Background and Purpose—Evidence for ethnic disparities in stroke incidence, severity, and mortality has continued to mount in recent years. However, the picture for disparities in acute management and rehabilitation remains more ambiguous. The objective of this report is to summarize current evidence from stroke epidemiology and studies focusing on disparities in stroke care and disability, suggesting courses for action.

Methods—A comprehensive search of current literature on ethnic/racial variation in stroke incidence, mortality, and severity, as well as acute and postacute patient care was performed.

Results—Recent evidence unambiguously reaffirms a greater burden of disease in stroke, greater mortality, and greater severity of strokes for blacks. Evidence for disparities in acute and postacute care is less conclusive, as is the evidence for disparities among other ethnic groups. Evidence for health disparities in stroke care across settings, regions, and the continuum of care varies considerably.

Conclusions—Minority ethnic groups have higher rates or more severe stroke, but variations in prognosis for clinical outcomes other than mortality remain less certain. There is considerable need for more studies that take into account regional ethnic variations in treatment and outcomes, and for better documentation of stroke outcomes among groups in addition to blacks. Dealing with ethnic disparities in stroke will be served by sustained attention to quality improvement in high-impact areas in stroke care, complemented by initiatives that promote cultural competence.

Key Words: ethnicity ■ health services research ■ outcome ■ racial differences
### TABLE 1. Selected Studies Reporting Stroke Incidence, Severity, and Mortality by Ethnic Groups

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study Design &amp; Data Used</th>
<th>Patients</th>
<th>Disparities and Relevant Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The same as above</td>
<td>The same as above</td>
<td>B and W patients with strokes and TIs</td>
</tr>
<tr>
<td></td>
<td>1999–2001 Medicare data</td>
<td>N = 40 045 with 5342 B</td>
<td>Probability mortality for both male and female 65–74 years: B &gt; W</td>
</tr>
<tr>
<td></td>
<td>The same as above</td>
<td>The same as above</td>
<td>First-ever and recurrent stroke incidence excluding TIA: 411/100 000 for B</td>
</tr>
</tbody>
</table>
environmental mechanisms for stroke disparities are rooted in broad historical trends, socioeconomic differentiation, questions of access, discrimination, and cultural variations in risk factors. Use of the terms black and Hispanic, while reflecting journal style and the categories found in the literature, may elide more nuanced ethnic variations in risk and care. This review does not address genetic risk or population-linked variations in cerebral vasculature, lines of investigation that form part of the broad concern with disparities prioritized by the National Institute for Neurological Disorders and Stroke (NINDS).11

Materials and Methods

This article presents a comprehensive literature review of ethnic variations in stroke epidemiology and studies from across the clinical course. Rather than focus on a particular intervention or make probabilistic statements regarding a specific outcome, we have sought to provide a broad overview of ethnic disparities in stroke. Included are studies of varying design, scale, and duration. This report builds on earlier reviews of minority issues in stroke epidemiology12–18 and reprises clinical and outcomes studies to gain additional detail found in Table 1.

Results

This summary begins with studies of ethnic differentials in the distribution of incidence and mortality, and then moves across the continuum of care to consider differentials in treatment and long-term prognosis for stroke survivors.

Variations in Stroke Epidemiology

There are definitive and persistent patterns of inequality in stroke incidence and prevalence, stroke severity, and mortality. Findings from this literature are summarized here, with additional detail found in Table 1.

Disparities in Incidence and Prevalence

Building on existing evidence for black/white disparities in incidence,16,19 the 6-month figure from the Greater Cincinnati/Northern Kentucky Stroke Study (GCNK) underlined the exceptional rate of first-ever strokes among blacks (288/100 000) compared with the rate for whites (179/100 000) collected in earlier work in Minnesota. The overall 6-month rate of stroke for blacks was 411/100 000.20 Most recently, this group has attributed excess black stroke mortality to elevated incidence rather than differentials in case fatality rates.1 A 1991 estimate compared an annual US rate of 753/100 000 for black men with 424/100 000 for white males.21 Across various regions, the rates for blacks have been more than double the figure for whites, and these disparities have been most pronounced among younger age groups.
There are also substantial disparities in the incidence of more severe hemorrhagic strokes, with blacks having twice the rate of subarachnoid hemorrhage as whites and 2.3-times the incidence of the intracerebral hemorrhage (ICH). Age-adjusted prevalence for black women increased dramatically across NHANES iterations (from 0.8% to 2.8%).

Figures for other groups are more variable, and it is probable that many Latino groups are at higher risk than white Americans. A 1995 study emphasized the need for oversampling Hispanics to better define national morbidity patterns, although prevalence figure for those older than 65 years self-reporting stroke were similar to those among blacks. Strong evidence for elevated ICH incidence among southwestern Hispanics was collected in a New Mexico county, whereas a case series from a single Arizona hospital was also suggestive of this profile. Higher risks for hemorrhagic stroke among Hispanic groups elsewhere could also be inferred from elevated mortality figure that likely reflect differentials in incidence rather than in case fatality rates.

Reliable incidence and prevalence figures among Native Americans have proven elusive because of ethnic misclassification, as well as regional and intertribal variation.

Severity
A Maryland study compared stroke types and outcomes for blacks and whites. Looking at death during hospitalization, age of death during acute hospitalization, and the proportion of patients having coma as indirect indices of stroke severity, there was strong evidence for more severe events among black patients. Black men had a significantly higher prevalence of coma than whites in all age cohorts for ICH, and for occlusive events except among the very old. Younger black women also had elevated rates of coma with hemorrhagic stroke. Ethnicity did not predict death from ICH during short hospitalizations, an important finding that authors attribute to improvements in hypertension control among blacks. However, being black remained significantly associated with the likelihood of dying from an occlusive event. Average ages for admission were lower for black patients than for white patients.

