Poor Outcomes in Hispanic and African American Patients after Acute Ischemic Stroke: Influence of Diabetes and Hyperglycemia

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Background: Stroke is a leading cause of mortality and disability in the United States, and it disproportionately affects vulnerable populations, such as Hispanics and African Americans. We compared the prevalence of stroke risk factors, in-hospital treatment of hyperglycemia, and outcome among different ethnic groups after acute ischemic stroke (AIS).

Methods: Retrospective study of patients with AIS treated at an urban tertiary care center. Hispanic, African American, and White patients were compared by demography, illness severity, co-morbid conditions, degree of treatment of hyperglycemia, and outcome. Data were analyzed by using *t* testing, χ^2 testing, and analyses of variance, as appropriate.

Results: 960 cases were reviewed (68% African American, 13% Hispanic, 11% White, 8% other). Hispanic and African American patients were younger than White patients. More White patients had atrial fibrillation (26.7%) than did Hispanic (9.5%) or African American patients (6.6%, $P<.001$). Hispanic and African American patients had higher rates of hypertension (76%, 77%) than did White patients (55%, $P<.001$), and more Hispanic patients had diabetes (58%) than did either African American (37%) or White patients (27%, $P<.001$). Hispanic patients had higher blood glucose levels than did African American or White patients at baseline, 24 hours, and 48 hours after admission ($P<.05$). Diabetic Hispanic patients had higher in-hospital mortality rates (8.0%) than did diabetic non-Hispanic patients (2.5%, $P=.03$).

Conclusion: The incidence of stroke risk factors (atrial fibrillation, diabetes mellitus, and hypertension) differs between urban African American, Hispanic, and White patients. Hyperglycemia, a known independent predictor of mortality after stroke, is more likely to be present and persist during hospitalization in Hispanic patients than in African American and White patients. These disparities may explain the disproportionate mortality rates among Hispanic and African American and White patients after AIS. Focusing prevention and treatment towards hypertension, diabetes, and hyperglycemia may reduce racial/ethnic disparities and improve mortality and disability after acute ischemic stroke. (*Ethn Dis*. 2008;18:330–335)

Key Words: Stroke, Diabetes Mellitus, Ethnic, Disparities, Treatment, Outcome

Background

Stroke is the third leading cause of mortality and a primary source of disability in the United States. Additionally, the public health burden of stroke is falling more heavily on select groups such as Hispanics and African Americans aged 35–65 years.[1] The prevalence of risk factors for cerebrovascular disease is highest among African Americans.[2–4] Diabetes and hyperglycemia with blood glucose levels as low as 130 mg/dL are known independent predictors of mortality after stroke.[5–6] Type 2 diabetes mellitus is much more prevalent in African Americans and Hispanic Americans than in White Americans[7] and may contribute to the significantly higher rates of recurrent stroke and death in these patients.[1–3] This study was undertaken to determine the relationships between race/ethnicity and the prevalence of and treatment for hypertension and hyperglycemia in patients with acute ischemic stroke (AIS).

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Methods

Design and Participants

This was a retrospective study of patients discharged from Temple University Hospital or Northeastern Hospital, Philadelphia, Pennsylvania, over a 40-month period with acute cerebrovascular injury (diagnosis-related group [DRG] code 14 [specific cerebrovascular disorders except transient ischemic attack]). From 1197 patients with DRG code 14,237 patients with discharge diagnoses of subarachnoid, intracerebral, or other/unspecified intracranial hemorrhage were excluded from study. To confirm the reliability of the data, a subset of 80 patients' records were reviewed to determine the correctness of the diagnosis and DRG. In addition, hospital-derived data were cross-referenced with the Atlas query-specific database. Doing so yielded no additional patients, which suggested good disease capture by DRG designation.

Patients were grouped by race/ethnicity into self-reported categories as 1) Black or African American, 2) Hispanic or Latino, 3) Caucasian or White from non-Hispanic or non-Latino origin, and 4) other. The Temple University institutional review board approved the study.

