 410 procedures in 2014 to 1,425 procedures in 2017 procedures in Q4 group (Figure 3).

The utilization of MC also increased in all income groups over the study timeframe with rates of MC utilization being persistently higher with higher income. In 2014, MC was performed for 1.6, 2.1, 1.8, and 1.9 per 1,000 admissions with mitral valve disease in the Q1, Q2, Q3, and Q4 groups respectively, while in 2017, MC was performed for 5.6, 6.5, 8, and 8 per 1,000 admissions with mitral valve disease in the Q1, Q2, Q3, and Q4 groups respectively (Figure 3).

Rates of in-hospital mortality, in-hospital stroke, in-hospital AMI, requiring PPM implantation and requiring post-procedural blood transfusion, and 30-day readmission were not significantly different between income groups, while in-hospital AKI was higher among lower-income patients (Table 2)

After adjusting for age, gender, atrial fibrillation, history of stroke and/or TIA, DM, hypertension, renal failure, dyslipidemia, congestive heart failure, obesity, smoking, and drug abuse, the Q1 group did not have a different

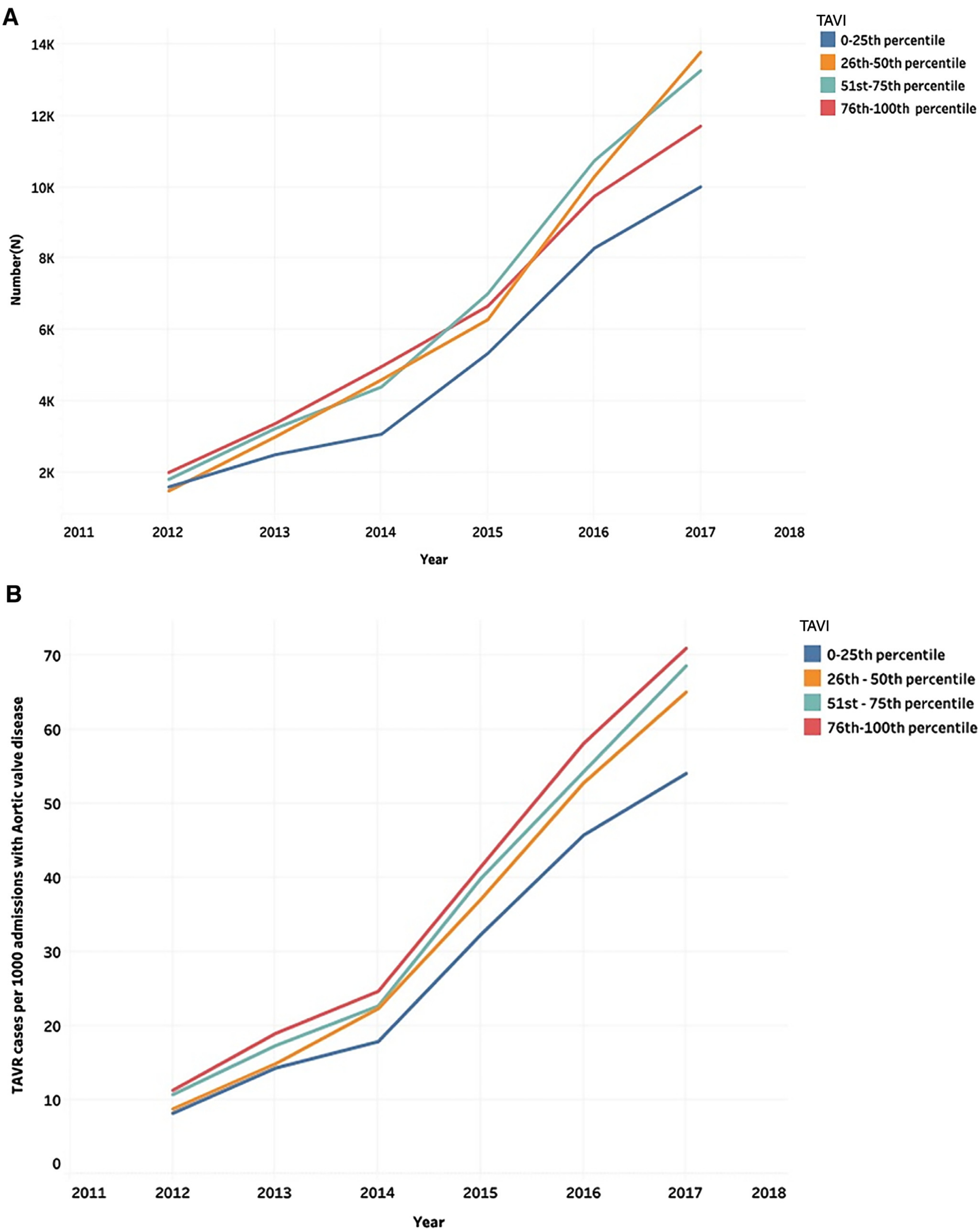

Figure 1. Number of procedures (*A*) and utilization (*B*) of TAVI every year in each income group.