Direct evidence for differentials in severity between blacks and whites on admission using the Canadian Neurological Scale came from a cohort of Veterans Health Administration (VA) patients at 9 sites. Unadjusted scores were significantly lower for blacks than for whites (7.96 versus 8.32; P=0.039). Ethnicity remained a significant predictor of severity when controlling for stroke type, atrial fibrillation, previous stroke, and previous living setting.

Disparities in Stroke Mortality
In general, stroke mortality for ethnic minorities in the United States is disproportionate, with localized exceptions. National age-adjusted death rates from 1999 were 35% higher for blacks than for non-Hispanic whites (225.2 versus 166.7/100 000). Recent figures on the age-standardized rates of ischemic stroke death for blacks have been reported as 30% higher than those for whites (95.8/100 000 versus 73.7/100 000). The mortality rates with ICH for blacks and Asian/Pacific Islanders were 1.7- and 1.5-times those of whites in 1995 to 1998 data, and the rates from subarachnoid hemorrhage were higher for all ethnic minorities. Black stroke mortality has been highest across all stroke types in all but the eldest age categories. This includes deaths for children. Stroke deaths have declined considerably in the US over the past 3 decades, although black men have experienced lower rates of decline through time. The geographic patterns in stroke incidence and mortality that have often been considered alongside ethnic variation have shifted, although the stroke belt remains an identifiable phenomenon.

Risks of death among US Hispanics for ischemic stroke have been considerably lower than those among non-Hispanic whites (relative risk [RR], 0.54; 95% confidence interval [CI], 0.53 to 0.55), slightly lower in cases of ICH (RR, 0.91; 95% CI, 0.88 to 0.94), but slightly higher for subarachnoid hemorrhage (RR, 1.11; 95% CI, 1.05 to 1.16). Because national level, age-adjusted rates for ICH are comparable, more localized reports of greater ICH incidence and death among Hispanics may reflect differences in age structure between Hispanic and non-Hispanic white populations rather than differences in vascular health. Between 1988 and 1991, stroke mortality rates for Native Americans were more comparable to those of whites for those younger than 65 years, and somewhat lower among older age groups.

Community and Clinical Studies of Risk Factor Variation and Prognosis
Investigators at the Columbia Presbyterian Neurological Institute looked at ethnic differentials in stroke recurrence and death at 1 year after stroke among a cohort of whites, blacks, and Hispanics in New York City. In the Stroke Data Bank study, whites showed higher risks for death or recurrence, although increasing risks tended to stabilize at ~6 months after the event. Risk for blacks and Hispanics tended to increase throughout the follow-up period, reducing the difference in risks with whites by 1 year.

Authors emphasized that ethnicity was not an independent predictor of recurrence or death, but rather a marker for the magnitude of other factors. For example, nonlacunar infarction, abnormal electrocardiogram, and a history of diabetes emerged as significant predictors of poor outcomes for Hispanics, whereas only an abnormal ECG result was predictive of death or recurrence for blacks and whites. The distribution of infarction types also differed among groups. Non-Hispanic whites more frequently had atherosclerotic events than blacks or Hispanics (30.4 versus 13.6 versus 13.4%, respectively; P=0.001), whereas the prevalence of lacunar infarction was highest among Hispanics (24.4 versus 13.6 versus 13.4%, respectively; P=0.001). Variation in rates of recurrence and death more clearly reflected the nature of infarction and risk factors, including relatively higher hypertension and diabetes rates among blacks and Hispanics.

Results from the Northern Manhattan Stroke Study also showed relatively higher mortality for non-Hispanic whites, although the statistical significance of ethnic variations evaporated with age adjustment. Risks for recurrence were considerably higher for minorities, but once again not statis-
tically significant because of the low number of recurrent events. Authors focused on the different risk factor profiles for death and recurrence.

Later work with this study cohort examined the etiologic fraction of risk factors accounting for strokes in different ethnic groups, confirming the significance of hypertension risks for blacks and Caribbean Hispanics compared with the relatively greater importance of atrial fibrillation among white stroke patients. In this prospective case-control study, investigators also identified the high relative significance of physical inactivity for minority patients, an attributable risk that is also considerable for white patients.

An Arizona study found a similar pattern comparing risk factors among Hispanics and non-Hispanic whites. Hyper-tension was significantly higher for Hispanic stroke patients in a case series from a single hospital than for non-Hispanic white patients (72% versus 66%; \(P<0.05\)). The prevalence of diabetes was exceptional among Native American patients (62%), and significantly higher among Hispanics relative to whites (36% versus 17%; \(P<0.05\)). Conversely, cardiac disease was more common among white patients than among Hispanics (34% versus 24%; \(P<0.05\)). Risk profile differences paralleled the distribution of stroke types, with the modal stroke type for Hispanics being hemorrhagic. Whites had significantly more cardioembolic events than Hispanics (16% versus 9%; \(P<0.05\)), whereas Native Americans had nearly twice the proportion of lacunar infarction as whites (30% versus 16%; \(P<0.05\)) and Hispanics (30% versus 15%; \(P<0.05\)).

Elevated diabetes prevalence among Mexican Americans hospitalized for stroke compared with non-Hispanic whites (odds ratio [OR], 2.69; 95% CI, 1.97 to 3.69) in a Texas county revealed a similar pattern. Mexican American patients likewise had significantly less atrial fibrillation than whites (OR, 0.53; 95% CI, 0.35 to 0.82), although the slightly higher likelihood of a Mexican American patient having hypertension was nonsignificant (OR, 1.19; 95% CI, 0.87 to 1.62). This study also revealed considerable social disparities between Mexican American and non-Hispanic white patients. The former were considerably more likely to have incomes <$20,000 per year (OR, 6.47; 95% CI, 1.97 to 3.69) and not to have finished high school (OR, 15.41; CI, 10.61 to 22.42). A telephone survey conducted by some of the same researchers focused on barriers to care and self-reported risk factors in the community also found that diabetes was significantly more prevalent among Mexican Americans (15% versus 9%; \(P<0.02\)). An earlier California study with smaller minority enrollment found no significant differences in heart or hypertensive risk between whites and ethnic minorities, although, once again, more Mexican American stroke patients had diabetes.

