# Epidemiology of Stroke in a Rural Area

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THE IMPACT of stroke is difficult to evaluate. Mortality data are full of complicating considerations, and they provide few clues about the medical, social, and psychological problems encountered by persons who have stroke. An approximate figure for countries reporting mortality from stroke is one death for each 1,000 persons per year, and the mortality rate for the United States is not far from this average (*1*, *2*).

Incidence, prevalence, and survivorship data will help to fill gaps in the knowledge of the epidemiology of stroke, and the data are necessary for planning service programs. The purpose of this paper is to add data related to the second year's experience with the Mid-Missouri Stroke Survey. Parrish and co-workers (*3*) reported on the incidence of stroke by age, sex, county, and race for the first year of the study, and Goldner and associates (*4*) reported on the prognosis for survival after stroke for the same period.

## Method

The Mid-Missouri Stroke Survey is a descriptive epidemiologic study which began July 1, 1963, and which attempts to gather information about all strokes occurring in a three-county area of central Missouri. This paper covers the period from July 1, 1964, to June 30, 1965, and the same categories of data reported on by Parrish and Goldner (*3*, *4*).

Data were collected from multiple sources to minimize underreporting. Physicians were visited monthly during the entire 2-year period by a representative from the Division of Health of Missouri. Hospitals in the area reported patients who signed out with diagnoses of cerebrovascular disease. Records of hospitals bordering the area were checked to find cases of cerebrovascular disease among persons residing in the study area but who were hospitalized outside of it. Death certificates registered at the Missouri Division of Health were checked for the entire 2-year study period and for a year following the study's completion. Study investigators reviewed charts to detect all hospitalized patients. Early in the survey nursing home records were surveyed, but this source was abandoned because the records generally were meager and because this kind of survey failed to uncover an appreciable number of definite cases which were not reported by physicians or hospitals or on death certificates.

Strokes were divided into major and minor categories on the basis of the patient's residual neurological deficit after 72 hours. The patient's physician made this decision, and the clinical records of hospitalized patients were reviewed by the study team. Generally, the physician's assessment coincided with that of the study team, but a few cases were deleted from the

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study because of the probability that their cerebral symptoms were caused by metastases. We felt that adequate etiological classification of the types of stroke could not be made because of differences in diagnostic procedures, case descriptions, and laboratory tests used by the various hospitals and private physicians.

### Incidence

A total of 189 patients with major strokes during the second year of the study were recorded. Of this total, 1 (0.5 percent) was age 25–44, 5 (2.6 percent) were age 45–54, 23 (12.2 percent) were age 55–64, 43 (22.8 percent) were age 65–74, and the remaining 117 (61.9 percent) were 75 or over. Table 1 gives the total number of strokes by age groups, race, and sex and table 2 the age-specific rates for the same groups. Populations were estimated by linear extrapolation using 1950 and 1960 census data as the base.

As expected, the increase in rate occurred with increasing age. The rates for white men and white women are approximately the same, with the rates for men being consistently a little higher.

The rates for nonwhite persons are consistently higher than those for white persons, and as in white persons, the rates for men are higher than those of women. Rates for nonwhite persons are based on smaller populations and fewer cases and are therefore more subject to random variability.

However, the racial differential is essentially the same as in the first year's data, which tend to support the hypothesis that there is a real difference. This difference is in the range of two-fold. Nichaman (*5*), in a study of mortality in Charleston, S.C., found a much greater difference in prevalence of stroke among white persons as compared with nonwhite persons.

