DEATH RATES for cerebrovascular disease have declined in the United States since at least the 1940’s. This decline continued through 1982 (fig. 1). Several studies have attributed this to declining incidence with little change in case fatality of acute stroke. Two studies reported declines in hospitalization rate, an indicator of stroke occurrence, during the 1970’s. In this report, data from the National Hospital Discharge Survey for a ten-year period are presented. These data show no consistent downward trend in hospital discharge rates for cerebrovascular disease but suggest a decline in case fatality rates between 1970 and 1983. In addition, effects of age, sex, race and region are presented and patterns of utilization of cerebral arteriography and carotid endarterectomy are examined.

Methods

The National Hospital Discharge Survey. As previously described, the National Hospital Discharge Survey encompasses patients discharged from non-institutional hospitals exclusive of Federal hospitals located in the 50 States and the District of Columbia. Included in the list of eligible hospitals are those licensed hospitals with at least six beds where the average length of stay for all patients is less than 30 days. Hospital discharges are selected for abstracting by a multi-staged sampling procedure described in detail elsewhere. From a universe of over 8,000 hospitals, a sample of over 500 is selected each year, of which over 400 consent to participate and meet eligibility criteria. With hospitals, the daily listing sheet of discharges was the frame from which subsamples of discharges were selected. Probabilities of selection at each stage of sampling are known so that estimates of national statistics may be obtained. Depending on the study procedure agreed on with the hospital administrator, either hospital staffs or representatives of the National Center for Health Statistics (NCHS) performed the sample selection and the transcription of information from the hospital record face sheet to abstract forms.

SUMMARY

Data from the National Hospital Discharge Survey were reviewed to assess trends in hospital discharge rates for cerebrovascular disease in the United States between 1970 and 1983. Hospital discharge rates showed little consistent change during the 1970’s but increased after 1979. Hospital case fatality declined during the same period. Cerebrovascular disease discharge rates were higher among older persons, men, and blacks. Hospital case fatality was higher in older persons and blacks. Rates of cerebral arteriography and endarterectomy of vessels of the head and neck increased between 1979 and 1983. Methodologic problems in monitoring cerebrovascular disease trends are reviewed and recommendations for future research presented.

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FIGURE 1. Age-adjusted death rates per 100,000 for cerebrovascular disease mortality by sex and race for persons 35-74 years and 75 years and over, United States, 1979-1982. (Age-adjustment performed separately for the two-age spans by the direct method using the 1980 U.S. resident population as standard.)

mates were taken from publications of the United States Bureau of the Census or from estimates obtained from the Bureau of the Census (1982 and 1983). Race-specific rates were computed for 1981 only. Because of the much larger percent of cases with missing race than for other imputed variables, caution should be used in drawing conclusions from the data by race.

Hospital case fatality was computed as follows: the number of discharges with discharge status coded dead was divided by the total number of discharges with cerebrovascular disease. This is a conservative estimate since those with discharge status coded "nonstat" are assumed to be alive at discharge. However, it includes deaths from co-morbid conditions.

Results

Trends

No downward trends in rates of discharge of patients with first-listed diagnoses of cerebrovascular disease appeared during this period except for persons 65 years and over between 1974 and 1978 (fig. 2). However, when rates for 1970 to 1973 were considered, there was no net change among older persons. In contrast to the appearance of little change during the 1970's, a definite upward trend in rates was seen between 1979 and 1983 for both young and old. Hospital case fatality rates declined over the period (fig. 3). The change was seen both among older and younger persons.

Several technical problems complicate the interpretation of these trends. In 1979, the number of abstracted diagnoses coded was increased from a maximum of 5 to 7. In addition, the comparability ratio between ICDA (1970-1978) and ICD 9 (1979-1983) for codes 430-438 is (ICDA-8/ICD-9-CM) 0.93 (NCHS, unpublished data). This most likely explains the upward discontinuity in discharge rates seen between 1979 and 1978 especially among older persons.

Hence trends should be examined within each ICD time period. A further problem is that the universe of hospitals sampled was updated and new hospitals were added to the sample in 1972, 1975, 1977, 1979 and 1981. As a result, the estimated number of discharges jumped in some of these years, tending to raise the rates and offset any decline.

