Racial and Ethnic Differences in Outcomes in Older Patients With Acute Ischemic Stroke

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Background—Little is known as to whether long-term outcomes of acute ischemic stroke (AIS) vary by race/ethnicity. Using the American Heart Association Get With The Guidelines–Stroke registry linked with Medicare claims data set, we examined whether 30-day and 1-year outcomes differed by race/ethnicity among older patients with AIS.

Methods and Results—We analyzed 200,900 patients with AIS >65 years of age (170,694 non-Hispanic whites, 85.0%; 20,514 non-Hispanic blacks, 10.2%; 6,632 Hispanics, 3.3%; 3,060 non-Hispanic Asian Americans, 1.5%) from 926 US centers participating in the Get With The Guidelines–Stroke program from April 2003 through December 2008. Compared with whites, other racial and ethnic groups were found to have a higher median score on the National Institutes of Health Stroke Scale. Whites had higher 30-day unadjusted mortality than other groups (white versus black: adjusted odds ratio, 0.83 [95% confidence interval, 0.74–0.94]; 1.28 [95% confidence interval, 1.21–1.37]; Hispanic: adjusted odds ratio, 1.22 [95% confidence interval, 1.11–1.35]). After risk adjustment, Asian American patients with AIS had lower 30-day and 1-year mortality than white, black, and Hispanic patients. Relative to whites, black and Hispanic patients had higher adjusted 1-year all-cause rehospitalization (black: adjusted odds ratio, 1.28 [95% confidence interval, 1.21–1.37]; Hispanic: adjusted odds ratio, 1.22 [95% confidence interval, 1.11–1.35]), whereas Asian patients had lower odds (adjusted odds ratio, 0.83 [95% confidence interval, 0.74–0.94]).

Conclusions—Among older Medicare beneficiaries with AIS, there were significant differences in long-term outcomes by race/ethnicity, even after adjustment for stroke severity, other prognostic variables, and hospital characteristics. (Circ Cardiovasc Qual Outcomes. 2013;6:284-292.)

Key Words: disparities ■ outcome ■ race and ethnicity ■ stroke

Stroke is a leading cause of serious long-term disability and ranks fourth among all causes of death in the United States.1 Racial and ethnic disparities in stroke care and outcomes remain a major public health challenge.2 The burden of stroke has been consistently reported to be higher in racial and ethnic minority groups.1,2 For example, compared with white patients, blacks have a higher prevalence of stroke risk factors,3,4 earlier age of stroke occurrence,1,2,6 more severe deficits at stroke onset,7,8 and less access to high-quality stroke care.8,10 Similarly, Hispanics have been found to be at greater risk for stroke because they have a higher prevalence of metabolic syndrome and diabetes mellitus.11-13 Given that racial and ethnic minorities now constitute 37% of the US population and are projected to comprise 57% of the population by 2060,14,15 there is an increasing need to identify and actively address racial and ethnic disparities in stroke care and outcomes.2

Prior studies have suggested that quality of care and clinical outcomes for hospitalized stroke patients may vary modestly across racial and ethnic groups.9,16-20 However, these studies have not been able to provide clear evidence of an association between race and ethnicity and long-term outcomes in hospitalized patients with stroke. Furthermore, these reports tended to be limited in size and were mostly focused on the inpatient setting. In addition, Asian Americans—the fastest growing minority group in the United States—have not been included in earlier analyses.14

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WHAT IS KNOWN

- Racial and ethnic disparities in stroke care remain a major public health challenge, and the burden of stroke has been consistently reported to be higher in racial and ethnic minority groups.
- Racial and ethnic minority groups will make up a majority of the US population in the coming decades, and Asian Americans and Hispanics are the fastest growing minority groups.
- However, little is known as to whether there are racial or ethnic differences in long-term acute ischemic stroke outcomes. Furthermore, Asian American stroke patients have not been studied before.

