Characterization of Incident Stroke Signs and Symptoms
Findings From the Atherosclerosis Stroke Risk in Communities Study

Saif S. Rathore, MPH; Albert R. Hinn, MD; Lawton S. Cooper, MD; Herman A. Tyroler, MD; Wayne D. Rosamond, PhD

Background and Purpose—Although patterns of stroke occurrence and mortality have been well studied, few epidemiological data are available regarding the clinical characteristics of stroke events.

Methods—We evaluated hospitalized stroke events reported in the Atherosclerosis Risk in Communities (ARIC) Study to describe the clinical characteristics of incident stroke. Confirmed stroke cases (n = 474) were evaluated for stroke symptoms (headache, vertigo, gait disturbance, convulsions) and stroke signs (hemianopia, diplopia, speech deficits, paresis, paresthesia/sensory deficits) and their univariate associations with race, sex, and stroke subtype.

Results—Over 9.2 years of follow-up, 402 (85%) ischemic and 72 (15%) hemorrhagic strokes occurred. Frequency of stroke symptoms (95% CIs) were as follows: headache (27.4%; 23.4% to 31.4%), gait disturbance (10.8%; 7.9% to 13.6%), convulsions (4.4%; 2.6% to 6.3%), and vertigo (2.1%; 0.8% to 3.4%). Speech deficits occurred in 24.0% (20.2% to 27.9%), hemianopia in 14.6% (11.4% to 17.7%), and diplopia in 5.5% (3.4% to 7.5%) of cases. Most cases involved paresis (81.6%; 78.1% to 85.1%), while fewer cases experienced sensory deficits (44.5%; 40.0% to 49.0%). Blacks were more likely than whites to experience paresis (85.4% versus 78.2%; P = 0.044). Men were more likely than women to experience a gait disturbance (14.4% versus 6.7%; P = 0.007). Persons with hemorrhagic strokes had a higher proportion of headaches (55.6% versus 22.4%; P = 0.001) and convulsions (11.1% versus 3.2%; P = 0.003) than those with ischemic events, while speech and sensory deficits were more common in ischemic strokes (26.1% versus 12.5%, P = 0.013, and 49.0% versus 19.4%, P = 0.001, respectively).

Conclusions—We present epidemiological data concerning the clinical characteristics of incident stroke in a population-based cohort. Although minor differences by race, sex, and stroke subtype were observed, data from additional follow-up are required to confirm observed variations. (Stroke. 2002;33:2718-2721.)

Key Words: cerebrovascular disorders ■ epidemiology ■ pathology ■ stroke

Stroke remains a major public health concern in the United States, with more than 600,000 cases diagnosed annually.1 Most epidemiological data have focused more on mortality rates and associated risk factors and less on characterizing incident events.2–5 Although mortality data are informative, they do not fully assess the qualitative nature of incident stroke: the signs, symptoms, sequelae, and associated deficits that represent the full clinical scope of a stroke event. These data are necessary to obtain a more complete understanding of the burden of stroke in a population and to better inform public health strategies, including public education and stroke prevalence assessments. We undertook an analysis of incident strokes reported in the Atherosclerosis Risk in Communities (ARIC) Study to better characterize the clinical presentation of incident stroke in a community-based setting.

Subjects and Methods

Study Population
The ARIC Study has been described in greater detail elsewhere.6 Potential stroke events in ARIC were identified from a cohort of 15,792 individuals age 45 to 64 years were recruited during 1986–1989 from 4 communities in the United States: Washington County, Maryland; northwest suburbs of Minneapolis, Minnesota; Forsyth County, North Carolina; and Jackson, Mississippi. Only blacks were enrolled at the Jackson site, while all other sites reflected the demographic composition of the communities from which they were drawn. ARIC participants attended a clinic visit triennially and received a follow-up telephone call annually.

Details of the identification and classification of stroke events are described in greater detail elsewhere.7 Potential stroke events were identified from self-reported hospitalizations obtained during the annual follow-up and from ongoing community-wide hospital surveillance. Medical records for potential stroke events were forwarded to a single nurse abstractor at a central ARIC office who abstracted each record for number, type, and severity of neurological

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deficits and supporting angiographic, CT, MRI, spinal tap, or autopsy evidence. A computerized algorithm and physician reviewer were used to independently confirm the diagnosis of stroke, with disagreements adjudicated by a second physician reviewer. Strokes were further classified as ischemic (thrombotic or embolic), hemorrhagic, undetermined type, or fatal out-of-hospital stroke.

