Patients Living in Impoverished Areas Have More Severe Ischemic Strokes

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Background and Purpose—Initial stroke severity is one of the strongest predictors of eventual stroke outcome. However, predictors of initial stroke severity have not been well-described within a population. We hypothesized that poorer patients would have a higher initial stroke severity on presentation to medical attention.

Methods—We identified all cases of hospital-ascertained ischemic stroke occurring in 2005 within a biracial population of 1.3 million. “Community” socioeconomic status was determined for each patient based on the percentage below poverty in the census tract in which the patient resided. Linear regression was used to model the effect of socioeconomic status on stroke severity. Models were adjusted for race, gender, age, prestroke disability, and history of medical comorbidities.

Results—There were 1895 ischemic stroke events detected in 2005 included in this analysis; 22% were black, 52% were female, and the mean age was 71 years (range, 19–104). The median National Institutes of Health Stroke Scale was 3 (range, 0–40). The poorest community socioeconomic status was associated with a significantly increased National Institutes of Health Stroke Scale by 1.5 points (95% confidence interval, 0.5–2.6; P<0.001) compared with the richest category in the univariate analysis, which increased to 2.2 points after adjustment for demographics and comorbidities.

Conclusions—We found that increasing community poverty was associated with worse stroke severity at presentation, independent of other known factors associated with stroke outcomes. Socioeconomic status may impact stroke severity via medication compliance, access to care, and cultural factors, or may be a proxy measure for undiagnosed disease states. (Stroke. 2012;43:2055-2059.)

Key Words: poverty ■ severity ■ socioeconomic status

Many patient-related factors are known to influence functional outcome in ischemic stroke patients.1–3 Chief among these is the initial stroke severity.4–6 Recent studies of stroke outcome have demonstrated that the initial National Institutes of Health Stroke Scale (NIHSS) score on presentation for medical attention is the most important predictor of outcome, and modeling outcome using the initial NIHSS score alone is more predictive than models that include patient demographics and comorbidities.7 However, predictors of initial stroke severity itself have not been well-described within a population. Some nonpopulation-based studies have suggested that heart failure, dementia, renal insufficiency, and atrial fibrillation (and treatment of atrial fibrillation) may impact stroke severity.8–10

Socioeconomic status (SES) has been shown to affect access to care, medication compliance, disease incidence, and chronic risk factor management in stroke and many other disease processes.11–21 Given these effects of poverty on premorbid conditions and that incidence of stroke is higher among lower SES groups, we postulated that poverty would also negatively influence the symptom severity on presentation to medical attention. “Community SES,” or the socioeconomic status of the neighborhood in which one resides, is a well-validated proxy variable for estimating the SES of an individual22–24 and is useful when individual income and/or educational level data are not available. Therefore, we hypothesized that stroke patients living in impoverished areas would have more severe initial stroke severity on presentation to emergency medical attention, even after controlling for other described predictors of stroke severity and outcome.

Materials and Methods
The Greater Cincinnati/Northern Kentucky region includes 2 southern Ohio counties and 3 contiguous Northern Kentucky counties that border the Ohio River. Only residents of the 5 study counties are considered for case ascertainment. There were 17 hospitals in the Greater Cincinnati/Northern Kentucky region in 2005. Previous studies have documented that residents of the 5 counties who have a stroke exclusively seek care at these hospitals rather than at hospitals in the outlying region.25 This study was approved by the Institutional Review Board at all participating hospitals.

The Greater Cincinnati/Northern Kentucky Stroke Study involved ascertainment of all stroke events that occurred in the population in calendar year 2005. Details of case ascertainment of previous study

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2055
periods have been previously published.26 In 2005, screening was identical to the techniques used in previous study periods. All area residents who either were inpatients or were discharged from the emergency department with primary or secondary stroke-related International Classification of Disease, 9th Revision discharge diagnoses 430 to 436 at the 17 acute care hospitals in the study region were screened for inclusion. All events were cross-checked to prevent double counting.