WHAT THE STUDY ADDS

- The present study finds that among older patients with acute ischemic stroke, there were significant differences in 30-day and 1-year outcomes by race/ethnicity, even after adjustment for stroke severity, other prognostic variables, and hospital characteristics. Older white patients with acute ischemic stroke had the highest 30-day mortality rates of any race/ethnicity group.
- Compared with older white patients with acute ischemic stroke, black and Hispanic patients were more likely to be readmitted to hospitals within 1 year, even after risk adjustment, and had comparable risk for 1-year mortality.
- Compared with other race/ethnicity groups, Asian American acute ischemic stroke patients had fewer comorbid conditions, higher median household income, and lower median body mass index. These patients received similar or even better evidence-based stroke care compared with whites and had the lowest risk-adjusted odds of 1-year mortality.

To address these issues, we sought to compare a comprehensive set of outcomes in non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic Asian American patients hospitalized with acute ischemic stroke (AIS) using the American Heart Association (AHA) Get With The Guidelines (GWTG–Stroke) registry linked to Medicare claims data set to determine whether racial and ethnic differences in long-term outcomes were present. Our specific goals were to (1) examine racial and ethnic differences in hospitalized AIS patients’ demographics, socioeconomic status, medical history, clinical characteristics, hospital characteristics, and stroke care performance measures; and (2) determine whether there were racial and ethnic differences in both short- and long-term outcomes among patients hospitalized with AIS.

Methods

Study Population
The primary data source was the GWTG–Stroke registry, the largest ongoing voluntary national stroke registry and continuous quality improvement program in the United States. Sponsored by the AHA/American Stroke Association, the GWTG–Stroke program is currently used by >1900 hospitals. The details of the design and conduct of the GWTG–Stroke registry had been described previously.21-23 In brief, the AHA/American Stroke Association had developed the GWTG–Stroke registry to improve stroke treatment quality and outcomes for hospitalized patients with stroke by focusing on care team protocols. The program consisted of a set of evidence-based performance measures to gauge and guide the stroke care quality improvement efforts at participating hospitals.

At each participating hospital, trained personnel used the GWTG–Stroke Internet-based patient management tool (Outcome Sciences Inc, Cambridge, MA) to collect patient-level information on consecutive stroke patients admitted to the hospital. Each case was identified by an International Classification of Diseases, Ninth Revision, principal diagnosis code, with AIS defined as 433.xx, 434.xx, and 436. Chart review followed to confirm case eligibility. Patient-level data included demographics, socioeconomic status, medical history, diagnosis and evaluation, in-hospital treatment and events, discharge treatments and counseling, and discharge destination. Data were collected, deidentified, and transmitted in a secure manner. The data collection tool provided direct links to standard data definitions and coding instructions and had predefined logic checks to prevent invalid entries.9,10,22 The validity and reliability of the data collected in the GWTG–Stroke registry had been confirmed by a recent study.24 For this study, the GWTG–Stroke registry was linked to Medicare claims file, which had the long-term outcomes information for Medicare beneficiaries with fee-for-service coverage.25 In addition, participating hospitals’ characteristics (hospital bed size, academic status, annual volume of AIS discharges, and geographic region) were obtained from the American Hospital Association database.26 All participating institutions were required to comply with local regulatory and privacy guidelines. The Duke Clinical Research Institute served as the data analysis center and had an agreement to analyze the aggregate deidentified data for research purposes. The Institutional Review Board of the Duke University Health System approved this study.

Our analyses included individuals who presented to GWTG–Stroke hospitals with AIS from April 1, 2003, through December 31, 2008. We excluded patients who could not be linked to Medicare claims data set and limited the study to patients who were non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic Asian American (n=9285 excluded). Only patients’ index admissions were included (n=10906 excluded). To get a homogenous patient cohort, we further limited the study to patients who were not transferred (n=8742 excluded) and who were from hospitals with ≥25 eligible AIS cases (n=2855 excluded). After these exclusions, our primary study population consisted of 209900 patients from 926 hospitals (Figure).