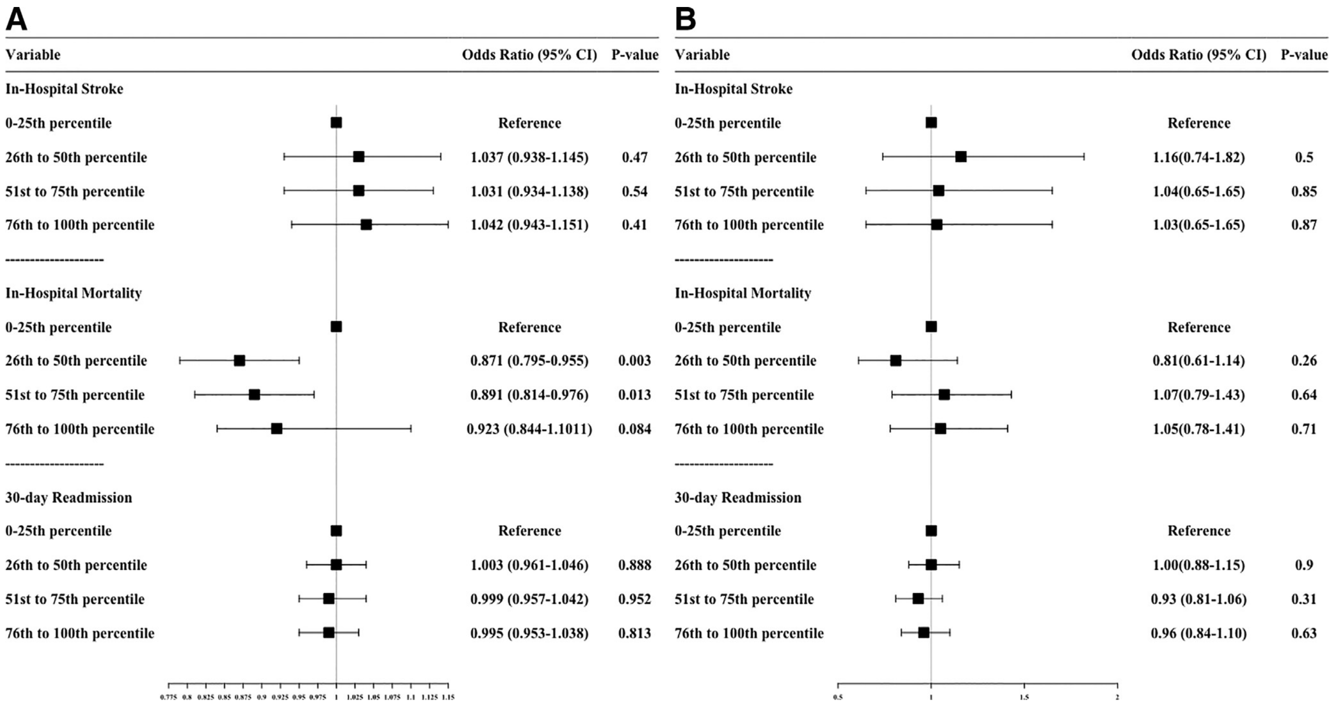

Figure 2. Risk of in-hospital stroke, in-hospital mortality, and 30-day readmission in income groups after TAVI (*A*) and Mitraclip (*B*).

in-hospital stroke risk when compared with other groups, and the predictors of in-hospital stroke included female gender, atrial fibrillation, and heart failure (Figure 2) (Supplementary Table 3). Similarly, the Q1 group did not have different in-hospital mortality compared with other groups and predictors of in-hospital mortality included heart failure, in-hospital stroke, and requiring post-procedural blood transfusion (Figure 2) (supplementary table 4). The risk of 30-day readmission did not change between income groups and predictors of 30-day readmission included female gender, atrial fibrillation, DM, hypertension, renal failure, heart failure, in-hospital stroke, and requiring post-procedural blood transfusion (Figure 2) (supplementary table 5).

