Abstract:

Previous studies have noted that the geographic differences in stroke mortality among areas of the United States were not due to artifacts of certification practices or accuracy of the diagnosis. A study of hospitalized stroke patients was completed in order to determine whether the mortality differences were due to a higher incidence or case fatality following a stroke in areas with high stroke death rates. Eight of the nine areas that participated in the Nationwide Mortality Study were included in this study. A total of 2,619 stroke cases were ascertained including 1,631 (62.3%) who were alive at the time of hospital discharge, 937 (35.8%) dead at discharge, 46 (1.7%) who were discharged alive but died outside of the hospital, and five (0.2%) who were dead at discharge and certified by the medical examiner.

The incidence of stroke was higher in the high stroke death rate areas especially for men. The ratio of the incidence of stroke in men as compared to women was higher in the younger age groups (45-54, 55-64) and in the high-incidence as compared to low-incidence areas.

The case-fatality percentage was lowest in Denver and highest in South Carolina. Presence of coma on admission was the principal determinant of subsequent mortality in all areas.

Finally, there was no consistent difference in the distribution of symptoms of stroke among the areas, and diagnostic procedures were performed more often in urban than rural areas. Approximately 80% of the stroke cases could be substantiated by either an autopsy verifying diagnosis, arteriography, hemorrhagic spinal fluid, hemiplegia or coma on admission. Several hypotheses to explain the differences have been suggested as well as the need for new information.

ADDITIONAL KEY WORDS  epidemiology stroke mortality
hypertension atherosclerosis hospitalization coma
risk factors

Introduction

Large differences in cerebrovascular disease mortality among geographic areas of the United States have been reported. Death rates were higher in the southeastern states, especially along the Atlantic coast, and lower in the
CEREBROVASCULAR DISEASE MORBIDITY STUDY

TABLE 1
Geographic Areas Included in Nationwide Cerebrovascular Disease Morbidity Study and Age-Adjusted Stroke Death Rates in Each Area (Ages 35-74), 1959-1961

<table>
<thead>
<tr>
<th>Area</th>
<th>WM</th>
<th>WF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami, Florida</td>
<td>87</td>
<td>63</td>
</tr>
<tr>
<td>Denver, Colorado</td>
<td>83</td>
<td>75</td>
</tr>
<tr>
<td>Flint Hills,* Kansas</td>
<td>82</td>
<td>68</td>
</tr>
<tr>
<td>Seattle, Washington</td>
<td>125</td>
<td>103</td>
</tr>
<tr>
<td>Buffalo, New York</td>
<td>125</td>
<td>102</td>
</tr>
<tr>
<td>Upper Coastal Plain,* N. C.</td>
<td>205</td>
<td>115</td>
</tr>
<tr>
<td>Savannah, Georgia</td>
<td>205</td>
<td>135</td>
</tr>
<tr>
<td>Pee-Dee,* S. C.</td>
<td>245</td>
<td>145</td>
</tr>
</tbody>
</table>

*Description of Rural State Economic area.

plains and Rocky Mountain regions. A study of death certificates in nine areas of the United States including three with high, three with intermediate, and three with low stroke death rates had shown that the geographic differences were not due to certification practices or to criteria for the clinical diagnosis of stroke. However, these variations in mortality could result from differences in either the incidence of stroke or the case-fatality ratios following a stroke. For example, the incidence of stroke could be higher and the case-fatality percentage the same, or the incidence could be the same but the case fatality greater in the high rates areas.

The study of stroke incidence presents a formidable problem. First, the incidence of stroke is relatively low for the age groups 40-69 which show the greatest mortality differences between the areas; it is only about 2/1000 for ages 45-54, and 4/1000 for ages 55-64. A large population sample followed for a reasonably long period is necessary in order to have enough cases to estimate an incidence at this level. Second, a cross-sectional or surveillance approach necessitates the cooperation of physicians because an unknown percentage of stroke cases are not admitted to a hospital or other medical facilities. Differences in reporting by physicians could substantially affect the incidence rates. Furthermore, the accuracy of the diagnosis of the reported cases by physicians is difficult to evaluate. Restricting the study to hospitalized cases would provide a reasonable estimate of the incidence of stroke and allow comparison among areas if: (1) a high percentage of stroke cases were hospitalized; (2) the percentage of all stroke cases hospitalized were similar among the areas or were known so that adjustments for the differences in hospital admission rates could be made; and (3) the hospital admission policies were unbiased for the variables being compared such as age, sex, race, etc.

Methods

A study of stroke morbidity in eight of the nine areas (table 1) which had participated in the Nationwide Mortality Study was completed in order to compare: (1) the incidence of stroke based on hospitalized cases only; (2) the case fatality following a stroke; and (3) the clinical characteristics of the stroke cases. Hospitals in each area were asked to participate in the study. In several areas, hospitals in the surrounding major medical centers were also included. Stroke cases were then ascertained from the hospital discharge indices.

