Natural History of Stroke in Rochester, Minnesota, 1945 Through 1954

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Abstract:
The records of the Mayo Clinic have been used as the primary basis for the study of stroke in the population of Rochester, Minnesota, from 1945 through 1954. The incidence rate for first stroke of all types was 194/100,000/year. The rates increased with age, and at age 65 to 74 years, about 1% of the population was affected annually. No significant differences were noted between men and women. The rate for cerebral thrombosis was 146/100,000/year for all ages. Cerebral hemorrhage represented less than 10% of all strokes and occurred in less than 15% of those who died; this is contrary to what is published in the U.S. Mortality Statistics. The prevalence rate was 547/100,000 on January 1, 1955. Twenty-one percent of these persons who had previously had a stroke were functioning with no incapacity on the date of prevalence determination and only 3% were bedridden. Death certificates were reviewed for all those who died after a stroke. Among those who died within a month after a stroke, some type of stroke was noted as the underlying or an associated cause of death in 91%. However, among those who died more than a month after a stroke, only 54% had such a diagnosis recorded. Probability of surviving after each type of stroke was determined and compared with survival in a normal population. The curve showing probability of surviving from cerebral thrombosis diverges throughout its course from that of the expected survival but diverges more sharply in the first several months. Among those patients with stroke who died, 41% died of causes related to the acute stroke and 10% died of a subsequent stroke. Heart disease was the cause of nearly twice as many deaths as was a subsequent stroke among those who survived the initial stroke. Autopsies were performed on approximately 50% of those persons who died following a stroke, and information from these studies confirmed the high degree of accuracy of the clinical appraisals.

ADDITIONAL KEY WORDS
- incidence
- prevalence
- mortality
- death certificates
- cerebral infarction
- subarachnoid hemorrhage
- stroke recurrence
- cerebral hemorrhage
- population study

This study was undertaken to establish the incidence, prevalence, and mortality for various types of strokes in the population of Rochester, Minnesota, and to define the long-term survivorship of persons who were residents of this city when the stroke occurred. It does not include patients from other sources who have been seen at the Mayo Clinic. It is intended that these data will provide a baseline for comparison with other populations and with other time periods for persons in Rochester. The period described herein precedes the general use of anticoagulant drugs, antihypertensive agents, and surgical treatment for strokes.

After the first few years of this century,
the physicians at the Mayo Clinic provided essentially all medical care, from birth to death, for persons living in Rochester and in Olmsted County, Minnesota. This situation prevailed until the mid-1950's when the Olmsted Medical Group began practice and the Olmsted Community Hospital was built and used principally by the Olmsted Medical Group. Both of these medical facilities flourished and have provided primarily general care for many of the Rochester residents.

For several decades the records of the Mayo Clinic have been indexed by diagnosis and are retrievable according to diagnosis for the study of a variety of medical problems. This medical indexing and record retrieval system has been implemented in the other medical institutions in and around Rochester. Therefore, identification is now assured of practically all Rochester residents in whom a serious illness has been diagnosed. This includes diagnoses made in the hospital, at the time of an office visit or house call, or at autopsy for all medical care units in the community. During the past 20 years, about 60% of all Rochester residents who died have had an autopsy performed by physicians in the Department of Experimental and Anatomic Pathology of the Mayo Clinic.

In our use, the term "natural history" refers to observations concerning disease states in which there is no interference with either the established medical care habits of the population or the existing patterns of medical management. Patients with transient ischemic attacks—that is, focal cerebral ischemia of less than 24 hours' duration—are not included in the study described herein. The total population in Rochester was 28,247 in 1950 and was estimated to be 32,600 in 1955 by intercensus interpolation.

Methods

All medical records for the population of Rochester which were kept at the Mayo Clinic and other medical institutions in Olmsted County were reviewed for the ten-year period 1945 through 1954, and those with a diagnosis of stroke, cerebrovascular disease, cerebral hemorrhage, subarachnoid hemorrhage, or occlusion of a cerebral vessel were identified. For convenience, all of these collectively will be referred to as cases of stroke. Cases were selected for this study on the basis of the following criteria: (1) signs of neurological deficit due to a central nervous system vascular lesion present for at least 24 hours, and clinical characteristics to suggest that a stroke was the cause of the lesion, or (2) a recent stroke was documented on autopsy. The medical records fulfilling these criteria were examined in depth to identify the presence of other significant disease, the degree of subsequent disability, and the length of survival.

