Changing Pattern of Cerebral Infarction: 1945–1974

W. Michael Garraway, M.B., Ch.B., M.F.C.M., Jack P. Whisnant, M.D.,
Leonard T. Kurland, M.D., and W. Michael O’Fallon, Ph.D.

SUMMARY This study has identified all persons in the population of Rochester, Minnesota, who had a diagnosis of cerebral infarction during the period Jan. 1, 1970, through Dec. 31, 1974, and has confirmed the continuing decline in the incidence rate previously reported. The decline in the rate has been accelerating, with a relatively greater reduction occurring in women and in the more elderly age groups. There has been a decline in the prevalence rate in women which was not seen in men. The over-all impact of cerebral infarction was to reduce the proportion of those persons who were completely independent from 57% before cerebral infarction to 16% after infarction. Comparison of survival among patients with cerebral infarction occurring in the two quinquennia 1945–49 and 1970–74 showed only a 2% increased probability of survival at 30 days; the difference in survival increased progressively to 16% at 5 years. The reason for the declining incidence and increased survival in cerebral infarction in this population has not been established, but evidence of increased community surveillance and treatment of hypertension among persons before the onset of cerebral infarction is presented.

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Methods

The medical records involving a diagnosis of stroke were identified for the population of Rochester, Minnesota, from the Mayo Clinic and its affiliated hospitals and the other medical facilities in Rochester; from the Olmsted Medical and Surgical Group and Olmsted Community Hospital; from the University of Minnesota Hospitals and the Veterans Administration Hospital in Minneapolis; and from hospitals in southeastern Minnesota. The 5-year period Jan. 1, 1970, through Dec. 31, 1974, was covered by using the same criteria and instructions previously applied and used for the period Jan. 1, 1945, through Dec. 31, 1969.3, 4 Records were retrieved for all diagnostic categories in which the diagnosis might have been stroke according to the following definition: the onset of a focal neurologic deficit arising as a result of a presumed vascular lesion and lasting for 24 hours or more. Transient ischemic attacks with focal neurologic deficits lasting less than 24 hours were excluded. The diagnosis of the type of stroke was based on all the information available in the clinical or autopsy records. Records of cases in which the diagnosis of primary subarachnoid hemorrhage and primary or secondary intracerebral hemorrhage had been made were separated out by using criteria that have been reported elsewhere.3, 4 Only cases of cerebral infarction were considered, and the following criteria were used to place patients into the remaining diagnostic categories of stroke:

1. Cerebral, cerebellar, or brainstem infarction — relatively rapid onset of focal neurologic deficit persisting for 24 hours or more and with clear cerebrospinal fluid or no evidence of hemorrhage on computed tomography scan (or both). Included in this category are all cases of cerebral infarction not associated with a recognized source of an embolus.

2. Cerebral, cerebellar, or brainstem embolus — abrupt onset of focal neurologic deficit in association with a known source of embolus. Because of this limitation, the number of embolic lesions is probably understated. A few red blood cells in the spinal fluid did not preclude this diagnosis.

3. Stroke of uncertain type — incomplete clinical details at the onset of the acute episode but a history of onset and residual deficit sufficiently well documented to ensure a high likelihood that a stroke had occurred. We reviewed the records and assigned the patients to the diagnostic categories according to the information available. If an autopsy or computed tomography of the head was performed, the information obtained...
was a determining factor in placing the patient into a diagnostic category. The autopsy rate among Rochester residents during the study period was 58%. Death certificates of residents of Rochester who died during the period 1970 through 1974 were also reviewed to identify those with cerebral infarction. In 4 cases in which cerebral infarction was listed on the death certificate, either death occurred suddenly or the time that had elapsed before death occurred was not known and autopsies were not performed; or the clinical records did not support the diagnosis recorded on the death certificate or no clinical record was available. These patients were presumed to have died from a cause other than cerebral infarction, and they were not included in the analysis.

