The Geographic Variation in Stroke Incidence in Two Areas of the Southeastern Stroke Belt

The Anderson and Pee Dee Stroke Study

Daniel T. Lackland, DrPH; David L. Bachman, MD; Timothy D. Carter, MD; Derek L. Barker, MS; Stephen Timms, MD; Harvinder Kohli, MD

Background and Purpose—South Carolina and the southeastern United States have maintained the highest stroke mortality in the country. The Anderson and Pee Dee Stroke Study is an assessment of cerebrovascular disease incidence in 2 geographically defined communities in the stroke belt.

Methods—Strokes were identified in the Anderson and Pee Dee areas of South Carolina. All hospitalized and out-of-hospital deaths occurring during 1990 among the residents of these 2 areas were included. Strokes were classified by an independent panel of neurologists using a standard protocol that included specific criteria for stroke and subtypes.

Results—The overall age-adjusted stroke incidence rates (per 100 000 population) were significantly higher in the Pee Dee population (293.1) compared with Anderson (211.2). The geographic differences were more dramatic in the younger age groups of 35 to 64 years. Likewise, incidence rates for blacks were nearly twice the rates for whites. The rates in the Pee Dee were higher than the rates from other studies in the United States and other parts of the world. Although the stroke subtypes did not vary between the 2 regions, race-sex differences were identified.

Conclusions—High stroke incidence and disease rates persist for all 4 race-sex groups in the Southeast and reflect similar risks as mortality rates. However, geographic variability in stroke rates suggests that the pattern of disease in the region is not so much a “belt” of increased stroke in contiguous areas but rather more a “necklace” of different levels of risk. These results should be useful in the identification of factors associated with this geographic enigma. (Stroke. 1998;29:2061-2068.)

Key Words: blacks ■ cerebrovascular disorders ■ epidemiology ■ geography ■ incidence

Although cerebrovascular disease mortality has been declining for the past 2 decades, stroke remains the third leading cause of death in the United States.1–3 However, significant geographic variation in stroke mortality within the United States has been detected.4 The southeastern region of the United States, dubbed the “stroke belt,” has been recognized as an area of excess cerebrovascular disease mortality for 4 decades.5 Although some recent investigations have suggested changes in the contiguous geographic pattern of mortality, areas of excessive stroke death rates continue to be reported in the Southeast.6–9 The reasons for these areas of high mortality risk remain an enigma10,11; however, death certificate reporting practices do not explain the geographic variation in stroke mortality.12

Stroke risks for this geographic region of the country have primarily been based on mortality rates as identified by death certificates. Although this approach is convenient because of the availability of mortality data, the results of such analyses are most useable to generate hypotheses. The limitations of death certificates severely reduce their validity in drawing conclusions about the true estimates of cerebrovascular disease incidence.13,14 In addition, stroke mortality rates are affected by case-fatality rates.15,16 The risk assessment of geographic variation for cerebrovascular disease is further complicated by the lack of stroke incidence data for the 2 primary ethnic populations of the Southeast. Incidence rates are generally considered a more accurate reflection of disease level than mortality rates, which are affected by case fatality and survival.17,18 The methodology for determining population stroke incidence is a critical consideration involving problems of case ascertainment and epidemiological review of multiple data sources.19–24 This study is one of the first major efforts to measure variation in stroke incidence and cerebrovascular disease in a southeastern stroke belt population.

Subjects and Methods

Study Population Areas

The 2 South Carolina population areas used in this study were Anderson county and the Pee Dee area, which includes Darlington.
Stroke Incidence in the Stroke Belt

and Florence counties. The 2 areas are separated by approximately 200 miles. In 1990, both areas had total populations of slightly less than 100,000. The median education level of both areas was approximately 12 years, with 16.1% of the Anderson adults having <9 years of education compared with 16.3% from the Pee Dee area. Unemployment levels were similar at 7.4%. Also, 9.7% of the Anderson population in 1990 was below the poverty level compared with 11.3% of the Pee Dee residents. Although socioeconomic status indicators are similar for the 2 areas, some racial variation is seen, with a higher black proportion in the Pee Dee area (33%) than in Anderson (18%). The 2 areas are considered predominantly rural, with the city of Anderson, in Anderson county, and Florence, in the Pee Dee area, as urban centers. The Pee Dee area has 7 hospitals, including 1 regional medical center, whereas Anderson is served by 1 hospital, a large regional medical center. The 2 populations have participated in cardiovascular disease studies in the past, including a surveillance study of acute myocardial infarction and population risk factors.25–27 This prior experience in assessing the incidence of acute myocardial infarction in these communities identified very little out-migration for acute health care. Therefore, almost all cases requiring hospitalization can be captured by reviewing the discharge records from the index hospitals. Hospital discharge records were reviewed from the entire state system to determine that all cases for residents had been included from out-of-area hospitals.