Patients who were residents of Rochester and who had the onset of their first stroke in the study period were included in the determination of incidence. Only the first stroke was considered when determining incidence. For mortality studies, patients were included who had a stroke and died while a resident in the community during the stated years. Death certificates were reviewed for all persons who died, and autopsy reports were reviewed when those were available. For some patients the clinical details at the time of the acute episode were not available or were fragmentary, but the history of onset and residual deficit were sufficiently well documented to ensure a high likelihood that a stroke had occurred; these were classified as "type unknown."

Autopsy protocols were reviewed to find any cases of stroke diagnosed for the first time at autopsy. If the stroke was considered to have been acute, the patient was included in the study; there were four such cases. There were other cases in which areas of old encephalomalacia were noted on examination of the brain, but there was no documentation of any clinical event which might have been a stroke. There is no way to relate these to the period studied and they are not included in the analysis which is described.

The diagnosis of the type of stroke was based on the information available in the clinical or autopsy records. The diagnosis of cerebral hemorrhage was based on a constellation of signs including some or all of the following: presence of localizing neurological signs, altered state of consciousness, evidence of meningeal irritation, bloody spinal fluid, and autopsy confirmation. Primary subarachnoid hemorrhage was distinguished from primary intracerebral hemorrhage by the lack of localizing neurological signs, by the late occurrence of localizing signs after clinical evidence of subarachnoid hemorrhage, or by autopsy.

Results

On the basis of diagnosis and residence, 648 cases were included in the study. In 98%, medical care was received at the Mayo Clinic at some time in the course of the illness. Table 1 shows the origin and the follow-up in these cases. In 548 cases, the first stroke occurred...
HISTORY OF STROKE IN ROCHESTER, MINNESOTA

TABLE 1
Number of Patients at Onset and Follow-up

<table>
<thead>
<tr>
<th>Course</th>
<th>Before 1945</th>
<th>In Rochester, 1945-1954</th>
<th>Elsewhere, moved to Rochester</th>
<th>Date unknown</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alive 1/1/55 in Rochester</td>
<td>17</td>
<td>161</td>
<td>6</td>
<td>0</td>
<td>184</td>
</tr>
<tr>
<td>Died 1945-1954</td>
<td>49</td>
<td>359</td>
<td>13</td>
<td>4</td>
<td>425</td>
</tr>
<tr>
<td>Elsewhere</td>
<td>5</td>
<td>26</td>
<td>4</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>Lost to follow-up</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>71</td>
<td>548</td>
<td>24</td>
<td>5</td>
<td>648</td>
</tr>
</tbody>
</table>

TABLE 2
Number of Patients by Age and Sex and Average Annual Incidence for 1945 Through 1954

<table>
<thead>
<tr>
<th>Age (yr)</th>
<th>Male (no.)</th>
<th>Female (no.)</th>
<th>No.</th>
<th>Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;35</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>35-44</td>
<td>9</td>
<td>4</td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td>45-54</td>
<td>26</td>
<td>27</td>
<td>53</td>
<td>159</td>
</tr>
<tr>
<td>55-64</td>
<td>47</td>
<td>50</td>
<td>97</td>
<td>369</td>
</tr>
<tr>
<td>65-74</td>
<td>83</td>
<td>91</td>
<td>174</td>
<td>1,081</td>
</tr>
<tr>
<td>≥75</td>
<td>67</td>
<td>140</td>
<td>207</td>
<td>2,494</td>
</tr>
<tr>
<td>Total</td>
<td>234</td>
<td>314</td>
<td>548</td>
<td>194</td>
</tr>
<tr>
<td>Age-adjusted† rate*</td>
<td>200</td>
<td>178</td>
<td>188</td>
<td></td>
</tr>
<tr>
<td>Age-adjusted and sex-adjusted† rate*</td>
<td></td>
<td></td>
<td></td>
<td>190</td>
</tr>
</tbody>
</table>

*Cases per 100,000 population per year.
†Adjusted to United States 1950 white population.

while the patient was a resident of Rochester during the study period. Studies of incidence and survivorship are based only on this group. Death certificate and autopsy diagnosis studies were based on the 425 patients who were residents of Rochester at the time of death in the study period but may or may not have been residents at the onset of the stroke. Prevalence is based on the 184 patients who had had a stroke and who were residents of Rochester on January 1, 1955. Only three patients were lost to follow-up.