Discussion

The principal findings of our study are (1) AVIs including TAVI and MC are utilized less frequently in patients with low income compared with patients in the higher income groups. (2) Clinically significant outcomes including in-hospital mortality, stroke, and 30-day readmissions were generally comparable across income groups except for a slight differential impact of ES on in-hospital mortality for patients undergoing TAVI.

Although socioeconomic disparities in the utilization of traditional cardiovascular interventions are well established,[1−3] limited data exist on the impact of economic status on the utilization of novel AVIs. In our study, we found that the number of TAVI procedures performed every year has consistently increased for all income groups across the study timeframe. However, throughout the study period (2012 to 2017), the number of AVIs performed was generally lower in the lower-income groups. Furthermore, it is important to note that the gap in utilization of TAVI and MC across income groups appears to be widening with time. The finding of significant underuse of AVIs in low-income patients in the present study is striking as there is no data to suggest that the prevalence of significant valvular pathologies requiring an invasive intervention is different based on ES.

Various studies have shown that socioeconomic status is an important determinant of the use of invasive cardiovascular procedures in the general population. In agreement with our findings, Philbin et al reported that patients in the highest quintile of income were 76% more likely to undergo any revascularization procedure than were patients in the lowest quintile and these income-based discrepancies persisted despite adjustment for age, gender, and race.[3] Yet, the pathways underlying the association between socioeconomic and differential utilization of AVIs remain less well understood. Multiple factors likely contribute to the observed income-based disparities in procedure use. First, geographic differences in terms of access to AVIs in low-income patients likely influences the rate of utilization of these procedures in this population. For Medicare to cover advanced valvular interventions including TAVI and MC, hospitals have to meet certain requirements in terms of experience and facility equipment.[13,14] It has been suggested that patients who reside in lower-income neighborhoods are more likely to receive their care from medical centers that are less likely to meet Medicare criteria leading to underuse of these advanced cardiovascular interventions in lower-income patients.[3,15,16] In a study of 1,551 patients who underwent TAVI in the State of Maryland, half of the patients with

Table 2
Patients who underwent Mitraclip between 2014 and 2017 (n = 15,387) divided by income

	Percentile income				
Variable	0 to 25th	26th to 50th	51st to 75th	76th to 100th	
Overall	3,382	4,034	4,054	3,916	
Age (years), median (IQR)	78 (69-84)	80 (72-86)	81 (74-86)	82 (74-86)	<0.001
Sex					<0.001
Men	1,615 (47.8%)	2,157 (53.5%)	2,139 (52.8%)	2,121 (54.2%)	
Women	1,767 (52.2%)	1,877 (46.5%)	1,915 (47.2%)	1,795 (45.8%)	
Primary expected payer					0.022
Medicare	2,870 (84.9%)	3,529 (87.5%)	3,527 (87%)	3,430 (87.6%)	
Medicaid	144 (4.3%)	94 (2.3%)	83 (2%)	47 (1.2%)	
Private insurance	303 (9%)	327 (8.1%)	367 (9.1%)	401 (10.2%)	
Self-pay	17 (0.5%)	24 (0.6%)	14 (0.3%)	14 (0.4%)	
No charge	4 (0.1%)	2 (0.0001%)	2 (0.0001%)	1 (0.0001%)	
Other	44 (1.3%)	56 (1.4%)	61 (1.5%)	21 (0.5%)	
		Co-morbidities			
Diabetes mellitus	1,006 (29.7%)	971 (24.1%)	1,024 (25.3%)	802 (20.5%)	<0.001
Hypertension	2,753 (81.4%)	3,119 (77.3%)	3,170 (78.2%)	3,021 (77.1%)	<0.001
Renal failure	1,304 (38.6%)	1,370 (34%)	1,408 (34.7%)	1,236 (31.6%)	<0.001
Dyslipidemia*	1,899 (56.2%)	2,245 (55.7%)	2,234 (55.1%)	2,240 (57.2%)	0.435
Congestive heart failure	2,779 (82.2%)	3,224 (79.9%)	3,128 (77.2%)	3,017 (77%)	<0.001
Atrial fibrillation	1,605 (47.5%)	1,913 (47.4%)	2,095 (51.7%)	2,036 (52%)	<0.001
Obesity†	368 (10.9%)	356 (8.8%)	297 (7.3%)	263 (6.7%)	<0.001
Stroke/TIA history	427 (12.6%)	407 (10.1%)	502 (12.4%)	423 (10.8%)	0.236
Valve surgery history	268 (7.9%)	341 (8.5%)	319 (7.9%)	397 (10.1%)	0.003
Smoker	1,335 (39.5%)	1,410 (35%)	1,271 (31.3%)	1,291 (33%)	<0.001
Alcohol abuse	28 (0.8%)	44 (1.1%)	26 (0.6%)	21 (0.5%)	0.03
Drug abuse	10 (0.3%)	15 (0.4%)	17 (0.4%)	17 (0.4%)	0.317
		Outcomes			
In-hospital mortality	93 (2.7%)	90 (2.2%)	109 (2.7%)	117 (3%)	0.272
In-hospital stroke	34 (1%)	47 (1.2%)	43 (1.1%)	42 (1.1%)	0.928
In-hospital acute myocardial infarction	75 (2.2%)	85 (2.1%)	92 (2.3%)	65 (1.7%)	0.144
In-hospital acute kidney injury	585 (17.3%)	622 (15.4%)	568 (14%)	477 (12.2%)	<0.001
permanent pacemaker	28 (0.8%)	37 (0.9%)	39 (1%)	36 (0.9%)	0.661
Post-procedural blood transfusion	314 (9.3%)	281 (7%)	273 (6.7%)	392 (10)	0.21
30-day readmission	488 (16.2%)	552 (15.7%)	526 (14.7%)	531 (15.4)	0.219