Nurses or other trained personnel abstracted the hospital records of all discharges listing stroke for whites aged 45-69 during 1965. Deaths were also ascertained from the lists of hospital deaths reported in the Nationwide Cerebrovascular Disease Mortality Study. Cases were collected for a two-year period in North Carolina and for one year in the other areas. Over 90% of the hospital

TABLE 2
Distribution of Stroke Cases in Nationwide Morbidity Study by Area and Category (Ages 45-69), 1965

<table>
<thead>
<tr>
<th>Category</th>
<th>Miami</th>
<th>Denver</th>
<th>Kansas</th>
<th>Seattle</th>
<th>Buffalo</th>
<th>N. C.*</th>
<th>Georgia</th>
<th>S. C.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Living</td>
<td>388</td>
<td>274</td>
<td>101</td>
<td>262</td>
<td>321</td>
<td>146</td>
<td>55</td>
<td>84</td>
<td>1,631</td>
</tr>
<tr>
<td>Died in hospital</td>
<td>231</td>
<td>90</td>
<td>52</td>
<td>111</td>
<td>246</td>
<td>80</td>
<td>46</td>
<td>81</td>
<td>937</td>
</tr>
<tr>
<td>Died out of hospital</td>
<td>6</td>
<td>14</td>
<td>1</td>
<td>14</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>46</td>
</tr>
<tr>
<td>Certified by M.E.</td>
<td>2</td>
<td>1</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>627</td>
<td>378</td>
<td>155</td>
<td>387</td>
<td>571</td>
<td>229</td>
<td>105</td>
<td>167</td>
<td>2,619</td>
</tr>
</tbody>
</table>

*Data collected for two-year period in North Carolina.
TABLE 3
Distribution of Strokes in Morbidity Study by Area and by Category of Diagnosis (Ages 45-69), 1965

<table>
<thead>
<tr>
<th>Area</th>
<th>Past Hx No.</th>
<th>Past Hx %</th>
<th>Past Hx and Stroke No.</th>
<th>Past Hx and Stroke %</th>
<th>No past Hx stroke No.</th>
<th>No past Hx stroke %</th>
<th>Unknown past Hx stroke No.</th>
<th>Unknown past Hx stroke %</th>
<th>Total No.</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami</td>
<td>88</td>
<td>14.0</td>
<td>116</td>
<td>18.5</td>
<td>398</td>
<td>63.5</td>
<td>25</td>
<td>4.0</td>
<td>627</td>
<td>100</td>
</tr>
<tr>
<td>Denver</td>
<td>74</td>
<td>19.6</td>
<td>62</td>
<td>16.4</td>
<td>39</td>
<td>10.3</td>
<td>203</td>
<td>53.7</td>
<td>378</td>
<td>100</td>
</tr>
<tr>
<td>Kansas</td>
<td>24</td>
<td>15.5</td>
<td>15</td>
<td>9.7</td>
<td>99</td>
<td>63.9</td>
<td>17</td>
<td>10.9</td>
<td>155</td>
<td>100</td>
</tr>
<tr>
<td>Seattle</td>
<td>10</td>
<td>2.6</td>
<td>21</td>
<td>5.4</td>
<td>340</td>
<td>87.9</td>
<td>16</td>
<td>4.1</td>
<td>387</td>
<td>100</td>
</tr>
<tr>
<td>Buffalo</td>
<td>36</td>
<td>6.3</td>
<td>61</td>
<td>10.7</td>
<td>462</td>
<td>80.9</td>
<td>12</td>
<td>2.1</td>
<td>571</td>
<td>100</td>
</tr>
<tr>
<td>North Carolina</td>
<td>12</td>
<td>5.3</td>
<td>33</td>
<td>14.4</td>
<td>183</td>
<td>79.9</td>
<td>1</td>
<td>0.4</td>
<td>229</td>
<td>100</td>
</tr>
<tr>
<td>Georgia</td>
<td>8</td>
<td>7.6</td>
<td>12</td>
<td>11.4</td>
<td>75</td>
<td>71.5</td>
<td>10</td>
<td>9.5</td>
<td>105</td>
<td>100</td>
</tr>
<tr>
<td>South Carolina</td>
<td>3</td>
<td>1.8</td>
<td>52</td>
<td>31.1</td>
<td>67</td>
<td>40.1</td>
<td>45</td>
<td>27.0</td>
<td>167</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>255</td>
<td>9.7</td>
<td>372</td>
<td>14.2</td>
<td>1,663</td>
<td>63.5</td>
<td>329</td>
<td>12.6</td>
<td>2,619</td>
<td>100</td>
</tr>
</tbody>
</table>

Records could be reviewed in six of the eight areas including the three low (Miami, Denver and part of Kansas) and the three high (parts of North Carolina, South Carolina and Savannah, Georgia) stroke death rate areas. Since the accuracy of the method of case ascertainment from hospital discharge indices was not known in each area or within each hospital, a sample of records for which stroke was not listed as a discharge diagnosis in the diagnostic index was also reviewed to determine if a stroke diagnosis was contained in the hospital chart.

The denominator for estimating the incidence of stroke was based on the 1960 census of the population. Changes in the population for those 45-69 years of age between 1960 and 1965 should have little effect on these estimates, except perhaps in Miami where the incidence will probably be overestimated because of the relatively more marked increase in the population. Estimates of incidence and case-fatality rates will be reported only for the six areas in which ascertainment of cases was practically complete.

Results
A total of 2,619 stroke cases were ascertained, including 1,631 (62.3%) who were alive at the time of hospital discharge, 937 (35.8%) who were dead at discharge, 46 (1.7%) who were discharged alive but died outside the hospital according to the death certificate obtained in the mortality study, and five (0.2%) who were dead at discharge and certified by the medical examiner (table 2). The 2,619 strokes were subdivided into the following four groups according to whether there was a new stroke on the current admission and/or a past history of stroke (table 3): (1) 255 (9.7%) with a past history of stroke only; (2) 372 (14.2%) with a past history of stroke and a new stroke on the current admission; (3) 1,663 (63.5%) with a new stroke and no past history of stroke; and (4) 329 (12.6%) with a new stroke and an unknown past history of stroke. Unless otherwise noted, the 255 strokes with a past history only were excluded from the analysis.