The review of death certificates disclosed 30 other cases with stroke on the certificate but without available clinical details. Since date of onset in these cases is unknown and no historical or physical examination data were available, they are not included in table 1.

INCIDENCE
Table 2 shows the incidence rates for stroke according to age and the number of strokes according to sex for the Rochester population. The rates, which are not shown according to sex in this table, are not significantly different in men and women in any age group. The number of women is greater than the number of men over the age of 75, but there are many more women than men alive at that age; thus the incidence rates are similar. About 1% of the population between 65 and 74 years of age were affected annually; for those over 75 years of age, about 2% were affected annually. The rate for all persons is 194 per 100,000 population per year. When age-adjusted and sex-adjusted to the United States white population in 1950, the rate is 190 per 100,000 per year.

The percentage distribution of the various types of stroke did not vary significantly during the ten years of the study. In the ensuing discussion we will use the terms "cerebral thrombosis," "cerebral embolism," and "cere-
bral hemorrhage.” It should be understood, however, that included in the term “cerebral thrombosis” are all cases of cerebral infarction not due to a known embolus. Cerebral infarction, due to thrombosis and other causes, accounts for 75% of cases, cerebral embolism for 3%, intracerebral hemorrhage for 10%, and subarachnoid hemorrhage for 5%; 7% were of unknown type.

The age distribution for each category of stroke is shown in table 3. Cerebral thrombosis occurred at more advanced ages than cerebral hemorrhage. The age distributions for cerebral embolus and for type unknown are not significantly different from the distribution for cerebral thrombosis.

Age-specific annual incidence rates for cerebral thrombosis are shown in table 4. The incidence rate of cerebral thrombosis increases...
with age to the oldest age group and is not significantly different for men and women in any age group. The number of cases in each age group in other categories of stroke are small and do not warrant computation of age-specific incidence rates. However, for cerebral hemorrhage the rate increases through age 65 to 74 years, and there is no increase after that. The rate for subarachnoid hemorrhage also increases until age 55 to 64 years, after which it is constant.

PREVALENCE

On the date selected for determination of prevalence rate, January 1, 1955, there were 184 patients who had a stroke and were known to be living in the community. Of these patients, 77% had had cerebral infarction due to thrombosis. Table 5 shows the prevalence rates by age and sex. These rates increase with age in both sexes, so that about 0.4% of those 45 to 54 years of age, 1.4% of those 55 to 64 years of age, and about 3% of those 65 to 74 years of age on this date were affected. About 6% of all persons over the age of 75 living in the community had had a stroke. This is an overall prevalence rate of 547 per 100,000 population. Perhaps more important is that, of the 184 patients in the community who had had a stroke and were alive, 21% were functioning with no significant incapacity, 73% were ambulatory with some degree of incapacity, and only 3% were bedridden; the status of 3% was not known. Among the 184 patients, 14% had some degree of aphasia.

DEATH CERTIFICATES AND MORTALITY RATES

Death certificates were obtained for all of the 425 Rochester residents with stroke who died during the study period. One hundred ninety of these died within one month after the acute stroke, stroke was certified on the death certificate as the underlying cause of death or as an additional cause in 91% of these death certificates (table 6). Among the 235 patients who died more than one month after the acute stroke, stroke was certified on the death certificate as the underlying cause or as an additional cause in 54%.

If we used "underlying cause of death," as stated on the death certificate, as the means of determining a mortality rate for stroke, the rate for this population would be about 106/100,000/year, which is close to the national average of about 103/100,000/year for this period. If the additional persons whose death certificates had stroke noted as a secondary or contributing cause of death are added, the rate for the community would then be 117/100,000/year.

SURVIVORSHIP

Probabilities of surviving for the first 30 days (fig. 1) and for 20 years (fig. 2) after the onset of various types of stroke are based on follow-up at least through January 1, 1968. Strokes of all degrees of severity in inpatients and outpatients were included. Among those patients with cerebral thrombosis, 73% were still alive 30 days after the onset of the stroke. The survivorship for one month is age dependent, being about 80% for those under 55 years of age, 74% in the age group 55 to 84 years, and 49% for those over 85 years of age.

