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Racial Differences in Mechanical Thrombectomy Utilization for Ischemic Stroke in the United States

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Background: Compared with non-Hispanic Whites (NHW), racial-ethnic minorities bear a disproportionate burden of stroke and receive fewer evidence-based stroke care processes and treatments. Since 2015, mechanical thrombectomy (MT) has become standard of care for acute ischemic stroke (AIS) patients with proximal anterior circulation large vessel occlusion (LVO).

Objectives: Our objectives were to: assess recent trends in nationwide MT utilization among patients with AIS; determine if there were racial differences; and identify what factors were associated with such differences.

Methods: We performed a retrospective cohort study using nationally representative data of a non-institutionalized population sample from 2006 to 2014 obtained from the Nationwide Inpatient Sample (NIS). We identified a total of 889,309 observations of AIS, of which there were 5,256 MT observations.

Results: In the fully adjusted model, rate of thrombectomy utilization was significantly lower in African Americans (AA) (OR .67, CI .58-.76, P<.001) compared with NHW and Hispanics (OR .94, CI .78-1.13, P=.5).

Conclusion: We found a significant disparity in MT utilization for AA compared with NHW and Hispanics. More work is needed to understand the drivers of this racial disparity in stroke treatment. *Ethn Dis*. 2020;30(1):91-96; doi:10.18865/ed.30.1.91

Keywords: Stroke; Mechanical Thrombectomy; Race; Racial Disparities; Large Vessel Occlusion

Introduction

In the United States, African Americans (AA) are 2-3 times more likely to have a stroke than non-Hispanic Whites (NHW).[1,2] Despite decades of national declines in stroke incidence, the gap in stroke-related racial disparities is widening. [3-5] This divide is thought to be related to differing risk factors profiles, decreased access to care, and differences in stroke treatment utilization.[6-9] Since 2015, mechanical thrombectomy (MT) has become standard of care for qualifying acute ischemic stroke (AIS) patients with proximal anterior circulation occlusions.[10] Moving forward, to track and address any potential ongoing racial disparities in the use of MT for AIS, it would be important to evaluate pre-2015 utilization rates, which would reflect the baseline status and help uncover key sociodemographic or clinical characteristics tied to any observed disparities. As such, the objectives of this study were to: assess recent trends in nationwide MT utilization among patients with large vessel occlusion (LVO); determine if there were racial differences; and identify what factors were associated with such differences.

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Methods

We conducted a retrospective cohort study using the National Inpatient Sample (NIS). The NIS is a health care database that approximates a 20% stratified sample of all hospital discharges in the United States. We queried the NIS from 2006-2014 using stroke-specific ICD 9 diagnostic codes (433, 434, 436, 437.0 and 437.1) and used procedure codes for endovascular thrombectomy (39.74) to identify those who received MT.[11] We stratified MT utilization rates by race (NHW, AA, Hispanic, and other). We adjusted for age, household income, insurance type, size of hospital, type of hospital, US region, tissue plasminogen activator (tPA), length of stay, admission day and disease severity. Chi-squared test was used to compare demographic characteristics by race among adults with MT. Mean age differences were tested using multiple comparison test of Bonferroni. Logistic regression was used to obtain adjusted race-specific rates of MT utilization. MT utilization rates shown in Figure 1 were obtained from unadjusted trend analysis and adjusted regression models. We performed fully adjusted interaction analyses between race and insurance, race and income, and race and US region.

Results

General Characteristics

We identified a total of 889,309 unweighted observations of stroke, of which there were 5,256 (.60%) instances of MT over the study period (Table 1). In the MT subgroup,

