Racial Variation in Initial Stroke Severity

Michael R. Jones, BS; Ronnie D. Horner, PhD; Lloyd J. Edwards, PhD; Jennifer Hoff, MS; S. Beth Armstrong, BA; Carol A. Smith-Hammond, PhD; David B. Matchar, MD; Eugene Z. Oddone, MD

Background and Purpose—Blacks experience greater morbidity and mortality from stroke than do whites. The degree to which this is due to the severity of the initial stroke is not known. The objective of this study is to determine whether there is a racial difference in initial stroke severity.

Methods—A secondary analysis of a prospective cohort of 984 veterans (29.7% black) admitted to any of 9 geographically diverse Veterans Administration Hospitals for acute stroke between April 1995 and March 1997 was performed. Initial stroke severity was ascertained by using the modified Canadian Neurological Scale (CNS) applied retrospectively to medical record data. Stroke severity, unadjusted and adjusted for covariates, was compared between black and white patients.

Results—Blacks had greater initial stroke severity than did whites (mean CNS score 7.96 versus 8.32, respectively; \( P=0.035 \)), with a 0.5-point difference on the scale corresponding to a single-level decrement in either speech or strength of half of an extremity. This difference persisted with adjustment for other important predictors of stroke severity \( (P=0.039) \). However, there was no significant racial difference in severity when CNS scores were collapsed into a priori clinically relevant categories.

Conclusions—Compared with whites, blacks show greater severity of stroke at hospital admission. It remains uncertain whether the relatively small but significant difference at presentation fully explains the striking racial differences in morbidity and mortality from stroke. (Stroke. 2000;31:563-567.)

Key Words: blacks | cerebrovascular disorders | disease severity

Whereas the average life expectancy for whites in the United States is at an all time high at 76.8 years, the average life expectancy for blacks is 6.6 years less. Stroke is the single most important contributor to excess mortality among blacks, accounting for 28% of the black-white mortality difference. Blacks aged 35 to 74 years are nearly twice as likely to suffer from stroke, more than twice as likely to die from strokes, and significantly more likely to have greater residual physical and functional deficits should they survive a stroke. A number of factors may contribute to these racially disparate outcomes, including system-related factors (such as inequities in access to care or treatment within the hospital setting), patient-related factors (such as delay between ictus and presentation), and disease related factors (particularly the initial severity of the stroke).

Multiple studies have found that the severity of the initial neurological deficit is the greatest single determinant of outcome for patients with stroke. Indeed, a racial difference in initial stroke severity is likely in view of documented racial variation in characteristics associated with more severe strokes, including comorbid risk factors, distribution of vascular pathology, stroke type (eg, hemorrhagic versus ischemic), and usage of preventative therapy (eg, carotid endarterectomy and aspirin).

To date, few studies have evaluated racial variation in stroke severity. Kuhlemeier and Stiens concluded that blacks tend to have more severe strokes on the basis of short-term outcomes; the authors specifically describe higher percentages of black patients who become comatose or die during short-term hospitalization. Another recent study found that among Medicare patients, blacks had a higher frequency of motor deficits at admission than did whites. Although these studies suggest that the initial lesion may be more severe in blacks than whites, neither study directly assessed stroke severity at admission or separated the effects of race from socioeconomic factors or access to care issues.

In the present study, we provide evidence regarding racial differences in initial stroke severity. We applied a validated stroke severity scale to a cohort of veterans suffering from acute stroke on the first day of hospitalization. Our hypothesis...
was that blacks, even when participating in an equal-access health care system such as the Veterans Health Administration (VHA), have more severe initial neurological deficits when presenting with acute stroke than do whites.

Subjects and Methods

Study Design
This is a secondary analysis of data from the VA Acute Stroke Study, a 9-site nation-wide prospective cohort study of 1073 patients with acute stroke who were clinically managed within the VHA.21 All patients were hospitalized between April 1, 1995, and March 31, 1997. The 9 sites are located across the United States, with 4 of the sites located in the “stroke belt” (ie, the southeastern United States); for reasons of confidentiality, the individual sites are not identified. The study involved following patients from presentation through 1 year after stroke, with a focus on key acute care practices received and a broad array of physical and psychological health outcomes experienced. Data on acute care practices were obtained from medical record review, and data on health outcomes were obtained from telephone interviews conducted at ~1 month, 6 months, and 12 months after admission. The study was approved by the Internal Review Board at each of the 9 sites.