Assessments and Outcome Parameters

Clinical and laboratory data were extracted from the MediTech laboratory

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management system and the Atlas Database, 2002 MediQual Systems, Inc., including age, sex, race, diabetes, hypertension, atrial fibrillation, and heart failure. Admission blood glucose, the first serum level reported by the clinical laboratory for the index hospitalization, and average blood glucose values obtained at 24±6 hours and 48±6 hours were recorded. When not available in the MediTech or Atlas information systems, blood glucose levels were obtained from AccuCheck measurements recorded in the medical chart. Clinical data also included use of insulin, oral hypoglycemic agents, and heparin during hospitalization. Discharge disposition and diagnoses were documented. Glasgow Coma Score (GCS) and All Patient-Refined Diagnosis-Related Groups (APR-DRGs, 3M Health Information Systems) risk of mortality and severity of illness measures[7] were used as assessments of baseline illness severity. GCS is a well recognized and widely used marker of neurologic injury severity. The APR-DRG incorporates clinical, laboratory, and radiographic variables that contribute to clinical disease severity. Admission severity is coded on a scale from one to four, representing minor, moderate, major, and extreme levels, respectively. Risk of mortality is coded on a scale of zero (least) to one (highest risk). APR-DRG measures have been used to reliably predict death and compare resource consumption and outcomes among hospitalized patients[7–8] and adjust for illness severity in stroke patients.[9]

Statistical Methods

Analyses were conducted by using SPSS version 14.0 (SPSS, Inc, Chicago, Ill). All statistical analyses were two-tailed and considered significant at the $P<.05$ level. Continuous variables were analyzed by using *t* tests and one-way analyses of variance; categorical variables were analyzed by using χ^2 or Fisher exact test for sample sizes less than five. White patients were used as the referent group for analyses.

RESULTS

Patient Characteristics

Patients were grouped as African American ($n=656$, 68.3%), Hispanic ($n=126$, 13.1%), White ($n=105$, 10.9%), or other (n=73, 7.6%). The average age of the study sample ($n=960$) was 65.7±13.6 years, and 55% was female. Co-morbid diagnoses included hypertension ($n=708$, 73.8%), type 2 diabetes ($n=392$, 40.8%), heart failure ($n=137$, 14.3%), and atrial fibrillation ($n=92$, 9.6%). Mean (plus or minus standard deviation) GCS was 13.8±1.7, mean injury severity score was .044±.06, and average admission severity score was 1.97±.42. Mean admission systolic blood pressure was 161.6±28.9 mm Hg, and diastolic blood pressure was 85.1±14.6 mm Hg. Mean admission blood glucose level was 151.8±94.4 mg/dL, and mean 24- and 48-hour levels were 143.7±74.8 mg/dL and 140.2±74.6 mg/dL, respectively. Patients were administered heparin ($n=129$, 13.4%), insulin, or an oral hypoglycemic agent separately or in combination ($n=478$, 49.8%). Most patients returned home after discharge (72.6%); 24.0% were transferred to another facility for additional acute care or, more likely, for nursing care or rehabilitation; 3.4% died during hospitalization. Portions of these and additional characteristics of the study sample have been reported previously.[6]

Demographic and Clinical Characteristics

Hispanic and African American patients were younger than White patients (Table 1). The incidence of co-morbid risk factors for stroke including hypertension, diabetes, and atrial fibrillation differed by race/ethnicity. White patients had higher rates of atrial fibrillation than did African American or Hispanic patients. However, Hispanic and African American patients had higher rates of hypertension than did Whites, and Hispanic patients had higher rates of diabetes than did either African American or White patients. More Hispanic and African American patients had a history of stroke than did White patients. We observed no significant differences between mean GCS, admission severity score, or calculated risk of mortality scores between racial/ethnic groups.