### Case Ascertainment

Stroke cases were identified from hospital records, emergency room records, death certificates, coroners’ records, physicians’ reports, and informant interviews. All case subjects 35 to 74 years of age were included in the study. Case subjects 75 years of age and older were excluded because of the difficulty in complete accounting as a result of different treatment and diagnosis for elderly patients, a higher rate

### TABLE 1. Chart and Record Review by Record Source and Site

<table>
<thead>
<tr>
<th>Record Source</th>
<th>Anderson n (%)</th>
<th>Pee Dee n (%)</th>
<th>Total n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital records</td>
<td>524 (70.6)</td>
<td>823 (68.6)</td>
<td>1347 (69.4)</td>
</tr>
<tr>
<td>Out-of-hospital deaths</td>
<td>35 (4.7)</td>
<td>36 (3.0)</td>
<td>71 (3.6)</td>
</tr>
<tr>
<td>Old CVA/TIA</td>
<td>183 (24.7)</td>
<td>341 (28.4)</td>
<td>524 (27.0)</td>
</tr>
<tr>
<td>Total records reviewed</td>
<td>742</td>
<td>1200</td>
<td>1942</td>
</tr>
<tr>
<td>Eligible case subjects, 35–74 y</td>
<td>274</td>
<td>400</td>
<td>674</td>
</tr>
</tbody>
</table>

CVA indicates cardiovascular accident; TIA, transient ischemic attack.
of old events, and higher rates of out-of-hospital case management such as nursing homes. Multiple events during the year were considered as 1 case.

**Hospital Cases**

Each hospital identified all hospitalizations and emergency room presentations with discharges of cerebrovascular disease (International Classification of Diseases, Revision 9, codes 430 to 438) occurring during the calendar year 1990. These selection criteria are broad to maximize the selection of all acute stroke cases. Hospitalizations for residents of Anderson, Darlington, and Florence counties occurring outside of the 3-county area were also identified through the South Carolina hospital discharge system. Records were manually abstracted by trained abstractors using standard methodology. The abstract forms and protocol were adapted from similar population studies of stroke incidence, and included modules of initial symptomatology, physical examination reports, comorbid conditions, associated discharges, diagnostic procedures including CT/MRI scan reports, hospital treatments, and supporting information from the medical records.29–32

**Death Cases**

Death certificates were obtained for all mortality in stroke cases occurring in residents of the 3-county area. Certificate information was merged with abstract information from hospitalized events. Out-of-hospital events with no prior hospital discharges in 1990 were considered new cases. In addition to death certificate information, coroners’ reports, autopsy reports, physicians’ reports, and informant interviews were included in the assessment. Case fatality rates were determined for deaths occurring for hospitalized cases of stroke.

**Stroke Classification**

A stroke was defined as a neurological deficit with an onset of 72 hours or less, and a duration of 24 hours or greater due to ischemic infarction or intraparenchymal hemorrhage. Subarachnoid hemorrhage and intraparenchymal hemorrhage due to berry aneurysm, trauma, neoplasm, or infection were not considered stroke for this study.

A review panel of 3 neurologists independently reviewed each case. Cases were randomly assigned by the lead neurologist (D. Bachman). The study neurologists were not familiar with any of the cases. Likewise, the panel was blinded to the community of origin for the cases.