Of the 1719 eligible potential stroke events identified among ARIC participants during 1987–1997, we limited our consideration to the 873 first events with evidence in the medical record of any neurological signs lasting >24 hours or development of new signs or symptoms leading to or during hospitalization. Of these 873 events, 498 were validated as either definite or probable strokes. From these 498 we excluded fatal out-of-hospital strokes (n=10), strokes of undetermined type (n=7), patients who recently experienced head trauma (n=2), and those with other neurological conditions that may be associated with stroke signs and symptoms (n=5). The remaining 474 confirmed incident stroke events were available for these analyses.

Study Outcomes
The principal objective of our study was to characterize the signs and symptoms of stroke found on examination. Specific symptoms evaluated included headache at admission (and severity), vertigo, gait disturbance, and convulsions. Stroke signs evaluated included hemianopia, diplopia, and speech deficits (aphasia and/or dysphasia). Paresis or paresthesia/sensory deficits of the face, arms, or legs were also noted.

Statistical Analysis
The frequency of stroke signs and symptoms among incident stroke events was determined and evaluated for univariate associations with race, sex, and stroke subtype with the use of \( \chi^2 \) analysis. All statistical calculations were performed with the use of SAS 7.0 software (SAS Institute Incorporated).

Results
Of the 474 confirmed incident stroke events in the study cohort, 402 (84.8%) were ischemic and 72 (15.2%) were hemorrhagic. Subjects were predominantly male, white, and aged 62 years on average at the time of their stroke, and most were current or former users of tobacco and alcohol. Few subjects experienced acute clinical risk factors for stroke in the month before their stroke (Table 1).

More than 25% of subjects hospitalized with a confirmed stroke presented with a headache at admission, while vertigo, convulsions, and gait disturbance were less frequent. The most common stroke sign on presentation was a speech deficit (24.0%), followed by hemianopia (14.6%) and diplopia (5.5%). More than 80% of subjects presented with some paresis, most often of the arms (75.5%), although a majority reported paresis of the face (54.6%) and legs (68.6%); location of paresis was equally distributed between right and left sides. A near majority of subjects (44.5%) presented with some sensory deficit, most often of the arms (38.6%) and also, in decreasing frequency, of the legs (34.4%) and face (20.7%). A majority of sensory deficits involved the left side of the affected location (Table 2).

Evaluation of stroke signs and symptoms by sex indicated little variation. Although men had more frequent occurrence of gait disturbance (14.4% versus 6.7%; \( P=0.007 \)) and women tended to have a higher frequency of headache and facial sensory deficits, sex was not associated with the occurrence of other stroke signs and symptoms (Table 2). In contrast, blacks were more likely to experience paresis of the face, arm, and leg, while whites tended to have more frequent occurrence of vertigo and a gait disturbance. Race was not associated with the occurrence of other stroke signs and symptoms (Table 2).

As expected, stroke signs and symptoms varied considerably by stroke subtype. Subjects with hemorrhagic strokes had a higher frequency of headaches (mostly severe) and convulsions at admission. In contrast, speech deficits were most common among ischemic strokes, while hemianopia and diplopia were comparable in occurrence. Hemorrhagic stroke events had the lowest frequency of paresis and sensory deficits in all sites (Table 2).

Discussion
Our evaluation of incident strokes in the ARIC cohort found that paresis, speech, and sensory deficits were common among subjects hospitalized with confirmed stroke events. Male subjects were more likely to experience gait disturbances, and blacks were more likely to experience paresis in any location. Subjects with ischemic strokes were more likely to experience paresis, speech, and sensory deficits, while
headaches were most common with hemorrhagic stroke events. Our data suggest that the clinical characteristics of stroke may vary for different population groups. These data provide a preliminary, detailed understanding of the specific functional burden of stroke in a population and can be used to better inform public health strategies, including public education and stroke prevalence assessments.

Use of the ARIC cohort provides several methodological advancements in the assessment of the clinical characteristics of incident stroke. The ARIC cohort was drawn from 4 US communities, including a substantial number of black participants, and thus represents a more population-based assessment than selected center data. ARIC used a clinically defined, validated diagnosis of stroke, which is an improvement from prior studies that relied solely on patient self-report, discharge codes from medical records, or administrative data. Finally, ARIC represents a recent evaluation of stroke events and associated clinical deficits, thus allowing for recent advances in stroke diagnosis, treatment, and management that may have reduced stroke-associated morbidity.