**Ethnic Variations in Acute Care**

Despite patterns of greater incidence, more severe strokes, and excess mortality for some ethnic minorities, our knowledge about variations in acute care is less secure. The following sections survey recent articles addressing disparities in acute management and procedure use. Articles referred to are included in Table 2, except when referenced previously.

**Delays from Onset to Care**

Delays in presentation are of concern because application of thrombolytic therapy depends on timely arrival at a medical facility. There has been significant if contradictory evidence for disparities in the initial response to acute cardiac symptoms and the situation for stroke is similarly ambiguous.

In a study from Minneapolis-St. Paul hospitals, delay to presentation was calculated as the difference between the time of hospital arrival and reported time of symptom onset and then modeled with demographic predictors, prestroke living situation (ie, living alone, living in a nursing home, etc), the presence of do not resuscitate requests, and a range of comorbidities. Investigators found that Asian/Pacific Islander ethnic designation, the presence of dependence in any activity of daily living, vision impairment, headache, and unsteadiness all significantly and independently predicted delays. Obvious markers of severity, high levels of disability, and hemorrhagic stroke were associated with shorter delays. Further ethnic variation in delay to presentation was negative, a result the authors attributed most to the relatively small minority ethnic representation in the sample.

The Minorities Risk Factors and Stroke Study also found no evidence for disparities in treatment delays in New York. Among 724 black, Hispanic, and white stroke patients in the case-control study, times from symptom onset to admission did not vary with ethnicity. Negative results for an association between delays and ethnicity were also found in a 502 patient study from a hospital in the stroke belt, and for 721 patients arriving in 48 different emergency departments with acute strokes.

However, a study conducted in San Diego detected a marked, but nonsignificant, trend toward later presentation among blacks. Seventy-three percent of Mexican Americans and whites arrived within 24 hours of the onset of symptoms, whereas this proportion was 53% for blacks. Another study conducted in 10 New Jersey hospitals found that blacks were twice as likely as whites to exceed a 3-hour window from onset to presentation (OR, 2.00; 95% CI, 1.10 to 3.64). Although there was no significant difference between blacks and whites in time to treatment once at the hospital, Hispanic stroke patients were considerably more likely to have to wait >15 minutes to see a physician than non-Hispanic whites (OR, 7.95; 95% CI, 1.51 to 41.6). In another study conducted in Ohio, white ethnic designation was strongly and independently associated with arriving to the emergency room within 3 hours (OR, 3.5; 95% CI, 1.3 to 10.0). Finally, work in an urban Texas hospital also found Hispanics having relatively longer delay time than blacks or whites, with <20% of Hispanic patients arriving within the recommended 3-hour window.

**Administration of Tissue-Type Plasminogen Activator**

Therapy with tissue plasminogen activator (tPA) is recommended by consensus guidelines when administration can be started within 3 hours of the onset of symptoms.
## TABLE 2. Selected Studies Addressing Ethnic Variation in Acute and Postacute Stroke Care and Outcomes

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study Design &amp; Data Used</th>
<th>Patient</th>
<th>Disparities, Relevant Findings, and Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Christian et al(^2) 2003</td>
<td>Cross-sectional study</td>
<td>Inpatients patients with diagnosis of 434 or 436</td>
<td>Nursing home residents low use of anticoagulant for secondary prevention</td>
</tr>
<tr>
<td>Escarce et al(^3) 1993</td>
<td>Descriptive study</td>
<td>Patients 65 y or older</td>
<td>Rate of noninvasive carotid imaging: W &gt; B</td>
</tr>
<tr>
<td>Horner et al(^6) 2001</td>
<td>Prospective case series</td>
<td>Ischemic stroke patients</td>
<td>No ethnic difference in time from onset to presentation</td>
</tr>
<tr>
<td>Goldstein et al(^4) 2002</td>
<td>Retrospective prognosis study</td>
<td>CEA patients from 132 VA hospitals</td>
<td>Slight difference in recurrent stroke or death: H</td>
</tr>
<tr>
<td>Horner et al(^5) 1997</td>
<td>Retrospective case series</td>
<td>B and W patients in 297 hospitals</td>
<td>No significant difference between W and NW in VHA across broad range of procedures and services</td>
</tr>
<tr>
<td>Homer et al(^1) 1991</td>
<td>Prospective case series</td>
<td>New ischemic stroke patients</td>
<td>B patients younger (NS) and impairment worse on admission (NS)</td>
</tr>
<tr>
<td>Homer et al(^9) 1995</td>
<td>Literature review</td>
<td>Patients with cerebrovascular disease</td>
<td>Suggest results may not be generalizable given VA context</td>
</tr>
<tr>
<td>Homer et al(^8) 1999</td>
<td>Retrospective case series</td>
<td>Medicare data with medical record abstraction</td>
<td>Delay to MD: Medicaid patient 10 times more likely than Medicare</td>
</tr>
<tr>
<td>Homer et al(^7) 2003</td>
<td>Retrospective prognosis study</td>
<td>OIA patients from 132 VA hospitals</td>
<td>Postoperative stays ≥3 d significantly more frequent: H &gt; B &gt; W</td>
</tr>
<tr>
<td>Johnston et al(^10) 2001</td>
<td>Retrospective case series</td>
<td>Stroke patients at ED in a Cincinnati hospital</td>
<td>Proportion returning to operation within 30 d related to CEA: H significantly &gt; W and B</td>
</tr>
<tr>
<td>Kohtari et al(^9) 1999</td>
<td>Retrospective case series</td>
<td>Discharge N=8608 with 205 IPI</td>
<td>Fewer B with &gt; delay achieving substantial 12-month functional recovery than W</td>
</tr>
<tr>
<td>Lacy et al(^4) 2001</td>
<td>Prospective case series</td>
<td>Patients with symptoms of acute stroke</td>
<td>Delay to ED ≥3 h from onset: B twice more likely than W</td>
</tr>
<tr>
<td>Mayer-Oakes et al(^6) 1992</td>
<td>Prospective cohort study</td>
<td>Ambulatory and community Medicare patients</td>
<td>Suggesting inequalities in rehabilitation use for minorities, less educated, and oldest old</td>
</tr>
<tr>
<td>Mitchell et al(^2) 2000</td>
<td>Retrospective case series</td>
<td>Patients discharged with TIA</td>
<td>B sig &lt; likely to receive noninvasive testing, cerebral angiography if imaged, CEA if record angiography, or have a neurologist as attending physician than W</td>
</tr>
</tbody>
</table>
TABLE 2. Continued