Age

Hospital discharge rates for persons 65 years and over are over five times those for persons 45-64 years (fig. 2). Hospital case fatality rates, however, were about 50 percent higher in persons 65 years and over as compared to persons under age 65 (fig. 3).

Sex

Men had somewhat higher cerebrovascular disease hospitalization rates than women in both age groups (fig. 2), the difference being greatest in those 45-64 years (sex ratio about 1.5). There were no substantial sex differences in trends of hospital discharge rates.

Race

The age-adjusted hospital discharge rates by race for persons 35-74 years of age in 1981 were: blacks, 652 per 100,000; whites, 483 per 100,000. Hence, the rate for first-listed diagnoses for blacks was 1.3 times that for whites. For persons over 75, there was little difference between rates in blacks (3540 per 100,000) and whites (3438 per 100,000). At ages 45-64, case fatality was over twice as high for men and 60 percent higher for women in blacks compared to whites. Over 65, the black excess fatality was 15 percent for men and 27 percent for women. However, these fatality data must be interpreted with caution because of the small number of blacks in the sample and resulting large standard error for subgroup estimates.

Region

Throughout the period the Midwest region had the highest overall discharge rates for cerebrovascular dis-
Cerebral Arteriography and Endarterectomy

Only ICD 9 CM permitted detailed examination of both these procedures. Rates of cerebral arteriography increased steadily between 1979 and 1983. For persons 45–64 years of age, the rate of all-listed procedures increased from 97 per 100,000 in 1979 to 130 per 100,000 in 1983 (34 percent). For persons 65 years of age and over, rates increased from 123 per 100,000 to 259 per 100,000 (111 percent). Similar trends were observed for endarterectomy of vessels of the head and neck (carotid artery). Rates increased from 45 to 56 per 100,000 among persons 45–64 years (24 percent) and from 131 to 252 per 100,000 among persons 65 years and over (92 percent) between 1979 and 1983. Cerebral arteriography was about twice as common among older persons whereas rates of endarterectomy were more than three times higher among older persons as compared to persons 45–64 years. Rates of both in men were 30 to 50 percent higher than in women. In 1981, the age-adjusted rate of cerebral angiography was equal in blacks and whites aged 35 to 74 years. However, the rate of endarterectomy among blacks was only 40 percent that of whites.

**Discussion**

In the National Hospital Discharge Survey, cerebrovascular disease hospitalization rates showed little change during the 1970's but increased after 1979. Hospital case fatality declined during the same period. Cerebrovascular disease discharge rates were higher among older persons, men, blacks and persons in the Midwest region. Patterns by age and sex are consistent with patterns of cerebrovascular disease mortality. However, time trends are not consistent with the marked downward trends in cerebrovascular disease mortality. However, the absolute and relative rate of mortality decline between 1979 and 1982 was less than between 1971 and 1975. The black-to-white ratio of hospitalization rates is somewhat lower than what would be expected from mortality ratios. Further, the very low rates of endarterectomy and the equivalent rates of cerebral arteriography among blacks as compared to whites are not consistent with patterns of mortality or morbidity. However, caution must be used in interpreting the race-specific data due to the large percent with race imputed. Mortality and prevalence data would lead one to expect the highest hospitalization rates in the South followed by the Midwest region.

Other published studies of cerebrovascular disease hospitalization and case fatality generally reported declining hospitalization rates and stable case fatality for initial stroke. The National Survey of Stroke reported a 14 percent decline in hospitalized initial stroke rates for persons aged 35 to 74 but an increase in recurrent stroke resulting in little change in overall rates in the coterminous United States between 1971 and 1976.
Rates of initial stroke for persons under 65 did not decrease, consistent with the present results. Over the period, 73.8 percent of patients had initial stroke and 26.2 percent had recurrent stroke. There were no "gross secular changes in patient survival for the six years study period." In the Minneapolis/St. Paul metropolitan area, hospitalization rates for acute stroke were lower in 1980 than in 1970 but there was no significant difference in hospital case fatality except for men 30–64 years of age. In Rochester, Minnesota, incidence of a first stroke declined between 1970–74 and 1975–79 by 27 percent in persons aged 55–64 years and by 13 percent in persons aged 65–74 years. Almost no change in 30 day survivorship occurred between these periods for all ages. A previous report has documented the steady increase in the number of endarterectomies for disease of the extracranial arteries of the head and neck since 1971.