Of 3,305 hospital records in which the hospital discharge index did not include a stroke diagnosis, only 52 (1.6%) had a stroke listed on the hospital record. Of these 52 stroke records, 37 (71.2%) listed stroke in the past history, three (5.8%) were admitting diagnoses, 10 (19.2%) occurred during hospitalization, and only two (3.8%) were discharge diagnoses. No differences between the areas were noted. The hospital discharge indices were therefore felt to be reasonably complete.

The incidence of stroke was higher in areas with high stroke mortality (North Carolina, South Carolina, and Savannah) as compared to the low areas (Miami, Denver, Kansas). These differences were present when the rates were based on either all stroke diagnoses including the strokes mentioned in the past history only (col. 1, table 4), or excluded strokes listed only in the past history (col. 2, table 4), or included only new stroke cases without a past history of stroke (col. 4, table 4).

For men, the age-specific incidence of stroke was greater in the high as compared to the low...
TABLE 4
Sex-Specific Incidence of Stroke by Area and by Whether Past History of Stroke Reported on Hospital Chart (Ages 45-69), 1965

<table>
<thead>
<tr>
<th>Area</th>
<th>Sex</th>
<th>Incidence/100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(1) All cases</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) Excluding past Hx only</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3) Recent strokes past Hx and no or unknown past Hx</td>
</tr>
<tr>
<td>Miami</td>
<td>Male</td>
<td>337</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>218</td>
</tr>
<tr>
<td>Denver</td>
<td>Male</td>
<td>378</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>278</td>
</tr>
<tr>
<td>Kansas</td>
<td>Male</td>
<td>363</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>252</td>
</tr>
<tr>
<td>North Carolina</td>
<td>Male</td>
<td>509</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>302</td>
</tr>
<tr>
<td>Georgia</td>
<td>Male</td>
<td>574</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>283</td>
</tr>
<tr>
<td>South Carolina</td>
<td>Male</td>
<td>541</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>192</td>
</tr>
</tbody>
</table>

areas in all three age groups (fig. 1) but only for the older ages for women (fig. 2). Also, the ratio of the incidence in men to that in women within an area was much greater in the high areas, especially North Carolina and Savannah among those under 55 years of age, than in the low areas (fig. 3); no differences between areas were noted among those 65-69 years of age.

Comparisons of incidence and death rates are shown in figure 4. The ratio of the age and sex-specific incidence rates in the high as compared to the low areas was generally smaller than the corresponding ratios of the death rates previously reported. For men both the incidence and mortality ratios were greatest for ages 45-54, while for women the ratios were greatest for ages 65-69.
Finally, the age-specific incidence rates for men in Savannah (high incidence area) based only on new stroke cases without a past history of stroke were higher than the incidence rates reported in several other community studies, while the incidence in Denver (low incidence area) was generally lower (fig. 5). This is especially interesting since higher incidence rates in Savannah were based on hospitalized cases only, while the other studies used more complete methods of case ascertainment.

Therefore, the incidence of stroke was (1) greater in high than low stroke death rate areas, (2) higher for men than women, especially in the high incidence areas, and (3) also apparently greater in the high areas than in other communities in the United States.

The case-fatality percentage was defined as the percentage of stroke cases who were dead at the time of hospital discharge. The case-fatality percentage varied from 28% in Denver to 49% in South Carolina (table 5). No consistent differences were noted in the case-fatality percentage by age or sex. Because the dead cases could be ascertained from two sources (hospital indices and the death certificates) while the living cases could be identified from the hospital indices only, the case-fatality percentage may be inflated. However, as previously noted, practically no stroke cases were located that were not listed in the indices.

Although the case-fatality percentage was similar in most of the areas, deaths tended to occur earlier in the hospitalization in the high areas. Approximately 8% of the stroke admissions had died within two days of admission in Denver and Kansas (low incidence areas), while nearly 20% had died in the three high stroke incidence areas. By the time of hospital discharge, however, there was much less difference between the high and low areas (table 6). Possible explanations for this observation are: (1) differences in the distributions of the specific types of stroke among the areas, deaths in the first few days being attributed to hypertensive cerebral hemorrhage and the later deaths to cerebral thrombosis or embolism; (2) greater delay between the onset

The sex ratio of the incidence of stroke in males as compared to females is higher in areas with high incidence, especially ages 45 to 54.

FIGURE 3
For males, both the ratio of incidence of stroke and mortality in the high as compared to low areas is greater in the youngest age group (45-54) while for females the ratio tends to increase with age.

**TABLE 5**

Age and Sex-Specific Case-Fatality Percentages by Areas*

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age</th>
<th>Total</th>
<th>Miami</th>
<th>Denver</th>
<th>Kansas</th>
<th>North Carolina</th>
<th>Georgia</th>
<th>South Carolina</th>
</tr>
</thead>
<tbody>
<tr>
<td>WM</td>
<td>45-54</td>
<td>36</td>
<td>45</td>
<td>27</td>
<td>20</td>
<td>32</td>
<td>35</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>55-64</td>
<td>39</td>
<td>42</td>
<td>27</td>
<td>36</td>
<td>37</td>
<td>44</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td>65-69</td>
<td>39</td>
<td>34</td>
<td>34</td>
<td>43</td>
<td>37</td>
<td>48</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>39</td>
<td>40</td>
<td>30</td>
<td>37</td>
<td>37</td>
<td>43</td>
<td>49</td>
</tr>
</tbody>
</table>

| WF    | 45-54| 40    | 42    | 26     | 36     | 40             | 100     | 67             |
|       | 55-64| 34    | 32    | 32     | 38     | 37             | 26      | 43             |
|       | 65-69| 38    | 43    | 18     | 55     | 34             | 50      | 52             |
|       | Total| 37    | 38    | 25     | 43     | 36             | 44      | 51             |

| GRAND TOTAL | 38 | 39 | 28 | 40 | 36 | 43 | 49 |

*Excludes cases with stroke in past history only.

