Lower carotid revascularization rates after stroke in racial/ethnic minority-serving US hospitals

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Abstract

Objective

We sought to determine whether the use of carotid revascularization procedures after stroke due to carotid stenosis differs between minority-serving hospitals and hospitals serving predominantly white patients.

Methods

We identified ischemic stroke cases due to carotid disease, identified by ICD-9-CM codes, from 2007 to 2011 in the Nationwide Inpatient Sample. The use of carotid endarterectomy (CEA) and carotid artery stenting (CAS) was recorded. Hospitals with $\geq 40\%$ racial/ethnic minority patients (minority-serving hospitals) were compared to hospitals with $< 40\%$ minority patients (predominantly white hospitals [hereafter, abbreviated to white]). Logistic regression was used to evaluate the use of CEA/CAS among minority-serving and white hospitals.

Results

Of the 26,189 ischemic stroke cases meeting inclusion criteria, 20,870 (79.7%) were treated at 1,113 white hospitals and 5,319 (20.3%) received care at 325 minority-serving hospitals. Compared to patients in white hospitals, patients in minority-serving hospitals were less likely to undergo CEA/CAS (17.6%, 95% confidence interval [CI] 16.6%–18.6%, in minority-serving vs 21.2%, 95% CI 20.7%–21.8%, in white hospitals; $p < 0.001$). In fully adjusted logistic regression models, the odds of CEA/CAS were lower in minority-serving compared to white hospitals (odds ratio 0.81, 95% CI 0.70–0.93), independent of individual patient race/ethnicity and other measured hospital characteristics. White and Hispanic individuals had significantly lower odds of CEA/CAS in minority-serving compared to white hospitals. Patient-level racial/ethnic differences in the use of carotid revascularization procedures remained within each hospital stratum.

Conclusion

The odds of carotid revascularization after stroke is lower in minority- compared to white-serving hospitals, suggesting system-level factors as a major contributor to explain race disparities in the use of carotid revascularization.

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Glossary

APR-DRG = All Patient Refined–Diagnosis-Related Group; CAS = carotid artery stenting; CEA = carotid endarterectomy; CI = confidence interval; HCUP = Healthcare Cost and Utilization Project; ICD-9-CM = *International Classification of Diseases, Ninth Revision, Clinical Modification*; IQR = interquartile range; NIS = Nationwide Inpatient Sample; OR = odds ratio.

Revascularization with either carotid endarterectomy (CEA) or carotid artery stenting (CAS) has been shown to decrease future stroke risk in eligible patients with ischemic stroke due to carotid artery stenosis.^{1–3} Racial/ethnic minority patients with stroke have lower rates of carotid revascularization compared to their white counterparts.^{4–6} Minority patients frequently cluster at “minority-serving” hospitals as a result of geographic differences in population diversity and residential segregation.⁷ Minority-serving hospitals may differ from hospitals serving predominantly white patients in their organizational structure and availability of equipment, technology, specialists, and funding.^{7–9} While previous studies have described individual patient race as a determinant of carotid revascularization,^{4–6} it is presently unclear whether the racial/ethnic makeup of the patient population in a given hospital, an example of a system-level hospital characteristic, contributes to racial/ethnic differences in carotid revascularization after stroke.

To develop effective strategies aimed at mitigating racial/ethnic disparities in stroke care, a deeper understanding of site of care as a potential cause of disparities is needed. In other words, elucidating whether differences in care quality are attributable to “where you receive care” as opposed to “who you are” may guide the efficient use of otherwise limited resources toward improving structural and system deficiencies in a few hospitals caring for the majority of minority patients. In the present study, we hypothesized that location of care, that is, receiving care at a minority-serving hospital, is an important contributor to ethnic/racial differences in the use of carotid revascularization after stroke, in addition to individual patient race/ethnicity. Identifying lower usage of carotid revascularization in a limited number of hospitals that care for the majority of racial/ethnic minority patients may present a unique and effective opportunity to address racial and ethnic disparities in stroke care delivery.

Methods

Data source

Data were obtained from the Nationwide Inpatient Sample (NIS). The NIS is the largest all-payer inpatient database in the United States, representing all discharges from a 20% stratified sample of nonfederal US hospitals (hcup-us.ahrq.gov). This study was exempt from institutional review board approval.