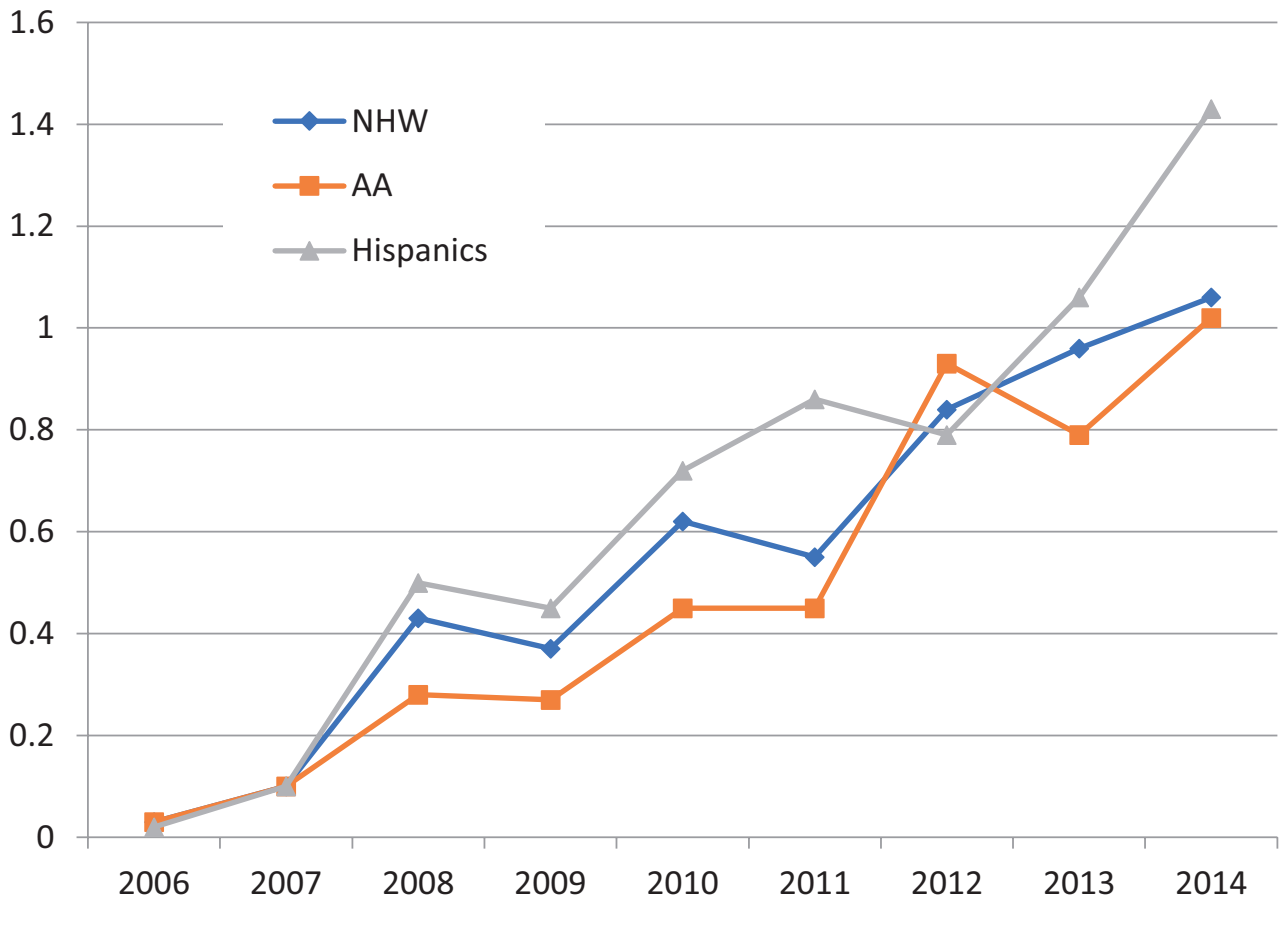

Figure 1. Unadjusted mechanical thrombectomy rates by race
Unadjusted thrombectomy rates (number of cases of mechanical thrombectomy divided by total cases of acute ischemic stroke) for each race by year.
AA, African American; NHW, non-Hispanic White.

AA were significantly younger (mean age 60.5 years, CI 59.3-61.7) compared with NHW (mean 68.1 years, CI 67.5-68.6), and Hispanics (mean 65.9 years, CI 64.3-67.6). We found significant baseline difference in US region, income, insurance and hospital type. AA were more likely to undergo MT in the US South, compared with NHW and Hispanics (56.4%, 42.0%, 42.0%, P<.001) and nearly 52% of AA in the MT group were in the lowest quartile of income, compared with 21% of NHW, and 35% of Hispanics (<.001). More NHW had Medicare (61%) compared with AA (44%) and Hispanics (53%) (P<.05). AA were also more likely to be treated in an urban teaching hospital (90.7%), compared with NHW (84.1%), and Hispanics (79.4%) (P<.048).

