Community Surveillance of Stroke in Persons under 70 Years Old: Contribution of Uncontrolled Hypertension

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Abstract: In 1979, a community-wide hospital surveillance system was established in Monroe County, New York (population 702,000), to investigate the continuing contribution of uncontrolled high blood pressure (HBP) to the occurrence of stroke. This paper reports findings among 200 consecutive strokes in persons under 71 years of age. Average age was 58. There was a prestroke history of HBP in 129 (65 per cent) cases. Two-thirds of the 129 had other predisposing conditions (heart disease, diabetes, previous cerebrovascular accident) and 95 per cent had one or more other cardiovascular risk factors (smoking, elevated cholesterol, obesity). Over 90 per cent had visited a physician during the year prior to stroke (average of four visits). Elevated pressures (DBP ≥ 95 or SBP ≥ 160) were recorded at half or more of the visits for 45 per cent of the patients; these cases were classified as uncontrolled. Reduction of "unnecessary" strokes in persons under age 71 should be achievable by giving increased attention to those already under medical care for hypertension who have co-existing stroke risk conditions and cardiovascular risk factors. (*Am J Public Health* 1983; 73:260–265.)

Introduction

United States vital statistics have documented declining stroke mortality for several decades, and at least one longitudinal study has documented a parallel decline in stroke incidence.[1,2] This downward trend was accelerated during the 1970s. There is compelling evidence that much of the recent decline in these rates is attributable to increased attention to detection and treatment of high blood pressure (HBP), which is the most common and strongest treatable risk factor for stroke.[3,4] In light of this evidence, it is important for the health care system to develop a strategy to assure provision of this preventive service to those persons most likely to benefit. Surveillance of new cases of HBP associated stroke to determine which ones might have been prevented has been recommended as one component of this strategy.[5,6] Analysis of such "unnecessary cases" should identify personal characteristics and medical care patterns of hypertensives in the community most in need of increased attention. This approach is analogous to the traditional use of case surveillance in the control of preventable communicable diseases such as syphilis and measles.

Such a surveillance system was developed in Monroe County, New York in 1979. This paper reports findings among stroke patients 70 years of age or below, the age group for which effectiveness of HBP treatment in protecting against stroke has been clearly and repeatedly established in clinical trials.[7,8] The contribution of these observations to preventing future strokes is discussed in light of emerging national efforts to identify and successfully treat all persons with HBP.

Materials and Methods

Monroe County

Monroe County is a mixed metropolitan and rural county located in western upstate New York, with an estimated population of 702,000, one-third of whom live in the city of Rochester. Nine percent of the population is over 65 years of age, 8 per cent non-White.

There are seven acute hospitals in the county: a 740-bed hospital at the University of Rochester Medical Center and six community hospitals ranging in size from 70 to 500 beds. The physician-to-population ratio in the county is approximately 1:550, and there is a network of neighborhood health centers as well as a federally certified health maintenance organization (HMO) in Rochester. The local Heart Associa-

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TABLE 1—Distribution of 129 HBP-Associated Strokes in Persons ≤70 Years Old by Demographic Characteristics, Predisposing Conditions, and Risk Factors, Monroe County, NY, July 1979–June 1980

	Number (Percent)		
	Male N = 78	Female N = 51	Total N = 129
Demographic Characteristics			
White	66 (85)	38 (75)	104 (81)
Non-White	12 (15)	13 (25)	25 (19)
Employed	39 (50)	15 (29)	54 (42)
Disabled	12 (15)	5 (10)	17 (13)
Married	61 (78)	33 (65)	94 (73)
Predisposing Conditions			
Heart Disease	41 (53)	22 (43)	63 (49)
Myocardial Infarction	21 (27)	9 (18)	30 (23)
Diabetes Mellitus	23 (30)	12 (24)	35 (27)
Previous Stroke	11 (14)	10 (20)	21 (16)
Transient Ischemic Attacks	12 (15)	12 (24)	24 (19)
Risk Factors			
Smoking	57 (73)	29 (57)	88 (67)
Obesity	44 (56)	36 (71)	80 (62)
Serum cholesterol >250 mg%	23 (30)	19 (37)	42 (33)
Left Ventricular Hypertrophy (EKG)	16 (21)	7 (14)	23 (18)
Serum Creatinine >1.5 mg%	11 (14)	4 (8)	15 (12)

tion has maintained a community-wide hypertension screening and referral program for several years; there are no formal programs for long-term treatment of HBP other than regular physician services, however. Between 1970 and 1978, the crude stroke mortality rate in the county declined from 90 to 69 per 100,000, paralleling the national trend.

Stroke Center

The Monroe County Comprehensive Stroke Center was established in 1978 under a contract with the National Institute of Neurological and Communicative Disorders and Stroke to evaluate effectiveness of health care delivery to stroke patients and stroke-prone persons in the county. In cooperation with the seven acute hospitals and the county medical society, the Stroke Center established a register for identifying all new hospitalizations with stroke or a stroke-related diagnosis on admission. Confirmatory diagnostic criteria consisted of a history of focal neurologic disturbance of acute onset which persisted for at least 24 hours and was not attributable to some recognizable pathologic process other than cerebrovascular disease.