of the stroke and admission to the hospital in the high rate areas so that the patient died shortly after reaching the hospital in the high areas; (3) differences in treatment within the hospital, delaying the time of death without changing the case-fatality percentage. Information about the time between onset of stroke and admission to the hospital was felt to be unreliable. As for difference in treatment, no accurate measure of the effect of medical care was available. Thus the reasons for the differences in distribution of time of death cannot be determined.

Only 19% of the patients were comatose on admission to the hospital in Denver as compared to 33% in South Carolina. As shown in figure 6, case fatality was considerably higher among those comatose on admission in all areas: 77% of comatose patients died as compared to 29% of noncomatose individuals.
The age-specific incidence of stroke for white males in Savannah is higher than that reported in other studies, while the age-specific incidence is lower in Denver.

The case-fatality percentage for comatose patients was similar among the areas, but only 18% of noncomatose patients had died in Denver as compared to 36% in South Carolina. Thus, differences in case fatality between Denver and South Carolina were related to both the percentage of comatose patients on admission (19% as compared to 33%) and the higher case fatality for noncomatose patients (18% as compared to 36%).

The distribution of the specific types of stroke was similar among the areas (table 7). Approximately half the cases were attributed to thrombosis and/or embolism, and for another 25%, no specific type of stroke was reported in the chart. As previously reported in the mortality study, the accuracy of the diagnosis of the specific type of stroke was suspect because of the paucity of diagnostic procedures such as spinal puncture, arteriogram, or postmortem examination. There was no evidence from this study, however, to suggest that any specific type of stroke accounted for the differences in incidence among the areas.

The frequency of symptoms of stroke on admission to the hospital is shown in table 8. Although there was considerable variation in the distribution of individual symptoms among the areas, no consistent pattern emerged. In general, the frequency of coma, convulsions and headache on admission was higher in the high incidence areas. However, there appeared
to be just as great a variation between areas within the high incidence group (North Carolina, Georgia and South Carolina) as between high and low incidence areas. Thus the frequency of coma on admission between two high areas varied from 32.7% in South Carolina to 24.3% in North Carolina and between two low areas from 27.5% in Miami to 17.7% in Kansas. Any difference in the distribution of symptoms among the areas may be due to either differences in type of stroke, adequacy of clinical examination, or completeness of the record.

Approximately 955 (41.2%) of the 2,320 records listed a spinal puncture, 351 (15.1%) an arteriogram, and 54 (2.3%) a craniotomy (table 9). The frequency of diagnostic procedures was much higher in the cities (Denver, Miami, Seattle, Buffalo, Savannah) than in the rural areas (Kansas and North and South Carolina). However, there was no difference between urban high or low incidence areas (Savannah and Denver) or rural high and low areas (Kansas and North and South Carolina).

Finally, the accuracy of the stroke diagnosis was based on a combination of diagnostic procedures and stroke symptoms. Approximately 80% of the stroke diagnoses could be substantiated by either an autopsy, an arteriogram, hemorrhagic spinal fluid, hemiplegia or coma on admission not apparently due to other causes. There was no consistent difference between the high and low areas (table 10).

Over half of the stroke records also listed either hypertension, arteriosclerotic heart disease, or diabetes (table 11). The distribution of these three diseases was similar among the areas except for the low frequency reported in South Carolina. Whether the frequency of these diseases is greater than would be expected can only be determined by a special study comparing these diseases in a stroke-free population. Other studies have also reported an increased risk of cerebrovascular disease among patients with hypertension, diabetes, or heart disease.\textsuperscript{11, 12}

**Discussion**

The high stroke mortality areas in the southeastern United States apparently also have a higher incidence of stroke than the low stroke mortality areas. Possible differences in...
TABLE 6
Cumulative Case-Fatality Percentage in Hospital by Area and by Length of Hospitalization (Ages 45-69)

<table>
<thead>
<tr>
<th>Area</th>
<th>No. Cases</th>
<th>&lt;2 Days</th>
<th>&lt;8 Days</th>
<th>&lt;30 Days</th>
<th>&gt;30 Days</th>
<th>All cases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No.</td>
<td>%*</td>
<td>No.</td>
<td>%*</td>
<td>No.</td>
<td>%*</td>
</tr>
<tr>
<td>Miami</td>
<td>539</td>
<td>75</td>
<td>13.9</td>
<td>129</td>
<td>23.9</td>
<td>185</td>
</tr>
<tr>
<td>Denver</td>
<td>304</td>
<td>24</td>
<td>7.9</td>
<td>41</td>
<td>13.5</td>
<td>69</td>
</tr>
<tr>
<td>Kansas</td>
<td>131</td>
<td>10</td>
<td>7.6</td>
<td>26</td>
<td>19.8</td>
<td>46</td>
</tr>
<tr>
<td>North Carolina</td>
<td>217</td>
<td>43</td>
<td>19.8</td>
<td>58</td>
<td>26.7</td>
<td>75</td>
</tr>
<tr>
<td>Georgia</td>
<td>97</td>
<td>18</td>
<td>18.6</td>
<td>30</td>
<td>30.9</td>
<td>38</td>
</tr>
<tr>
<td>South Carolina</td>
<td>164</td>
<td>31</td>
<td>18.9</td>
<td>54</td>
<td>32.9</td>
<td>74</td>
</tr>
<tr>
<td>Total</td>
<td>1,452</td>
<td>201</td>
<td>13.8</td>
<td>338</td>
<td>23.3</td>
<td>487</td>
</tr>
</tbody>
</table>

*Cumulative percentage dead by stated number of days of hospitalization.

