Community Surveillance for Cerebrovascular Disease: The Framingham Cardiovascular Disease Survey

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TO ESTIMATE CEREBROVASCULAR ACCIDENT (CVA) incidence in communities, reliable yet economical methods are needed by which the geographic and temporal patterns of CVA occurrence, as well as the effects of community hypertension detection and treatment programs, can be accurately assessed. The Framingham Cardiovascular Disease Survey (CVDS) was undertaken (*a*) to determine the accuracy of incidence rates generated from a short-term surveillance study of a defined community as compared with a longitudinal survey of a sample of the same population and (*b*) to investigate the methodological problems of such a short-term study. Our report deals with the results of the Framingham CVDS.

Methods

During a 1-year period in 1970–71, all new CVAs occurring among residents over the age of 30 in Framingham, Mass. (population 64,048 in 1970), were surveyed. A detailed description of the methods used has been published (*1, 2*). Briefly, the following intentionally overlapping surveillance techniques were used: monitoring of admissions to hospitals and nursing homes in and around the town, perusing of death certificates, and reporting of local physicians. Admissions to local hospitals were monitored directly; admissions to hospitals in Boston and elsewhere in Massachusetts, with the aid of several Boston and statewide data banks. All death certificates filed in the town during and for 3 months after the study period were reviewed. Community physicians were supplied with standard forms for case-reporting and queried periodically about CVA cases. Clinical and laboratory data for each potential CVA case were abstracted onto standardized forms.

Final classification of a case as CVA was based on a formal review of the abstracted data by a neurologist and a CVDS staff physician, who applied criteria (see box) adapted from those used in the Framingham Heart Study (FHS). To determine whether the clinical data ordinarily found in a patient's medical record are adequate as a basis for assigning diagnoses, a member of the staff of the Boston University School of Medicine performed a neurological examination on, reviewed the pertinent laboratory data for, and made an independent assessment of 32 of the CVA patients while they were in

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hospital. Then the diagnoses that had been assigned for these patients with and without use of the neurologist's findings were compared. In addition, the frequency with which the results of various laboratory tests, diagnostic procedures, local neurological consultations, and autopsies were available in the medical records of the patients was recorded. This frequency was found to be as follows:

Procedure	*Number of patients*
Lumbar puncture	30
Skull film	21
Brain scan	20
Angiogram	19
Electroencephalogram	10
Neurological consultation	8
Craniotomy	5
No procedures	19

Criteria for Cerebrovascular Accident (CVA)

Atherothrombotic brain infarction (ABI)

1. Localizing neurological deficit (aphasia, hemiparesis, and so forth) with:
   a. Sudden onset
   b. Documentation by a physician
   c. Duration of more than 24 hours
2. Absence of the following:
   a. Known source of embolism
   b. Intracranial hemorrhage
   c. Known hypercoagulable states
   d. Other disease processes causing focal neurological deficits

Cerebral embolus (EM)

Clinical picture as for ABI but with known source of embolism (artrial fibrillation, rheumatic mitral stenosis, recent myocardial infarction, bacterial endocarditis)

Intracerebral hemorrhage (IC)

1. Evidence of progressive mass lesion within brain substance
2. Bloody cerebrospinal fluid
3. Absence of the following:
   a. Known source of embolism
   b. Known hemorrhagic states
   c. Subarachnoid hemorrhage
   d. Other disease processes causing a similar picture

Subarachnoid hemorrhage (SAH)

1. Change in the state of consciousness, headache, and signs of meningeal irritation
2. Bloody cerebrospinal fluid, under increased pressure

Transient ischemic attack (TIA)

1. Definite neurological deficit
   a. Sudden onset
   b. Duration of less than 24 hours
   c. First diagnosis within the study period
   d. First TIA only considered to be a new event
2. Absence of other causes of transient neurological deficit (seizure disorder, hypoglycemia, drug effects, and so forth)

In the 11 of the 32 cases in which the patient died, a portmortem examination of the brain was performed.

Results

Incidence of CVA. In 89 of the CVA cases detected during the study period in persons over the age of 30, there was no prior history of CVA. The distribution of these cases by age of patient and type of CVA is shown in table 1. Death occurred within 6 weeks of onset in 36 percent (32 patients).