Patient Population
Patients were identified within 48 hours of admission by a research assistant who screened the hospital’s admission logbook for patients admitted with symptoms suggestive of stroke. The diagnosis was confirmed by review of medical records and discussions with the attending physician. To ensure that no stroke patient was missed, the hospital’s computerized discharge files were screened for patients with a discharge diagnosis of intracerebral hemorrhage (International Classification of Diseases, 9th Revision, Clinical Modification [ICD-9-CM] code 431) or acute cerebral infarct (ICD-9-CM code 434 or 436). A final review of the medical record was conducted to exclude patients whose stroke was iatrogenic, secondary to brain tumor or trauma, occurring during hospitalization for other medical conditions, or occurring >7 days before admission. However, patients with a history of stroke(s) in which the index stroke was not considered an extension of a previous stroke were considered eligible for enrollment. Thus, the cohort was composed of patients with acute intracerebral hemorrhagic or ischemic stroke.

For the present analysis, women were excluded because they constituted only 1.6% of the cohort. Patients whose racial self-description was neither “African American” nor “white” (3.1%) were also excluded to produce more homogeneous racial cohorts. This left a cohort of 984 male veterans that was 29.7% black and 70.3% white. Medical records were available for all enrolled patients.

Stroke Severity
Stroke severity at admission was determined by using a modified Canadian Neurological Scale (CNS) as described by Goldstein and Chilutuki.22 This instrument has been demonstrated to be both valid and reliable in assessing stroke severity.22,23 All assessments were performed by a single trained rater (M.R.J.) and were based on admission day medical record data recorded by physicians who were unaware of the study hypothesis.

The modified CNS is an aggregate ordinal scale that produces discrete scores ranging from 0 to 11.5 (stepwise by 0.5). Clinical factors that determine scoring include level of consciousness, orientation, language, and motor function.22 For the purposes of calibrating the scale, we created logical clinical categories of stroke severity. Specifically, scores were categorized as “mild” (scores 8.5 to 11.5), “moderate” (scores 6.0 to 8.0), and “severe” (scores 0.0 to 5.5) for each race. These categories reflect clinical syndromes. Mild is defined as nonmotor deficits or mild hemiparesis with or without dysarthria and without alteration in sensorium. Moderate refers to moderate/severe hemiparesis with or without dysarthria and with or without disorientation or isolated receptive aphasia. Finally, severe refers to comatose, hemiplegic, or globally aphasic patients. The severity categories, and cut points that define them, also follow natural clusters in the data and mirror a predictive model derived in a previous study for the original CNS.24

To determine intrarater reliability, 100 randomly selected cases were reevaluated by the primary rater without knowledge of previously derived CNS scores. To determine interrater reliability, both the main rater and a second trained observer (C.A.S.-H.) independently scored 63 additional patients who had participated in the pilot phase of the VA Acute Stroke Study. Both intrarater and interrater reliability were high, with weighted k values of 0.77 and 0.79, respectively, showing excellent agreement.25

Secondary Outcomes
To determine the prognostic capabilities of the CNS scale scores and to relate our findings to previous studies, we also examined 2 clinically based secondary end points.19 Admission or transfer to an intensive care unit was measured as a dichotomous variable (1 indicated admission or transfer to intensive care unit at any point in the index hospitalization as noted in the medical record, and 0 indicated all patient care outside of the intensive care setting). In-hospital mortality was likewise measured by a dichotomous variable.

Primary Independent Variable and Covariates
The primary independent variable was racial group, which was determined by patient self-report. Years of educational and marital status also were obtained by a structured telephone interview conducted at 1-month after admission for stroke. Interviews were not obtained for patients who either died before the interview (n=107), were unable to be contacted before the interview date had passed (n=188), or were unable to communicate and had no proxy informant (n=42). Information for patients who were demented, comatose, or with significant receptive aphasia was obtained from proxy respondents.