Table 3 gives the age-adjusted rate by county, sex, and race, and the overall age-adjusted rate for the total population. Again, numbers in the

**Table 1. Number of strokes recorded in Mid-Missouri Stroke Survey, July 1, 1964–June 30, 1965, by age, race, and sex**

| Age (years) | White | | Nonwhite | | Total [1] |
|---|---|---|---|---|---|
| | Men | Women | Men | Women | |
| 25–34 | 0 | 1 | 0 | 0 | 1 |
| 35–44 | 0 | 0 | 0 | 0 | 0 |
| 45–54 | 1 | 0 | 2 | 2 | 5 |
| 55–64 | 12 | 9 | 2 | 0 | 23 |
| 65–74 | 18 | 14 | 6 | 5 | 43 |
| 75–84 | 31 | 40 | 4 | 2 | 77 |
| 85 and over | 17 | 20 | 2 | 1 | 40 |
| Total | 79 | 84 | 16 | 10 | 189 |

[1] 95 men, 94 women; 163 white patients, 26 nonwhite patients.

**Table 2. Age-specific rates per 1,000 for major stroke, by race and sex, Mid-Missouri Stroke Survey, July 1, 1964–June 30, 1965**

| Race and age (years) | Number of strokes | Projected population | Rate per 1,000 |
|---|---|---|---|
| | Males | | |
| White: | | | |
| 25–34 | 0 | 4, 424 | 0 |
| 35–44 | 0 | 3, 779 | 0 |
| 45–54 | 1 | 3, 824 | .3 |
| 55–64 | 12 | 3, 060 | 3.9 |
| 65–74 | 18 | 2, 424 | 7.4 |
| 75–84 | 31 | 1, 319 | 23.5 |
| 85 and over | 17 | 321 | 52.8 |
| Nonwhite: | | | |
| 25–34 | 0 | 330 | 0 |
| 35–44 | 0 | 230 | 0 |
| 45–54 | 2 | 195 | 10.3 |
| 55–64 | 2 | 265 | 7.5 |
| 65–74 | 5 | 216 | 27.7 |
| 75–84 | 2 | 131 | 30.5 |
| 85 and over | 1 | 25 | 83.3 |
| | Females | | |
| White: | | | |
| 25–34 | 1 | 3, 761 | .3 |
| 35–44 | 0 | 3, 992 | 0 |
| 45–54 | 0 | 3, 907 | 0 |
| 55–64 | 9 | 3, 523 | 2.6 |
| 65–74 | 14 | 3, 036 | 4.6 |
| 75–84 | 40 | 1, 777 | 22.5 |
| 85 and over | 20 | 451 | 44.2 |
| Nonwhite: | | | |
| 25–34 | 0 | 293 | 0 |
| 35–44 | 0 | 258 | 0 |
| 45–54 | 2 | 269 | 7.5 |
| 55–64 | 0 | 273 | 0 |
| 65–74 | 5 | 259 | 19.4 |
| 75–84 | 2 | 136 | 14.6 |
| 85 and over | 1 | 21 | 47.6 |
| | Both sexes | | |
| Both races: | | | |
| 25–34 | 1 | 8, 614 | .1 |
| 35–44 | 0 | 8, 281 | 0 |
| 45–54 | 5 | 8, 192 | .6 |
| 55–64 | 23 | 7, 121 | 3.2 |
| 65–74 | 43 | 5, 935 | 7.2 |
| 75–84 | 77 | 3, 364 | 22.9 |
| 85 and over | 40 | 819 | 48.8 |

various subcategories are too small to test for significance, even when the numbers are combined with the first year's data.

### Survival

Turning to case fatality rate after stroke for white persons, in the first year Goldner and associates (*4*) found a 1-week mortality rate of 33 percent, a 1-month rate of 50 percent, and a 1-year rate of 67 percent. These rates were calculated on the basis of survival after the first major stroke during the year and were computed without regard to prior stroke experience or number of strokes during the year.

Table 4 gives the 1-week, 1-month, and 1-year case fatality rates for the second year of the study. For white persons 1-week case fatality rates ranged from zero to 54 percent in age-specific groups, with an overall rate of 46 percent. The 1-month case fatality rates ranged from zero to 76 percent, with an overall rate of 61 percent, and the 1-year case fatality rates ranged from zero to 81 percent, with an overall rate of 74 percent. The age gradient in the 1-year case fatality rates shows younger patients surviving longer than the older patients. This trend is not nearly as pronounced in the 1-week and 1-month rates.