For the determination of incidence, only patients whose first cerebral infarct occurred between Jan. 1, 1970, and Dec. 31, 1974, were considered. Prevalence rates were determined by identifying all patients who had had a cerebral infarct and who were alive and were residents of Rochester on Jan. 1, 1975. Only patients who had been living in Rochester for a continuous period of 1 year before their cerebral infarction were recorded as bona fide residents. This approach was designed to exclude those patients who might have migrated into the community to obtain medical care. The total population of Rochester was 52,629 in 1970. The functional status of survivors was graded from relevant details in the clinical records according to the method first described by Rankin, whose criteria are as follows:

Grade I: No significant disability; able to carry out all usual duties,

Grade II: Slight disability; unable to carry out some previous activities but able to look after own affairs without assistance,

Grade III: Moderate disability; requiring some help but able to walk without assistance,

Grade IV: Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance,

Grade V: Severe disability; bedridden, incontinent, and requiring constant nursing care and attention.

A total of 362 patients were accepted for the study as incidence or prevalence cases on the basis of diagnosis and residence. In 263 patients, the first cerebral infarct or stroke of uncertain type occurred while the patient was a resident of Rochester during the period Jan. 1, 1970, through Dec. 31, 1974. Incidence rates and survivorship are based only on data from these patients, 88% of whom were seen by physicians of the Mayo Clinic. Seventy-three percent were seen by a neurologist, and 82% were admitted to a hospital after the onset of cerebral infarction during the period of the study. Prevalence rates are based on the 246 patients who were resident in Rochester on Jan. 1, 1975, and who may or may not have been resident at the time of stroke onset. No patient was lost to follow up.

Results

Incidence

The average annual incidence rates for cerebral infarction were higher in men than in women in all age groups (table 1). When the overall rates are adjusted to take into account the age structure of the Rochester population, there were 3 men with onset of cerebral infarction during the period 1970 through 1974 for every 2 women. Thirteen percent of the total infarcts for this period were embolic in origin, and a further 6% were categorized as stroke of uncertain type. Thus, the remainder, 4 of 5 infarcts, were cases of cerebral infarction presumably due to thrombosis, with no clinical evidence of a source for an embolus.

The trend in the incidence of cerebral infarction was examined over the time period 1945 through 1949. Table 2 and figure 1 show age-adjusted average annual incidence rates for each sex and for both sexes combined over consecutive quinquennial periods from

<table>
<thead>
<tr>
<th>Age group (yr)</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Rate</td>
<td>Rate</td>
<td>Rate</td>
</tr>
<tr>
<td>&lt;55</td>
<td>10</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>55-64</td>
<td>226</td>
<td>168</td>
<td>40</td>
</tr>
<tr>
<td>65-74</td>
<td>660</td>
<td>90</td>
<td>30</td>
</tr>
<tr>
<td>75-84</td>
<td>1,381</td>
<td>1,004</td>
<td>2,385</td>
</tr>
<tr>
<td>≥85</td>
<td>1,884</td>
<td>1,337</td>
<td>3,221</td>
</tr>
<tr>
<td>All ages</td>
<td>117</td>
<td>146</td>
<td>263</td>
</tr>
</tbody>
</table>

*Cases per 100,000 population, based on estimated population, July 1972.
†Adjusted to the 1950 U. S. white population.
1945 through 1974. These data show a decline in the rates in women which began following the 1950–54 period. There was a lesser decline in the rates in men until the last quinquennium, when the rate of decline increased. For the 2 sexes combined, there was a decline throughout the period studied.

When the trend is examined in age-specific groups (fig. 2), it is apparent that the relative decline in rates has been similar in all age groups. However, the absolute rates in the more elderly groups were much higher to begin with, and so, not surprisingly, their rates decreased more during the period under review. The ratio of the rates between the age groups 55 through 59 years and 85 years and older narrowed from 1:16 in 1945–49 to 1:8 in 1970–74. The relative proportions of cerebral infarcts, embolic infarcts, and strokes of uncertain type did not change during the period under review.

### Age at Onset

The mean age at onset of the first cerebral infarct in women showed a gradual increase over the 6 quinquennia from 72 to 75 years of age. Excluding the first quinquennium, the same was true for men from 68 to 71 years of age.