Variables of Interest and Outcomes
Patient race/ethnicity information was recorded by trained hospital staff. The data entry system supported single race, multiple race, and ethnic classification. Hispanic ethnicity was captured as part of a multiselect option that also included racial categories (black, white, Asian, American Indian/Alaska native, and Hawaiian/Pacific Islander) from January 2003 through September 2005; thereafter, it was implemented as a separate data element (yes versus no/not documented).9

The primary outcome measures were 30-day and 1-year mortality and rehospitalization rates. In particular, these included 30-day and 1-year mortality rates of admission, 1-year mortality of discharge, 1-year all-cause, 1-year stroke-associated, 1-year cardiovascular disease-associated, and 1-year myocardial infarction–associated rehospitalization rates after discharge. Secondary end points consisted of death in the index admission, length of stay >4 days, whether the patient was discharged to home and whether the patient had independent ambulatory ability at discharge.

Statistical Analyses
Exploratory analyses were performed to compare patient demographics, socioeconomic status, medical history, hospital characteristics and clinical characteristics, and stroke care performance measures among non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic...
Asian American patients with stroke. Means, standard deviations, medians, interquartile range, and percentages were used to describe the distribution of continuous and categorical variables. The Kruskal–Wallis test for continuous variables and the Pearson χ² test for categorical variables were used to examine statistical associations.

Multivariable logistic regression analyses were performed in a sequential manner to examine the relationship between race/ethnicity and each of the stroke outcome measures. We first adjusted for patient-level demographics (age, gender) and medical history (atrial fibrillation/flutter, prosthetic heart valve, coronary artery disease or prior myocardial infarction, carotid stenosis, diabetes mellitus, peripheral vascular disease, hypertension, current smoking, dyslipidemia, heart failure, and previous stroke or transient ischemic attack; model 1). Then, we added patient socioeconomic variables to the model (residence zip code level median household income, high school graduation rate, and college graduation rate; model 2). Next, we adjusted for hospital-level variables (geographic region, academic status, number of beds, annual AIS volume, and primary stroke center designation status; model 3). Finally, we included patient baseline National Institutes of Health Stroke Scale (NIHSS) score (range: [0, 42], higher score for greater stroke severity; model 4) among patients with NIHSS documented. By running regression models in aforementioned steps, we were able to measure the contribution of each newly added independent variable’s contribution in explaining the racial/ethnic difference in stroke outcomes. All patient-level variables and hospital characteristics were selected in the regression models mainly because previous studies supported their association with stroke outcomes. We applied the generalized estimating equations method to account for within-hospital clustering. We also calculated and compared C-statistics for each multivariable logistic regression model. All statistical analyses were performed using SAS version 9.3 software (SAS Institute, Cary, NC). A 2-tailed significance level of 0.05 was used for all tests.

**Results**

The mean age of the study population was 79.6±8.0 (SD) years, and over half (58.2%) of the population was women. The race/ethnicity composition was 85.0% non-Hispanic white (n=170694), 10.2% non-Hispanic black (n=20514), 3.3% Hispanic (n=6632), and 1.5% non-Hispanic Asian American (n=3060).

In comparison with non-Hispanic white patients, non-Hispanic black and Hispanic patients were younger; had a lower median household income; were less likely to have a medical history of atrial fibrillation/flutter, prosthetic heart valve, coronary artery disease/prior myocardial infarction, carotid stenosis, peripheral vascular disease, and previous stroke/transient ischemic attack; and were more likely to have a medical history of diabetes mellitus and hypertension, whereas non-Hispanic Asian American patients had a much higher median household income and were less likely to have a medical history of coronary artery disease/prior myocardial infarction, peripheral vascular disease, heart failure, and previous stroke/transient ischemic attack. Compared with other race/ethnicity groups, non-Hispanic Asian American patients were less likely to arrive at hospital by ambulance and had lower median body mass index. Non-Hispanic black and Hispanic patients had more severe strokes as measured by median score on NIHSS compared with non-Hispanic white and non-Hispanic Asian Americans (Table 1).

Non-Hispanic black patients were more likely to be treated at high-volume and academic hospitals, which were more likely to be located in the south region. Hispanics and non-Hispanic Asian American patients were more likely to be treated at low-volume and nonacademic hospitals, which were more likely to be in the west region (Table 2).