The reasons for the apparent recent upturn in National Hospital Discharge Survey hospitalization rates and decline in hospital case fatality for cerebrovascular disease are unclear. Decreasing incidence with stable survivorship, as reported in other studies, should lead to decreasing hospitalization rates and stable hospital case fatality. However, detection of milder strokes by computerized tomography and increased rates of elective hospitalization for cerebral angiography and endarterectomy might be contributing factors to increased hospitalization and decreased fatality rates. Increased hospitalization of recurrent acute strokes would increase both hospitalization rates and case fatality. Increased hospitalization of patients with chronic cerebrovascular disease would increase hospitalization rates with variable effect on case fatality. Subgroups of codes used to indicate acute thrombotic or hemorrhagic stroke in one published surveillance study constituted about 80 percent of all cerebrovascular disease (ICD 430–438) discharges for persons 45–64 years of age and about 90 percent of discharges of persons 65 years and over in the National Hospital Discharge Survey during 1979–83, the period when ICD 9 CM was used. The corresponding percentages were about 75 percent of younger and about 85 percent of older patients during 1974–78, the period of ICD 9, suggesting little change in the proportion of chronic cerebrovascular disease. No national data are available that permit accurate assessment of trends in cerebrovascular disease prevalence, a major determinant of hospital utilization. However, data from the U.S. Health Interview Survey suggest an increase in prevalence of cerebrovascular disease reported in health interviews for both sexes at ages 45–64 and 65 and over between 1972 and 1977. This finding is consistent with an effect of declining national case fatality (fig. 3). Further studies are needed to determine how much of the apparent discrepancy in trends between national discharge data and data from various localities is due to methodologic considerations.

Several previous papers have discussed methodologic problems in community surveillance of trends in cerebrovascular disease, mortality and morbidity. Similar problems may affect both national and local studies. These problems occur in studies regardless of whether the sampling fractions of hospitals and of discharges are 100 percent (as in many smaller studies) or much less than 100 percent (as in the National Hospital Discharge Survey). Cases of cerebrovascular disease treated at home or in institutions cannot be detected while those dying out of hospital may be detected by death certificate. Estimation of acute cerebrovascular disease hospitalization rates is made difficult by several problems. Noncooperation of hospitals selected to be sampled is a significant problem. For example, the sample of the National Hospital Discharge Survey for 1981 consisted of 550 hospitals. Of these, 71 refused to participate and 51 were out of scope either because the hospital had gone out of business or because it failed to meet the definition of a short-stay hospital. To produce unbiased national estimates, an adjustment for nonresponse was made as a component of the estimation procedure. There is difficulty in establishing an accurate sampling frame especially in retrospective studies of years prior to 1979. Many hospitals have closed or merged and may have changed record numbering systems, making sampling difficult. New hospitals have opened during the period of interest. Thus frequent updating of the hospital sample universe is necessary. Although much less in recent years, variation in hospital systems of discharge data retrieval may make sampling difficult because of lacking data on age, residence, year of discharge, discharge status or discharge codes in a form suitable for easy sampling. Fortunately, most hospitals can provide data as computer printouts or computer tapes rather than as file cards or other difficult formats.