#### Prevalence

On Jan. 1, 1975, 246 Rochester residents were alive after a cerebral infarct. Figure 1 shows the age-adjusted prevalence rates on Jan. 1, 1975, compared with the respective rates on Jan. 1, 1955, and Jan. 1, 1965. There was an excess in the age-adjusted rate in men compared with the rate in women. There was a decline in prevalence rates in women which was not seen in men.

#### Status of Survivors

Table 3 compares the level of dependency before the cerebral infarct with dependency present 1 year after the onset. Nearly half of the persons had some preinfarction dependency, and 16% required at least some help with daily living activities. All persons in grade

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**Table 2** Average Annual Age-Adjusted Incidence Rates for Cerebral Infarction in Various Time Periods (Rates Are per 100,000 Population)*

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Males†</td>
<td>181</td>
<td>151</td>
<td>156</td>
<td>147</td>
<td>147</td>
<td>105</td>
</tr>
<tr>
<td>Females†</td>
<td>138</td>
<td>114</td>
<td>121</td>
<td>97</td>
<td>70</td>
<td>69</td>
</tr>
<tr>
<td>Total†</td>
<td>156</td>
<td>214</td>
<td>152</td>
<td>139</td>
<td>125</td>
<td>107</td>
</tr>
<tr>
<td>Age- and sex-adjusted‡</td>
<td>150</td>
<td>152</td>
<td>142</td>
<td>125</td>
<td>107</td>
<td>83</td>
</tr>
</tbody>
</table>

*Figures under N are actual numbers of cases in each quinquennial period.
† Age-adjusted to 1950 U.S. white population.
‡ Age- and sex-adjusted to 1950 U.S. white population.

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**Figure 1.** Point prevalence rates and average annual incidence rates for cerebral infarction from all causes according to calendar years. Both prevalence and incidence rates are age-adjusted to 1950 U.S. white population according to sex.

**Figure 2.** Age analysis of incidence of cerebral infarction, 1945–49 to 1970–74.
TABLE 3  Comparison of Dependency Before and 1 Year After Onset of Cerebral Infarction

<table>
<thead>
<tr>
<th>Pre cerebral infarct, Rankin grade</th>
<th>Postcerebral infarct, Rankin grade</th>
<th>IV and V</th>
<th>Died</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>I</td>
<td>18</td>
<td>15</td>
<td>148   (57%)</td>
</tr>
<tr>
<td>II</td>
<td>II</td>
<td>18</td>
<td>19</td>
<td>70     (27%)</td>
</tr>
<tr>
<td>III</td>
<td>III</td>
<td>14</td>
<td>12</td>
<td>20     (11%)</td>
</tr>
<tr>
<td>IV and V</td>
<td>IV and V</td>
<td>6</td>
<td>8</td>
<td>14     (5%)</td>
</tr>
<tr>
<td>Total (16%)</td>
<td>Total (25%)</td>
<td>53 (20%)</td>
<td>54 (21%)</td>
<td>261* (100%)</td>
</tr>
</tbody>
</table>

*Excludes 2 patients in whom dependency grades could not be estimated.

IV and V, who required the most assistance, were aged 75 years and older. The overall impact of cerebral infarction on the dependency of this group of individuals was to reduce the proportion of persons in the completely independent (grade I) group from 57 to 16% and to increase the proportion in the heavily dependent grades IV and V from 5 to 20%.

Survivorship

Among all patients with the onset of cerebral infarction from 1970 through 1974, 88% were alive 7 days and 82% were alive 30 days after onset. The proportions surviving for cerebral thrombosis, embolic infarcts, and uncertain type of stroke, respectively, were 89%, 91%, and 75% at 7 days, and 82%, 83%, and 75% at 30 days. The probabilities of surviving each type of cerebral infarction for up to 5 years were compared with the survival of a standard Minnesota population made up of persons of the same age, sex, and race as the study population (fig. 3).