* Dyslipidemia is defined as disorders of lipoid metabolism (specific codes are present in Supplementary Table 1).

† Obesity is defined as overweight, obese, and/or having BMI 30 or higher (specific codes are present in Supplementary Table 1).

low socioeconomic status have to travel long distances to undergo TAVI compared with the most affluent patients.[6] Second, insurance status has been proposed as a factor that may account for differences in procedure use among income groups.[17,18] This is not supported by our study findings as insurance status did not differ significantly based on income, with Medicare being the primary expected payer for approximately 85% to 90% of patients in all income groups. Finally, caring for low-income patients is, in general, less favorable financially and system-related biases in the quality of cardiovascular care provided for low-income patients is well-documented.[19] These pecuniary disincentives, while difficult to measure, are likely an additional factor at play.

Our study also suggests that the distribution of baseline comorbidities was heterogeneous among income groups with low-income patients being more likely to have renal failure and obesity, but less likely to have atrial fibrillation compared with patients in the higher-income groups. Most other baseline comorbidities were similarly distributed across income groups. Importantly, clinically significant outcomes including in-hospital mortality, stroke, and 30-day readmissions were generally comparable across income groups except for a slight differential impact of ES on the risk of in-hospital mortality for patients undergoing TAVI. To our knowledge, this is the first study to report the impact of ES on clinical outcomes after AVIs. Although these data are reassuring, further studies are needed to confirm these observations as the use AVIs continues to expand with wide acceptance and gradual increase in utilization across different socioeconomic strata.

Our study is not without limitations. First, the present study was based on retrospective analyses of an administrative claims database designed to collect data for billing purposes. Information regarding patient preferences and physician recommendations were not available in our data set. Therefore, it is not possible to assess whether patient treatment preferences might have been different across various socioeconomic status strata. Second, we quantified economic status based on median ZIP code−derived household income. Although it has validity, it may be less robust than including individual-based economic status estimates. Third, the true denominator of TAVI and/or MC eligible patients per income group is not known in the NRD. The utilization of these procedures across income groups was calculated based on the overall admissions for aortic and