Once potential cases were identified, a study research nurse abstracted information regarding stroke symptoms, physical examination findings, medical/surgical history, medication use before stroke, social history/habits, prehospital evaluation, vital signs and emergency room evaluation, neurological evaluation, diagnostic test results (including laboratory testing, electrocardiogram and cardiac testing, and neuroimaging of any type), treatments, and outcome. To clarify, medical history was recorded as noted on admission (ie, a history of hypertension was only counted if documented in the medical record as being present before the stroke event). Stroke severity was estimated using a validated method of retrospective NIHSS score (rNIHSS) obtained from review of the physician examination as documented in the emergency department evaluation.27 Classification of race/ethnicity was as reported in the medical administrative record. The research nurse made a determination as to whether a stroke or transient ischemic attack may have occurred and consulted with study physicians for any questionable cases. If the nurse abstractor was unsure whether a stroke occurred, the event was abstracted so a study physician could determine whether the event met stroke criteria.

Stroke-trained study physicians reviewed every abstract to verify whether a stroke or transient ischemic attack had occurred after taking into account all available information, including imaging reports and, when necessary, review of actual images. Events with transient symptoms with positive diffusion-weighted imaging are considered ischemic strokes.28 Both study nurses and study physicians undergo extensive training before reviewing events, and the study maintains detailed physician and research nurse study manuals that describe screening, abstraction, and reviewing procedures, ensuring a consistency of methodology among study personnel.

Cases of acute ischemic strokes, both first-ever and recurrent, were included in the present analysis. Intracerebral hemorrhage and subarachnoid hemorrhage events were not included. The onset of stroke symptoms must have occurred within the study time period. A stroke-trained study physician reviewed every abstract to verify whether a stroke or transient ischemic attack had occurred. The case definition of ischemic requires either a focal neurological deficit in the study physicians' opinion (which took into account all available information, including imaging reports and, when necessary, review of actual images), or both. Events with transient symptoms with positive diffusion-weighted imaging are considered ischemic strokes.29 Both study nurses and study physicians undergo extensive training before reviewing events, and the study maintains detailed physician and research nurse study manuals that describe screening, abstraction, and reviewing procedures, ensuring a consistency of methodology among study personnel.

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Table 1. Demographics, Vascular Risk Factors, and Community Socioeconomic Status for Ischemic Stroke Patients Included and Excluded From This Analysis of the Greater Cincinnati/Northern Kentucky Population

<table>
<thead>
<tr>
<th></th>
<th>Excluded Ischemic Stroke Patients</th>
<th>Included Ischemic Stroke Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N=353)</td>
<td>(n=1895)</td>
</tr>
<tr>
<td>Age (SD)</td>
<td>77 (16.5)</td>
<td>69 (14.3)</td>
</tr>
<tr>
<td>Black (%)</td>
<td>73 (20.7)</td>
<td>417 (22.0)</td>
</tr>
<tr>
<td>Female (%)</td>
<td>249 (70.5)</td>
<td>990 (52.2)</td>
</tr>
<tr>
<td>History of HTN (%)</td>
<td>287 (81.3)</td>
<td>1486 (78.4)</td>
</tr>
<tr>
<td>History of DM (%)</td>
<td>132 (37.4)</td>
<td>686 (36.2)</td>
</tr>
<tr>
<td>History of coronary artery disease (%)</td>
<td>124 (35.1)</td>
<td>659 (34.8)</td>
</tr>
<tr>
<td>History of untreated atrial fibrillation (%)</td>
<td>58 (16.4)</td>
<td>157 (8.3)</td>
</tr>
<tr>
<td>History of treated atrial fibrillation (%)</td>
<td>42 (11.9)</td>
<td>125 (6.6)</td>
</tr>
<tr>
<td>History of HF (%)</td>
<td>101 (28.6)</td>
<td>321 (16.9)</td>
</tr>
<tr>
<td>History of dementia (%)</td>
<td>148 (41.9)</td>
<td>123 (6.5)</td>
</tr>
<tr>
<td>History of previous stroke (%)</td>
<td>143 (40.5)</td>
<td>486 (25.6)</td>
</tr>
<tr>
<td>Current smoker (%)</td>
<td>113 (32.0)</td>
<td>1036 (54.7)</td>
</tr>
<tr>
<td>Prestroke disability mRS &lt;2 (%)</td>
<td>278 (18.9)</td>
<td>358 (78.8)</td>
</tr>
<tr>
<td>Estimated NIHSS score mean (SD)</td>
<td>9.7 (8.5)</td>
<td>5.7 (6.7)</td>
</tr>
</tbody>
</table>

DM indicates diabetes mellitus; HF, heart failure; HTN, hypertension; mRS, modified Rankin Scale; NIHSS, National Institutes of Health Stroke Scale; SD, standard deviation; SES, socioeconomic status.