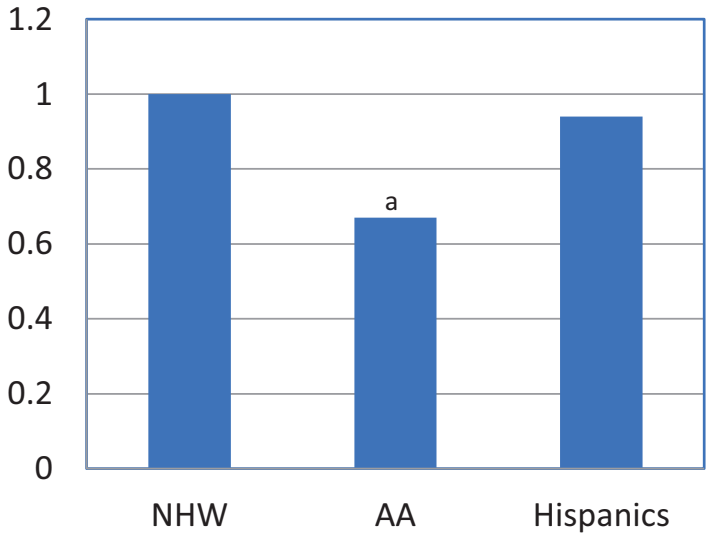

Figure 2. Adjusted thrombectomy rates by race
AA, African American; NHW, non-Hispanic White.
a. P<.05.

Trends in Thrombectomy Utilization

Overall, MT utilization nearly quadrupled in 2012-2014 when compared with 2006-2008 (OR 3.6, CI 2.50-5.10, P<.0001). When stratified by race, unadjusted MT utilization rates were highest in Hispanics (.71), followed by NHW (.58) and AA (.53) (Figure 1). In the fully adjusted model, MT utilization was significantly lower in AA, compared with NHW (OR .67, 95% CI .58-.76, P<.001), and similar in Hispanics when compared to NHW (OR .94, CI 0.78-1.13, P<.5) (Table 2 and Figure 2). Women were slightly more likely to undergo MT (1.12, CI 1.06-1.19). Age was inversely associated with MT utilization (age groups 35-44 (reference), 45-64 (OR .61, CI .54-.69), 65-84 (OR .59, CI .51-.67), >84 (OR .33, CI .28-.39)). MT utilization rates varied by insurance type with the lowest rate seen in patients with Medicaid (OR .87, CI .76-.99) and the highest in patients

Table 1. Baseline characteristics

	Total, n (%)	NHW, n (%)	AA, n (%)	Hispanic, n (%)	Other, n (%)	P
Total patients	5,256	3,796	652	421	387	-
Female	2,605 (49.6)	1,879 (49.4)	334 (51.2)	214 (51.0)	178 (46.0)	.36
Mean age, yrs		68.1	60.5	65.9	65.4	
Insurance						
Medicare	2,975 (56.7)	2,278 (60.9)	287 (44.1)	225 (53.5)	185 (48.1)	<.001
Medicaid	437 (8.4)	187 (4.9)	115 (17.7)	83 (19.9)	52 (13.4)	
Private	1,446 (27.5)	1,089 (28.7)	178 (27.3)	60 (14.3)	119 (30.6)	
Other	394 (7.5)	240 (6.3)	71 (10.9)	52 (12.3)	31 (8.0)	
Income quartile						
1	1,334 (26.0)	788 (21.3)	335 (52.0)	143 (35.1)	68 (17.9)	<.001
2	1,251 (24.3)	954 (25.6)	138 (21.4)	88 (21.7)	71 (18.5)	
3	1,267 (24.7)	955 (25.8)	101 (15.6)	108 (26.4)	103 (27.3)	
4	1,296 (25.1)	1,018 (27.4)	70 (10.9)	69 (16.9)	139 (36.3)	

The total population studied includes 889,309 with a diagnosis of ischemic stroke from 2006-2014. CI, confidence interval; % refers to column percentage.