Relationships between In-Hospital Treatment and Outcome and Race/Ethnicity

Ninety two patients (9.6%) had discharge diagnoses of atrial fibrillation. Approximately one-third (31.5%) of patients received heparin by intravenous infusion. White patients with atrial fibrillation were 63% more likely to be treated with intravenously administered heparin (39.3%) than were Hispanic (25.0%) or African American (25.6%, nonsignificant) patients. Hypertension occurred in >70% of the study sample. Average systolic blood pressures were similar between racial/ethnic groups. However, African Americans had higher diastolic blood pressures than did Hispanic or White patients. Mean arterial pressures were higher in African Americans than in Whites and Hispanic patients.

Diabetes mellitus was common, occurring in >40% of the study sample. More Hispanic patients had diabetes than did either African American or White patients. Hispanic patients were more likely to be treated with insulin (47.6%) than were African American (28.2%) or White (25.7%) patients ($P<.001$). Similarly, Hispanic patients were more likely to be treated with an oral hypoglycemic agent (46.6%) than were African Americans (27.2%) or Whites (30.2%) after AIS ($P<.001$). However, despite receiving glucose-lowering medications, Hispanic patients were more likely than African American or White patients to have persistent hyperglycemia 48 hours after admission

Table 1. Demographic and clinical characteristics of patients with acute ischemic stroke, Philadelphia, Pennsylvania

Variable	White ($n = 105$)	Hispanic ($n = 126$)	African American ($n = 656$)	*P* value
Demographic Variables				
Age, mean (SD)	68.6 (14.3)	63.9 (11.5)*	65.2 (13.7)*	.021
Female, *n* (%)	54 (51.4%)	64 (50.8%)	369 (56.3%)	.396
Injury Severity				
Admission severity (1–4), mean (SD)	2.03 (.47)	1.96 (.43)	1.96 (.42)	.375
Risk of mortality (0–1), mean (SD)	.051 (.09)	.042 (.06)	.044 (.05)	.553
GCS (3–15), mean (SD)	13.8 (1.59)	14.0 (1.58)	13.8 (1.8)	.497
Co-morbid Conditions				
Hypertension, *n* (%)	58 (55.2)	97 (77.0)***	501 (76.4)***	<.001
Diabetes, *n* (%)	28 (26.7)	73 (57.9)***	245 (37.3)	<.001
Atrial fibrillation, *n* (%)	28 (26.7)	12 (9.5)***	43 (6.5)***	<.001
Heart failure, *n* (%)	18 (17.1)	13 (10.3)	92 (14.1)	.318
Prior stroke, *n* (%)	24 (23.1)	54 (43.1)*	280 (42.7)*	.014
Admission Blood Pressure				
Systolic, mm Hg, mean (SD)	159.2 (27.1)	156.2 (31.7)	163.4 (29.0)	.255
Diastolic, mm Hg, mean (SD)	75.6 (13.2)	82.7 (10.4)*	87.4 (15.3)***	<.001
MAP, mm Hg, mean (SD)	103.5 (15.2)	108.4 (14.1)	113.1 (17.6)*	.010
Glucose Levels				
Initial, mg/dL, mean (SD)	141.9 (81.2)	171.8 (100.2)*	150.2 (96.7)	.036
24-hour, mg/dL, mean (SD)	149.7 (109.9)	162.5 (79.6)**	138.5 (68.0)	.008
48-hour, mg/dL, mean (SD)	140.8 (74.0)	167.2 (82.1)**	135.0 (74.7)	.006
≥130 mg/dL over 48 hours (persisent hyperglycemia), n (%)	29 (27.9)	50 (40.0)*	174 (26.5)	.047

SD = standard deviation, GCS = Glasgow Coma Score, MAP = mean arterial pressure.
Groups were analyzed by using analyses of variance for continuous variables and χ^2 for dichotomous variables with White as referent group. $^{*}P \leq .05$, $^{**}P \leq .01$, $^{***}P \leq .001$, two-tailed.

for AIS. Figure 1 shows average BG levels over the first 48 hours of hospitalization among race/ethnic groups. Hispanic patients had higher average blood glucose levels at baseline and at 24 and 48 hours than did African American or White patients.