Results

There were 2248 ischemic stroke events detected in 2005, and 353 cases were excluded: 7 because of age younger than 18; 29 because of missing NIHSS score; 14 because of incorrect International Classification of Disease, 9th Revision code; and 303 were excluded because of residence within institutions.
Among the 1895 remaining cases, 22.0% were black, 52.2% were female, and the median age was 71 years (range, 19–104). The median estimated NIHSS score was 3 (range, 0–40). The demographic and vascular risk factor characteristics of the included and excluded ischemic stroke patients are presented in Table 1, as well as the distribution of community SES among these patients.

The Figure presents the geographic distribution of census tracts and community poverty status within the 5-county region of the overall Greater Cincinnati/Northern Kentucky region. Although most of the more impoverished areas in the region are near the “downtown” region of urban Cincinnati city proper, there are impoverished rural regions represented within this area as well.

Those living in a census tract with >25% poverty had a mean rNIHSS score of 6.7 (95% confidence interval, 5.8–7.6), which was on average 1.5 points higher than for those living in census tracts with <5% poverty (mean NIHSS score, 5.2; 95% confidence interval, 4.7–5.7). This difference was highly significant ($P=0.006$) and was further exaggerated to 2.2 points when adjusting for comorbidities and demographic factors hypothesized to impact stroke severity a priori (Table 2). Of the prespecified factors, a higher initial rNIHSS score was associated with age, prestroke disability, a history of heart failure, untreated atrial fibrillation (defined as no anticoagulation or antiplatelet medication at the time of the event), and, marginally, a history of dementia. A history of hypertension was associated with a slightly lower rNIHSS score. All other risk factors and demographics were not statistically significantly associated with severity. An analysis of ischemic stroke subtypes and the impact on stroke severity did not find a significant overall difference in median rNIHSS score between the subtypes of ischemic stroke (small vessel, large vessel, cardioembolic, other known cause, and undetermined etiology; Kruskall-Wallis test, $P=0.07$). We also did not find a difference in the distribution of ischemic stroke subtypes when stratified by SES ($\chi^2$, $P=0.152$).

We also performed a secondary analysis to explore the association between SES and severe stroke using a dichotomized NIHSS score. Of the mild to moderate strokes, 22.4% occurred in those who were black, whereas 20.0% of those with severe strokes were black. There was no statistical difference between these proportions ($P=0.403$). The odds of rNIHSS score >10 were twice as high for the patients within the poorest SES category compared with the richest (odds ratio, 2.0; 95% confidence interval, 1.2–3.2; $P=0.006$) after controlling for demographics and vascular risk factors.

**Discussion**

We found that ischemic stroke patients who lived in poorer areas presented with significantly higher stroke severity at presentation for medical attention, independent of other reported factors associated with stroke severity and outcomes. In fact, patients living in poorer regions were twice as likely to have a severe stroke (rNIHSS score >10). To our knowl-
Table 2. Multivariable Model of Change in Initial NIHSSS Associated With Socioeconomic Status, Demographics, and Medical Comorbidities