There were statistically significant differences across race/ethnicity groups in 5 of 7 unadjusted quality of care measures (IV tissue-type plasminogen activator use <3 hours, early antithrombotics, antithrombotics at discharge, deep vein thrombosis prophylaxis, and lipid-lowering medication prescribed at discharge; \( P \leq 0.002 \)) and the summary defect-free care measure (\( P < 0.001 \)). Compared with other race/ethnicity groups, non-Hispanic black patients were less likely to receive IV tissue-type plasminogen activator use <3 hours, early antithrombotics, antithrombotics at discharge, and lipid-lowering medication prescribed at discharge (Table 3).

**Primary Outcomes**

The unadjusted 30-day mortality rate of admission ranged from 9.9% to 15.0%, and the unadjusted 1-year mortality rate of admission ranged from 23.9% to 31.7% across race/ethnicity groups (Table 4). Non-Hispanic black, Hispanic, and non-Hispanic Asian American patients were less likely than non-Hispanic whites to die within 30 days of admission, within 1 year of admission, and within 1 year of discharge. However, non-Hispanic black and Hispanic patients were more likely than non-Hispanic Asian American and non-Hispanic white patients to be rehospitalized within 1 year of discharge for any causes, for stroke-related causes, for cardiovascular disease–related causes, and for myocardial infarction–related causes. After multivariable adjustment for both patient-level and hospital-level characteristics, compared with non-Hispanic white patients, other racial and ethnic groups were less likely to die within 30 days of admission (black: adjusted odds ratio [AOR], 0.62; 95% confidence interval [CI], 0.56–0.69; \( P < 0.001 \)); Hispanic: AOR, 0.77; 95% CI, 0.67–0.88; \( P < 0.001 \); Asian: AOR, 0.79; 95% CI, 0.64–0.98; \( P = 0.03 \); Table 4). However, only non-Hispanic Asian American patients retained this survival advantage after 1 year.
of admission (black: AOR, 0.99; 95% CI, 0.92–1.07; P=0.88; Hispanic: AOR, 0.91; 95% CI, 0.82–1.01; P=0.07; Asian: AOR, 0.70; 95% CI, 0.60–0.82; P<0.001) and after 1 year of discharge (black: AOR, 1.03; 95% CI, 0.96–1.11; P=0.38; Hispanic: AOR, 0.92; 95% CI, 0.82–1.02; P=0.12; Asian: AOR, 0.69; 95% CI, 0.59–0.81; P<0.001; Table 4).

NIHSS score was one of the most important predictors of hospitalized AIS patients’ 1-year mortality risk. Before adjusting for NIHSS score (model 3), compared with non-Hispanic white patients, non-Hispanic black patients were more likely to die within 1 year of admission (black: AOR, 1.08; 95% CI, 1.04–1.13; P<0.001) and within 1 year of discharge (black: AOR, 1.13; 95% CI, 1.08–1.17; P<0.001); however, after adjusting for NIHSS score, these differences were no longer significant (Table 4). By contrast, we did not find that adjusting for patients’ socioeconomic status (eg, zip code level median household income, zip code level high school graduation rate, and zip code level college graduation rate) and hospital characteristics (region, rural versus urban, academic status, hospital beds, hospital annual AIS discharge...
Secondary Outcomes
Non-Hispanic black and Hispanic patients were less likely than non-Hispanic Asian American and non-Hispanic white patients to have death at admission (Table 5). However, non-Hispanic black and Hispanic patients were more likely than non-Hispanic Asian Americans and non-Hispanic whites to have a length of stay >4 days. Compared with other race/ethnicity groups, non-Hispanic Asian Americans were more likely to be discharged home. After multivariable adjustment for both patient-level and hospital-level characteristics, compared with non-Hispanic white patients, non-Hispanic black and Hispanic patients were more likely to have a longer hospital stay (ie, length of stay >4 days; black: AOR, 1.30; 95% CI, 1.22–1.39; \( P<0.001 \); Hispanic: AOR, 1.12; 95% CI, 1.02–1.23; \( P=0.02 \)) and less likely to be ambulatory independent at discharge (black: AOR, 0.81; 95% CI, 0.76–0.87; \( P<0.001 \); Hispanic: AOR, 0.89; 95% CI, 0.79–0.99; \( P=0.04 \)). Furthermore, non-Hispanic black patients were less likely to have death at admission (black: AOR, 0.78; 95% CI, 0.68 to 0.89; \( P<0.001 \)) or to be discharged home (black: AOR, 0.87; 95% CI, 0.81–0.94; \( P<0.001 \); Table 5).