Case selection

We identified adult cases with a primary diagnosis of acute ischemic stroke due to carotid stenosis between 2007 and 2011 by using ICD-9-CM codes 433.11 and 433.31.⁴ Elective admissions, those enrolled in a clinical trial, transferred out to another

hospital, or with missing information on key characteristics were excluded (figure 1). Only admissions in hospitals with ≥ 3 admissions with complete data were included for analysis.

Primary exposures, hospital strata, and outcome of interest

The primary exposures of interest were self-identified minority race/ethnicity and hospitals serving predominantly white vs racial/ethnic minority patients. To ensure that missingness of race/ethnicity values did not influence our findings by introducing bias, we performed multiple imputation with 12 iterations to impute missing race/ethnicity values.¹⁰

Among stroke admissions, we compared differences in carotid revascularization use among, and by patient race/ethnicity within, hospitals serving predominantly white (hereafter,

Figure 1 Flow diagram indicating case selection

*Categories are not mutually exclusive. ICD-9 = *International Classification of Diseases, Ninth Revision*.

abbreviated to white) or predominantly racial/ethnic minority patients. Hospitals were stratified based on the proportion of minority patients: hospitals serving predominantly white stroke patients (<40% racial/ethnic minority patients; “white hospitals”); and hospitals serving predominantly racial/ethnic minority stroke patients ($\geq 40\%$ racial/ethnic minority patients; “minority-serving hospitals”), similar to what has been described previously.¹¹ This cut point was chosen because approximately 40% of the US population are of a race/ethnicity other than Non-Hispanic white. Racial/ethnic minority patients are thus underrepresented in hospitals with <40% minority patients and overrepresented in hospitals with $\geq 40\%$ minority patients. In addition, the proportion of racial/ethnic minority patients per hospital was modeled as continuous. The outcome of interest was carotid revascularization, identified by ICD-9-CM codes 38.12 (CEA) and 00.63 (CAS).

Comorbidity and severity adjustment

Comorbidities were measured using a modified Charlson Comorbidity Index.¹² Case severity was determined using the All Patient Refined–Diagnosis-Related Groups (APR-DRGs), a validated 4-point ordinal scale (minor, moderate, major, and extreme risk of mortality) derived from age, primary and secondary diagnoses, and procedures.¹³

Statistical analysis

Patient and hospital characteristics were compared by hospital strata using test of proportions for categorical variables and comparison of medians for continuous variables. Logistic regression was performed to determine the association of CEA/CAS with hospital strata.

Multivariable models accounted for the stratified cluster design of the NIS and were adjusted for patient demographics (age, sex, race/ethnicity, primary expected payer, and median household income in the patient’s zip code), hospital characteristics (region, location, teaching status, bed size, and annual stroke case volume), admission year, weekend admission, and clinical characteristics (modified Charlson Comorbidity Index, APR-DRG severity, diabetes mellitus, coronary artery disease, hypertension, hypercholesterolemia, valvular disease, peripheral vascular disorders, renal failure, and thrombocytopenia). Our models also included hospital-acquired complications, such as sepsis, gastrointestinal bleeding, pneumonia, urinary tract infection, deep vein thrombosis/pulmonary embolism, and dysphagia. In addition, we adjusted for IV thrombolysis, prolonged mechanical ventilation, craniotomy/craniectomy, cerebral angiography, gastrostomy, and palliative care use (data available from Dryad, table e-1, doi.org/10.5061/dryad.s7v0bh2).

To quantify between-hospital variability of carotid revascularization, we built an empty (without covariates) multilevel logistic regression model of CEA/CAS with a random intercept for hospitals. Between-hospital variation in CEA/CAS use was quantified with the intraclass correlation coefficient, defined as the proportion of variance of the outcome attributable to between-hospital variability.¹⁴

Statistical analysis was performed using Stata version 15 (StataCorp LLC, College Station, TX). A p value <0.05 was considered statistically significant, and 95% confidence intervals (CIs) are reported.

Data availability

NIS data were obtained from the Healthcare Cost and Utilization Project (HCUP). Onward sharing of individual-level data is prohibited by the HCUP data user agreement, but NIS data may be available per request from HCUP at hcup-us.ahrq.gov. Aggregated summary data may be available from the corresponding author where the data requested are considered appropriate and relevant to this study.