The probability of survival at 30 days and at annual intervals thereafter up to 5 years after the onset of cerebral infarction was compared for the periods 1945-49 and 1970-74 (fig. 4). There was a 2% increase in the probability of surviving to 30 days between the 2 quinquennial periods, but this increased progressively with duration of survival so that 5 years after the onset of cerebral infarction the difference in survival between 1945-49 and 1970-74 was 16%. The increased probability of survival was such that persons with the onset of cerebral infarction in 1970-74 had the same probability of survival to 5 years as those with onset of cerebral infarction in 1945-49 had of survival to 2 years.

Discussion

Comparison of the results of previous Rochester stroke studies1, 2 with those of the present study has permitted extension of the long-term trend in incidence rates, prevalence rates, and survival for patients with cerebral infarction in the community from 1945 through 1974. The previously reported decline in the incidence rate for cerebral infarction3 has continued producing an average annual age- and sex-adjusted rate of 83.1 per 100,000 persons for 1970-74. This represents the major portion of the decline in incidence rates for all strokes which has recently been reported.4

The relative decline in incidence between the 6 consecutive quinquennia commencing with 1945-49 has been 4%, 7%, 12%, 14%, and, finally, 22% between the age- and sex-adjusted rates for 1965-69 and those for 1970-74. Thus, for every 100 new cases of cerebral infarction occurring in 1945-49 per unit of population, there were only 52 new cases occurring in 1970-74. The decline in rates was greater in women than in men until the last quinquennium, when the rate of decline increased in men (fig. 1). The higher age-specific rates for men compared with women was maintained throughout the period under review, except for the...
1950–54 period. Some previous studies have indicated that the mortality rate from cerebral infarction is approximately equal for the 2 sexes.7–9 Because of the nature of the surveillance of the community under study, the decrease in incidence rates is unlikely to be due to changes in diagnostic methods or in case ascertainment. Computed tomography of the head was introduced in Rochester in June 1973, and so it would have had little if any influence on the distribution of types of stroke for the period under consideration. We have no direct evidence to explain why the decline being reported has occurred, but there is mounting evidence from other studies that antihypertensive therapy may produce a reduction in cardiovascular events at a community level.10–12 Although they cannot be regarded as anything other than inferential, 3 trends with respect to blood pressure findings during the 4 quinquennial periods commencing with 1955–59 are presented. This first period coincides with the introduction of effective drug therapy for hypertension. Only the blood pressure findings of those persons who had cerebral infarction during this period have been considered; cases of embolic infarction and stroke of uncertain type have been excluded. Figures 5 and 6 summarize the findings. The proportion of patients who had their blood pressures taken within the period of 1 year before the onset of cerebral infarction increased progressively from 35% in 1955–59 to 61% in 1970–74. Allied to this increase in community surveillance of blood pressure has been a reduction in the proportion of cases with at least moderately increased diastolic blood pressure (to more than 105 mm Hg) or with no record that the blood pressure had ever been taken. By 1970–74, the former had decreased to one-half and the latter to one-third of their 1955–59 levels. There was no difference in these observations between men and women.

These changes have been accompanied by an increase in the relative proportion of patients with diastolic pressures at various levels who were receiving antihypertensive drug treatment before the onset of cerebral infarction. The increase is present in all 3 diastolic groups — 105 mm Hg or more, 95 to 104 mm Hg, and less than 95 mm Hg — but the point at which the main increase in the proportions occurred in these groups under treatment differs. For patients with a diastolic pressure of 105 mm Hg or more, the steepest increase (15%) occurred between 1960–64 and 1965–69. For patients with diastolic pressures of 95 to 104 and less than 95 mm Hg, the steepest increases (20% and 15%, respectively) occurred later, between 1965–69 and 1970–74. Thus, a “delay” appears to have occurred between increased recognition of hypertension through better community surveillance and the subsequent application of drug therapy.

The markedly increased proportion of patients with mild or moderate hypertension who were under treatment by 1970–74 may have contributed to the increased rate of decline in the incidence of cerebral infarction, but more definite evidence to support this can only be obtained by examining similar trends in blood pressure among persons who did not have a stroke during the period 1965–74. There were too few patients on antihypertensive treatment at each blood pressure level to determine whether there was a difference between men and women which might have contributed to the difference in the decline in incidence rates between the sexes.