TABLE 7
Distribution of Type of Stroke as Admitting and Discharge Diagnoses on Hospital Record by Area (Ages 40-69)*

<table>
<thead>
<tr>
<th>Area</th>
<th>Total</th>
<th>Carotid Artery</th>
<th>%</th>
<th>Intracerebral</th>
<th>%</th>
<th>Subarachnoid Hemorrhage or</th>
<th>%</th>
<th>Epidural or Subdural Hemorrhage</th>
<th>%</th>
<th>Cerebral Thrombosis or Infarction</th>
<th>%</th>
<th>Cerebral Embolism</th>
<th>%</th>
<th>CVA Type Undetermined</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami</td>
<td>530</td>
<td>98</td>
<td>18.5</td>
<td>39</td>
<td>7.4</td>
<td>240</td>
<td>45.3</td>
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<td>21</td>
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<td>102</td>
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<td></td>
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<td>Kansas</td>
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<tr>
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<td>46</td>
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<td>189</td>
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<tr>
<td>Buffalo</td>
<td>563</td>
<td>93</td>
<td>16.5</td>
<td>55</td>
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<td>249</td>
<td>44.2</td>
<td>27</td>
<td>4.8</td>
<td>139</td>
<td>24.7</td>
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<td></td>
<td></td>
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<tr>
<td>North Carolina</td>
<td>213</td>
<td>58</td>
<td>27.2</td>
<td>15</td>
<td>7.0</td>
<td>95</td>
<td>44.6</td>
<td>6</td>
<td>2.8</td>
<td>39</td>
<td>18.3</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Georgia</td>
<td>86</td>
<td>16</td>
<td>18.6</td>
<td>5</td>
<td>5.8</td>
<td>42</td>
<td>48.8</td>
<td>1</td>
<td>1.2</td>
<td>22</td>
<td>25.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Carolina</td>
<td>162</td>
<td>32</td>
<td>19.8</td>
<td>7</td>
<td>4.3</td>
<td>63</td>
<td>38.9</td>
<td>3</td>
<td>1.9</td>
<td>57</td>
<td>35.2</td>
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<td></td>
</tr>
<tr>
<td>Low areas Total</td>
<td>942</td>
<td>161</td>
<td>17.1</td>
<td>70</td>
<td>7.4</td>
<td>376</td>
<td>40.0</td>
<td>65</td>
<td>6.9</td>
<td>270</td>
<td>28.6</td>
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<td></td>
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</tr>
<tr>
<td>High areas Total</td>
<td>461</td>
<td>106</td>
<td>23.0</td>
<td>27</td>
<td>5.9</td>
<td>200</td>
<td>43.4</td>
<td>10</td>
<td>2.2</td>
<td>118</td>
<td>25.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2,331</td>
<td>406</td>
<td>17.4</td>
<td>198</td>
<td>8.5</td>
<td>1,014</td>
<td>43.5</td>
<td>126</td>
<td>5.4</td>
<td>587</td>
<td>25.2</td>
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<td></td>
</tr>
</tbody>
</table>

*Excludes cases with stroke in past history only or during hospitalization.

the percentage of all stroke cases that were hospitalized might explain the variations in incidence among the areas. If a high percentage of all stroke cases were admitted to the hospital in the high areas, the incidence based on only hospitalized cases would be inflated relative to the other areas. A higher percentage of less severely ill stroke cases would, therefore, be admitted in the South and this should result in lower case-fatality percentage. However, it was found that the case-fatality percentage was either the same or higher in the high areas as compared to the low areas. Certainly both a higher case-fatality percentage and a higher frequency of coma in South Carolina as compared to Denver would suggest a more selective admission policy in South Carolina. The difference in the incidence of stroke between these two areas was, therefore, probably underestimated. Furthermore, the greater difference in incidence for men as compared to women among the areas would also rule out an effect of a hospital admission bias unless there were selective admission.
CEREBROVASCULAR DISEASE MORBIDITY STUDY

TABLE 8
Percentage of Symptoms of Stroke on Admission to Hospital by Area (Ages 45-69)*