Among persons with an unknown type of stroke, 92% were alive at the end of one month. This reinforces our impression that most of these cases were cerebral infarcts and, because they usually were less severe than in the group included under cerebral infarction, there usually was a longer interval between onset and diagnosis. Cerebral hemorrhage had a one-month survivorship of only 17% and
subarachnoid hemorrhage had a one-month survivorship of 35%. The high mortality for subarachnoid hemorrhage reflects the inclusion of patients who survived only a few hours or less; some did not survive long enough to reach the hospital.

To compare probability of surviving various types of stroke (figs. 3, 4, and 5) to expected survival for each type, the survival of the normal population was determined as if there were a person of identical age, sex, and race for each person in the study population. These graphs are shown on log scale so that the slopes of the curves can be compared to judge relative survival for any segment of the time scale.

The curve showing probability of survival after cerebral thrombosis diverges throughout its course from that of the expected survival, but it diverges more sharply in the first several months (fig. 3). The curves for cerebral embolus and for type unknown were not significantly different from those for cerebral thrombosis and are not shown.

For intracerebral hemorrhage there is a marked divergence from the expected survival but the number of survivors after the first month is small (fig. 4). For subarachnoid hemorrhage, after the first two months the survival curve for the study population is essentially parallel to the expected survival curve (fig. 5). Only during the first two months was there an excess mortality as compared to expected survival. Again, however, the numbers for comparison are small after the first month or two.

AUTOPSIES
Autopsy information concerning the brain was available for about 50% of those who had a history of stroke and died in Rochester, Minnesota. Of the 213 cases in which the brain was examined at autopsy, 73% were diagnosed as cerebral or brain stem infarction, 3% as
cerebral embolus, 17% as cerebral or brain stem hemorrhage, and 7% as subarachnoid hemorrhage (table 7).

CAUSE OF DEATH
Causes of death of 473 patients who had an acute stroke between 1945 and 1955 and subsequently died prior to January 1, 1968, are shown in table 8. One hundred ninety-three patients (41%) died of causes related to the acute stroke and 49 (10%) died of a subsequent stroke. Heart disease was the cause of 18% of deaths if sudden deaths are included as cardiac disease. However, heart disease was the cause of nearly twice as many deaths as was a subsequent stroke among those persons who survived the initial stroke. On the basis of the clinical records, 45% of the patients with cerebral thromboses were judged to have died of the initial or a subsequent stroke.

RECURRENT STROKE
Among 362 patients surviving more than one month after the initial stroke, recurrence of stroke occurred in 115 (32%) up to January 1, 1968: in 85 there was one recurrence, in 25 there were two recurrences, in four there were three recurrences, and in one there were four recurrences. Table 9 shows the type of second stroke which occurred for each category of first stroke other than those categorized as “unknown.” It is notable that there were six cases of subsequent intracerebral hemorrhage among patients whose initial stroke had been due to cerebral thrombosis. Also, among patients whose initial stroke was subarachnoid hemorrhage, the second stroke was hemorrhage of some type in two and infarction of some type in three. The second stroke occurred within one year after the first stroke in 35, in one to three years in 29, in three to five years in 18, and in more than five years in 33.

Discussion
This study has attempted to identify all persons
Stroke is a major cause of morbidity and mortality in this country. It frequently occurs in elderly persons who are no longer productive in society and whose downward sloping survival curve is, to a considerable extent, related to age alone. Death due to stroke is strongly related to the type of stroke. The most lethal form, cerebral hemorrhage, is relatively uncommon. Survival after an acute episode of cerebral infarction can be quite long. According to our data, the average degree of disability of those surviving is not as severe as generally assumed.