Between July 1, 1979 and June 30, 1980, a total of 768 confirmed new stroke cases were registered. Approximately 40 per cent of the cases involved persons 70 years of age or below. The present report is based upon the first 200 of these cases. On the basis of clinical observations and CT (computed tomography) scan results, which were available for over 80 per cent of the study patients, the cases were distributed among broad pathologic categories as follows: 7 per cent subarachnoid hemorrhage, 10 per cent intracerebral hemorrhage, 8 per cent embolism, 69 per cent thrombosis, 6 per cent unspecified.

Data Collection

Information on characteristics present prior to occurrence of stroke was obtained from reviewing the patient's hospital records in a manner similar to that employed in the National Survey of Stroke[9]: data were collected on a standard form by a baccalaureate nurse experienced in medical record abstracting. The data included demographic characteristics (age, sex, race, marital and occupational status); physician's history of major diseases known to increase the probability of stroke (high blood pressure, diabetes, heart disease, previous stroke, and transient ischemic attack); presence of selected cardiovascular risk factors (cigarette smoking, obesity, and elevated serum cholesterol, defined as > 250 mg per cent); results of selected diagnostic studies reflecting end-organ effects of HBP (EKG evidence of left ventricular hypertrophy; elevated serum creatinine, defined as > 1.5 mg per cent). Those cases with history of high blood pressure in their hospital record were defined as HBP-associated strokes.

Information for assessing status of HBP control prior to the stroke was obtained by a questionnaire sent to the physician or clinic identified as the patient's regular source of medical care during the previous year. The following information was obtained from office records for the 12-month period prior to the patient's stroke: number visits for HBP care; list of the most recent blood pressures (up to six); regimen of anti-hypertensive medication (if any) being pre-

TABLE 2—Distribution of 129 HBP-Associated Strokes in Persons ≤70 Years Old by Presence of Multiple Predisposing Conditions and Risk Factors, Monroe County, NY, July 1979–June 1980

	Number (Percent)		
	Male N = 78	Female N = 51	Total N = 129
No. Predisposing Conditions Present*			
None	23 (30)	19 (37)	42 (33)
1	36 (46)	23 (45)	59 (46)
2	18 (23)	6 (12)	24 (19)
3	1 (1)	3 (6)	4 (3)
No. Risk Factors Present**			
None	4 (5)	2 (4)	6 (5)
1	34 (44)	21 (41)	55 (43)
2	30 (39)	21 (41)	51 (40)
3	10 (13)	7 (14)	17 (13)
No. Predisposing Conditions and/or Risk Factors Present			
None	0	1 (2)	1 (1)
1	6 (8)	6 (12)	12 (9)
2	30 (39)	17 (33)	47 (36)
3	25 (32)	17 (33)	42 (33)
4	12 (15)	7 (14)	19 (15)
5	4 (5)	2 (4)	6 (5)
6	1 (1)	1 (2)	2 (2)

*Heart disease, diabetes mellitus, stroke
**Cigarette smoking, obesity, cholesterol ≥250 mg%

scribed; increases or decreases in medication regimen; and estimate of patient non-compliance. (The latter was ascertained by the question, "In your view has this patient sometimes gone for periods of two or more days without taking the medicine you prescribed for high blood pressure?").

Analysis

All data were computerized as unit records for each case. Mean systolic (SBP) and diastolic (DBP) blood pressures were calculated and the number of times pressures were elevated (either systolic ≥ 160 or diastolic ≥ 95) during the year were noted for each case. Patients with elevated DBP and/or SBP recorded at one-half or more physician visits were considered poorly controlled.

Results

Pre-Stroke Profiles

One hundred twenty-nine (65 per cent) of the 200 cases had a history of high blood pressure prior to the occurrence of the stroke. Seventy-eight (60 per cent) were males and 51 (40 per cent) were females; mean age was 58 years for both sexes. Demographic characteristics and frequencies of predisposing conditions and risk factors among these cases are summarized in Table 1. Nineteen per cent were non-White, 43 per cent were employed, and 73 per cent were married. With the exception of employment status, there were no significant differences between male and female cases with respect to any of the factors listed.

Table 2 summarizes the HBP-associated cases by number of predisposing conditions and risk factors present. Two-thirds had a history of heart disease, diabetes, or previous stroke and 95 per cent had evidence of at least one other cardiovascular disease risk factor (smoking, obesity, elevated cholesterol) in addition to high blood pressure. Combinations of three or more predisposing conditions or risk factors were documented in over 50 per cent of cases.