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Total</th>
<th>Miami</th>
<th>Denver</th>
<th>Kansas</th>
<th>Seattle</th>
<th>New York</th>
<th>North Carolina</th>
<th>Georgia</th>
<th>South Carolina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coma</td>
<td>2,320</td>
<td>531</td>
<td>293</td>
<td>130</td>
<td>365</td>
<td>532</td>
<td>214</td>
<td>93</td>
<td>162</td>
</tr>
<tr>
<td>Confusion</td>
<td>22.5</td>
<td>27.5</td>
<td>18.8</td>
<td>17.7</td>
<td>9.9</td>
<td>13.2</td>
<td>20.1</td>
<td>19.4</td>
<td>31.5</td>
</tr>
<tr>
<td>Convulsion</td>
<td>18.4</td>
<td>21.3</td>
<td>17.7</td>
<td>20.8</td>
<td>3.8</td>
<td>0.8</td>
<td>5.6</td>
<td>10.8</td>
<td>10.5</td>
</tr>
<tr>
<td>Headache</td>
<td>4.4</td>
<td>5.3</td>
<td>4.4</td>
<td>3.8</td>
<td>0.8</td>
<td>2.8</td>
<td>5.6</td>
<td>10.8</td>
<td>10.5</td>
</tr>
<tr>
<td>Stiff neck</td>
<td>16.6</td>
<td>19.6</td>
<td>14.0</td>
<td>14.5</td>
<td>12.3</td>
<td>13.7</td>
<td>25.2</td>
<td>19.4</td>
<td>22.2</td>
</tr>
<tr>
<td>Hemiplegia</td>
<td>8.0</td>
<td>8.5</td>
<td>6.1</td>
<td>9.2</td>
<td>7.4</td>
<td>8.5</td>
<td>6.5</td>
<td>14.0</td>
<td>6.8</td>
</tr>
<tr>
<td>Aphasia</td>
<td>56.9</td>
<td>61.8</td>
<td>55.6</td>
<td>45.4</td>
<td>54.0</td>
<td>53.0</td>
<td>65.9</td>
<td>50.5</td>
<td>64.2</td>
</tr>
<tr>
<td>Loss of vision</td>
<td>17.3</td>
<td>23.2</td>
<td>13.3</td>
<td>10.0</td>
<td>10.1</td>
<td>18.2</td>
<td>17.8</td>
<td>30.1</td>
<td>16.0</td>
</tr>
</tbody>
</table>

*Excludes deaths certified by the medical examiner (five), cases discharged alive from hospital but subsequently found dead on mortality study (40), and stroke in past history only.

TABLE 9
Distribution of Diagnostic Procedures Listed in Hospital Chart by Area (Ages 45-69)*

<table>
<thead>
<tr>
<th>Procedures</th>
<th>Total No.</th>
<th>Miami</th>
<th>Denver</th>
<th>Kansas</th>
<th>Seattle</th>
<th>New York</th>
<th>North Carolina</th>
<th>Georgia</th>
<th>South Carolina</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinal puncture</td>
<td>2,320</td>
<td>955</td>
<td>412</td>
<td>9.5</td>
<td>15.1</td>
<td>54.2</td>
<td>17.5</td>
<td>3.2</td>
<td></td>
</tr>
<tr>
<td>Arteriogram</td>
<td>955</td>
<td>351</td>
<td>122</td>
<td>31.2</td>
<td>17.9</td>
<td>41.2</td>
<td>19.8</td>
<td>12.6</td>
<td></td>
</tr>
<tr>
<td>Cranietomy</td>
<td>351</td>
<td>69</td>
<td>20</td>
<td>5.6</td>
<td>29.8</td>
<td>19.8</td>
<td>17.9</td>
<td>1.9</td>
<td></td>
</tr>
</tbody>
</table>

*Excludes deaths certified by medical examiner (five), cases discharged alive from hospital but subsequently found dead in mortality study (40), and stroke in past history only.

policies for men in the high areas. Again, the absence of a difference in case fatality between men and women in each area would be strong evidence against differential admission policies.

Differences in case fatality between the areas was small except for that noted between Denver and South Carolina. Most of the differences in mortality between areas of the United States are probably a manifestation of a higher incidence of stroke rather than of differences in case fatality following a stroke.

The reasons for the differences in incidence among the areas of the United States is not known. International differences between the United States and Japan are being studied and suggest that the higher rates in Japan are due to both cerebral thromboembolism and hemorrhage. Also, the Japanese have as much or more atherosclerosis of the circle of Willis as an age, sex-matched comparison group in Minnesota, but little atherosclerosis of the coronary arteries and low arteriosclerotic heart disease death rates. Areas of the United States with high stroke death rates, on the other hand, also have higher death rates from arteriosclerotic heart disease as compared to the low stroke areas. Also, within the United States, Negroes have much higher stroke rates than whites, but either the same or lower mortality and morbidity from arteriosclerotic heart disease. Whether one specific type of stroke accounts for the race, sex and area difference within the United States is unknown. Lack of adequately detailed clinical and pathological studies in these areas of the United States precluded a careful separation of hemorrhage and thromboembolism.

Perhaps a better method of classifying...
Stroke disease should include (1) the location of the involved vessel (intracranial or extracranial), (2) size of the vessel, and (3) type of pathology. Differences in the characteristics of atherosclerotic disease in the intracranial and extracranial vessels have been noted as well as the possible association of intracerebral vascular disease with both hemorrhage and occlusion.

Three risk factors appear to be of major importance for stroke: elevated blood pressure, elevated lipids, and high blood sugar or diabetes. Considering the geographic differences in stroke incidence and mortality and the reported distribution of these variables, a reasonable hypothesis might be that: (1) populations characterized by a high prevalence of hypertension but low lipid levels would have high rates of primary intracranial disease, consisting of both thromboembolism and hemorrhage, but little extracranial disease or atherosclerotic heart disease (Japan); (2) populations with both elevated blood pressures and lipids would have high rates of both intracranial and extracranial disease as well as atherosclerotic heart disease (U.S. Negroes); and (3) populations with elevated lipids would tend to have extracranial disease and high rates of atherosclerotic heart disease, but little thromboembolism or hemorrhage, and high rates of atherosclerotic heart disease (U.S. whites). Elevated blood sugar probably also affects the incidence, type and distribution of disease.