Discussion
To our knowledge, our research represents the largest and most comprehensive study to examine stroke outcomes as a function of race and ethnicity (ie, non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic Asian American).
non-Hispanic black, Hispanic, and non-Hispanic Asian American) using the nationwide contemporary GWTG–Stroke registry linked with the Medicare claims data set. In this analysis of 200,900 patients with AIS ≥65 years from 926 US centers participating in the GWTG–Stroke program between 2003 and 2008, we found that there were important racial/ethnic differences in baseline characteristics, clinical profiles, and stroke care performance measures and in both short-term and long-term outcomes. There were significant differences in long-term outcomes by race/ethnicity, even after risk adjustment for stroke severity, other prognostic variables, and hospital characteristics.

In comparison with non-Hispanic white patients, all other measured race/ethnicity groups had lower 30-day mortality rates of admission. After 1-year postdischarge, this survival advantage remained for non-Hispanic Asian American patients but was no longer significant for non-Hispanic black or Hispanic patients. Compared with non-Hispanic white patients, non-Hispanic black and Hispanic patients had higher 1-year all-cause and stroke-associated rehospitalization rates, whereas non-Hispanic Asian American patients had lower 1-year all-cause rehospitalization rates.

Table 4. Racial and Ethnic Differences in 30-Day and 1-Year Mortality and Rehospitalization Rates in Acute Ischemic Stroke