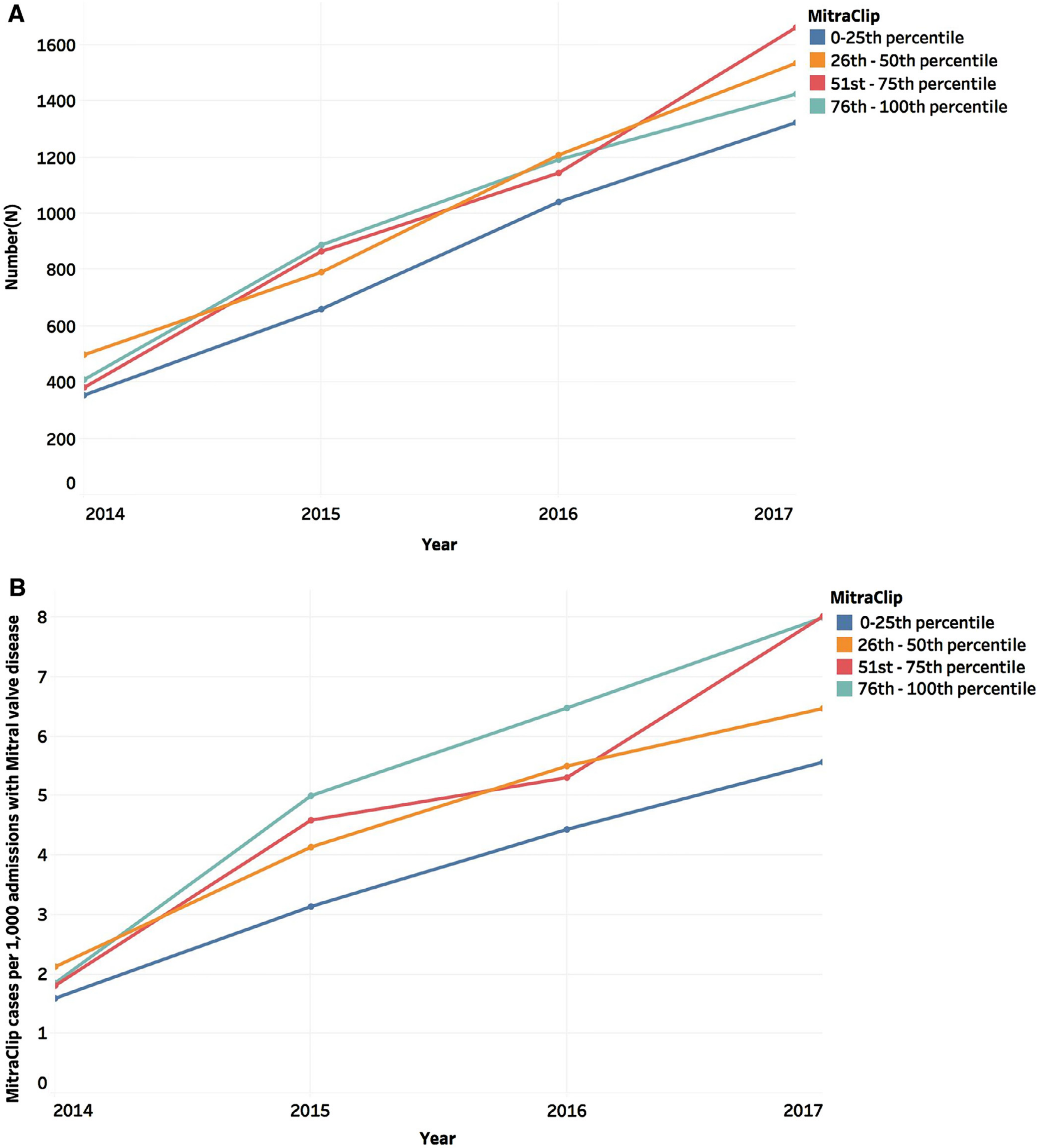

Figure 3. Number of procedures (*A*) and utilization (*B*) of Mitraclip every year in each income group.

mitral valve disease, however, this estimation may be subject to bias. Finally, although our risk adjustment model included numerous salient clinical covariates, data on race, procedural characteristics, and adherence to medication regimen are not available in the NRD. As such, the impact of these variables on the relationship between ES and utilization and outcomes of AVIs could not be assessed in the present study.

In conclusion, significant ES-based disparities in the utilization of AVIs exist in the US, with lower-income patients being underrepresented among patients undergoing TAVI and MC. This is particularly important given that clinically relevant outcomes including in-hospital mortality, stroke, and 30-day readmissions were generally comparable across income groups. Further studies are needed to examine the etiologies behind these disparities and to identify targeted strategies for its mitigation.

Authors Contribution

Anas M. Saad and Medhat Farwati: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Writing - original draft; Vardhmaan Jain: Methodology, Writing - original draft; Keerat Rai Ahuja: Visualization, Software, Writing - review & editing; Agam Bansal: Writing - original draft; Mohamed M. Gad: Conceptualization, Validation, Methodology, Writing - review & editing; Toshiaki Isogai: Conceptualization, Methodology, Validation, Supervision, Writing - review & editing; Omar Abdelfattah: Methodology, Writing - original draft; Shashank Shekhar: Methodology, Writing - review & editing; Medhat Farwati: Methodology, Writing - review & editing; Nicholas Kassis: Writing - review & editing; Essa Hariri: Writing - review & editing; Amar Krishnaswamy: Conceptualization, Supervision, Validation, Writing - review & editing; Lars G. Svensson: Conceptualization, Supervision, Validation, Writing - review & editing; Samir Kapadia: Conceptualization, Supervision, Validation, Writing - review & editing, Project administration, Resources.

Disclosures

Authors declare no conflict of interests.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.amjcard.2020.11.040.

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