This hypothesis suggests that the prevalence of both hypertension and elevated lipids should be greater in the high rate areas of the southeastern United States because of the increased death rates from both stroke and arteriosclerotic heart disease among whites and Negroes. Further studies of these relationships should include: (1) complete ascertainment of all stroke cases in these areas in order to determine the true incidence of stroke as well as the comparison of incidence among Negroes and whites; (2) treatment of hypertension alone should have a greater effect on stroke than hypertension and atherosclerotic heart disease, while treatment of hypertension alone should have a greater effect on stroke than atherosclerotic heart disease; and (3) populations with both hypertension and elevated lipids would tend to have extracranial disease and high rates of atherosclerotic heart disease while populations with elevated lipids would tend to have extracranial disease and high rates of atherosclerotic heart disease.

None of those

<table>
<thead>
<tr>
<th>Area</th>
<th>Autopsy No.</th>
<th>Autopsy %</th>
<th>Arteriogram No.</th>
<th>Arteriogram %</th>
<th>Hemiplegia No.</th>
<th>Hemiplegia %</th>
<th>Comp. on admission No.</th>
<th>Comp. on admission %</th>
<th>Aphasia No.</th>
<th>Aphasia %</th>
<th>Nonhemorrhagic puncture No.</th>
<th>Nonhemorrhagic puncture %</th>
<th>None of those No.</th>
<th>None of those %</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miami</td>
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<td>9.6</td>
<td>30</td>
<td>15.2</td>
<td>74</td>
<td>28.9</td>
<td>276</td>
<td>80.1</td>
<td>22</td>
<td>84.2</td>
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<td>86.0</td>
<td>24</td>
<td>90.5</td>
<td>51</td>
</tr>
<tr>
<td>Denver</td>
<td>29</td>
<td>9.5</td>
<td>10</td>
<td>12.8</td>
<td>21</td>
<td>19.7</td>
<td>169</td>
<td>75.3</td>
<td>16</td>
<td>80.6</td>
<td>3</td>
<td>81.6</td>
<td>14</td>
<td>86.2</td>
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<tr>
<td>Kansas</td>
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<td>4</td>
<td>4.6</td>
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<td>9.2</td>
<td>61</td>
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<td>1</td>
<td>64.9</td>
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<tr>
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<td>18.0</td>
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<td>29.2</td>
<td>187</td>
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<td>4</td>
<td>79.8</td>
<td>3</td>
<td>80.6</td>
<td>27</td>
<td>87.8</td>
<td>46</td>
</tr>
<tr>
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<td>77</td>
<td>14.4</td>
<td>27</td>
<td>19.4</td>
<td>80</td>
<td>34.3</td>
<td>237</td>
<td>78.5</td>
<td>17</td>
<td>81.7</td>
<td>11</td>
<td>83.8</td>
<td>30</td>
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<td>3</td>
<td>3.7</td>
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<td>10.1</td>
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<td>82.0</td>
<td>5</td>
<td>84.3</td>
<td>2</td>
<td>85.3</td>
<td>32</td>
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<td>3.1</td>
<td>4</td>
<td>7.2</td>
<td>7</td>
<td>14.4</td>
<td>44</td>
<td>59.8</td>
<td>10</td>
<td>70.1</td>
<td>5</td>
<td>73.3</td>
<td>3</td>
<td>78.4</td>
<td>21</td>
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<td>South Carolina</td>
<td>5</td>
<td>3.0</td>
<td>1</td>
<td>3.7</td>
<td>6</td>
<td>7.3</td>
<td>102</td>
<td>69.5</td>
<td>14</td>
<td>78.0</td>
<td>9</td>
<td>83.5</td>
<td>4</td>
<td>86.0</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
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<td>98</td>
<td>13.5</td>
<td>250</td>
<td>24.1</td>
<td>1,223</td>
<td>75.8</td>
<td>103</td>
<td>80.2</td>
<td>47</td>
<td>82.2</td>
<td>107</td>
<td>86.7</td>
<td>315</td>
</tr>
</tbody>
</table>

*Excludes stroke in past history only.
†Denotes cumulative percent.
TABLE 11

Distribution of Other Diseases Listed in Hospital Chart—Stroke Cases by Area (Ages 45-69)

<table>
<thead>
<tr>
<th>Area</th>
<th>Total stroke cases</th>
<th>Hypertension</th>
<th>ASHD</th>
<th>Diabetes</th>
<th>At least one</th>
</tr>
</thead>
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<tr>
<td>Miami</td>
<td>531</td>
<td>159</td>
<td>206</td>
<td>91</td>
<td>289</td>
</tr>
<tr>
<td>Denver</td>
<td>293</td>
<td>81</td>
<td>91</td>
<td>36</td>
<td>135</td>
</tr>
<tr>
<td>Kansas</td>
<td>130</td>
<td>42</td>
<td>32</td>
<td>15</td>
<td>62</td>
</tr>
<tr>
<td>Seattle</td>
<td>365</td>
<td>90</td>
<td>82</td>
<td>44</td>
<td>142</td>
</tr>
<tr>
<td>Buffalo</td>
<td>532</td>
<td>224</td>
<td>237</td>
<td>143</td>
<td>348</td>
</tr>
<tr>
<td>North Carolina</td>
<td>214</td>
<td>88</td>
<td>59</td>
<td>36</td>
<td>123</td>
</tr>
<tr>
<td>Georgia</td>
<td>93</td>
<td>30</td>
<td>31</td>
<td>15</td>
<td>54</td>
</tr>
<tr>
<td>South Carolina</td>
<td>162</td>
<td>37</td>
<td>13</td>
<td>8</td>
<td>37</td>
</tr>
<tr>
<td>Total</td>
<td>2,320</td>
<td>751</td>
<td>751</td>
<td>388</td>
<td>1,190</td>
</tr>
</tbody>
</table>