Other demographic data (age and sex) was obtained from the medical record, as was smoking status (in pack years). Stroke subtype (infarct versus intracerebral hemorrhage) and presence of comorbid conditions, such as diabetes mellitus, hypertension, atrial fibrillation, congestive heart failure, and prior stroke, were determined by ICD-9-CM discharge diagnoses for the stroke admission and verified by medical record review. History of stroke, history of transient ischemic attack, and origin of admission (recorded as either from a nursing home or not from a nursing home) were assessed from the medical record and used as proxy measures of the burden of disease before the index stroke.

Data Analysis
Characteristics for patients were compared by a χ2 analysis for categorical variables and Student t test for continuous variables. Because the CNS is an ordinal scale, mean CNS scores for each racial group were calculated and compared with use of a Wilcoxon rank sum test. Proportions of patients falling into the mild, moderate, and severe categories of stroke severity were then compared between races by χ2 analysis. A value of P≤0.05 was considered significant.

To assess the influence of important demographic and comorbid conditions on stroke severity, we used the general linear model to perform multivariable linear regression analyses. Because of the large number of covariates, a model building technique was used to develop the final regression model. First, bivariable regression models were tested; these models involved each explanatory variable and race (main effects only, no interaction at this stage) to determine whether the variable was significant (at the P≤0.10 level) over and beyond having race in the model. After the first stage of model building, 11 predictor variables were used in an initial multivariable regression model (race, atrial fibrillation, origin of admission, prior stroke, diabetes mellitus, type of stroke, income, hypertension, marital status, smoking, and congestive heart failure). Second, a backward selection technique was used to reduce the initial multi-
variable model. Each variable not significant at the $P \leq 0.05$ level was removed, and the model was refit until a final reduced model having only main effects was achieved. Finally, interactions between race and the other predictor variables in the final model were investigated. Assumptions underlying the model were assessed and found to have been met. Last, secondary outcomes were compared between races by $\chi^2$ analysis.

### Results

#### Cohort Characteristics

Blacks and whites differed in several characteristics that may be associated with stroke severity (Table 1). Blacks more often had been given a diagnosis of hypertension but less often had concomitant ischemic heart disease. Blacks reported substantially lower cigarette use than did whites. We found no statistically significant difference between races in the prevalence of congestive heart failure, atrial fibrillation, or diabetes mellitus within our cohort.

Blacks were less likely to be married or to have a high school or greater level of education. We observed no racial difference in mean age among our stroke patients. There were also no racial differences in any of our proxy measures of disease burden before admission, including prior stroke, prior transient ischemic attack, and admission from a nursing home. Furthermore, there was no racial difference in prevalence of intracerebral hemorrhage. Nor was there a racial difference in the time between stroke onset and presentation at the hospital: 76.4% of blacks and 75.7% of whites presented within 48 hours of stroke onset.

#### Stroke Severity

The mean CNS score was lower for blacks than for whites, indicating more severe strokes (Figure). In the unadjusted analysis, the absolute difference between races was 0.36 scale points ($P=0.039$). Prior studies suggest that a 0.5 difference in individual patients’ scores corresponds to a clinically important difference, such as a single-level decrement in speech or strength of an extremity.23,24 However, as shown in Table 2, this statistically and clinically significant difference was not present when the CNS scores were collapsed into the predefined categories ($P=0.304$).

Table 3 shows that after adjusting for potentially confounding factors, race remained a significant independent predictor of severity ($P=0.0035$). There were no significant interactions between race and the other predictor variables used in the final model.

Atrial fibrillation and intracerebral hemorrhage were both associated with more severe strokes. Indicators of poor prior function (prior stroke and admission from nursing home) were also independent predictors. Age, income, marital status, smoking history, alcohol consumption, diabetes mellitus, ischemic heart disease, and congestive heart failure were not independent predictors of more severe stroke.