Table 2 shows age-specific and age-adjusted incidence rates for total CVA and for atherothrombotic brain infarction (ABI) in the CVDS and the FHS. The rates were adjusted by the direct method, with the 1970 Framingham population 45–74 years taken as the standard. Age-specific CVDS rates were in general higher among men and lower among women as compared with FHS rates. The differences between the CVDS and the FHS standardized rates for men or women did not achieve significance at the $\alpha = 0.05$ level (*4*).

Table 1. Distribution of new cerebrovascular accidents, by sex and age of patient and type of disease

Sex and age	*ABI*	*EM*	*IC*	*SAH*	*TIA*	*All CVAs*
Men						
35–65	8	2	0	1	4	15
65–74	7	2	1	1	1	12
75 and over	8	3	1	0	0	12
All ages ...	23	7	2	2	5	39
Women						
35–64	4	1	0	3	2	10
65–74	4	0	0	0	2	6
75 and over	17	6	7	0	3	[1] 34
All ages ...	25	7	7	3	7	[1] 50

[1] Includes 1 case of unspecifiable type.
NOTE: ABI—atherothrombotic brain infarction, CVA—cerebrovascular accident, EM—cerebral embolism, IC—intracerebral hemorrhage, SAH—subarchnoid hemorrhage, TIA—transient ischemic attack.

Table 2. Annual incidence of new cerebrovascular accidents in Framingham Cardiovascular Disease Survey and Framingham Heart Study, by patients' sex and age

	All cardiovascular accidents [1]		*Atherothrombotic brain infection* [1]	
Sex and age	*CVDS*	*FHS*	*CVDS*	*FHS*
Men				
45–54	5.9	19.9	2.9	9.0
55–64	54.6	34.8	29.8	22.0
65–74	101.0	78.3	55.1	38.0
All ages [2]	36.8	34.3	13.0	17.9
Women				
45–54	5.7	8.5	2.8	5.0
55–64	16.4	25.6	12.3	17.0
65–74	23.6	81.0	17.7	46.0
All ages [2]	20.8	30.3	7.0	17.9

[1] Incidence of new cases per 10,000 population.
[2] Age was adjusted by direct method with 1970 Framingham population aged 45–74 as standard.

Methodological observations. As was true with coronary heart disease, more than 90 percent of the CVA cases were detected by hospital surveillance, death reports, or both. Reporting by community physicians led to the discovery of less than 10 percent of the cases. Thus, physician reporting added little as a casefinding tool in Framingham, where nearly all patients with completed strokes are hospitalized or institutionalized. It had been hoped that transient ischemic attacks (TIAs) in persons who were not hospitalized would be reported by physicians, but this hope was realized in only a few cases.

The diagnoses of the local physicians were compared with those that the CVDS review panel had assigned after receiving all the clinical data and applying the criteria for CVA. There was good agreement (88 percent) as to whether a stroke had occurred, but agreement fell to 60 percent when cases were assigned to the various categories of CVA. Local physicians tended to diagnose more cases as nonspecific "stroke," or "cerebrovascular accident," and as TIA, whereas in all but one case, the review panel was able to assign a specific diagnosis other than nonspecific CVA. Thus, accepting the unverified diagnoses of the local physicians would have led to a fairly accurate estimate of the total CVA occurrence but not of the frequency of the various types of CVA.

Next, the diagnoses appearing on death certificates were compared with the corresponding diagnoses of the CVDS panel. Again, agreement as to whether CVA had occurred was fairly good, at 83 percent, but agreement fell to 38 percent when cases were assigned to specific CVA categories. As might be anticipated, 13 (40 percent) of the 32 death certificates for CVA patients did not specify the type of CVA. Thus, if the diagnoses on the death certificates alone had been used to classify the CVA cases in which death occurred, the total frequency would have been underestimated by about 20 percent and a breakdown by CVA types would have been inaccurate.

In 7 of the 32 cases in which the patient was examined in the hospital by the outside neurologist, his findings and assessment had an important impact on the final diagnostic decision of the reviewing physician as to the type of CVA involved, but they had little impact on the reviewing physician's decision as to whether or not a stroke had occurred. This result suggests that in a significant number of cases, the quantity and quality of the clincial data routinely recorded in the medical record may not be sufficient to accurately classify CVAs into various subcategories when these data are subjected to formal review with set criteria.