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unadjusted Rate, %</th>
<th>AOR and 95% CI (Model 1)</th>
<th>AOR and 95% CI (Model 2)</th>
<th>AOR and 95% CI (Model 3)</th>
<th>AOR and 95% CI (Model 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-Day mortality of admission</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>White</td>
<td>15.0</td>
<td>(Reference)</td>
<td>(Reference)</td>
<td>(Reference)</td>
<td>(Reference)</td>
</tr>
<tr>
<td>Black</td>
<td>9.9</td>
<td>(0.60–0.67)</td>
<td>(0.75–0.83)</td>
<td>(0.75–0.83)</td>
<td>(0.75–0.83)</td>
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<tr>
<td>Hispanic</td>
<td>11.9</td>
<td>(0.70–0.82)</td>
<td>0.70 (0.82–0.97)</td>
<td>0.89 (0.82–0.97)</td>
<td>0.89 (0.82–0.97)</td>
</tr>
<tr>
<td>Asian</td>
<td>11.1</td>
<td>(0.64–0.80)</td>
<td>0.83 (0.79–1.01)</td>
<td>0.89 (0.81–1.04)</td>
<td>0.91 (0.80–1.03)</td>
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<td>1-Year mortality of admission</td>
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<tr>
<td>White</td>
<td>31.7</td>
<td>(Reference)</td>
<td>(Reference)</td>
<td>(Reference)</td>
<td>(Reference)</td>
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<tr>
<td>Black</td>
<td>28.6</td>
<td>(0.82–0.89)</td>
<td>1.09 (1.05–1.14)</td>
<td>1.08 (1.04–1.13)</td>
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<tr>
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<td>0.97 (0.91–1.04)</td>
<td>0.96 (0.90–1.02)</td>
<td>0.95 (0.89–1.12)</td>
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<td>Asian</td>
<td>23.9</td>
<td>(0.62–0.74)</td>
<td>0.84 (0.76–0.92)</td>
<td>0.85 (0.77–0.93)</td>
<td>0.85 (0.77–0.93)</td>
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<td>1-Year mortality of discharge</td>
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<tr>
<td>White</td>
<td>27.4</td>
<td>(Reference)</td>
<td>(Reference)</td>
<td>(Reference)</td>
<td>(Reference)</td>
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<tr>
<td>Black</td>
<td>25.0</td>
<td>(0.85–0.91)</td>
<td>1.13 (1.09–1.18)</td>
<td>1.12 (1.08–1.17)</td>
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<tr>
<td>Hispanic</td>
<td>24.0</td>
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<td>0.97 (0.90–1.04)</td>
<td>0.96 (0.89–1.03)</td>
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<td>Asian</td>
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<td>1-Year all-cause rehospitalization after admission</td>
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<tr>
<td>White</td>
<td>54.7</td>
<td>(Reference)</td>
<td>(Reference)</td>
<td>(Reference)</td>
<td>(Reference)</td>
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<td>Black</td>
<td>62.5</td>
<td>(1.27–1.37)</td>
<td>1.38 (1.33–1.44)</td>
<td>1.37 (1.32–1.43)</td>
<td>1.37 (1.31–1.42)</td>
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<td>Hispanic</td>
<td>60.0</td>
<td>(1.12–1.26)</td>
<td>1.21 (1.14–1.29)</td>
<td>1.18 (1.11–1.26)</td>
<td>1.19 (1.12–1.27)</td>
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<tr>
<td>Asian</td>
<td>48.6</td>
<td>(0.79–0.82)</td>
<td>0.86 (0.78–0.93)</td>
<td>0.85 (0.78–0.93)</td>
<td>0.88 (0.81–0.96)</td>
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<tr>
<td>1-Year stroke-associated rehospitalization after discharge</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>13.8</td>
<td>(Reference)</td>
<td>(Reference)</td>
<td>(Reference)</td>
<td>(Reference)</td>
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<tr>
<td>Black</td>
<td>18.9</td>
<td>(1.37–1.52)</td>
<td>1.45 (1.37–1.53)</td>
<td>1.44 (1.36–1.52)</td>
<td>1.38 (1.27–1.49)</td>
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<td>(1.09–1.29)</td>
<td>1.18 (1.09–1.29)</td>
<td>1.15 (1.05–1.25)</td>
<td>1.17 (1.07–1.28)</td>
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<td>Asian</td>
<td>12.9</td>
<td>(0.80–1.03)</td>
<td>0.96 (0.84–1.09)</td>
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<td>1.00 (0.87–1.13)</td>
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<tr>
<td>White</td>
<td>13.6</td>
<td>(Reference)</td>
<td>(Reference)</td>
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<tr>
<td>Black</td>
<td>17.2</td>
<td>(1.22–1.36)</td>
<td>1.33 (1.26–1.41)</td>
<td>1.32 (1.25–1.40)</td>
<td>1.31 (1.24–1.38)</td>
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<td>(1.13–1.35)</td>
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<td>Asian</td>
<td>10.7</td>
<td>(0.65–0.86)</td>
<td>0.78 (0.68–0.90)</td>
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<td>0.81 (0.69–0.94)</td>
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<td>1-Year MI-associated rehospitalization after discharge</td>
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<tr>
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<td>2.2</td>
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<td>(Reference)</td>
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<td>(Reference)</td>
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<td>Black</td>
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<td>1.24 (1.10–1.40)</td>
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<td>1.23 (1.09–1.39)</td>
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<td>(0.57–1.08)</td>
<td>0.84 (0.60–1.18)</td>
<td>0.86 (0.61–1.21)</td>
<td>0.89 (0.63–1.24)</td>
</tr>
</tbody>
</table>

AOR indicates adjusted odds ratio; CI, confidence interval; CVD, cardiovascular disease; MI, myocardial infarction; and NIHSS, National Institutes of Health Stroke Scale.