<table>
<thead>
<tr>
<th>Change in NIHSSS Score Points*</th>
<th>95% CI of the Change</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Below poverty within census tract: poorest vs richest category</td>
<td>2.23 (1.06–3.39)</td>
<td>0.000</td>
</tr>
<tr>
<td>Age (by decade)</td>
<td>0.30 (0.06–0.53)</td>
<td>0.013</td>
</tr>
<tr>
<td>Race (not black vs black)</td>
<td>0.64 (–0.19 to 1.48)</td>
<td>0.132</td>
</tr>
<tr>
<td>Gender, F vs M</td>
<td>–0.43 (–1.04 to 0.17)</td>
<td>0.162</td>
</tr>
<tr>
<td>Prestroke disability mRS (per point)</td>
<td>0.44 (0.15–0.73)</td>
<td>0.003</td>
</tr>
<tr>
<td>History of stroke</td>
<td>0.57 (–0.14 to 1.28)</td>
<td>0.113</td>
</tr>
<tr>
<td>History of CAD</td>
<td>0.08 (–0.60 to 0.75)</td>
<td>0.823</td>
</tr>
<tr>
<td>History of treated atrial fibrillation</td>
<td>0.59 (–1.82 to 0.24)</td>
<td>0.348</td>
</tr>
<tr>
<td>History of untreated atrial fibrillation</td>
<td>1.88 (0.79–2.97)</td>
<td>0.001</td>
</tr>
<tr>
<td>History of HTN</td>
<td>–1.36 (–2.12 to –0.61)</td>
<td>0.000</td>
</tr>
<tr>
<td>History of CHF</td>
<td>2.07 (1.21–2.93)</td>
<td>0.000</td>
</tr>
<tr>
<td>History of DM</td>
<td>–0.06 (–0.69 to 0.58)</td>
<td>0.865</td>
</tr>
<tr>
<td>History of dementia</td>
<td>1.11 (–0.16 to 2.38)</td>
<td>0.086</td>
</tr>
<tr>
<td>Current smoking (vs nonsmoking)</td>
<td>–0.23 (–0.84 to 0.38)</td>
<td>0.465</td>
</tr>
</tbody>
</table>

CAD indicates coronary artery disease; CHF, coronary heart failure; CI, confidence interval; DM, diabetes mellitus; F, female; HTN, hypertension; M, male; mRS, modified Rankin Scale; NIHSS, National Institutes of Health.
*A negative value is associated with a lower NIHSS score.

edge, predictors of initial stroke severity within a diverse population have not been reported previously.

There are many possible explanations for our findings. SES may impact stroke severity via medication compliance, access to care, cultural factors, or may be a proxy measure for undiagnosed disease states. Most studies of functional outcome after stroke did not appear to impact the initial stroke severity. It is likely that comorbidities such as diabetes or smoking are contributing to complications in an already impaired person after stroke, which may be an entirely different mechanism than what impacts the initial severity of a stroke event.

The amount of change in the rNIHSS associated with poorer SES is relatively modest, only 2.2 points. How meaningful this would be clinically could be of debate. It should be noted that the NIHSS score is a simple ordinal scale that describes stroke severity, and likely all “points” on the scale are likely not equal in clinical significance. For example, does getting 1 point for “hemibody numbness” really equal having mild-to-moderate aphasia on neurological examination? Despite these limitations, the NIHSS score is the best well-validated measure of severity that exists today and therefore was our primary measure of severity in this analysis.

A limitation of our analysis is that community SES may not necessarily reflect individual SES and is a limitation of any analysis that uses aggregate measures of SES. We did not use individual SES because this information is not available in the medical record; even insurance status is not well-documented in our community. Community SES is a validated proxy for individual SES. Additionally, community SES may offer unique contributions, (especially regarding access to medical care) that may be less dependent on individual SES (eg, traffic patterns, crime, and other factors). Previous work also has suggested racial differences in the importance of community effects. We do note that the excess risks we found are valid only within our population. Another potential bias is that, although patients excluded because of geocoding difficulties or those already institutionalized were not different from included patients by age, race, or gender, we do not know if they had a different SES than included patients. However, patients with addresses unable to be geocoded are likely to be of diverse SES, potentially including urban homeless patients and patients using post office box or rural addresses. We did not include premorbid medications in our analysis, because we have no way of measuring compliance with the medication regimen. Data on the impact of medications on stroke severity are mixed and inconclusive, even if compliance is assumed. An important subgroup of patients that was excluded from this analysis are nursing home residents, for similar reasons as described. These patients are more likely to be disabled, and the excluded patients do have a higher stroke severity than those included in this analysis (Table 1). In addition, any incidence study that relies on medical contact for counting of events risks missing events that were not recognized by the general public as needing medical attention.

In conclusion, we present factors associated with initial stroke severity and have found that community SES is significantly associated with severity of ischemic stroke. Understanding how socioeconomic factors contribute to initial stroke severity is critical to improving outcomes among stroke patients in the United States.

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References


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