Finally, in 9 of the 89 cases surveyed, the patients were found to have been members of the FHS cohort. Therefore the diagnoses for these nine cases, which the FHS and the CVDS had arrived at independently using essentially identical data, were compared. In all nine cases, there was agreement as to the presence of CVA, and in six of the seven diagnosed as CVA in both studies, there was agreement as to the type. One case diagnosed as ABI by the FHS was labeled TIA by the CVDS.

Discussion

Although the age-specific rates for total CVA in Framingham during the study period are based on small numbers of cases, these rates are generally similar to those reported in other population studies in the literature (*5,6*). In addition, they are grossly similar to those generated by different study methods applied in the same community (table 2). The greatest discrepancies between the age-specific rates of the CVDS and the FHS were in the youngest age group (in which the number of cases was small in both studies) and in older women. It is of interest that there was also a large discrepancy between the CVDS and the much higher FHS rates for total coronary heart disease, myocardial infarction, and especially angina pectoris, in women aged 65-74 (7). It is not clear to what extent these discrepancies represent (*a*) true differences between the disease experience of older women in the general population of Framingham in 1970–71 and the accumulated experience of older women in the FHS cohort, (*b*) underdetection by the CVDS, or (*c*) the detection of milder events by repeated examination in the FHS.

Table 3 summarizes the dates and salient methodological features of other community surveillance studies of CVA in the literature (*8–25*). Examination of these reports, as well as the results of the CVDS, indicates that studies aimed primarily at CVA should have sufficiently large target populations and be of sufficient duration to yield at least 200 cases if CVA rates are to be accurately estimated. In addition, the CVDS experience indicates:

1. Reporting by local physicians is not a cost-efficient surveillance tool in the United States; reviews of hospital discharge records and death certificates are the methods of choice.

2. Unverified diagnoses by local physicians and the diagnoses on death certificates may suffice for estimation of total CVA occurrence, that is, of all types of CVAs combined, but they are inadequate for accurately estimating the occurence of the various types of CVAs. This conclusion is in agreement with other

Table 3. Community surveillance studies of cerebrovascular disease

Study and reference number	Duration of study	Population (thousands)	Disease categories [1] CVA	CHD	MI	Total cases	Data sources[1] MD	HR	DC	Other
North Dakota (*8*)	Sept. 1957–Aug. 1958	106	X	X		228	X	X	X	X
Connecticut (*9*)	Apr. 1957–Mar. 1958	84	X	X		962	X	X	X	
Australia (*10*)	Nov. 1962–Nov. 1964	24	X			158	X			
Missouri (*11*)	July 1963–July 1964	80	X			219		X	X	X
Oxford, England (*12*)	Jan. 1963–Dec. 1964	340	X	X	X	722		X	X	
Fargo and Moorehead, N. Dak. (*13*)	Jan. 1965–Jan. 1966	94	X			653	X	X	X	
USA nationwide (*14, 15*)	Jan. 1965–Jan. 1966	1,311	X			2,619	X	X	X	
Pennsylvania (*16*)	Jan. 1968–Jan. 1969	201	X			696	X	X	X	
Nova Scotia, Canada (*17*)	Jan. 1967–Jan. 1969	750	X	X		3,014		X	X	
Manitoba, Canada (*18*)	Jan. 1970–June 1971	660	X			1,367		X		
Uppsala, Sweden (*19*)	Jan. 1967–Jan. 1971	200	X			347		X		X
Minnesota (*20, 21*)	1945–1969	35	X			1,541	X	X	X	X
Carlisle, England (*22*)	1955–1961	69	X			695	X	X	X	X
Jerusalem, Israel (*23*)	1960–1967	210	X			1,522		X		X
Göteburg, Sweden (*24*)	[2] 1969–	500	X	X	X	2,084	X	X	X	X
North Karelia, Finland (*25*)	[2] 1972–	185	X	X	X	683		X	X	X

[1] CHD—coronary heart disease, CVA—cerebrovascular accident, DC—death certificate, HR—local physician, MI—myocardial infarction.

[2] Ongoing study.

studies in the literature (*13,14, 26–32*). Indeed, medical records may have limited use in the diagnosis of subgroups of CVAs, even if clinical and laboratory data are independently reviewed (*14,30*).

3. Because the costs of and problems in implementation of a surveillance system compare favorably with other possible methods of disease detection (*33*), surveillance is the method of choice for assessing morbidity trends in communities.

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