Other problems relate to the lack of reliability of information on medical record discharge sheets. Studies by the Institute of Medicine have indicated that this problem is considerable and varies greatly by discharge diagnosis and type of data abstracted. There is a substantial lack of reliability in the designation of a diagnosis as principal and the assumption that the first-listed diagnosis is the principal is fraught with difficulty. It is clearly appropriate to report whether first-listed (principal) or all-listed diagnoses is used in any published reports. The introduction of diagnosis-related groups and prospective payment in 1983 may affect the frequency of cerebrovascular disease codes, further complicating the study of trends over time. For estimation of rates of acute thrombotic or hemorrhagic stroke resulting from hypertension or arteriosclerosis, exactly which of the codes 430–438 are most appropriate is not clear. If resources are limited, one of the subsets of codes used in two large published studies may be adopted. Separation of initial acute stroke from recurrent admissions for acute stroke or for late complications of stroke is probably not possible based on information on the discharge sheet alone. Even using first-listed diagnosis, a single patient might be counted more than once in a given year by the National Hospital Discharge Survey, if there were multiple discharges with codes 430–438 from a sampled hospital. Once the
sample is finally selected, the desired charts may be missing from the medical record room. Further, race and other important demographic or other data may be missing from the face sheet (or even from the chart as a whole). This is a particularly severe problem in studies like the National Hospital Discharge Survey in which the protocol precludes searching the body of a chart for information not listed on the discharge sheet. Such problems may extend even to coding of discharge status as alive or dead.

Another problem is the validity of discharge diagnoses quite apart from the reliability of their abstracting and coding. In the Nationwide Study of Stroke, 1846 (68.1 percent) of 2,710 cases with discharge ICD codes 430-438 and 436 could be confirmed as acute stroke. Of the 864 not confirmed, 383 had probable transient ischemic attack, 223 had old stroke and 106 were transferred to another hospital. In a Minnesota study, about half of abstracted cases met strict criteria for acute stroke. Even studies with the resources needed to attempt validation of discharges through review of hospital, clinical and laboratory data face considerable problems in this regard. Even with detailed review of medical records by trained nurses or clinicians, pertinent variables in the medical history, physical examination and laboratory examination including computed axial tomography, lumbar puncture, and isotopic brain scans may be inconsistently obtained or recorded on substantial proportions of the cases. Further, the development and application of diagnostic criteria suitable for such a data set is problematic. This is particularly true when trends over substantial periods of time are assessed. Innovations in diagnostic technology make it difficult to establish the comparability of cases over time. For example, the introduction of computed axial tomography (CAT scanning) in the late 1970’s may have resulted in more cases being diagnosed as acute stroke as compared to earlier times. The rate of CAT scans of the head among patients discharged from U.S. hospitals between 1979 and 1982. The detection of small infarcts or hemorrhages would substantially alter the case mix and hence the case fatality. This makes it difficult to find a common set of criteria which can be uniformly applied across long periods of time. A further problem for studies which attempt to approximate incidence is the unknown validity and reliability of the history of previous cerebrovascular disease as abstracted from the hospital record.

Much methodologic research is needed to improve the methods for monitoring trends in cerebrovascular disease mortality and morbidity. Further analysis of data from ongoing and past surveillance studies may provide much needed information. Despite these problems researchers should routinely exploit existing data resources such as those of the National Center for Health Statistics and its National Hospital Discharge Survey, National Institute of Neurological and Communicative Disorders and Stroke, the Commission on Professional and Hospital Activities, the Health Care Financing Administration (Medicare), and the Veterans Administration especially when planning epidemiologic studies. Regional or state planning organizations and local professional standards review organizations or hospital associations may also have valuable data. In analysis of data and reporting of data from these sources or from special studies, researchers should examine age-, sex- and race- specific data.

To further elucidate the causes and effects of the decline in stroke mortality, simultaneous monitoring of stroke incidence, recurrence, prevalence and case fatality rates adjusted for severity is needed. Long-term survivorship after acute stroke should be assessed. The few studies that have determined the prevalence and incidence of cerebrovascular disease in black populations have found higher prevalence and incidence in blacks than whites, especially among women. Data is lacking on trends of stroke hospitalization and case fatality in the black population. Strategies are needed to reduce the percent of medical records with missing race and introduce better techniques for routine imputation of race in national data sets. Studies should also be done to determine whether blacks have access to diagnostic and therapeutic facilities for cerebrovascular disease appropriate for their high incidence and mortality. Population-based studies of vascular pathology of stroke in blacks compared to whites are needed to confirm reports suggesting that the low rates of carotid endarterectomy may be due to a preponderance of intracranial occlusion in blacks. Many methodologic problems remain to be solved to facilitate such research. Meanwhile efforts aimed at primary prevention of cerebrovascular disease through hypertension control should be vigorously continued.

References

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