Excludes deaths certified by medical examiner (five), cases discharged alive from hospital but subsequently found dead in mortality study (40), and stroke on past history only.

with the high incidence of stroke in the high stroke incidence and mortality areas; (3) measurement of possible environmental and familial factors that are associated with hypertension in order to develop procedures for primary prevention of elevated blood pressure; (4) better clinical and pathophysiological correlations in order to determine the type of stroke disease, the typographical distribution of disease and interrelationships with the risk factors. For example, a comparison of the distribution of significant vascular disease (intracranial and extracranial) among individuals with stroke in different populations would be worthwhile as well as a comparison of this distribution in relation to selected risk factors such as diabetes, hypertension and elevated lipids; and (5) clinical trials to measure the effectiveness of reducing the levels of blood pressure and serum lipids on the incidence of stroke and heart disease in the community.

References

6. The Framingham Study; an epidemiological investigation of cardiovascular disease. Monograph, Section 6, Table 7-9, 1968

Stroke, Vol. 1, March-April 1970 97
18. Cardiovascular Disease 1960, Data on national and state mortality experience, US Dept HEW, Public Health Service 1964

Addendum

AREA 1—FLORIDA HOSPITALS
Abbey Hospital
Cedars of Lebanon
Community Hospital
Doctors Hospital
Jackson Memorial Hospital
James Archer Smith
Hialeah Hospital
Kendall Hospital

Mercy Hospital
Miami Heart Institute
Mt. Sinai Hospital
North Miami General
North Shore Hospital
North West Hospital
Osteopathic General Hospital
Pan American Hospital
Saint Francis
South Miami
U.S. Air Force Hospital
Veterans Administration Hospital
Victoria Hospital
Parkway General (Formerly Cloverleaf)

AREA 2—COLORADO HOSPITALS
American Medical Center
Bethesda Hospital
Colorado Psychopathic Hospital
Denver General Hospital
Fitzsimmons General Hospital
General Rose Memorial Hospital
Fort Logan Health Center
Lutheran Hospital and Medical Center
Mercy
National Jewish Hospital
Porter's Memorial Hospital
St. Luke's Hospital
Swedish Medical Center
Presbyterian Medical Center
University of Colorado, Colorado General Hospital
Valley View Com.
Gate's Mutual Benefit Club
Mt. Airy Hospital
Rocky Mt. Osteopathic
St. Joseph's Hospital
St. Anthony
Beth Israel
Graig Rehabilitation
Veterans Administration Hospital
St. Francis Hospital
Memorial Hospital

AREA 3—KANSAS HOSPITALS
Arkansas City Hospital
Dechairo Hospital
Geary County Hospital
Greenwood Hospital
Newman Memorial
Newton Memorial
Onaga Com. Hospital
St. Francis Hospital
St. Joseph Hospital
St. Mary Hospital-Emporia-Lyon
CEREBROVASCULAR DISEASE MORBIDITY STUDY

St. Mary Hospital, Manhattan-Riley
Stormont-Vail Hospital
Susan B. Allen Memorial
Wesley Hospital
Veterans Administration
Sedan City Hospital
Morris Co. Hospital
Memorial Manhattan
Irwin Army
A.T.S.F., Topeka, Kansas
Genn Co. Hospital
Kansas University Medical Center
Haistead Hospital
Clay Co. Hospital
Veterans Hospital, Topeka

AREA 5—SEATTLE, WASHINGTON HOSPITALS
Doctor's Hospital
Group Health
Kirkland
Maynard
Medical Dental Hospital
Northgate General
Overlake Memorial
Providence Hospital
Roverton
*St. Francis Cabrini
Seattle General
Stimson Cobb Hospital
Swedish
U.S. Public Health
Valley General
Veterans Administration
Virginia Mason

AREA 6—NEW YORK HOSPITALS
Buffalo Columbus
Millard Fillmore
Sisters of Charity
Veterans Administration
Deaconess
Lafayette General
Emergency
E. J. Meyer Memorial

Roswell Park
Buffalo General
Kenmore Mercy
DeGraff Memorial
St. Francis
Mercy

AREA 7—NORTH CAROLINA HOSPITALS
Cherry Hospital
Cape Fear
Eastern, North Carolina
4th Tactical Hospital
Wayne County Memorial
Wilson Memorial
Walker Memorial

AREA 8—GEORGIA HOSPITALS
Candler General Hospital
Memorial Medical Center
Oglethorpe
St. Joseph Hospital
U.S. Public Health

AREA 9—SOUTH CAROLINA HOSPITALS
Orangeburg Reg. Hospital
St. Eugene Hospital
Georgetown County Memorial
Whitten Village Intensive
Medical College Hospital
Roper Hospital
South Carolina Baptist
Veterans Administration Hospital
South Carolina State Hospital
McLeod Infirmary
Tuomey Hospital
Byerly Hospital
Bamberg County Memorial Hospital
Ocean View Memorial Hospital
Coleman Aimar
Wilson Clinic Hospital
Finger Clinic Hospital
Marion County Memorial
Williamsburg County Memorial
Loris Community Hospital
Mullins Hospital
Kerchaw County Memorial
Aiken County Hospital
Colleton County Hospital
Lee County Memorial

*St. Francis Xavier and St. Francis Cabrini are the same Hospital.
Nationwide Cerebrovascular Disease Morbidity Study
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