The incidence rate of first episode of stroke in this study is 194/100,000/year. Other reported rates are: 170/100,000 by Eisenberg and associates (includes both first and recurrent strokes; their rate for first attack only is 140/100,000); 150/100,000 population aged 30 to 59 at the time of entry into the study in the Framingham study; 154/100,000 population based on hospital and general practitioners' records by Brewis and co-workers in Carlisle, England; and 258/100,000 (age-adjusted) from a population base of about 80,000 persons in mid-Missouri (this
TABLE 7
Autopsy Diagnosis in Deaths After Stroke in Rochester, Minnesota, 1945 Through 1954

<table>
<thead>
<tr>
<th>Autopsy diagnosis</th>
<th>Died within 1 mo. of stroke</th>
<th>Died more than 1 mo. after stroke</th>
<th>No.</th>
<th>%</th>
<th>No.</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebral infarct</td>
<td>37</td>
<td>70</td>
<td>107</td>
<td>50</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Brain stem infarct</td>
<td>8</td>
<td>8</td>
<td>16</td>
<td>8</td>
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<td></td>
<td></td>
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<tr>
<td>Cerebral &amp; brain stem infarct</td>
<td>8</td>
<td>17</td>
<td>25</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cerebral embolism</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Intracerebral hemorrhage</td>
<td>20</td>
<td>3</td>
<td>23</td>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Brain stem hemorrhage</td>
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<td>7</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intracerebral &amp; brain stem hemorrhage</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subarachnoid hemorrhage with aneurysm</td>
<td>10</td>
<td>3</td>
<td>13</td>
<td>6</td>
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<td></td>
<td></td>
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<tr>
<td>Subarachnoid hemorrhage</td>
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<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Other</td>
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<td>2</td>
<td>6</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>105</td>
<td>108</td>
<td>213</td>
<td>100</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>No autopsy report</td>
<td>85</td>
<td>127</td>
<td>212</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Total</td>
<td>190</td>
<td>235</td>
<td>425</td>
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</tbody>
</table>

TABLE 8
Cause of Death in Residents Who Had First Stroke in Rochester, Minnesota, 1945 Through 1954, and Died Prior to January 1, 1968

<table>
<thead>
<tr>
<th>Cause of death</th>
<th>Cerebral thrombosis</th>
<th>Cerebral embolus</th>
<th>Type of first stroke</th>
<th>Subarachnoid hemorrhage</th>
<th>Unknown</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Initial stroke</td>
<td>118</td>
<td>5</td>
<td>45</td>
<td>18</td>
<td>7</td>
<td>193</td>
</tr>
<tr>
<td>Subsequent stroke</td>
<td>41</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>49</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>43</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>5</td>
<td>52</td>
</tr>
<tr>
<td>Cardiac failure</td>
<td>19</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>22</td>
</tr>
<tr>
<td>Sudden death</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Gastrointestinal</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Respiratory tract disease</td>
<td>35</td>
<td>0</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>45</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Cancer</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>General atherosclerosis</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td>Renal or urinary tract disease</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>3</td>
</tr>
<tr>
<td>Unknown</td>
<td>19</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>355</td>
<td>11</td>
<td>52</td>
<td>23</td>
<td>32</td>
<td>473</td>
</tr>
</tbody>
</table>

was a predominantly white population) by Parrish and associates.4

The distribution as to type of stroke is considerably different from Wylie's5 report that cerebral hemorrhage made up 58.9% of the strokes. However, the population surveys from Framingham2 (4% cerebral hemorrhage), Goulburn, Australia,6 (17%) and Hisayama, Japan,7 are much closer to the 9.4% found in the present series.

Cerebral hemorrhage has been a common misdiagnosis applied in cases of sudden and unexpected death, especially before the significance of myocardial infarction as a cause of sudden death was fully realized. Actually, stroke of any type is an uncommon cause of sudden death or death occurring within a few hours of the onset of unconsciousness.8

Because the term “cerebral hemorrhage” has been used too loosely and frequently in the past as the cause of death, mortality rates that are recorded for various types of
stroke are quite misleading. The Vital Statistics for the United States from 1905 through 1965 indicate that the ratio of cerebral hemorrhage to cerebral infarction for these particular years was as high as 80:1 in 1920 and gradually decreased to about 2:1 in 1965 (fig. 6). Part of the change is due to changes in the coding system. However, from 1945 to 1955 the ratio of cerebral hemorrhage to cerebral infarction changed from about 9:1 to about 2.5:1. That contrasts greatly with the ratio, 0.15:1, in the Rochester population for 1945 through 1954. It is apparent that even the more recent national mortality statistics reflect a considerable degree of overdiagnosis of cerebral hemorrhage compared to infarction on death certificates.