Results

Patient and hospital characteristics

Of the 26,189 ischemic stroke cases meeting inclusion criteria (figure 1), 20,870 (79.7%) were treated at 1,113 predominantly white hospitals and 5,319 (20.3%) received care at 325 hospitals serving minority patients with stroke (tables 1 and 2). After multiple imputation of missing values for race/ethnicity, 15.3% of patients in white hospitals were racial/ethnic minorities, while 53.5% of patients in minority-serving hospitals were of nonwhite race/ethnicity ($p < 0.001$; table 1). Other characteristics of stroke patients treated in white and minority-serving hospitals are summarized in table 1. The median number of patients with stroke due to carotid stenosis/disease per hospital was 11 (interquartile range [IQR] 6–22), ranging from 3 to 195. Minority-serving hospitals were more likely to be teaching hospitals, and were more likely to be in urban areas and in the South of the United States, compared to white hospitals (table 2). Other hospital characteristics are presented in table 2.

Lower carotid revascularization rates in minority-serving hospitals

There was substantial between-hospital variability in CEA/CAS rates among the 1,438 included hospitals, and the median annual CEA/CAS rate was 14.3 (IQR 0–28.6) per 100 cases (figure 2 and table 2). The intraclass correlation coefficient of an empty (without covariates) multilevel model of CEA/CAS with a random intercept for hospitals was 0.153, suggesting that 15.3% of the overall variability in CEA/CAS use was attributable to between-hospital variability.

Compared to patients in white hospitals, patients in minority-serving hospitals were less likely to undergo CEA/CAS (17.6%, 95% CI 16.6%–18.6%, in minority-serving vs 21.2%, 95% CI 20.7%–21.8%, in white hospitals; $p < 0.001$). The median carotid revascularization rate in minority-serving hospitals was 12.5 (IQR 0–25) vs 15.1 (IQR 0–30) per 100 admissions in white hospitals ($p = 0.088$; table 2). In fully adjusted logistic models, the odds of CEA/CAS were lower in minority-serving compared to white hospitals (odds ratio [OR] 0.81, 95% CI 0.70–0.93). Similarly, the adjusted predicted probability of CEA/CAS was significantly lower in minority-serving compared to white hospitals (0.183, 95% CI 0.168–0.198, vs 0.210, 95% CI

Table 1 Characteristics of patients in white vs minority-serving hospitals

Patient characteristics	Observed, ^a all patients (n = 26,189)	After imputation ^b		p Value ^c
		Patients in white hospitals (n = 20,870)	Patients in minority-serving hospitals (n = 5,319)	
Age, y, median (IQR)	71 (61–80)	72 (61–81)	69 (60–78)	<0.001
Female	11,527 (44.0)	9,124 (43.7)	2,403 (45.2)	0.061
Race/ethnicity				<0.001
White	16,642 (63.5)	17,685 (84.7)	2,471 (46.5)	
Black	2,424 (9.3)	1,736 (8.3)	1,396 (26.2)	
Hispanic	1,364 (5.2)	687 (3.3)	908 (17.1)	
Asian/PI	448 (1.7)	297 (1.4)	231 (4.3)	
Other	612 (2.3)	465 (2.2)	313 (5.9)	
Missing data	4,699 (17.9)	—	—	
Health insurance				<0.001
Medicare	16,671 (63.7)	13,537 (64.9)	3,134 (58.9)	
Medicaid	1,712 (6.5)	1,171 (5.6)	541 (10.2)	
Private insurance	5,843 (22.3)	4,742 (22.7)	1,101 (20.7)	
Self-pay/other	1,963 (7.5)	1,419 (6.8)	544 (10.2)	
Median household income per zip code				<0.001
Quartile 1	7,352 (28.1)	5,311 (25.4)	2,041 (38.4)	
Quartile 2	7,003 (26.7)	5,898 (28.3)	1,104 (20.8)	
Quartile 3	6,456 (24.7)	5,194 (24.9)	1,262 (23.7)	
Quartile 4	5,378 (20.5)	4,467 (21.4)	911 (17.1)	
Teaching hospital	12,988 (49.6)	9,552 (45.8)	3,436 (64.6)	<0.001
Hospital region				<0.001
Northeast	4,183 (16.0)	3,428 (16.4)	755 (14.2)	
Midwest	6,319 (24.1)	5,790 (27.7)	529 (10.0)	
South	10,901 (41.6)	7,985 (38.3)	2,916 (54.8)	
West	4,786 (18.3)	3,667 (17.6)	1,119 (21.0)	
Hospital location				<0.001
Rural	2,217 (8.5)	2,010 (9.6)	207 (3.9)	
Urban	23,972 (91.5)	18,860 (90.4)	5,112 (96.1)	
Hospital bed size				<0.001
Small	2,150 (8.2)	1,837 (8.8)	313 (5.9)	
Medium	5,919 (22.6)	4,721 (22.6)	1,198 (22.5)	
Large	18,120 (69.2)	14,311 (68.6)	3,808 (71.6)	
Hospital stroke case volume, y				<0.001
Quartile 1	4,642 (17.7)	3,876 (18.6)	766 (14.4)	
Quartile 2	6,583 (25.1)	5,120 (24.5)	1,464 (27.5)	
Quartile 3	7,264 (27.7)	5,803 (27.8)	1,462 (27.5)	
Quartile 4	7,700 (29.4)	6,072 (29.1)	1,628 (30.6)	