<table>
<thead>
<tr>
<th>Reference</th>
<th>Study Design &amp; Data Used</th>
<th>Patient</th>
<th>Disparities, Relevant Findings, and Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991 MedPAR data</td>
<td>N=17 437 with 8203 noninvasive testing, 1306 CEA patients having angiography, and 1508 B discharged alive</td>
<td>Neurologist attending was sig predictive of referral to testing and angiography, or have a neurologist as attending physician than W</td>
<td>Suggesting disparity in imaging may lie in access to neurological care</td>
</tr>
<tr>
<td>Monane et al1996</td>
<td>Case series, prognosis study</td>
<td>1st ischemic stroke patients (ICD-9 434 and 436)</td>
<td>LOS significantly related with non-W in univariate analysis (no detail)</td>
</tr>
<tr>
<td>1982–1995 discharge data</td>
<td>Tertiary-care hospital in MA with N=745</td>
<td>No association in adjusted odds model</td>
<td></td>
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<tr>
<td>Morris et al2000</td>
<td>Prospective cohort study</td>
<td>Acute stroke patients at 48 EDs in 1997</td>
<td>Median hours prehospital delay: W &gt; B</td>
</tr>
<tr>
<td>Genentech Stroke Presentation Survey</td>
<td>N=721 with 95 B</td>
<td>Delay to CT: B &gt; W and total delays equal (4.0 hrs.)</td>
<td></td>
</tr>
<tr>
<td>Oddone et al1993</td>
<td>Retrospective case series</td>
<td>Ischemic stroke or TIA patients</td>
<td>B patients with carotid angiography at half rate of W</td>
</tr>
<tr>
<td>1988–1989 all VAMCs data</td>
<td>N=35 922 with 3535 carotid angiographies, 1249 CEA, 6526 B, 1126 H, and 27 690 W discharged</td>
<td>Minority patients younger and &lt; likely to have service connected disability status</td>
<td>Ethnicity predicting CEA in adjusted model</td>
</tr>
<tr>
<td>Oddone et al1999</td>
<td>Retrospective case series</td>
<td>Patients with TIA, ischemic stroke, or amaurosis fugax</td>
<td>Invasive and noninvasive carotid imaging for TIA: B patients &lt; W</td>
</tr>
<tr>
<td>1991–1995 4-VAMC medical record abstraction</td>
<td>N=803 with 389 B and 414 W</td>
<td>W with &gt;50% stenosis than B and more appropriate for CEA by guidelines</td>
<td>Disparity in referral for imaging remains unexplained</td>
</tr>
<tr>
<td>O’Donnell et al1997</td>
<td>Retrospective case series</td>
<td>First admission stroke patients discharged from 53 VA rehabilitation units N=2031</td>
<td>Ethnicity not an independent predictor in adjusted models for FIM, LOS, or home discharge</td>
</tr>
<tr>
<td>Ontiveros et al2001</td>
<td>Prospective cohort study</td>
<td>MS stroke patients older than 65 y</td>
<td>Noninstitutionalized eider MA with &gt; disability vs primarily W Framingham cohort</td>
</tr>
<tr>
<td>1993–1994 data</td>
<td>N=3050 with 159 with stroke</td>
<td>15% to 50% significant difference in frequency of self-report of 5 IADL impairments</td>
<td></td>
</tr>
<tr>
<td>Ottenbacher et al2000</td>
<td>Retrospective case series</td>
<td>Stroke patients</td>
<td>Readmissions: B &gt; H &gt; other</td>
</tr>
<tr>
<td>1994–1996 UDSMR data</td>
<td>N=96 473 from 167 facilities in 40 states</td>
<td>Proportion of total patients: B &gt; H &gt; other</td>
<td></td>
</tr>
<tr>
<td>Ottenbacher et al2001</td>
<td>Retrospective case series</td>
<td>Patients with stroke</td>
<td>Rehospitalization by ethnic group: W &gt; B &gt; Other &gt; H &gt; API</td>
</tr>
<tr>
<td>1994–1996 UDSMR data</td>
<td>N=15 992 from 167 facilities in 40 states</td>
<td>Ethnicity significantly predicting rehospitalization overall</td>
<td></td>
</tr>
<tr>
<td>Owens et al2002</td>
<td>RCT and prospective cohort</td>
<td>Postmenopausal women in 20 CN, MS hospitals</td>
<td>B and W male &gt; likely than H male to be rehospitalized 80–180 d after stroke</td>
</tr>
<tr>
<td>Women’s Estrogen for Stroke Trial–WEST data</td>
<td>N=620</td>
<td>Non-W women with low education &gt; likely to over-report functional status on Barthel</td>
<td></td>
</tr>
<tr>
<td>Reed et al2001</td>
<td>Retrospective case series</td>
<td>ICD-9 codes 434 or 436 for patients 18 y and older</td>
<td>Over-reporting more common with stroke than TIA, &gt; comorbidities, and &gt; cognitive impairment</td>
</tr>
<tr>
<td>1998–1999 HBSI data with 137 community hospitals</td>
<td>N=23 058 with 362 with IV IPA treatment</td>
<td>B &lt; likely to receive IV IPA than W</td>
<td>10.6% B with neurologist attending vs 20.3% W</td>
</tr>
<tr>
<td>Smith et al37 1998</td>
<td>Retrospective case series</td>
<td>CVA patients admitted to Minneapolis-St. Paul hospitals</td>
<td>API only ethnic designation predicting delayed presentation</td>
</tr>
<tr>
<td>Medical record extractions</td>
<td>N=1895 with 1334 with onset time and 561 imputed</td>
<td>Suggesting sample size of other ethnic groups attenuating association</td>
<td></td>
</tr>
<tr>
<td>Stineman et al2001</td>
<td>Retrospective case series</td>
<td>Records: 52 362 non-VA vs 3056 VA</td>
<td>B vs W ethnicity accounting for 6.2% significantly LO-LS in VA and 2.0% significantly &gt;LOS non-VA</td>
</tr>
<tr>
<td>1994–1995 UDSMR data</td>
<td>Inpatient rehab facilities: 467 non-VA vs 60 VA</td>
<td>Average B motor FIM score sig&lt;W in VA and non-VA</td>
<td></td>
</tr>
</tbody>
</table>