Comparison of our findings with prior data is limited because few studies evaluate stroke signs in an epidemiological setting or report specific clinical deficits rather than composite severity scores such as the Barthel Index or Rankin Scale scores. Two studies, however, have reported stroke signs and symptoms with sufficient detail for comparative purposes. An analysis of stroke events in the northern Sweden World Health Organization Monitoring Trends and Determinants in Cardiovascular Disease (MONICA) cohort reported paresis in 48.9% of events, which is markedly lower than the 82% paresis frequency observed in ARIC. In contrast, stroke sign and symptom frequencies reported in an evaluation of health maintenance organization enrollees in Portland, Oregon, found similar rates for visual deficits (20%) and diplopia (5.5%) compared to the 27.2% and 4.4% reported in ARIC, respectively.

Differences in symptom ascertainment, evaluation, and documentation may have consequences for valid estimations of stroke sign and symptom frequencies between studies. The variation in ascertainment and evaluation may be expected because of their use of different populations: MONICA enrolled subjects as young as 35 years, while the Portland health maintenance organization study focused on elderly (aged ≥65 years) subjects. Differences in symptom ascertainment, evaluation, and documentation may have consequences for valid estimations of the frequency of stroke signs and symptoms given the 4.4

### TABLE 2. Signs and Symptoms Among Incidence Stroke Stratified by Sex, Race, and Stroke Type

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Overall</th>
<th>Female</th>
<th>Male</th>
<th>P</th>
<th>White</th>
<th>Black</th>
<th>P</th>
<th>Ischemic Stroke</th>
<th>Hemorrhagic Stroke</th>
<th>P</th>
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</thead>
<tbody>
<tr>
<td>n</td>
<td>474</td>
<td>224</td>
<td>250</td>
<td>248</td>
<td>226</td>
<td>402</td>
<td>72</td>
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<tr>
<td>Symptoms</td>
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<tr>
<td>Headache at admission, %</td>
<td>27.4 (23.4–31.4)</td>
<td>31.3</td>
<td>24.0</td>
<td>0.077</td>
<td>29.0</td>
<td>25.7</td>
<td>0.412</td>
<td>22.4</td>
<td>55.6</td>
<td>0.001</td>
</tr>
<tr>
<td>Severity, severe/mild/unspecified, %</td>
<td>48/18/33</td>
<td>54/13/33</td>
<td>42/25/33</td>
<td>0.162</td>
<td>48/26/25</td>
<td>48/8/43</td>
<td>0.013</td>
<td>34/22/43</td>
<td>80/10/10</td>
<td>0.001</td>
</tr>
<tr>
<td>Vertigo, %</td>
<td>2.1 (0.8–3.4)</td>
<td>1.8</td>
<td>2.4</td>
<td>0.642</td>
<td>3.2</td>
<td>0.9</td>
<td>0.077</td>
<td>2.5</td>
<td>0.0</td>
<td>0.176</td>
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<tr>
<td>Gait disturbance, %</td>
<td>10.8 (7.9–13.6)</td>
<td>6.7</td>
<td>14.4</td>
<td>0.007</td>
<td>13.3</td>
<td>8.0</td>
<td>0.061</td>
<td>11.4</td>
<td>6.7</td>
<td>0.257</td>
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<tr>
<td>Convulsions, %</td>
<td>4.4 (2.6–6.3)</td>
<td>4.5</td>
<td>4.4</td>
<td>0.973</td>
<td>4.0</td>
<td>4.9</td>
<td>0.659</td>
<td>3.2</td>
<td>11.1</td>
<td>0.003</td>
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<tr>
<td>Signs</td>
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<tr>
<td>Speech deficit, %</td>
<td>24.0 (20.2–27.9)</td>
<td>27.2</td>
<td>21.2</td>
<td>0.125</td>
<td>20.8</td>
<td>27.0</td>
<td>0.114</td>
<td>26.1</td>
<td>12.5</td>
<td>0.013</td>
</tr>
<tr>
<td>Hemianopia, %</td>
<td>14.6 (11.4–17.7)</td>
<td>13.0</td>
<td>16.0</td>
<td>0.347</td>
<td>16.5</td>