Mortality rates were higher in Hispanic patients than in non-Hispanic patients with diabetes. Mortality rates were not significantly different in Hispanic (5.6%), African American (3.0%), and White (2.9%) patients. We observed no difference in mortality or in death/dependence rates between Hispanic compared with non-Hispanic patients without diabetes (Table 2). However, Hispanic patients had higher in-hospital mortality rates (8.0%) than did non-Hispanic patients with diabetes (2.5%) after AIS (P=.03).

DISCUSSION

The demographic and clinical characteristics of AIS patients in an urban US environment, the extent to which they were treated for atrial fibrillation or hyperglycemia, and mortality rates, especially among patients with diabetes, were directly related to race/ethnicity. This study confirms the presence of inequity in risk factor and stroke prevalence among racial/ethnic groups.[10–13] African American and Hispanic patients were younger than White patients who had had AIS; however, despite being younger, African American and Hispanic patients had double the rate of prior stroke than did White patients. The high incidence of recurrent stroke may be due to higher rates of major risk factors for stroke in both African American and Hispanic patients than in White patients. Although White patients had higher rates of atrial fibrillation than did African American or Hispanic patients, African American patients had a 50% higher rate of hypertension than did Whites, and Hispanic patients had a 40% higher rate of hypertension and more than twice the rate of diabetes than did White patients. This ethnic disparity has been reported in broader US populations.[14–16] The prevalence of diabetes among persons aged ≥65 years is 22% and twice as high in non-Hispanic Blacks and Mexican Americans.[17] Patients in the present study had higher rates of diabetes than found nationally in all groups; the prevalence reached 37% in African American and 58% in Hispanic patients. The current study sample was primarily from poor, urban communities and had had AIS. These characteristics may account for the high rates of stroke risk factors in the study sample compared with the broader US population.

In this study, African American and Hispanic patients had more uncontrolled hypertension and hyperglycemia than did White patients with AIS. These differences may be explained in several ways. Racial/ethnic minority

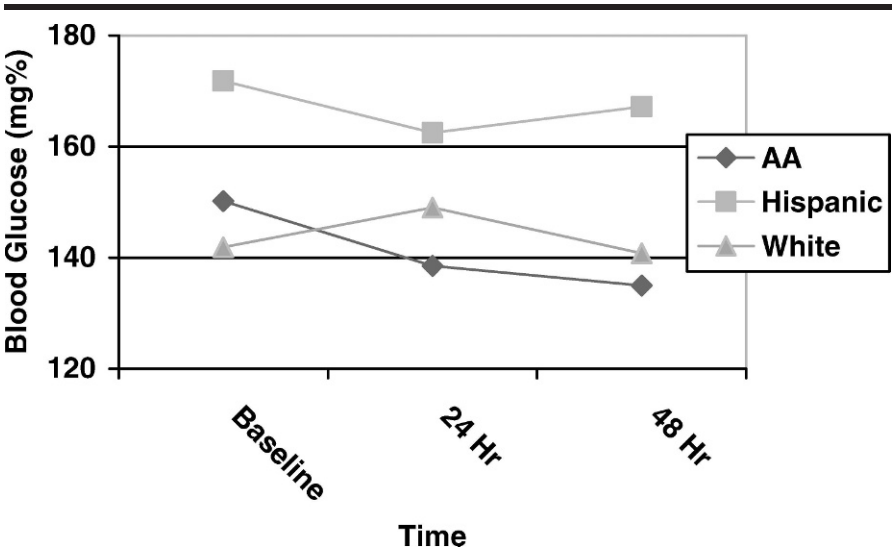

Fig 1. Average blood glucose levels in African American (-◆-), Hispanic (-■-) and White (-▲-) patients at baseline and 24- and 48-hours after admission for acute ischemic stroke

patients may not see their doctors or may delay presenting to the hospital for treatment.[18] This delay may be due to socioeconomic, linguistic, and cultural issues, in addition to behavioral characteristics and perhaps a degree of distrust in the medical system.[19–21] These differences can become barriers to care, and these barriers can be amplified in patients with physical, cognitive, and personality impairment caused by brain disease and injury.[21]