Continued

Table 1 Characteristics of patients in white vs minority-serving hospitals (*continued*)

Patient characteristics	Observed, ^a all patients (n = 26,189)	After imputation ^b		p Value ^c
		Patients in white hospitals (n = 20,870)	Patients in minority-serving hospitals (n = 5,319)	
Modified CCI				0.076
0	9,352 (35.7)	7,445 (35.7)	1,907 (35.9)	
1	8,982 (34.3)	7,139 (34.2)	1,843 (34.6)	
2	4,747 (18.1)	3,798 (18.2)	949 (17.8)	
≥3	3,108 (11.9)	2,488 (11.9)	620 (11.7)	
APR-DRG severity				<0.001
Minor	1,787 (6.8)	14,333 (6.9)	354 (6.7)	
Moderate	11,232 (42.9)	8,975 (43.0)	2,257 (42.4)	
Major	10,726 (41.0)	8,633 (41.4)	2,093 (39.3)	
Extreme	2,444 (9.3)	1,829 (8.8)	615 (11.6)	
IV thrombolysis	1,277 (4.9)	1,021 (4.9)	256 (4.8)	0.795
LOS, d, median (IQR)	5 (3–7)	4 (3–7)	5 (3–9)	<0.001
Total charges, in 1,000 USD, median (IQR)	33.0 (19.6–58.1)	30.9 (18.7–54.0)	42.4 (24.8–76.9)	<0.001
In-hospital mortality	1,220 (4.7)	943 (4.5)	278 (5.2)	0.035

Abbreviations: APR-DRG = All Patient Refined–Diagnosis-Related Group; CCI = Charlson Comorbidity Index; IQR = interquartile range; LOS = length of stay; PI = Pacific Islander; USD = US dollars.

^a Values presented as n (%) unless stated otherwise.

^b Values presented as n (%) across imputed datasets unless stated otherwise.

^c The p values compare patients in minority-serving vs white hospitals.

0.202–0.218; $p < 0.001$; table 3). When the proportion of minority patients was modeled as continuous, every 10 percentage points increase in the proportion of minority patients per hospital was associated with 3% lower adjusted odds of carotid revascularization (OR 0.97, 95% CI 0.94–1.00; $p = 0.039$). Individual patient race/ethnicity was adjusted for in the analyses, suggesting that a stroke patient at a minority-serving hospital has lower odds of undergoing carotid revascularization than a patient at a white hospital, regardless of individual patient race/ethnicity.

Table 3 and figure 3 present the adjusted predicted probabilities and adjusted ORs of carotid revascularization in white patients and various racial/ethnic groups within and between the 2 hospital strata, respectively. While predicted probabilities and adjusted odds of Asian patients and those identifying as “other” race/ethnicity category did not significantly differ between hospital strata, white patients had significantly lower probability (table 3) and odds of CEA/CAS in minority-serving compared to white hospitals (OR 0.78, 95% CI 0.67–0.92; figure 3). Similarly, Hispanic patients in minority-serving hospitals had significantly lower odds/probabilities of CEA/CAS compared to white hospitals ($p = 0.038$; figure 3 and table 2). Compared to white patients in white hospitals, black patients had the lowest odds and probability of carotid revascularization among any race/ethnic group in either hospital stratum (table 3 and figure 3), but the odds of CEA/CAS did not differ significantly between hospital

strata (OR 0.35, 95% CI 0.29–0.43 in white hospitals, vs OR 0.30, 95% CI 0.23–0.39 in minority-serving hospitals; p value for interaction 0.274; figure 3).