Table 2. Adjusted multivariable logistic regression for mechanical thrombectomy utilization among adults with ischemic stroke from 2006-2014

		OR	P	CI
Race	NHW	1		
	AA	.67	<.001	.58-.76
	Hispanic	.94	.521	.78-1.13
	Other	1.00	.919	.85-1.20
Sex	Male	1		
	Female	1.12	<.001	1.06-1.19
Age	35-44	1		
	45-54	.61	<.001	.54-.69
	55-64	.59	<.001	.51-.67
	65-74	.33	<.001	.28-.39
Insurance	Medicare	1		
	Medicaid	.87	.048	.76-.99
	Private	1.24	<.001	1.14-1.34
Income Quartile	1	1		
	2	1.06	.27	.96-1.18
	3	1.04	.47	.93-1.18
	4	1.16	.06	.99-1.37
Year	2006-2008	1		
	2009-2011	2.24	<.001	1.56-3.23
	2012-2014	3.61	<.001	2.50-5.19
tPA	Yes	16.9	<.001	15.06-18.88

Models adjusted for sex, age, insurance status, tPA utilization, household income, year of presentation, (Models adjusted for hospital size, hospital type, US region, day of the week, length of stay (LOS) and Charlson co-morbidity index are available from corresponding author).
NHW, non-Hispanic White; AA, African American, OR: Odds ratio, CI: confidence interval.

with private insurance (OR 1.24, CI 1.14-1.34), when compared with patients with Medicare. Hospital size and hospital type were directly related to MT utilization, with large and urban teaching hospitals having 4.7 (CI 3.28-6.74) and 32.8 (CI 17.67-60.85) higher odds of MT utilization compared to small and rural non-teaching hospitals. Utilization rates were slightly higher in the West (OR 1.54, CI 1.15-2.07) compared with the Northeast. Interaction analyses between race and: 1) insurance type, 2) income quartile and 3) US region, revealed a lower odds of MT utilization in Hispanic with private insurance (OR 0.46, CI 0.34-0.64) or other insurance (OR .6, CI .4-.88), and a higher odds of MT utilization in Hispanics in the third income quartile (1.51, CI 1.10-2.08). There was a higher odds of MT utilization for AA in the Midwest (1.51, CI 1.10-2.08), Hispanics in the Midwest (2.33, CI 1.25-4.34), Hispanics in the South (2.47, CI 1.51-4.05) and Hispanics in the West (2.04, CI 1.25-3.33), when compared with NHW in the US Northeast. (Detailed tables with these data are available from the corresponding author.)

Associated Mortality

In the unadjusted logistic regression model, mortality was significantly lower in AA compared with NHW (OR .78, CI .61-.98). There was a slightly lower and non-significant mortality in Hispanics (.89, CI .66-1.2) compared with NHW. After adjusting for all covariates, mortality in AA (.98, CI .75-1.27), Hispanics (.96, CI .69-1.33) and others (1.26, CI .96-1.67) were statistically insignificant compared with NHW. Private insurance was associated with a lower mortality (OR .75, CI .58-.97) compared with Medicare. There was a non-statistically significant trend toward higher mortality in patients with Medicaid (OR 1.22, CI .87-1.7) vs Medicare. Being female was associated with a lower mortality (OR .85, CI .72-.99). Age was positively

associated with mortality; the highest quartile of age was associated with a nearly three-fold higher odds of dying compared with the lowest quartile (OR 2.96, CI 1.92-4.55). Weekend admission was also associated with a higher mortality (OR 1.31, CI 1.11-1.55). Hospitals in the Midwest and West had a lower mortality when compared with the Northeast, while mortality in the South was not significantly different. Compared with 2006-2008, odds of mortality in 2009-2011 was .71 (CI 0.52-0.95) and .44 (CI .34-.59) in 2012-2014.