### Table 1. Demographic and Clinical Characteristics of Cohort of Acute Stroke Patients According to Patient’s Race

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Black (n=292)</th>
<th>White (n=696)</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age, y</td>
<td>67.2±10.0</td>
<td>67.9±10.0</td>
<td>0.40</td>
</tr>
<tr>
<td>Married,* %</td>
<td>52.5</td>
<td>63.0</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>High school graduate,* %</td>
<td>49.5</td>
<td>61.8</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Resident in nursing home before admission, %</td>
<td>2.7</td>
<td>3.8</td>
<td>0.43</td>
</tr>
<tr>
<td><strong>Comorbid conditions</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atrial fibrillation, %</td>
<td>10.6</td>
<td>13.6</td>
<td>0.21</td>
</tr>
<tr>
<td>Congestive heart failure, %</td>
<td>9.3</td>
<td>7.4</td>
<td>0.31</td>
</tr>
<tr>
<td>Diabetes mellitus, %</td>
<td>34.9</td>
<td>34.4</td>
<td>0.89</td>
</tr>
<tr>
<td>Hypertension, %</td>
<td>66.1</td>
<td>55.8</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Ischemic heart disease, %</td>
<td>16.4</td>
<td>31.0</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Cigarette smoking, pack-years</td>
<td>20.7±26.7</td>
<td>27.5±38.8</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Cerebrovascular disease, %</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intracerebral hemorrhage</td>
<td>10.3</td>
<td>7.3</td>
<td>0.09</td>
</tr>
<tr>
<td>History of stroke</td>
<td>31.5</td>
<td>33.5</td>
<td>0.54</td>
</tr>
<tr>
<td>History of transient ischemic attack</td>
<td>7.9</td>
<td>12.0</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Values are mean±SD for age and cigarette smoking.

*Data obtained by interview vs medical record (blacks, n=200; whites, n=516).
TABLE 3. Adjusted Parameter Estimates of Association Between Selected Factors and Stroke Severity (CNS Score): General Linear Regression, Final Model

<table>
<thead>
<tr>
<th>Model Parameter</th>
<th>β Coefficient</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>8.96</td>
<td>0.0001</td>
</tr>
<tr>
<td>Race (black=1, white=0)</td>
<td>-0.36</td>
<td>0.0350</td>
</tr>
<tr>
<td>Prior nursing home resident (yes=1, no=0)</td>
<td>-1.74</td>
<td>0.0001</td>
</tr>
<tr>
<td>Atrial fibrillation (yes=1, no=0)</td>
<td>-0.59</td>
<td>0.0128</td>
</tr>
<tr>
<td>Type of stroke (hemorrhagic=1, ischemic=0)</td>
<td>-2.54</td>
<td>0.0001</td>
</tr>
<tr>
<td>Prior stroke (yes=1, no=0)</td>
<td>-0.82</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Severity mean was 8.21. $R^2=0.134$; $P=0.0001$.

intensive care units (23.6% versus 18.7% for whites), and they had a higher in-hospital mortality (12.7% versus 9.5% for whites). However, these differences were not statistically significant ($P=0.077$ and 0.116, respectively).

Discussion

The present study examines racial variation in initial stroke severity by using a geographically and racially diverse cohort of veterans suffering from acute stroke. Within an equal-access health care system, we found a small but significant increase in stroke severity among blacks. This difference persisted after controlling for other potential influences on severity, such as atrial fibrillation, stroke type, and history of prior stroke.

Although there is relatively little literature regarding this issue, available studies, such as that of Kuhlemeier and Stiens,19 suggest that there are substantial racial differences in stroke severity. Their study, though, is based on proxy indicators of severity and fails to control for confounding variables, such as socioeconomic status, access to care, and clinical factors. The present study, which directly measured severity and controlled for potential confounders, provides methodologically stronger evidence of racial variation in stroke severity. It remains less clear, however, whether the relatively small difference in initial stroke severity observed in the present study accounts for the striking racial differences in morbidity and mortality from stroke. The racial difference in stroke severity that we observed was supported by racial differences of a similar magnitude in the proportion of patients with an intensive care unit stay and those dying in the hospital, although the racial differences in these later parameters were of borderline statistical significance. Although the matter demands further study, it is likely that factors other than stroke severity contribute to the differences in stroke outcome currently documented between blacks and whites.