*Model U, unadjusted model.
†Model 1, adjusted for patient demographics and comorbidities.
‡Model 2, adjusted for all the variables in model 1 plus patient socioeconomic status.
§Model 3, adjusted for all the variables in model 2 plus hospital characteristics.
¶Model 4, adjusted for all the variables in model 3 plus NIHSS, using a subgroup of patients whose NIHSS information was available. C-statistics: 30-day mortality of admission (model U: 0.52, model 1: 0.69, model 2: 0.69, model 3: 0.69, model 4: 0.84); 1-year mortality of admission (model U: 0.51, model 1: 0.70, model 2: 0.70, model 3: 0.70, model 4: 0.79); 1-year mortality of discharge (model U: 0.51, model 1: 0.70, model 2: 0.70, model 3: 0.70, model 4: 0.77); 1-year all-cause rehospitalization after discharge (model U: 0.52, model 1: 0.61, model 2: 0.61, model 3: 0.61, model 4: 0.64); 1-year stroke-associated rehospitalization after discharge (model U: 0.52, model 2: 0.58, model 2: 0.58, model 3: 0.59, model 4: 0.60); 1-year CVD-associated rehospitalization after discharge (model U: 0.52, model 1: 0.60, model 2: 0.60, model 3: 0.61, model 4: 0.61); 1-year MI-associated rehospitalization after discharge (model U: 0.51, model 1: 0.64, model 2: 0.64, model 3: 0.64, model 4: 0.65).
As suggested by the Institute of Medicine,\textsuperscript{28} we first presented with the dependent variables being stroke outcome measures. Specifically, we computed death at admission, length of stay (LOS) greater than 4 days, discharge home, and independent ambulatory status at discharge. We conducted sequential regression analyses, adjusting for patient demographics and comorbidities; patient socioeconomic status; NIHSS score; and hospital characteristics. Our findings indicate that, compared with non-Hispanic whites, non-Hispanic black, Hispanic, and non-Hispanic Asian American patients had lower in-hospital mortality and 30-day mortality rates, even after full adjustment for patient demographics, medical history, socioeconomic status, NIHSS score, and hospital characteristics. Our findings support previous research from administrative data and stroke registries, suggesting that racial/ethnic minority groups have a lower risk for short-term all-cause mortality after being hospitalized for AIS than non-Hispanic white patients.\textsuperscript{5,29-32} One possible explanation for such findings is that there are relatively high rates for small vessel lacunar and intracranial atherosclerotic stroke types compared with large-vessel cardioembolic stroke type among racial/ethnic minority patients compared with non-Hispanic whites.\textsuperscript{33-36} Another possible explanation is that racial/ethnic minority patients might receive intensive life-sustaining interventions more often, which could lead to a short-term survival advantage.\textsuperscript{29,37}

However, we found that these survival benefits were no longer significant for non-Hispanic black and Hispanic patients by 1 year but were retained by non-Hispanic Asian American patients only. This finding is notable because little is known about the temporal trend of survival advantages among these minority patients with AIS. One recent observational study reported that black race was independently associated with lower all-cause mortality within 30 days.\textsuperscript{29} Unfortunately, that study had several limitations, such as using a statewide hospital discharge data set, focusing on patients in urban areas, and not adjusting for patient’s stroke severity at admission. Furthermore, we demonstrated for the first time that compared with non-Hispanic whites, Hispanics had similar 1-year mortality rates, whereas non-Hispanic Asian Americans still had lower 1-year mortality rates. Because Hispanics and non-Hispanic Asian Americans are the fastest growing minority groups in the United States, a better understanding of the outcomes of Hispanic and non-Hispanic Asian American stroke patients is imperative.\textsuperscript{2} Moreover, our findings suggest that using in-hospital and 30-day stroke mortality rates only may not sufficiently capture the temporal changes of survival benefits in certain minority groups.

We also found that, compared with non-Hispanic white patients, non-Hispanic blacks and Hispanics had higher 1-year rehospitalization rates (including all-cause, stroke-associated, cardiovascular disease–associated, and myocardial infarction–associated rehospitalizations), whereas non-Hispanic Asian American patients had lower 1-year rehospitalization rates. Given the high frequency and cost of rehospitalizations among Medicare patients, reducing unnecessary rehospitalizations has received increasing attention in the literature\textsuperscript{38} and become...
a national priority. In the case of AIS, 1 recent study showed that ≈50% of Medicare patients were rehospitalized within 1 year, and the average acute care Medicare charges for patients with stroke were more than twice the charges of patients without stroke. Our observed 1-year all-cause rehospitalization rates are comparable but vary considerably by race/ethnicity.