Cases were designated as probable stroke, possible stroke, and uncertain cases (see Appendix). Cases that met the criteria for 1 of the 5 stroke subtypes (atheroembolic stroke, cardioembolic stroke, lacunar stroke, intraparenchymal hemorrhage, and indeterminate) with a CT scan and/or MRI scan that demonstrated an acute lesion corresponding to the clinical findings were designated as “probable stroke.” Cases meeting the clinical criteria for stroke in which a CT or MRI scan did not demonstrate an acute lesion, or no scan was performed, were designated as “possible strokes.” The remaining cases were designated “uncertain strokes.” All-criteria strokes included those classified as probable, possible, and uncertain. Case subjects designated as having atheroembolic stroke exhibited typical clinical features of stroke; cardioembolic case subjects exhibited typical clinical features of stroke and a likely cardiogenic source of embolus; lacunar cases fit 1 of the classic clinical profiles of lacunar stroke; and intraparenchymal hemorrhage cases were diagnosed by CT scan or MRI scan. Details of syndrome criteria are presented in the Appendix.

**Statistical Analysis**

Incidence rates of stroke were calculated as cases per 100 000 population. Rates were age-adjusted using the direct method and the 1970 US population as the standard. Rates were compared for statistical significance. When all cell sizes used in the comparisons were greater than 5, the normal theory test (2-sample test for binomial proportions) was used, and for obtaining a confidence interval for the binomial function. When any cells in the comparisons were <5, the exact method was used.33

Interrater agreement was assessed with a 10% random sample of the cases rated by the lead neurologist (D. Bachman), after he was blinded to the initial rating. The κ statistic was used to measure the level of agreement. Incidence rates were compared with other population-based stroke studies.

**Results**

Abstractions reviewed 1942 records as part of the case ascertainment process. More than one fourth of the records (27.0%) were determined to be ineligible because the event was a transient ischemia attack only or other nonstroke cerebrovascular disorder and/or the event was considered to be “old,” ie, occurring before 1990. The proportions of these ineligible cases were similar for the 2 areas (Anderson, 24.7%; Pee Dee, 28.4%). The case ascertainment process identified 1418 case subjects from the 2 areas (Table 1). The majority (60.6%) of the total case subjects were ascertained from the Pee Dee area. Nearly all (95.0%) of the case were identified from hospital records, with the remainder as out-of-hospital deaths determined from death certificate review. The proportion of hospitalized cases was similar for both areas. The second component of the triage process consolidated multiple admissions to 1 case subject and removed case subjects who were not between the ages of 35 and 74 years, resulting in 674 (274 from Anderson, 400 from Pee Dee) cases eligible for review by the neurologists.

The majority (51%) of the 674 cases were classified as uncertain (Table 2). Thirty-six percent were determined to be probable, and 13% were possible. The proportions of cases in the 3 classifications were similar for the 2 study areas. Likewise, similar patterns were seen for the 4 race-sex
groups. The 10% quality control re-review determined excellent interrater agreement for stroke classification and subtype as identified by $\kappa > 0.75$.

“First-ever” strokes represented 76% of cases ascertained. Similar rates of first-ever strokes were detected for the 4 race-sex groups (white males, 77%; white females, 77%; black males, 74%; and black females, 76%). Nearly all of the 35- to 44-year-old case subjects were first-ever strokes. The other age groups were similar, with nearly three fourths of the cases identified as first-ever strokes. First-ever strokes were similar for the 2 sites (Anderson, 78%; Pee Dee, 74%).

All-criteria incidence rates for Anderson and Pee Dee are presented in Table 3. Although whites had higher numbers of strokes, black males and females had significantly higher incidence rates than their white counterparts. These higher rates were observed for each of the age groups as well. Overall, the rates for the Pee Dee area were statistically higher than for Anderson.

Atheroembolic stroke was the most prevalent subtype, accounting for 50% of the events in both Anderson and the Pee Dee area. The variation in subtypes was significant among the 4 race-sex groups ($P = 0.021$).

### Table 4. Number, Rate (per 100,000 Population), and 95% Confidence Interval for Probable and Possible Stroke Case Subjects by Age, Race, Sex, and Area