Discussion

In the present study, we found that patients with stroke in minority-serving hospitals are less likely to undergo carotid revascularization compared to patients who present to hospitals serving predominantly whites. Our findings are consistent with a previous study of hospitals in the US Veterans Affairs system demonstrating lower use of carotid imaging at minority-serving hospitals.¹⁵ Structural differences, including availability of specialists (such as vascular surgeons or neurosurgeons) and local hospital culture, may contribute to differences in the use and/or availability of CEA/CAS in minority-serving hospitals,⁸ and hospitals serving minority patients are commonly underfunded and understaffed.^{9,16} In our study, patients cared for in minority-serving hospitals were more likely to receive Medicaid and were more likely to live in a low-income zip code. This combination of disadvantaged payer mix and neighborhood income level may adversely influence the structure and care processes at a given hospital.¹⁷ Similarly, hospitals providing stroke care to greater numbers of low-income patients may not have adequate resources to invest in quality-of-care improvement initiatives. Of note, patient-level racial/ethnic differences in CEA/CAS use

Table 2 Characteristics of included hospitals

Hospital characteristics	All hospitals (n = 1,438)	White hospitals (n = 1,113)	Minority-serving hospitals (n = 325)	p Value
Teaching hospital	481 (33.5)	334 (29.1)	157 (48.2)	<0.001
Hospital region				<0.001
Northeast	257 (17.9)	208 (18.7)	49 (15.1)	
Midwest	337 (23.4)	302 (27.1)	35 (10.8)	
South	559 (38.9)	407 (36.5)	152 (46.8)	
West	285 (19.8)	196 (17.7)	89 (27.2)	
Hospital location				<0.001
Rural	256 (17.8)	228 (20.5)	28 (8.7)	
Urban	1,182 (82.2)	885 (79.5)	297 (91.3)	
Hospital bed size				0.081
Small	225 (15.6)	186 (16.7)	39 (12.1)	
Medium	431 (30.0)	335 (30.1)	96 (29.5)	
Large	782 (54.4)	592 (53.2)	190 (58.4)	
Hospital stroke case volume/y				0.015
Quartile 1	634 (44.1)	515 (46.3)	119 (36.6)	
Quartile 2	426 (29.6)	313 (28.1)	113 (34.8)	
Quartile 3	237 (16.5)	176 (15.8)	61 (18.9)	
Quartile 4	141 (9.8)	109 (9.8)	32 (9.7)	
Hospital CEA/CAS rate per 100 cases, median (IQR)	14.3 (0–28.6)	15.1 (0–30.0)	12.5 (0–25.0)	0.088
Hospital total charges per case, median (IQR)	34,942 (23,033–54,760)	32,562 (21,577–50,344)	48,379 (30,911–75,394)	<0.001

Abbreviations: CAS = carotid artery stenting; CEA = carotid endarterectomy; IQR = interquartile range.

Figure 2 Hospital rank order of the annual percentage of CEA/CAS in patients with stroke due to carotid artery disease

CAS = carotid artery stenting; CEA = carotid endarterectomy.

remained within each hospital stratum, suggesting that individual-level and system-level effects contribute to racial/ethnic differences in the use of carotid revascularization.

The decrease in carotid revascularization use in minority-serving hospitals was mainly driven by lower likelihood of CEA/CAS among white and Hispanic patients in those hospitals. This finding highlights that racial/ethnic differences in the use of CEA/CAS are insufficiently explained by individual patient-level differences alone, but are in part attributable to between-hospital variation. As such, future studies investigating the minutia of the underlying causes of race/ethnicity differences in stroke procedures, including CEA/CAS use, after stroke should account for care location and setting in addition to individual patient characteristics. Of note, while black patients consistently had the lowest revascularization rates in either hospital stratum, Asian patients or those identifying as “other” race had revascularization rates similar to white patients in minority-serving hospital. This is consistent with other reports and suggests that disparities are not merely a binary concept of less vs more or vice versa but rather a continuum of differences where black patients often fare worse than other racial/ethnic minority groups.¹⁸

Table 3 Predicted probabilities of carotid revascularization among different race/ethnicity groups, stratified by white vs minority-serving hospitals