We found that the higher rehospitalization rates for non-Hispanic black and Hispanic patients persisted even after adjustment for patient and hospital characteristics. This finding has several implications. First, the race/ethnicity of patients with stroke was important in predicting readmission rates for patients with AIS. Similar findings have been reported from prior studies on hospital readmissions for other conditions or interventions, such as heart failure and coronary artery bypass surgery. As Section 3025 of the Affordable Care Act establishes the Hospital Readmissions Reduction Program, which reduces Medicare’s payments to hospitals with higher than expected readmission rates since October 2012, it is imperative to understand how hospitals’ racial/ethnic minority composition affects the expected readmission rates for certain conditions. It may be advisable to include racial/ethnic composition when adjusting hospitals’ expected readmission rates. In addition, our results suggest that because non-Hispanic black and Hispanic AIS patients have higher odds of readmission, they may be most in need of more effective transitional care such as hospital discharge planning and patient—provider communication, accessing and training available caregivers, arranging for postdischarge care, and developing collaborations between providers and community organizations.

Our study has several limitations. First, because GWTG–Stoke program participation is voluntary, it is possible that our findings may not be representative of those nonparticipating hospitals. However, the GWTG–Stoke registry includes hospitals in each state, and the patient population is similar in racial/ethnic makeup to the US population composition. Second, our study focused on Medicare fee-for-service patients with stroke and may not apply to patient populations with other types of insurance coverage. Third, race and ethnicity may have been by patient self-designation or assigned by administrative personnel or admitting clinicians. Therefore, race and ethnicity may be less reliable for they are not based on direct patient self-report. In addition, it is possible that Hispanic ethnicity is underreported in this registry. Fourth, the findings for rehospitalization may be impacted by competing risks from mortality. However, because we showed that non-Hispanic black and Hispanic AIS patients had similar adjusted 1-year mortality rates, our findings that non-Hispanic black and Hispanic patients with stroke had higher adjusted 1-year readmission rates are unlikely to change. The readmission models had lesser discrimination, and as a result, these findings need to be interpreted with greater caution. Fifth, socioeconomic status was based, in part, on residence zip code level median household income rather than direct measure. Finally, this study reported odds ratio, which should not be interpreted as relative risk. Although we adjusted for many variables of prognostic importance, residual measured and unmeasured confounding might have influenced some or all of these findings.

In summary, this research represents the largest study to date to examine whether a comprehensive set of outcomes differs by race/ethnicity groups in Medicare beneficiaries ≥65 years hospitalized with AIS. We found that older non-Hispanic white AIS patients had the highest 30-day mortality rates of any race/ethnicity group. By 1 year, only non-Hispanic Asian American patients had differentially lower odds of mortality. In contrast, non-Hispanic black and Hispanic patients had higher odds of readmission within 1 year. These findings provide empirical evidence of contemporary racial/ethnic disparities in stroke outcomes. Further studies are warranted to identify the root causes of these racial and ethnic disparities in stroke outcomes.

Disclosures
Dr Schwamm serves as a stroke systems consultant to the Massachusetts Department of Public Health and is the Chair of the AHA GWTG national steering committee. Dr Bhatt discloses the following relationships—Advisory Board: Medscape Cardiology; Board of Directors: Boston VA Research Institute, Society of Chest Pain Centers; Chair: AHA GWTG Science Subcommittee; Honoraria: American College of Cardiology (Editor, Clinical Trials, Cardiosource), Duke Clinical Research Institute (clinical trial steering committees), Slack Publications (Chief Medical Editor, Cardiology Today Intervention), WebMD (Chief Medical Editor, steering committees); other: Senior Associate Editor, Journal of Invasive Cardiology; Research Grants: Amarin, AstraZeneca, Bristol-Myers Squibb, Eisai, Ethicon, Medtronic, Sanofi Aventis, The Medicines Company; Unfunded Research: FlowCo, Plx Pharma, Takeda. All participating institutions were required to comply with local regulatory and privacy guidelines and, if required, to secure institutional review board approval. Because data were used primarily at the local site for quality improvement, sites were granted a waiver of informed consent under the common rule. Outcome Sciences, Inc (Cambridge, MA) served as the registry coordinating center. The Duke Clinical Research Institute (Durham, NC) served as the data analysis center, and institutional review board approval was granted to analyze aggregate deidentified data for research purposes. The GWTG–Stoke program was provided by the AHA. The GWTG–Stoke program was supported, in part, through the AHA Pharmaceutical Roundtable and an unrestricted educational grant from Merck. The other authors have no conflicts to report.

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