<table>
<thead>
<tr>
<th>Age, y</th>
<th>White Males</th>
<th>White Females</th>
<th>Black Males</th>
<th>Black Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Anderson</td>
<td>Pee Dee</td>
<td>Anderson</td>
<td>Pee Dee</td>
<td></td>
</tr>
<tr>
<td></td>
<td>White Males</td>
<td>White Females</td>
<td>Black Males</td>
<td>Black Females</td>
<td></td>
</tr>
<tr>
<td>35–44</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Rate</td>
<td>11.1</td>
<td>10.7</td>
<td>0.0</td>
<td>52.1</td>
<td>13.8</td>
</tr>
<tr>
<td>95% CI</td>
<td>(0.0, 62.0)</td>
<td>(0.0, 59.9)</td>
<td>(0.0, 0.0)</td>
<td>(0.0, 289.7)</td>
<td>(0.0, 40.4)</td>
</tr>
<tr>
<td>45–54</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>7</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>Rate</td>
<td>98.2</td>
<td>27.2</td>
<td>383.5</td>
<td>326</td>
<td>101.5</td>
</tr>
<tr>
<td>95% CI</td>
<td>(25.5, 170.8)</td>
<td>(0.0, 98.3)</td>
<td>(104.6, 979.0)</td>
<td>(88.9, 832.6)</td>
<td>(53.3, 149.7)</td>
</tr>
<tr>
<td>55–64</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>14</td>
<td>11</td>
<td>6</td>
<td>5</td>
<td>36</td>
</tr>
<tr>
<td>Rate</td>
<td>241.8</td>
<td>171.0</td>
<td>870.8</td>
<td>503.5</td>
<td>258.9</td>
</tr>
<tr>
<td>95% CI</td>
<td>(115.3, 368.3)</td>
<td>(70.0, 272.0)</td>
<td>(177.1, 1564.6)</td>
<td>(163.7, 1171.1)</td>
<td>(174.4, 343.4)</td>
</tr>
<tr>
<td>65–74</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>33</td>
<td>36</td>
<td>7</td>
<td>9</td>
<td>85</td>
</tr>
<tr>
<td>Rate</td>
<td>732.4</td>
<td>601.8</td>
<td>1211.1</td>
<td>1019.3</td>
<td>711.4</td>
</tr>
<tr>
<td>95% CI</td>
<td>(483.4, 981.3)</td>
<td>(405.8, 797.8)</td>
<td>(319.3, 2102.8)</td>
<td>(356.7, 1681.8)</td>
<td>(560.7, 862.0)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>55</td>
<td>50</td>
<td>17</td>
<td>19</td>
<td>141</td>
</tr>
<tr>
<td>Age-adjusted rates</td>
<td>208.7</td>
<td>149.3</td>
<td>519.2</td>
<td>397.9</td>
<td>211.2</td>
</tr>
<tr>
<td>95% CI</td>
<td>(153.8, 263.6)</td>
<td>(101.7, 196.6)</td>
<td>(307.8, 730.6)</td>
<td>(228.2, 567.6)</td>
<td>(175.1, 247.3)</td>
</tr>
<tr>
<td>Percent</td>
<td>67</td>
<td>42</td>
<td>316.6</td>
<td>161.1</td>
<td></td>
</tr>
</tbody>
</table>

Percent of probable/possible stroke by subtype categories (atheroembolic, cardioembolic, lacunar, intraparenchymal hemorrhage, and indeterminate) and race-sex categories. The variation in subtypes was significant among the 4 race-sex groups ($P = 0.021$).
TABLE 4. Continued

<table>
<thead>
<tr>
<th></th>
<th>Pee Dee</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Black Males</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>67.5</td>
<td>90.0</td>
</tr>
<tr>
<td>(13.9, 197.2)</td>
<td>(11.2, 168.9)</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>374.2</td>
<td>126.6</td>
</tr>
<tr>
<td>(130.2, 618.3)</td>
<td>(34.5, 323.9)</td>
</tr>
<tr>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>817.4</td>
<td>707.6</td>
</tr>
<tr>
<td>(405.5, 1229.4)</td>
<td>(390.6, 1024.7)</td>
</tr>
<tr>
<td>17</td>
<td>19</td>
</tr>
<tr>
<td>1119.2</td>
<td>777.4</td>
</tr>
<tr>
<td>(590.1, 1648.2)</td>
<td>(429.2, 1125.6)</td>
</tr>
<tr>
<td>44</td>
<td>47</td>
</tr>
<tr>
<td>509.0</td>
<td>360.0</td>
</tr>
<tr>
<td>(381.9, 636.1)</td>
<td>(263.1, 456.9)</td>
</tr>
</tbody>
</table>

Pee Dee area (see the Figure). Although some variation was determined for subtypes (atheroembolic stroke, cardioembolic stroke, lacunar stroke, intraparenchymal hemorrhage, and indeterminate) the distributions between the 2 areas were not statistically different. However, statistically significant (P = 0.021) variation in subtypes was detected for the race-sex groups, with blacks having the higher rates of intraparenchymal hemorrhage (Figure). In particular, one fourth of the strokes in black males were classified as intraparenchymal hemorrhage. Some variation of stroke type was detected by the age groups <65 years and ≥65 years (atheroembolic stroke, 62% versus 55%; cardioembolic stroke, 7% versus 12%; lacunar stroke, 11% versus 21%; and intraparenchymal hemorrhage, 17% versus 10%, respectively).