### Discussion

Data from the 2 years of this study represent a reasonable effort to define the morbidity and mortality of stroke. Eisenberg (*6*) and Kurland (*7*) have obtained results from comparable studies with incidence figures similar to the Mid-Missouri survey. However, certain trends began during the second year of the study which were of concern to us.

**Table 3. Age-adjusted rates for stroke per 1,000 persons,[1] by county, race, and sex, Mid-Missouri Stroke Survey, July 1, 1964–June 30, 1965**

| County and sex | White | Nonwhite | Both races |
|---|---|---|---|
| Boone: | | | |
| Male | 2.3 | 3.8 | 2.4 |
| Female | 2.0 | 3.5 | 2.1 |
| Cooper: | | | |
| Male | 2.6 | 5.4 | 2.8 |
| Female | 1.3 | 4.2 | 1.4 |
| Howard: | | | |
| Male | 1.8 | 8.7 | 2.5 |
| Female | 2.0 | 2.7 | 2.1 |
| Total | 2.0 | 4.5 | 2.2 |

[1] Based on estimated 1964 Missouri population.

The total number of cases reported during the study was 219 during 1963–64 and 189 during 1964–65. The number of nonwhite patients reported increased from 24 in the first year to 26 in the second year, relatively no change. The number of cases reported in white persons decreased from 195 to 163 (−17 percent). This difference in reporting in these years (32 cases) was not statistically significant at the $\alpha=0.05$ level ($0.05<P\chi 2<0.10$).

Age groups 35–74 years accounted for the major portion of the difference in reporting from the first year to the second year (80 cases compared with 54 cases, $P\chi 2<0.05$). The reduced number of younger patients in the second year of the study and the consistent increase for the second year in the case fatality rates for white

**Table 4. Death rates among white patients who had a major stroke, by age and period of survival, Mid-Missouri Stroke Survey, July 1, 1964–June 30, 1965**

| Age (years) | Number with stroke | Lived 1 week | | Lived 1 month | | Lived 1 year | |
|---|---|---|---|---|---|---|---|
| | | Number died | Percent died | Number died | Percent died | Number died | Percent died |
| 45–54 | 1 | 0 | | 0 | | 0 | |
| 55–64 | 21 | 9 | 42.9 | 10 | 47.5 | 11 | 52.4 |
| 65–74 | 32 | 13 | 40.6 | 21 | 65.6 | 22 | 68.8 |
| 75–84 | 71 | 32 | 45.1 | 40 | 56.3 | 57 | 80.3 |
| 85 and over | 37 | 20 | 54.1 | 28 | 75.7 | 30 | 81.1 |
| Total | 162 | 74 | 45.7 | 99 | 61.1 | 120 | 74.1 |

persons in all time periods (1 week, 1 month, 1 year) led us to suspect that we were not obtaining reports for all milder strokes.

This study was heavily dependent on physicians' reporting for noninstitutionalized patients with presumably milder strokes. This experience could be accounted for by waning interest in reporting cases. We hasten to add that these busy practitioners extended themselves during the study in the spirit of cooperativeness alone and with no additional benefits to themselves or their patients.

Two methodological considerations should be kept in mind when interpreting these data.

1. Random variation in numbers of stroke deaths by year would be expected.

2. Population estimates in small areas for noncensus years are often inaccurate.

The method of linear extrapolation tends to ignore sharply changing trends in population composition. We do not feel these considerations invalidate the general mortality figures presented. However, we hesitate to interpret minor differences in incidence rates within county and age groups as being meaningful.

#### Recommendations

Combining a survey of this type with a program of professional education or community service should help to maintain the motivation of the physicians. Such a program was considered in the Mid-Missouri Stroke Survey but was not enacted because of lack of personnel.

In establishing the length of the study, careful consideration should be given both to the expected duration of physicians' interest and potential of the study to meet certain of the needs of the community. The practicing physician should not be burdened with case reporting when other sources are available.