Calif indicates California; CEA, carotid endarterectomy; CT, computer tomography; EH, English-speaking Hispanic; FIM, functional independence measure; HBSI, Healthcare Benchmarking Systems International; IADL, Instrumental Activities of Daily Living score; LTC, long-term care; MD, Maryland; NJ, New Jersey; NS, nonsignificant; PT/OT, physical therapy/occupational therapy; RCT, randomized clinical trial; SH, Spanish-speaking Hispanic; tPA, tissue plasminogen activator; > may refer to greater than, more, elevated, or higher; < may refer to less than, less, reduced, or lower.
ever, the promise of reductions in subsequent stroke-related disability is in part compromised by the persistence of ethnic disparities.

In a medical record review from 42 academic medical centers, blacks were one-fifth as likely to be administered tPA as whites, controlling for gender, severity, and insurance status (OR, 0.21; 95% CI, 0.06 to 0.68). Delays to presentation and contraindications were more frequent among black patients, but not statistically significant from whites. Investigators confirmed the disparity with records of ischemic stroke patients drawn from a discharge database from 84 academic medical centers. In another study conducted in community hospitals, black patients were 54% as likely to receive intravenous tPA, controlling for factors including severity, physician specialty, and location (OR, 0.54; 95% CI, 0.31 to 0.95). Patients undergoing the care of an attending neurologist were 3.7-times more likely to be administered tPA (OR, 3.70; 95% CI, 2.2 to 5.46). Approximately 11% of black patients were under neurological care, whereas the figure was >20% for white patients. Recent work in the Veterans Health Administration has reaffirmed the beneficial effects of neurological care for stroke outcomes. One suggestion has been that the roots for differences in tPA therapy rates lie in ethnic variations in pathophysiology, emphasizing differences in the prevalence of small-vessel infarction between blacks and whites and critiquing studies for failing to consider stroke subtype. Other authors have responded that these differences are not likely to be clinically significant. Most recently, authors from the GCNK group have reported a figure of 29% tPA eligibility for any patient based on clinical contraindications, a figure that is reduced to ≈8% when also taking into account the criterion of timely presentation.56

**Acute Length of Stay**

Acute care length of stay (LOS) is an important outcome indicator that has been taken as a measure of stroke severity but may equally reflect provider decisions or institutional practices. In a study using Maryland state data, age- and sex-adjusted LOS was 3.3 days longer for blacks than for whites having ischemic strokes (P<0.0001) and 2.6 days longer with hemorrhagic events (P=0.029). However, in a Massachusetts case series study in which LOS was treated categorically, longer LOS was independently predicted by race (no probability value provided), an association that subsequently proved nonsignificant when controlled for insurance coverage, comorbidities, and admission years showing a downward trend in LOS.57

**Diagnostic Imaging and Procedures**

Recent work from the Veterans Administration Acute Stroke (VAS) Study showed little evidence for disparities across a broad range of services and procedures, including carotid endarterectomy (CEA). Investigators found no significant differences in white and nonwhite use of computed tomography, magnetic resonance imaging, ultrasound, echocardiography, or the range of therapeutic services. However nonwhite patients received electrocardiogram more frequently than whites (81.6% versus 73.5%; P=0.01), and angiography less frequently (3.1% versus 8.5%; P=0.01). However, earlier VA work and studies from other settings have shown clear evidence for ethnic variations in care. For one large VA cohort of ischemic stroke and transient ischemic attack patients, the likelihood of carotid angiography for black patients was ≈47% that of white patients (RR, 0.47; 95% CI, 0.42 to 0.53), with Hispanics ≈75% as likely as non-Hispanic whites to receive angiography (RR, 0.78; 95% CI, 0.63 to 0.98), adjusted for age, service connection, region, and various clinical characteristics. In yet another study limited to 4 VA medical centers, whites were 50% more likely to be sent for any carotid imaging study than blacks, adjusting for age, comorbidities, clinical presentation, and location (OR, 1.50; 95% CI, 1.06 to 2.13). In a national study focusing on 32 different medical and diagnostic procedures, whites were 26% more likely to receive higher-technology, noninvasive carotid imaging than black patients when adjusted for sex and age, including ultrasound, B-scanning, and Doppler or duplex scanning (RR, 1.26; 95% CI, 1.19 to 1.34). In a subsequent study also using Medicare data, the likelihood of black use of noninvasive testing was 83% that of whites (OR, 0.83; 95% CI 0.73 to 0.93), and just 54% that of whites for receiving cerebral angiography (OR, 0.54; 95% CI, 0.36 to 0.80).