Variable	Patients, %	Unadjusted probability (95% CI)	Adjusted ^a probability (95% CI)
White hospitals			
All patients	79.7	0.212 (0.202–0.222)	0.210 (0.202–0.218)
White	67.5	0.225 (0.214–0.236)	0.229 (0.220–0.238)
Black	6.6	0.110 (0.092–0.127)	0.113 (0.096–0.129)
Hispanic	2.6	0.183 (0.150–0.217)	0.187 (0.156–0.217)
Asian	1.1	0.155 (0.108–0.201)	0.148 (0.106–0.190)
Other	1.8	0.208 (0.164–0.251)	0.211 (0.173–0.249)
Minority-serving hospitals			
All patients	20.3	0.176 (0.160–0.191)	0.183 (0.168–0.198)
White	9.4	0.218 (0.197–0.239)	0.197 (0.179–0.215)
Black	5.3	0.100 (0.080–0.121)	0.098 (0.079–0.118)
Hispanic	3.5	0.160 (0.131–0.189)	0.145 (0.121–0.170)
Asian	0.9	0.190 (0.130–0.250)	0.180 (0.124–0.235)
Other	1.2	0.217 (0.167–0.268)	0.209 (0.157–0.260)

Abbreviation: CI = confidence interval.

^a Models were adjusted for age, sex, hospital characteristics (teaching status, bed size, location, region, and annual volume of stroke cases), weekend admission, modified Charlson Comorbidity Index, All Patient Refined–Diagnosis-Related Group severity, insurance status, median household income per patient's zip code, year, hypertension, diabetes mellitus, dyslipidemia, atrial fibrillation, coronary artery disease, peripheral vascular disease, chronic kidney disease, valvular disease, thrombocytopenia, pneumonia, urinary tract infection, sepsis, gastrointestinal bleeding, deep vein thrombosis, pulmonary embolism, dysphagia, IV thrombolysis, craniotomy/craniectomy, cerebral angiography, gastrostomy, prolonged mechanical ventilation, and palliative care use.

Because of known racial/ethnic differences in the prevalence of carotid disease,¹⁹ we included only discharge records with a clinical diagnosis of stroke due to carotid stenosis, and excluded admissions with ICD-9-CM codes suggestive of an alternate stroke etiology. We did not study TIA cases because TIA only has moderate accuracy in administrative datasets,²⁰ and because ICD-9-CM coding does not allow to reliably distinguish a TIA due to carotid stenosis from a TIA (i.e., in the posterior circulation) in the setting of an incidentally found asymptomatic carotid stenosis. Our findings do not apply to patients with asymptomatic carotid stenosis, which we omitted because of the uncertainty of the therapeutic benefit of CEA/CAS for asymptomatic carotid disease.²¹

Our study is limited by the potential for miscoded data in administrative datasets. While race/ethnicity is typically self-reported, it is possible that information captured in the race/ethnicity variable is not entirely accurate. We did not have information on the degree of carotid stenosis, and we were unable to adjudicate the appropriateness of CEA/CAS.²² We attempted to mitigate the absence of clinical and physiologic data in NIS by adjusting all models for the Charlson Comorbidity Index, a validated measure of patient comorbidities in stroke,¹² and medical complications. Lastly, we were unable to investigate the potential contribution of provider attitudes and patient preferences to the observed differences in carotid revascularization use.

Despite these limitations, our data suggest that racial/ethnic differences in carotid revascularization after stroke due to carotid stenosis are in part explained by lower use of CEA/

Figure 3 Graphic representation of odds ratios of the use of carotid revascularization procedures for the various race/ethnic groups, stratified by hospitals

White patients in white hospitals serve as the reference. * $p = 0.003$ for the comparison of white patients in minority-serving vs white hospitals; ** $p = 0.039$ for the comparison of Hispanic patients in minority-serving vs white hospitals. CI = confidence interval.

CAS at hospitals where racial/ethnic minorities receive stroke care. Our study highlights that mere focus on individual-level determinants of care delivery and usage is insufficient to fully understand racial/ethnic differences in stroke care. Focus on improvement of care in minority-serving hospitals may be a high-yield strategy to address racial and ethnic disparities in stroke care delivery in the United States.

Author contributions

Dr. Faigle was involved in study design, statistical analysis, data interpretation, and writing of the manuscript. Dr. Cooper was involved in data interpretation and writing of the manuscript. Dr. Gottesman was involved in study design, data interpretation, and writing of the manuscript.

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Disclosure

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