The proportion of patients with diastolic blood pressures of more than 105 mm Hg who were not receiving treatment before the onset of cerebral infarction remained surprisingly high, 53%, in the last period considered (1970–74). This suggests that if antihypertensive therapy is effective in reducing the incidence of cerebral infarction, we may expect the decline in the incidence rate to continue for some years ahead.

The mean age of the patients at the onset of cerebral
infarction increased during the period under review, particularly in women. This should not be interpreted as meaning that the onset of cerebral infarction was being delayed. It was more likely related to the increasing proportion of older persons in the population and the fact that cerebral infarction incidence rates are higher in older age groups.

The point prevalence rates in women (fig. 1) indicate that there was a decline corresponding to the decline in incidence rates. However, prevalence rates in men were relatively constant. There may not have been time for the decrease in incidence rates in men in the last quinquennium to be reflected in the most recent prevalence rate.

There was only a 2% improvement in survival at 30 days between 1945-49 and 1970-74. This reflects the lack of progress in treating acute cerebral infarction during the early period of high mortality. It has been postulated that the risk of dying from cerebral infarction is not related to the after-effects of the lesion in terms of mental or physical disability but rather to the slow progression of the underlying vascular disease. The gradual improvement in the probability of survival up to 5 years between patients who had the onset of cerebral infarction in 1945-49 and those with the onset in 1970-74 may be a result of a reduction in the rate of progression of the underlying vascular disease. However, it seems more likely that improved management of respiratory and cardiac disorders in persons with established cerebral infarction is more relevant.

Acknowledgment

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References

Recovery in Treated Aphasia in the First Year Post-Stroke

MARTHA TAYLOR SARNO, M.A. AND ERIC LEVITA, PH.D.

SUMMARY During a one year post-stroke period of observation, the recovery trend in treated aphasic patients was characterized by general progression in communication skill. The most notable improvement occurred on a measure of everyday function with changes worthy of note on tasks of auditory comprehension and spontaneous word production. In the first 6 months post-stroke, the greatest gain occurred in aphasic patients classified as Fluent, and the least gain in Global aphasics. On the auditory comprehension task, however, improvement was noted in all aphasics regardless of type. In contrast, during the latter half of the first year post-stroke, Fluent aphasics showed least and Global aphasics the greatest improvement. In spite of their progress, Global aphasic patients remained considerably more impaired than the other groups. That the Global aphasics remained so impaired was expected, but the extent and temporal characteristics of their progress in communicating was unexpected.

Study findings are probably affected by failure to consider the variable of time since onset.\textsuperscript{10, 13, 14} For this reason, the primary objective of this study was to explore the influence of time in the recovery course of aphasic patients receiving speech therapy.

Methods

Subjects

We studied 34 aphasic patients referred to the Speech Pathology Service of the Institute of Rehabilitation Medicine between May 1970 and December 1976. Patients selected for study had vascular lesions of the left hemisphere confirmed in most by neuroradiologic studies. One had a CVA due to arteriovenous malformation and another due to a ruptured aneurysm of the left internal carotid artery. All were Caucasian, right-handed adults, native speakers of English with normal hearing thresholds across the speech frequencies.

Patients were excluded from the study if they had a history of alcoholism, pre-existing speech disorder, psychiatric disease, previous CVA, or known TIA, or had already received aphasia therapy. Those with aphasia secondary to head trauma or neoplasm, equivocal handedness, or evidence of right hemisphere pathology were also excluded. Patients who were not

Knowledge of recovery and rehabilitation in aphasia is based mostly on studies of post-traumatic patients,\textsuperscript{1-13} in whom the outcome is known to be more favorable than in patients whose aphasia is associated with vascular pathology and who are not, therefore, representative of the large majority of aphasic patients.\textsuperscript{8} Very few aphasia recovery studies have been concerned exclusively with patients who have had stroke.\textsuperscript{8, 12}

Research concern with pathophysiology is reflected in an extensive literature on aphasia localization and classification with relatively little on recovery and rehabilitation. The medical community is relatively indifferent to the subject of recovery and seems to assume that no further exploration is necessary. Also, the many problems associated with designing and conducting research in recovery from aphasia often deter investigators.