The reasons behind these disparities remain unclear. Having controlled for relevant clinical characteristics, the hypothesis that referral bias based on physicians’ preconceptions of a lower likelihood for black carotid disease cannot be ruled out. However, the lack of sufficient information on stroke subtype in some administrative studies is problematic. Patient decision-making may play a role as well, particularly in the case of invasive procedures. Another factor may be access to a neurologist’s care. The likelihood of any transient ischemic attack patient being referred for noninvasive testing in one of the medicare studies was 63% greater under the care of an attending neurologist than in cases in which the attending physician was an internist (OR, 1.63; 95% CI, 1.52 to 1.75). Yet the odds for black patients having a neurologist as the attending physician was 0.79 (95% CI, 0.69 to 0.90) relative to white patients having similar clinical characteristics.

There is also evidence for ethnic disparities in the administration of CEA. White patients were 3-times as likely to receive CEA as blacks in a 1986 study (OR, 3.01; 95% CI, 2.32 to 3.89). And the percentage of blacks receiving the procedure was 25% that of white patients based on 1991 data (2.0% versus 0.5%; P<0.01). In one VA study, adjusted odds of blacks receiving CEA were 0.28 (95% CI, 0.20 to 0.38) and 0.45 (95% CI, 0.28 to 0.73) for Hispanics among the 1988 to 1989 ischemic stroke and transient ischemic attack cohort. However, later work indicated that among those receiving imaging, fewer black patients were actually appropriate candidates for CEA than white patients (4% versus 18%; P=0.001) based on RAND/Academic Medical Center Consortium guidelines. Although clinical appropriateness explains CEA variations in particular cases, reported disparities may elsewhere reflect issues of clinical decision making (particularly relating to referral imaging), patient preferences, communication with providers, as well as barriers to access.
Evidence for ethnic differentials in postoperative outcomes in CEA have been addressed by another study. Primary outcomes including stroke and death showed no significant differences between white and ethnic minority VA endarterectomy patients. However, higher risks for return to surgery related to the index CEA for Hispanic patients led authors to suggest further work on ethnic disparities in postoperative outcomes.

**Ethnic Variations in Postacute Care: Disparities in the Use of Rehabilitation**

The evidence for ethnic variations in use of rehabilitation services has been contradictory. White ethnic designation was the greatest single predictor of occupational and physical therapy use in a study following-up 809 male and female Medicare patients in Los Angeles. Although not restricted to stroke patients, the overall findings were compelling. “Minority groups, less well educated individuals and the oldest old were significantly less likely to use [physical therapy/occupational therapy] PT/OT services, even when disability and rehabilitating diagnosis were controlled for.”

However, analyses from another Medicare sample from 297 hospitals in 5 states showed a greater proportion of black patients receiving inpatient PT/OT than whites (66.3% versus 55.8%; \( P<0.01 \)). A greater proportion of the minority patients had motor deficits on admission and the use of rehabilitation services was consistent with differences in the need for physical therapy. There were no significant differences in the timing of PT/OT. Unadjusted median times were similar for both white and black patients, with adjustment yielding a slightly shorter but nonsignificant average time to the start of inpatient OT/PT for blacks (6.6 days versus 7.7 days).

Most recently, a Veterans Health Administration study found no ethnic differences in the use of stroke rehabilitation, although the average time to rehabilitation initiation was slightly longer on average for blacks than for whites. This was caused primarily by a greater proportion of long delays in starting therapy (\( \geq 10 \) days) among blacks than among whites.

**Rehabilitation LOS**

LOS in inpatient rehabilitation may provide another indicator for ethnic disparities in postacute disability. One study compared uniform data system for medical rehabilitation records for 55,438 stroke patients from 1995 for nonveteran patients with 1994 and 1995 records from VA inpatient rehabilitation facilities. LOS were longer in the VA system overall, and the proportion of minority patients treated in VA facilities was significantly greater than in the non-VA facilities. Black designation relative to white identification accounted for 6.2% (\( P=0.01 \)) longer average LOS in the VA sample and 2.0% (\( P=0.0009 \)) longer LOS in the non-VA sample. Greater residual disability was suggested by discharge functional independence measure scores, with black patients having significantly lower scores compared to white patients.

**Disparities in Functional Rehabilitation Outcomes**

Ethnic variations in the use of medical rehabilitation services found that rehospitalization in the year after stroke rehabilitation was comparable for white and black patients (17.9% and 17.0%, respectively). However, both white (OR, 1.79; 95% CI, 1.27 to 2.54) and black (OR, 1.63; 95% CI, 1.11 to 2.38) men were more likely to be rehospitalized than Hispanic men. The authors noted that relatively low levels of rehospitalization for Hispanic men and Asian patients overall suggest further research into ethnic variations in the role of family support and access to medical services. Potential disparities in secondary pharmacological prevention for recurrent stroke are also a major concern. A study using uniform data system for medical rehabilitation data found that rehospitalization in the year after stroke rehabilitation was comparable for white and black patients (17.9% and 17.0%, respectively).