Mortality rates differed by ethnicity in this study. Although we observed no differences between mean GCS, admission severity score, or calculated risk of mortality scores between ethnic groups, Hispanic patients with diabetes had higher in-hospital mortality rates than did non-Hispanic patients after AIS. Therefore, differences in mortality between groups cannot be explained by differences in illness severity. Instead, higher mortality rates in Hispanic patients may be related to either higher degrees of uncontrolled hypertension and hyperglycemia after stroke or to differences in treatment after stroke. In addition to higher baseline blood glucose levels, Hispanic patients were more likely to have blood glucose levels that remained persistently elevated from arrival to 24 hours and 48 hours after hospital admission. Differences in blood glucose may, in part, explain the differences in mortality rates between these patient groups.

Differences in treatment of illness and injury related to race/ethnicity have been reported. For example, gaps were found in the administration of newer and more costly medications and procedures between African American and White patients with non-ST segment elevation acute myocardial infarction.[22] Fewer Hispanics than non-Hispanics undergo bypass surgery after acute myocardial infarction.[23] Hispanic ethnicity has been associated with poorer functional outcomes one year after traumatic brain injury, even after controlling for age, sociodemographic characteristics, severity of injury, and early post-injury functional status.[24] In AIS, intravenous thrombolytic therapy is used less frequently in African American patients presenting within three hours of symptom onset.[25]

In this study, hyperglycemia was managed less effectively in Hispanic patients than in African American or White patients. Hispanic patients had significantly higher mean blood glucose levels not only at baseline but at 24 hours and 48 hours after admission for stroke, and more Hispanic patients had persistent hyperglycemia with blood glucose levels >130 mg/dL (a value associated with increased risk of mortality)[5,6] than did African Americans or Whites. However, in the present study, persistent hyperglycemia was not likely due to differences in treatment between racial/ethnic groups. Hispanic patients with hyperglycemia were more likely to be treated with insulin or oral hypoglycemic agents than were African Americans or Whites after AIS, but blood glucose levels in these patients remained high. One possibility is that genetic and molecular differences account for differences between racial/ethnic groups. Genetic polymorphisms have been associated with insulin sensitivity, diabetes, and metabolic syndrome in the Hispanic American population.[26] Pharmacogenetic differences also affect re-

Table 2. Mortality and disability in patients with and without type 2 diabetes after acute ischemic stroke, Philadelphia, Pennsylvania

Variable	Without Diabetes			With Diabetes		
	Non-Hispanic (*n*=517)	Hispanic (*n*=51)	*P* value	Non-Hispanic (*n*=317)	Hispanic (*n*=75)	*P* value
Mortality, *n* (%)	18 (3.5)	1 (2.0)	.478	8 (2.5)	6 (8.0)	.033
Dead/Dependent, *n* (%)	75 (14.3)	5 (9.8)	.096	51 (14.2)	11 (14.7)	.566

In this study, African American and Hispanic patients had more uncontrolled hypertension and hyperglycemia than did White patients with AIS.

sponsiveness to treatment. For example, genotypic differences in platelet suppression by aspirin[27] exist between Black and White patients with coronary artery disease and in symptom severity and patient response to antihypertensive drug treatment.[28–29] Genetic variants have even been found between Puerto Rican and Mexican Americans with asthma that effect bronchodilator responsiveness.[30] There may be a genetic susceptibility to insulin resistance[31–32] that contributes to greater disease severity. This susceptibility, when combined with extremely high rates of hypertension and diabetes, all play a part to increase the incidence of first and recurrent stroke at a relatively young age among the urban-dwelling ethnic minorities in this study.

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Acquisition of data: Gentile, Seftchick
Data analysis and interpretation: Gentile, Seftchick
Manuscript draft: Gentile
Statistical expertise: Gentile
Acquisition of funding: Gentile
Administrative, technical, or material assistance: Gentile
Supervision: Gentile