Discussion

As expected, MT utilization across all races steadily increased from 2006 to 2014. The unadjusted odds of thrombectomy utilization were only slightly lower in AA compared with NHW. After adjusting for patient and hospital-specific variables, AA had one-third lower odds of thrombectomy utilization when compared with NHW, in the years 2006-2014. While unadjusted thrombectomy utilization rates were higher in Hispanics compared with NHW, the rates between the two groups were equal in the adjusted model. These findings are similar to those by Brinjikji et al in 2013.[12] Their study included 371 cases and found a .59 lower odds of thrombectomy utilization in AA, compared with NHW (P<.001).

It has been suggested that racial differences in stroke treatment are related to delays in presentation and differing stroke etiologies.[13,14] We have previously shown that racial disparities in stroke mortality in the Southeast US are rooted in long-standing social and economic institutional marginalization.[1] The disproportionate under-utilization of thrombectomy in AA, may similarly be the result of long-standing societal disenfranchisement. Consistent with this theory are our observations that AA were significantly younger at the time of thrombectomy, were more likely to be in the lowest quartile of income, and less likely to have private insurance or Medicare compared with NHW. Further, Schwamm et al found that AA were significantly less likely to receive standard medical therapy after their stroke, suggesting an intrinsic inequality in acute stroke care.[13] We did not, however, find an interaction effect between AA race and income or insurance type, which may be related to adjustment of related covariates.

After adjusting for patient and hospital-specific variables, AA had one-third lower odds of thrombectomy utilization when compared with NHW, in the years 2006-2014.

Genetic differences, or a higher incidence of lacunar stroke, are unlikely to fully account for the racial disparity we observed. A review of the Trial of ORG 10172 in Acute Stroke Treatment (TOAST) found only a 5.5% higher incidence of lacunar stroke in AA compared with NHW.[15] Further, Hispanics have similar rates of hypertension and diabetes, the two main risk factors for lacunar stroke, but we found a significantly higher rate of thrombectomy utilization in Hispanics, again similar to what was reported by Schwamm et al in the Get With the Guidelines-Stroke program.[13]

Our study has a few limitations. First, we used a retrospective database. Second, our study time period ended before 2015, when mechanical thrombectomy became standard of care, limiting our ability to comment on current practices in MT utilization. Third, while we adjusted for several covariates, we could not account for stroke subtype, stroke severity, eligibility for thrombectomy, onset-to-presentation time and patient/surrogate refusal. Additionally, there may be limitations in the accuracy of racial designations as the NIS uses self-reported social constructs. Lastly, because we used an administrative database, there may be errors in the accuracy of assigned diagnostic and therapeutic codes.

Conclusions

We found that from 2006 to 2014, MT utilization rates increased across all races, but were consistently lower in AA compared with NHW and Hispanics. With MT being a standard treatment for patients with LVO since 2015, disparities in its utilization are likely to become more

significant. We must, therefore, strive to implement surveillance programs and develop community-based interventions aimed at improving factors that drive racial disparities in stroke.

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Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Esenwa, Lekoubou, Bishu, Ovbiagele; Acquisition of data: Bishu; Data analysis and interpretation: Esenwa, Lekoubou, Bishu, Small, Liberman; Manuscript draft: Esenwa, Lekoubou, Small, Liberman, Ovbiagele; Statistical expertise: Esenwa, Lekoubou, Bishu; Administrative: Esenwa, Small, Liberman; Supervision: Esenwa, Ovbiagele