Even in well-documented cases of stroke, cerebral hemorrhage frequently has been diagnosed on the basis of rapid course to death within a few days. Cerebral hemorrhage frequently does lead to death within a few days but, if we consider only those persons dying within four days after the onset of a stroke in our series, only 30% had cerebral hemorrhage. The availability of accurate clinical records and a high percentage of autopsies has permitted us to delineate the type of lesion in many cases and demonstrate that cerebral hemorrhage does not comprise a very large percentage of strokes. Cerebral infarction occurs four to six times more frequently in the ages 45 to 64 years and more than 20 times more frequently in ages over 75 years than does intracerebral hemorrhage.

Autopsy information concerning the brain was available for about 50% of those who died with a stroke in Rochester during the study period. This is a high autopsy rate for a study of this type and in general the autopsy information (table 7) confirms the high degree of accuracy of the clinical appraisal.

The higher percentage of cerebral hemorrhage in mortality data and hospital or autopsy series is undoubtedly due to the high fatality rate of cerebral hemorrhage as compared to cerebral infarction and the greater likelihood for death to occur in the hospital and for autopsies to be performed on patients who die early in the course of an illness. In our present series, autopsies were performed on approximately 60% of those dying of cerebral hemorrhage and 50% of those dying of cerebral infarction.

Subarachnoid hemorrhage made up 5.5% of the strokes in our study. The number of persons with subarachnoid hemorrhage in the 65 to 84 year age group is about the same as in the 35 to 54 year age group. However, the incidence rate is nearly three times higher in the older age group. We do not have documenta-
tion of the presence of aneurysms in all these cases since angiography was not performed regularly throughout the period studied. However, aneurysms were found in 14 of the 18 cases autopsied.

The prevalence rate in our study is 547/100,000. A prevalence rate of 400/100,000 was estimated in the Hisayama study based on the presence of neurological deficit at the time of the first examination. However, the population in that study was smaller and also younger than that of Rochester, making comparison difficult. The combined one-year incidence-prevalence rate (referred to as annual prevalence) for Middlesex County has been calculated as 220/100,000. This rate for Rochester in 1954 was over 700/100,000, more than three times that reported for Middlesex. The large number of milder strokes identified and the continuing survival of these patients in the community over at least a ten-year period could account for much of this difference.

Because there have been so few community-based studies on stroke, estimates of incidence and geographical distribution have generally been derived from mortality reports based on death certificates. The problems inherent in such a source are well known. Since the probability of stroke being reported on the death certificate is much greater among patients dying within the first 30 days than among the larger proportion dying later, estimates of incidence of stroke from mortality statistics cannot be expected to correspond to those derived from morbidity surveys in the total population of a community. In the 30 cases (not included in our analyses) in which stroke was given on the death certificates but could not be substantiated from medical records, a disproportionately high percentage were reported as cerebral hemorrhage. We were aware that, when called to see a patient who had died or who was dead on arrival at the hospital, one general practitioner in this area tended to call such cases "coronary sclerosis" on the death certificate and another called them "cerebral hemorrhage." This is an isolated example of how diagnostic fashion can influence incidence rates and mortality rates for the various types of stroke.

The survival rate for the first few months for patients with cerebral thrombosis was better than that noted in other population studies. This is most likely because of the inclusion in the study of mild cases seen at home or on an outpatient basis and not requiring hospitalization. The very low survival rate for cerebral hemorrhage in the first 30 days is consistent with other studies.

Among survivors of the first stroke from cerebral thrombosis and from all causes, nearly twice as many died from heart disease as from a subsequent stroke. This contrasts with a Worcester, Massachusetts, hospital-based study which noted that 41% of survivors of cerebral thrombosis died of a subsequent stroke and 30% died of heart disease.

Acknowledgment

The authors would like to acknowledge the assistance of Dr. N. Matsumoto in reviewing records, Mrs. Margaret A. Danielson in abstracting and follow-up procedures, and Miss Eileen B. Fjerstad in preparation of the manuscript.

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Stroke. 1971;2:11-22
doi: 10.1161/01.STR.2.1.11
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
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