Based on a national cross-sectional study of nursing home residents, the use of any treatment was lower for Hispanics (45.5%), non-Hispanic blacks (49.4%), and Asian/Pacific Islanders (38.9%) than for whites (54.3%), although higher among a subsample of Native Americans (58.0%) (no significance tested reported). Aspirin use was comparable across ethnic groups, and actually higher for Native Americans, blacks, and Hispanics than for whites. However, among patients for whom warfarin treatment was indicated, use of

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the anticoagulant was demonstrably lower for ethnic minority groups, once again with the exception of Native Americans whose proportion (36.4%) was only slightly lower than that of whites. Whereas 39.6% of non-Hispanic whites received warfarin treatment, the figure for Asian/Pacific Islanders, non-Hispanic blacks, and Hispanics were 25.7%, 31.7%, and 25.4%, respectively (no significance test reported).

Return to Work
In a review reporting on return to work after stroke, Wozniak and Kittner reported on 2 studies addressing ethnic differences. One was the North Carolina Comprehensive Stroke Program that involved follow-up on 379 working patients. For patients followed-up from 1968 to 1973, return to work was positively associated with white ethnic designation, although the reasons behind black and white differences were unclear. A later multicenter study by Wozniak et al conducted in urban hospitals found no association between ethnicity and return to work.

Conclusion
Although epidemiological data on ethnic disparities in stroke risk, incidence, and mortality are considerable, and we suggest unambiguous for blacks at the most general levels, the magnitude of disparities for other underserved minorities has been less thoroughly investigated. This situation mirrors the evidence base on health disparities more generally, and is central to current research initiatives sponsored by NINDS.

Yet work on disparities in acute care, the nature of differences in rehabilitation, and residual disability has grown considerably, and has begun to paint a more complex picture of ethnic variations in stroke. As this work makes clear, the presence or absence of ethnic differentials in care can be locally and institutionally contingent.

This creates a risk in the approach we have taken in this review. Casting the net broadly increases the possibility for overlooking evidence. And just as with quantitative systematic reviews that hone in on particular interventions and outcomes, negative evidence regarding disparities may be unpublished. The literature is extremely heterogeneous in terms of scale, methodology, and analytic approach, particularly across the range of clinical studies we have summarized here. Ironically, in looking at the clinical literature, we also find yet another disparity—minority under-representation in clinical trials and black reticence to participate in clinical research continue to be critical problems.

Despite limitations, the state of our knowledge provides a basis for further research, as well as for action in dealing with stroke disparities. We can begin to draw implications for translating what we know into practice.

Disconnects Between National and Local Data
Macrolevel data may or may not apply to local specificities or problems that impact minority populations. Andresen et al have recently put it well, “National-level data are rarely sufficient to help determine the problems and differences relevant to smaller geographic areas and across heterogeneous minority groups.” Although national patterns are important and define the need for attending to stroke disparities, they may not prove to be reliable guides for local public health efforts or clinical praxis. Both clinical and community studies we review have shown considerable variation with regard to stroke disparities. This should not be surprising. But it demands further investigation into the prevalence and sources of regional or local ethnic variations in care.

Enhancing inclusion of minority research participants in clinical studies will be paramount. Even in apparently large samples with medical records, adequately powering analyses that capture differences where they exist can be a challenge because of misclassification or missing data, depending on the type of analysis used. We suspect that future local studies will find little that contraindicates the best established patterns of risk—hypertension among blacks or diabetes among Mexican Americans in the Southwest, for example. But the task of attending to local specificities of risks, stroke types, and patterns of disease will better serve to direct effective community interventions and primary prevention efforts.

The caveat is that population-level patterns, whether local or national, are not reliable guides to clinical practice. As Frey et al have emphasized, responses to risk factors across ethnic groups are similar, even as risk factor profiles may vary across ethnic groups. Clearly, the population profile cannot serve for diagnosing the patient, a practice that could conceivably aggravate rather than help with disparities in care. Enhancing knowledge about the pattern and scope of ethnic disparities is a different process than providing patient-centered care.

High Impact Areas
The literature provides apparently contradictory evidence for disparities in high impact areas of clinical stroke care. These include such things as delays in arriving to emergency departments that can preclude administering efficacious anticoagulation therapy, variations in the administration of such therapy when it is indicated, ethnic differentials in receiving diagnostic modalities or procedures, and disparities in use of secondary prophylaxis. The inconsistencies in the evidence for disparities once again underline that local and regional variations make a difference.

More importantly, they suggest that a quality-improvement approach to targeting high-risk patients and high-impact concerns will at the same time help confront ethnic disparities where they appear in stroke treatment. The emerging VA stroke Quality Enhancement Research Initiative’s (QUERI-STR) emphasis on antiplatelet and anticoagulation therapy in secondary prevention is a good example of how attention to guidelines will aid in honing in on significant areas where disparities are evident, providing for translation from research to practice.

The Need for Cultural Competence
Beyond this, there is need for a positive synergy between basing care on the best available evidence and attending to cultural competence. Guidelines alone cannot solve the medical legacies of what are broader historical and social inequities, leading to variations in risk profiles and clinical variations in care.
Cultural competence is a broad term with organizational, structural, and clinical dimensions, all of which can be brought to bear as a means for addressing disparities. The first implies developing a diverse and representative workforce, whereas the structural dimension of cultural competence involves interventions guaranteeing access to quality such as interpreting services and culturally appropriate educational materials. Interventions to improve clinical cultural competence are aimed at providers and should involve more than awareness of generalities about values and behaviors—categorical knowledge that can sometimes better promote stereotypes than inform quality care. Rather, better attention to communication styles and sensitivity to cultural specificities, explanatory models, and sources of reticence in clinical encounters will be needed. Interventions to enhance the different levels of cultural competence will provide a vital complement to best practices.