The fatality rates for all criteria cases were not significantly different between the 2 sites (Anderson, 14.7%; Pee Dee area, 12.8%). Likewise, the case-fatality rates were similar for the 4 race-sex groups by Anderson and Pee Dee area (white males, 14.0% and 9.6%; white females, 14.0% and 12.7%; black males, 27.3% and 19.2%; and black females, 12.5% and 20.0%, respectively).

Discussion

The variation in cerebrovascular disease incidence has been recognized and reported from different areas of the world. Nonetheless, estimates of cerebrovascular disease have been limited in the Southeast United States, and the purpose of this paper was to determine incidence rates for stroke in specific populations of this region. Although this study has the obvious limitations of a retrospective chart review, very conservative criteria for stroke diagnosis were used to identify cases. Likewise, interrater reliability for the classification of categories was high, as indicated by κ > 0.75. The protocols were adapted from other population studies. Although case management and diagnostic approaches are important considerations in such a study, the similar proportions of cases classified as strokes would suggest similar situations for the 2 South Carolina areas included in this study.

Classification of stroke cases, particularly from death certificates and cases with insufficient information in the medical record, is a critical consideration in the assessment of cerebrovascular disease patterns. This study provides an opportunity to identify a range of stroke incidence. Disease rates, as determined by probable/possible criteria, reflect the minimum incidence rates for the population. Likewise, incidence rates based on all-criteria cases would represent the maximum rates of stroke and probably an overestimate of the true incidence. Nonetheless, the complete range of stroke rates determined by this study is considerably greater than the levels reported from other incidence studies from Framingham, Rochester, Missouri, Connecticut, and Norway. For example, the stroke incidence rates for 45- to 54-year-old white males in the Pee Dee area ranged from 2.4/1000 population per year (probable/possible) to 4.0 (all criteria). This range is clearly higher than the rates from these other population studies: Framingham 2.2; Rochester, 0.6; Missouri, 0.3; Connecticut, 1.2; and Norway, 0.6. Similar patterns for 55- to 64-year-old white males were found, with the range in the Pee Dee area from 5.7 to 10.6 compared with Framingham at 4.6, Rochester 3.6, Missouri 3.9, Connecticut 4.6, and Norway 2.2. For white males 65 to 74 years old, the range in the Pee Dee area was 6.2 to 16.1/1000 population compared with Framingham at 9.8, Rochester 8.9, Missouri 7.4, Connecticut 11.9, and Norway 7.3. Similar patterns are seen from other population studies.

The conservative probable/possible category of stroke classification was higher in the Pee Dee area than in nearly all of the comparison populations. The differences are even greater when all criteria incidence rates are compared. The higher incidence rates in South Carolina are most dramatic when compared with the other population studies performed in younger subjects (45 to 64 years). Comparison rates for blacks are not available, but the higher incidence rates for blacks are much higher than the rates reported for these other population studies.

The geographic variation in stroke and higher rates in the Southeast have been reported. However, those previously reported populations were separated by considerable distance in contrast to the significantly different incidence rates of the relatively proximal areas of Pee Dee and Anderson. Although blacks have substantially higher rates of stroke overall, the geographic variation between these 2 study sites is more evident for white males and females. In fact, the incidence rates for blacks did not significantly differ from site to site.