In an attempt to isolate the disease-specific (biological) aspects of racial variation in stroke outcome, we used a cohort of veterans that inherently lacks constraints on access to care and generally has attenuated socioeconomic differences between races. However, race is a complex entity not merely reflected in the content of one’s chromosomes but rather the interaction of such with environmental circumstance. In the US population as a whole, race is intimately associated with socioeconomic status, and socioeconomic factors are docu-

mented to contribute to the excess stroke mortality found among blacks.26,27 Thus, the racial difference we observed in initial stroke severity may be greater in other patient populations, where black race is more strongly associated with low socioeconomic status and, therefore, less access to health care.

We recognize that our results should be interpreted with caution because veterans, particularly those who use the VHA health care system, may differ from the general population in characteristics associated with stroke severity. First of all, women were excluded from our analysis. Other studies examining racial variation in stroke have described sex as an independent predictor and as having an interaction with race when considering stroke risk factors, incidence, and mortality.27–30 Thus, it may be inappropriate to generalize our findings regarding stroke severity to female stroke patients. Second, we had a slightly lower percentage of intracerebral hemorrhages than do most stroke cohorts (8% versus 10% to 15%) and did not demonstrate the previously documented black preponderance of intraparenchymal hemorrhages.17,28,31–33 Moreover, the in-hospital mortality rate for blacks and whites in our cohort was about half that reported for similar racial groups in the North Manhattan cohort,28 and we have a relative paucity of severe strokes in our cohort compared with severe strokes reported in a smaller study that used the CNS24 (19% versus 32%). Because patients seen at VA hospitals often travel in excess of 100 miles for their nonacute care, these patients are unlikely to travel such a distance in the event of a severe acute stroke (such as a large or rapidly expanding intracerebral hemorrhage). Given that a large proportion of patients presenting with acute intracerebral hemorrhage and other severe strokes die while hospitalized for the event, it is likely that many veterans who reside at some distance from the VA hospital may not have survived to transfer, attenuating the number of patients with severe stroke in our cohort.34,35 Previous studies have indicated that blacks are more likely to have such an event.17,36 Thus, our findings may represent a conservative estimate of the actual racial difference in stroke severity. Third, our findings of a significant racial difference in stroke severity held only when we considered the continuous measure of severity; within clinically defined categories, the proportion of blacks was slightly greater in the moderate and severe categories but not significantly so. Whereas this may reflect the loss of information that occurs with the use of categories versus actual scores, it also may indicate the lack of a clinically relevant difference in stroke severity.

However, with respect to other important characteristics associated with stroke severity, our cohort of veterans was similar to nonveteran cohorts. In terms of comorbidity, ~10% to 15% of our patients had atrial fibrillation, 10% had congestive heart failure, 35% had diabetes mellitus, and 50% to 60% had a diagnosis of hypertension. This comorbidity profile is similar to that reported for patients in the North Manhattan Stroke Study and the cohort derived from the University of California at San Diego Stroke Data Bank.11,37 Moreover, whereas time from onset of symptoms to presentation may also affect stroke severity, 76% of our cohort versus 70% of a community-based nonveteran cohort (adjust-
ed to match our enrollment restriction of presentation within 7 days) presented within 48 hours of ictus.28

In summary, we found evidence of a small but significant racial difference in initial stroke severity, with blacks having more severe strokes. This difference persisted in a model controlling for other important characteristics. The explanatory importance of this difference in stroke outcomes (eg, residual disability and death) remains to be determined. Moreover, the antecedent factors that account for the difference have yet to be ascertained but could include poorer control of known risk factors, greater susceptibility to disease given similar risk factor profiles, and the greater presence of undefined risk factors among blacks. These possibilities suggest a number of interventions, including more aggressive risk factor control for blacks and greater patient education to emphasize health-promoting behaviors, thereby reducing the likelihood of a severe neurological lesion.

Acknowledgments
This study was supported by a grant from the VA Health Services Research and Development Service (SDR 93-003). Dr Horner was supported, in part, by a grant from the VA Cooperative Studies/Epidemiologic Research and Information Center Programs (VA CSP/ERIC 002).

References
Racial Variation in Initial Stroke Severity

Stroke. 2000;31:563-567
doi: 10.1161/01.STR.31.3.563
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2000 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/31/3/563

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office. Once the online version of the published article for which permission is being requested is located, click Request Permissions in the middle column of the Web page under Services. Further information about this process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org/subscriptions/