Overall, the take-home message is straightforward. Large and persisting ethnic disparities in stroke mortality and the burden of disease are a priority issue for both public health and medical care. The scope and complexity of stroke disparities suggest that long-term and ongoing attention from researchers and clinicians, complemented by institutional and policy supports, will be needed to resolve them.

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Editorial Comment

Ethnic Disparities in Stroke

Epidemiology, Acute Care, and Postacute Outcomes

In the current issue of Stroke, Stansbury et al provide a broad survey of ethnic disparities in stroke. Going beyond the frequently covered topics of incidence and mortality, this selected review of literature published from 1991 to 2003 considers ethnic variations in risk factor profiles, acute care, and the more chronic issues of use of rehabilitation services, functional outcomes, and recurrent stroke prevention. Data are most prevalent regarding black/white differences, allowing for firmer conclusions regarding disparities between these groups than can be drawn regarding other minority groups. Similarly, examination of the more easily and frequently measured variables of incidence and severity yields clearer conclusions, but the authors are also commended for drawing attention to less well-studied but equally important areas of possible disparity.

The authors focus on race or ethnicity (preferring the latter designation) as a construct primarily characterizing cultural and socioeconomic factors that relate to issues of access, societal discrimination, or behavioral variation more than they do genetics or biology. This seems entirely appropriate given that the biological effects of risk factors and medications are generally consistent across ethnic or racial groups, and the degree of genetic homogeneity within the groups considered is limited.1

This review confirms what is probably already well recognized in the medical community: the increased incidence in stroke and stroke mortality among black Americans; but it points out that this phenomena extends to intracerebral and subarachnoid hemorrhage as well as ischemic stroke. Among traditional risk factors, the review confirms that hypertension is more prevalent among black and Hispanic patients and atrial fibrillation more common among white, non-Hispanic stroke patients, but overall, the literature apparently does not seem to demonstrate large discrepancies in the risk factor profiles among different ethnic groups. In the less well-studied area of acute stroke care, there appears to be less consensus, but perhaps some meaningful trends emerge. The overall delay from symptom onset to care may not vary by ethnicity, but whites are more likely to present in the crucial <3-hour time window, increasing their potential access to intravenous thrombolysis. A lesser intensity of diagnostic evaluation also seems to put blacks at a disadvantage, although this may be explained by a relative lack of access to neurological expertise rather than a different level of care being rendered by similar physicians. However, these disparities do not seem to translate into dramatically longer lengths of stay.

The data reported regarding postacute care are remarkable for their heterogeneity, with no clear-cut preponderance of evidence of ethnic disparities regarding use of rehabilitation services such as physical therapy or length of inpatient rehabilitation stays. Similarly, the data regarding functional outcome do not provide consistent evidence of any disparity. Interestingly, whereas blacks were less likely to return to work in a study conducted early in the time period considered, this was no longer true in a study published in 1999, raising the question of secular trends in disparities. Although a definitive answer is beyond the already broad scope the authors set for themselves and may be unapproachable given existing data, this observation suggests the possibility that something may actually be improving.

Recently, several additional reports of data that bear on these issues have served to further underscore some of the key issues raised in the review of Stansbury et al. Data from the baseline evaluations of subjects enrolled in the African American Anti-
platelet Stroke Prevention Study demonstrate a significant lack of awareness and control of stroke risk factors. Among 383 known diabetics with serum glucose levels assessed at baseline, 32% had levels \( \geq 200 \) mg/dL, and 48% of the 143 subjects with no history of hypertension had blood pressure \( \geq 140/90 \) mm Hg. Only 30% of the subjects treated for hypertension had a blood pressure \(<140/90 \) mm Hg. Undertreatment of hypercholesterolemia was equally apparent: 24% of those with no history of hypercholesterolemia had cholesterol levels \( \geq 240 \) mg/dL, and 38% of those on a lipid-lowering agent had levels in that range.

A population-based case-control study in the United Kingdom extended the findings evident in American blacks to the United Kingdom. This study estimated the population- attributable risk (PAR) associated with traditional risk factors among black African, black Caribbean, and white south Londoners, producing data similar to those found in American studies: hypertension and diabetes produced higher PARs and atrial fibrillation a lower PAR, among blacks. In a recent prevalence study based on household interviews conducted in the United States from 1999 to 2001 reported a prevalence of stroke survivors 1.65 \times \) greater among blacks than whites. Among stroke survivors, hypertension, diabetes, being overweight, and inactivity were more prevalent in blacks and Hispanics relative to white non-Hispanics. These additional studies lend further credence to the importance of targeting these risk factors in recurrent stroke prevention efforts among minorities.

Racial and ethnic minorities have an increased risk and ongoing burden of stroke. They also tend to have lower-quality health care. The complex roots of these disparities include access factors such as insurance and income status, patient factors such as mistrust of the health care system and lower levels of health literacy, and physician factors such as stereotyping and lack of cultural sensitivity, yet they remain poorly understood. To address the challenge presented by the lack of understanding of how these disparities may best be eliminated, in November 2002, the National Institute for Neurological Disorders and Stroke convened a Stroke Disparities Advisory Panel that produced a series of recommendations regarding scientific priorities for addressing disparities in stroke. The recommendations included characterizing temporal trends in racial and ethnic disparities and identifying PAR and risk interactions, evaluating the contributions of factors relating access to quality of care such as insurance status and provider attitudes, identifying barriers to adherence to stroke prevention strategies specific to minority groups, and investigating how race/ethnicity affects access to and the quality of stroke rehabilitation services. The comprehensive review presented in this month’s Stroke begins to address these issues by summarizing the current state of knowledge and emphasizes the importance of continuing to address these concerns.

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Editorial Comment—Ethnic Disparities in Stroke: Epidemiology, Acute Care, and Postacute Outcomes
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