Assistance in making difficult and differential diagnoses should be made available to community physicians. Encouragement could be provided for increasing autopsy rates through these interpersonal consultations.

This study was a joint effort of the Missouri Division of Health, the University of Missouri, and the Public Health Service. Participation by agencies with these varying scopes of interest gave us excellent coverage in both the counties studied and in the health structure of mid-Missouri. However, the presence of several interested, active groups in the study hampered the fixing of primary responsibility and authority with one investigator or agency. The agency responsible for collecting the information did not have the necessary authority to obtain records as needed. We feel when several agencies are participating in this type of community study, the agency responsible for assembling data should have direct access to all the sources.

Several factors which could be important in other community-based studies became apparent with time. In these rural counties surveys of the nursing homes produced no new cases of stroke which we had not found through physician reports of hospital record review. We did not approach the families of stroke patients and thereby missed an important source of data on the natural history of stroke. Finally, review of completed records on receipt would provide an opportunity to query the physicians concerning patients recently treated (of course, delay in completion of records should be reduced when possible).

#### Summary

The Mid-Missouri Stroke Survey was an epidemiologic study conducted by the University of Missouri Medical School, the Division of Health of Missouri, and the Public Health Service from July 1, 1963, to June 30, 1965. The study covered Boone, Cooper, and Howard Counties. Data were collected from physicians, hospitals, and death certificates to minimize underreporting.

In the second year of the study, 189 cases of stroke were revealed among persons over 25 years old. This is an age-adjusted rate of 2.2 per 1,000 persons based on the estimated 1964 population.

In the first year of the study the mortality rate for white persons was 33 percent for 1 week, 50 percent for 1 month, and 67 percent for 1 year. These rates were calculated on the basis of survival after the first major stroke during the year and were computed without regard to prior stroke experience or the number of strokes during the year.

In the second year case fatality rates for white persons for 1 week ranged from zero to 54 percent in age-specific groups, with an over-

all rate of 46 percent. The 1-month case fatality rates ranged from zero to 76 percent, with an overall rate of 61 percent, and the 1-year case fatality rates ranged from zero to 81 percent, with an overall rate of 74 percent. Fewer younger patients in the second year led to the suspicion that milder strokes were not being reported, possibly as a result of waning interest of participating physicians.

Long-term surveys of this type should be combined with professional education or community service to maintain the participants' motivation. The agency responsible for collecting data should have access to all sources.


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#### Tearsheet Requests

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## Pollution-Free Cars

Two contracts have been awarded by the National Air Pollution Control Administration, Public Health Service, to further the development of a practically pollution-free powerplant for the family car.

The Thermo Electron Corp. of Waltham, Mass., was awarded $174,173, with a 1-year completion deadline, for the design of an integrated propulsion system using the Rankine cycle engine. A contract for studying the combustion characteristics of the heat-generating portion of such a power system was awarded to the Marquardt Corp. of Van Nuys, Calif., in the amount of $96,683, also with a 1-year completion time. Automobiles powered by Rankine cycle vapor system were popular in the 1920's.

The integrated propulsion system design contract will provide a complete set of plans from which a powerplant and vehicle could be built. In selecting and linking together such components as combustors, steam generators, vapor condensers, pumps, and controls, consideration will be given to current availability, cost, and potential for mass production. The design will show how the powerplant would be placed in a vehicle and would indicate space requirements.

The study of combustion characteristics will provide information from which to design a burner system that would result in the lowest possible emissions of hydrocarbons, carbon monoxide, and oxides of nitrogen.

In the Rankine cycle propulsion system, fuel ignition takes place in a burner outside the engine, which permits relatively complete combustion and, therefore, relatively low emissions. The combustion characteristics study will investigate ways of changing different components of the burner system to reduce the emissions still further. Consideration will be given to size and shape of the combustion chamber, types of burners, location and method of introducing fuel, and other factors affecting the production of air contaminants.