<td>12.4</td>
<td>0.201</td>
<td>15.4</td>
<td>9.7</td>
<td>0.207</td>
</tr>
<tr>
<td>Diplopia, %</td>
<td>5.5 (3.4–7.5)</td>
<td>5.4</td>
<td>5.6</td>
<td>0.908</td>
<td>6.0</td>
<td>4.9</td>
<td>0.573</td>
<td>5.2</td>
<td>6.9</td>
<td>0.555</td>
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<tr>
<td>Paresis</td>
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</tr>
<tr>
<td>Paresis at any site, %</td>
<td>81.6 (78.1–85.1)</td>
<td>82.6</td>
<td>80.8</td>
<td>0.615</td>
<td>78.2</td>
<td>85.4</td>
<td>0.044</td>
<td>87.6</td>
<td>48.6</td>
<td>0.001</td>
</tr>
<tr>
<td>Location, left/right/both, %</td>
<td>49/51/0</td>
<td>47/53/0</td>
<td>51/49/0</td>
<td>0.523</td>
<td>48/52/0</td>
<td>51/49/0</td>
<td>0.611</td>
<td>49/52/0</td>
<td>54/47/0</td>
<td>0.463</td>
</tr>
<tr>
<td>Location, left/right/both, %</td>
<td>75.5 (71.6–79.4)</td>
<td>75.5</td>
<td>75.6</td>
<td>0.967</td>
<td>70.6</td>
<td>81.0</td>
<td>0.008</td>
<td>81.1</td>
<td>44.4</td>
<td>0.001</td>
</tr>
<tr>
<td>Location, left/right/both, %</td>
<td>68.6 (64.4–72.7)</td>
<td>71.9</td>
<td>65.6</td>
<td>0.142</td>
<td>62.1</td>
<td>75.7</td>
<td>0.001</td>
<td>73.4</td>
<td>41.7</td>
<td>0.001</td>
</tr>
<tr>
<td>Location, left/right/both, %</td>
<td>48/48/2</td>
<td>50/47/3</td>
<td>50/49/1</td>
<td>0.165</td>
<td>50/49/1</td>
<td>48/49/3</td>
<td>0.275</td>
<td>48/50/2</td>
<td>59/39/3</td>
<td>0.340</td>
</tr>
<tr>
<td>Location, left/right/both, %</td>
<td>48/49/3</td>
<td>46/49/5</td>
<td>50/49/1</td>
<td>0.054</td>
<td>50/49/1</td>
<td>46/50/4</td>
<td>0.280</td>
<td>47/51/2</td>
<td>57/33/10</td>
<td>0.015</td>
</tr>
<tr>
<td>Sensory deficits</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deficits at any site, %</td>
<td>44.5 (40.0–49.0)</td>
<td>45.5</td>
<td>43.6</td>
<td>0.672</td>
<td>45.2</td>
<td>43.8</td>
<td>0.767</td>
<td>49.0</td>
<td>19.4</td>
<td>0.001</td>
</tr>
<tr>
<td>Deficit of the face, %</td>
<td>20.7 (17.0–24.3)</td>
<td>24.1</td>
<td>17.6</td>
<td>0.081</td>
<td>20.2</td>
<td>21.2</td>
<td>0.772</td>
<td>22.9</td>
<td>8.3</td>
<td>0.005</td>
</tr>
<tr>
<td>Location, left/right/both, %</td>
<td>57/41/2</td>
<td>60/37/4</td>
<td>54/47/0</td>
<td>0.304</td>
<td>55/41/4</td>
<td>59/41/0</td>
<td>0.380</td>
<td>57/40/3</td>
<td>50/50/0</td>
<td>0.855</td>
</tr>
<tr>
<td>Deficit of the arms, %</td>
<td>38.6 (34.2–43.0)</td>
<td>39.7</td>
<td>37.6</td>
<td>0.634</td>
<td>38.7</td>
<td>38.5</td>
<td>0.962</td>
<td>42.3</td>
<td>18.1</td>
<td>0.001</td>
</tr>
<tr>
<td>Location, left/right/both, %</td>
<td>52/42/3</td>
<td>58/37/5</td>
<td>52/47/1</td>
<td>0.190</td>
<td>58/39/3</td>
<td>52/46/2</td>
<td>0.584</td>
<td>55/42/2</td>
<td>54/38/8</td>
<td>0.520</td>
</tr>
<tr>
<td>Deficit of the legs, %</td>
<td>34.4 (30.1–28.7)</td>
<td>34.4</td>
<td>34.4</td>
<td>0.995</td>
<td>33.9</td>
<td>34.9</td>
<td>0.804</td>
<td>37.6</td>
<td>16.7</td>
<td>0.001</td>
</tr>
<tr>
<td>Location, left/right/both, %</td>
<td>58/39/4</td>
<td>57/38/5</td>
<td>58/40/2</td>
<td>0.621</td>
<td>64/32/4</td>
<td>51/46/4</td>
<td>0.200</td>
<td>58/39/3</td>
<td>58/33/8</td>
<td>0.651</td>
</tr>
</tbody>
</table>

Values in parentheses are 95% CIs. Values may not sum to 100 because of rounding.
found an increased frequency of stroke deficits, specifically paresis, among blacks. As expected, stroke signs and symptoms varied by stroke subtype. Data such as these may be used to more fully inform current epidemiological assessments of incident stroke events.

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References
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