References

1. Esenwa C, Ilunga Tshiswaka D, Gebregziabher M, Ovbiagele B. Historical slavery and modern-day stroke mortality in the United States stroke belt. *Stroke*. 2018;49(2):465-469. https://doi.org/10.1161/STROKEAHA.117.020169 PMID:29335332
2. Boan AD, Feng WW, Ovbiagele B, et al. Persistent racial disparity in stroke hospitalization and economic impact in young adults in the buckle of stroke belt. *Stroke*. 2014;45(7):1932-1938. https://doi.org/10.1161/STROKEAHA.114.004853 PMID:24947293
3. Ovbiagele B, Goldstein LB, Higashida RT, et al; American Heart Association Advocacy Coordinating Committee and Stroke Council. Forecasting the future of stroke in the United States: a policy statement from the American Heart Association and American Stroke Association. *Stroke*. 2013;44(8):2361-2375. https://doi.org/10.1161/STR.0b013e31829734f2 PMID:23697546
4. Towfighi A, Saver JL. Stroke declines from third to fourth leading cause of death in the United States: historical perspective and challenges ahead. *Stroke*. 2011;42(8):2351-2355. https://doi.org/10.1161/STROKEAHA.111.621904 PMID:21778445
5. Kleindorfer DO, Khoury J, Moomaw CJ, et al. Stroke incidence is decreasing in whites but not in blacks: a population-based estimate of temporal trends in stroke incidence from the Greater Cincinnati/Northern Kentucky Stroke Study. *Stroke*. 2010;41(7):1326-1331. https://doi.org/10.1161/STROKEAHA.109.575043 PMID:20489177
6. White H, Boden-Albala B, Wang C, et al. Ischemic stroke subtype incidence among whites, blacks, and Hispanics: the Northern Manhattan Study. *Circulation*. 2005;111(10):1327-1331. https://doi.org/10.1161/01.CIR.0000157736.19739.D0 PMID:15769776
7. Harris R, Nelson LA, Muller C, Buchwald D. Stroke in American Indians and Alaska Natives: a systematic review. *Am J Public Health*. 2015;105(8):e16-e26. https://doi.org/10.2105/AJPH.2015.302698 PMID:26066955
8. Aparicio HJ, Carr BG, Kasner SE, et al. Racial disparities in intravenous recombinant tissue plasminogen activator use persist at primary stroke centers. *J Am Heart Assoc*. 2015;4(10):e001877. https://doi.org/10.1161/JAHA.115.001877 PMID:26467999
9. Hsia AW, Edwards DF, Morgenstern LB, et al. Racial disparities in tissue plasminogen activator treatment rate for stroke: a population-based study. *Stroke*. 2011;42(8):2217-2221. https://doi.org/10.1161/STROKEAHA.111.613828 PMID:21719765
10. Powers WJ, Rabinstein AA, Ackerson T, et al and the American Heart Association Stroke Council. 2018 Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals. *Stroke*. 2018;49(3):e46-e110. https://doi.org/10.1161/STR.0000000000000158 PMID:29367334
11. Adamczyk P, Attenello F, Wen G, et al. Mechanical thrombectomy in acute stroke: utilization variances and impact of procedural volume on inpatient mortality. J Stroke Cerebrovascular Dis. 2013.22(8):1263-1269. https://doi.org/10.1016/j.jstrokecerebrovasdis.2012.08.007
12. Brinjikji W, Rabinstein AA, McDonald JS, Cloft HJ. Socioeconomic disparities in the utilization of mechanical thrombectomy for acute ischemic stroke in US hospitals. *AJNR Am J Neuroradiol*. 2014;35(3):553-556. https://doi.org/10.3174/ajnr.A3708 PMID:23945232
13. Schwamm LH, Reeves MJ, Pan W, et al. Race/ethnicity, quality of care, and outcomes in ischemic stroke. *Circulation*. 2010;121(13):1492-1501. https://doi.org/10.1161/CIRCULATIONAHA.109.881490 PMID:20308617
14. Havranek EP, Mujahid MS, Barr DA, et al; American Heart Association Council on Quality of Care and Outcomes Research, Council on Epidemiology and Prevention, Council on Cardiovascular and Stroke Nursing, Council on Lifestyle and Cardiometabolic Health, and Stroke Council. Social determinants of risk and outcomes for cardiovascular disease: a scientific statement from the American Heart Association. *Circulation*. 2015;132(9):873-898. https://doi.org/10.1161/CIR.0000000000000228 PMID:26240271
15. Hassaballa H, Gorelick PB, West CP, Hansen MD, Adams HP Jr. Ischemic stroke outcome: racial differences in the trial of danaparoid in acute stroke (TOAST). *Neurology*. 2001;57(4):691-697. https://doi.org/10.1212/WNL.57.4.691 PMID:11524481