The reasons there are differences in stroke incidence rates between these 2 communities are not known. Available medical care facilities and manpower appear to be similar between the 2 areas. The profiles of stroke subtypes, which are associated with different risk factors, are similar.
between the areas. The case-fatality rates were also similar for the Anderson and Pee Dee populations. Although socioeconomic status is associated with stroke, the education and economic profiles of these 2 communities are also similar. Likewise, there is no difference in the percentage of Medicare admissions for stroke between the Anderson and Pee Dee areas. Behavioral risk factors (including hypertension, smoking, and obesity) are strongly associated with stroke. However, these factors are similar for these 2 communities. Perhaps an obscure interaction of socioeconomic status, access to primary care, and the prevalence of risk factors may yet explain the differences in stroke rates. Or, some as-yet unidentified environmental risk factor, such as magnesium in drinking water or an early life event affecting birth weight, may play an important role in the geographic variation of stroke incidence. Geographic variation in disease rates for heart disease was also seen between these 2 areas, with the incidence of acute myocardial infarction and congestive heart failure higher for white males in the Pee Dee area. These differences in heart disease and stroke rates suggest a variation in overall risk for atherosclerotic disease.

The present study demonstrates that high stroke rates persist in the southeastern United States and confirms the findings of other mortality and morbidity reports for the region. Although declines and changes in stroke mortality have been reported from other investigations, the high incidence rates (a measure of disease) reported here indicate that the populations residing in the Southeast have an excess cerebrovascular disease risk. The geographic variability in stroke incidence rates suggests that the region is not so much a “belt” of areas of contiguous increased stroke risks as a “necklace” of areas of varying risks. Significant regional variability of stroke rates within a defined geographical area may help to identify additional important risk factors for stroke that need to be further investigated.

Conclusions
The Pee Dee area had an overall 40% greater stroke incidence rate that was statistically significant compared with the Anderson area. The geographic difference was more dramatic in younger subjects: the Pee Dee rates were 58% greater for subjects aged 55 to 64 years and 100% greater for those aged 45 to 54 years, but only 13% greater for the 65- to 74-year age group. This contrast was particularly evident for white males: the rates for the 2 areas were nearly identical for age group 65 to 74 years, but rates were twice as high for Pee Dee white males 55 to 64 years old and 3.6 times greater in the 45- to 54-year-old age group. The small cell size and wide confidence interval are limitations of our study comparing the 2 areas by age-race-sex groups. Nonetheless, a consistent pattern for the trends appears to be present.

Appendix

Criteria for Anderson and Pee Dee Stroke Study
I. Definition: A stroke is a neurological deficit with an onset of \( \approx 72 \) hours and a duration of \( \geq 24 \) hours due to ischemic infarction or intraparenchymal hemorrhage. Subarachnoid hemorrage or intraparenchymal hemorrhage due to berry aneurysm, trauma, neoplasm, or infection is not considered stroke for purposes of this study.

II. Syndrome definitions
A. Atheroembolic stroke
1. Clinical signs—hemiplegia, hemiparesis, or hemianopsia or at least 2 or more of the following:
   a. Depression or level of consciousness
   b. Disturbance of vision
   c. Hemihypesthesias or hemiparesthesias
   d. Speech or language impairment
   e. Ataxia
   f. Cranial nerve abnormalities
   g. Neuropsychological dysfunction associated with a focal lesion
B. Cardioembolic stroke
1. A (1) criterion
2. Establishment of a likely cardiogenic source by history or examination (must have 1 of the following):
   a. Significant valvular disease
   b. Atrial fibrillation
   c. Myocardial infarction (within 6 weeks)
   d. Recent cardiac surgery
   e. Bacteria endocarditis
   f. Atrial myxoma
C. Lacunar stroke—focal syndrome with typical features for 1 of the following:
   1. Pure motor stroke
   2. Pure sensory stroke
   3. Pure hemiballismus
   4. Pure hemichorea
   5. Ataxic hemiparesis
   6. Dysarthria/clumsy hand syndrome
D. Intraparenchymal hemorrhage
   1. A (1) criteria—clinical signs also may include sudden, severe headache
   2. CT scan or MRI scan consistent with clinical findings
E. Stroke of indeterminate type
   1. A (1) criteria
   2. Any 1 of the following:
      a. Inadequate or conflicting information to make a determination
      b. Presence of a significant comorbid disease or condition (eg, cancer or lupus) makes etiology uncertain

III. Stroke diagnosis
A. Probable stroke
1. Meets clinical criteria for 1 of stroke syndromes
2. CT scan or MRI scan consistent with clinical findings
B. Possible stroke
1. Meets clinical criteria for 1 of stroke syndromes
2. No CT scan or MRI scan available, or if available, no lesion that corresponds to clinical findings
C. Stroke uncertain—A (1) clinical criteria of uncertain validity

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References


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