Pre-Stroke Medical Care for HBP

Pre-stroke medical care information was obtained for 100 (78 per cent) of the 129 patients with history of HBP. Their mean age was 60, and frequency distributions of demographic characteristics, predisposing conditions, and cardiovascular risk factors were very similar to those of the full 129 HBP associated cases listed in Table 1.

Eleven of the patients had been diagnosed as hypertensive in the past but had not seen a doctor during the year prior to the stroke. The remaining 89 had all seen a physician one or more times during the previous year with an average of four visits. Patterns of diastolic and systolic blood pressures recorded at these visits are summarized in Table 3. Average DBPs were above 90 mm Hg and average SBPs were above 140 mg Hg in the majority of cases. Sixty-six per cent of cases had at least one DBP ≥ 95 mm Hg and 81 per cent had at least one SBP ≥ 160 mm Hg. Twelve cases had DBP readings of 115 or above and 18 cases had SBP readings

TABLE 3—Distribution of 89 Cases of HBP-Associated Stroke in Persons ≤70 Years Old by Average and Highest Blood Pressures Recorded during Year Prior to Stroke

	Cases with Average BP in Interval	Per Cent	Cases with Highest BP in Interval	Per Cent
Diastolic Pressure Intervals mm (Hg)				
<90	37	(42)	14	(16)
90–94	28	(31)	16	(18)
95–104	19	(21)	31	(35)
105–114	5	(6)	16	(18)
115+			12	(13)
Total	89		89	
Systolic Pressure Intervals mm (Hg)				
<140	10	(11)	3	(3)
140–159	43	(48)	14	(16)
160–179	26	(29)	29	(33)
180–199	7	(8)	25	(28)
200+	3	(3)	18	(20)
Total	89		89	

TABLE 4—Parameters of Medical Treatment Among 81 Cases of HBP-Associated Stroke in Persons ≤70 Years Old during Year Prior to Stroke

	Number	Per Cent
Number with at Least One Change in Medication*	42	(52)
Dose Increased	22	(27)
New Drug Added	20	(25)
Dose Decreased	12	(15)
Drugs Discontinued	4	(5)
Patients Judged by Physician to Miss Taking Drugs for Intervals of Two or More Days		
Yes	19	(24)
No	28	(35)
Don't Know	34	(42)

*More than one of the four types of medication changes was reported in a number of cases.

of 200 or above one or more times. DBP ≥ 95 and/or SBP ≥ 160 were recorded at one-half or more of all visits during the year in 40 (45 per cent) cases.

The 89 patients had been followed for HBP by their physicians for an average of three years, with 20 per cent followed for less than one year and 34 per cent followed for five or more years. Eighty-one (91 per cent) were being actively treated with anti-hypertensive drugs. Parameters of medical treatment for HBP among these 81 patients during the year prior to stroke are summarized in Table 4. Physicians made one or more changes which involved increasing or decreasing the dose or number of drugs prescribed in 52 per cent of those treated. In the physician's judgment, 19 patients (24 per cent) missed taking prescribed drugs for intervals of two or more days; however, in 42 per cent of treated cases, physicians indicated that they did not know whether the patient had missed taking his/her medication. Sixteen patients missed two or more scheduled appointments for HBP care during the year prior to stroke.

Discussion

Hospital-based stroke surveillance has documented a history of HBP in 65 per cent of 200 consecutive strokes occurring in 1979-1980 among persons 70 years of age and below living in a mixed metropolitan and rural county in the northeastern United States. This experience is remarkably consistent with results from a recent nationwide survey of newly hospitalized strokes in which a history of HBP was documented in 60-70 per cent of cases involving persons under 70 years of age.[9] These observations suggest that a significant number of preventable strokes with their attendant high burden in death, disability, and dollars continue to occur in spite of widespread efforts to detect and treat HBP in recent years.

The systematic case surveillance reported here allows one to ascertain, on a community-wide basis, what proportion of such stroke cases did in fact have poorly controlled HBP and hence might have been prevented. It further provides demographic and medical profiles for identifying those hypertensives in the community among whom such preventable strokes are most likely to occur in the future.

There are no universally accepted standards for defining control of HBP over time in the individual patient; however, on the basis of evidence from epidemiologic studies and controlled clinical trials, the Joint National Committee on Detection, Evaluation and Treatment of High Blood Pressure recommended in the mid-1970s that treatment, while individualized, should be aimed at maintaining DBP less than 90 mm Hg. The Committee further recommended that all adults with SBP of 160 or above and/or DBP of 95 or above be closely followed to assure such control.[10] Pre-

TABLE 5—Comparison of Frequencies of Selected Conditions and Risk Factors among Hypertensive Persons Experiencing New Strokes and Hypertensives in the General Population

	HBP-Associated New Stroke Cases (A)	HDFP Study Population (B)*	Ratio A:B
History of Predisposing Conditions			
Stroke	16	4	4.0
Myocardial Infarction	23	7	3.3
Diabetes	27	8	3.3
Risk Factors			
Cigarette Smoking	66	20	3.3
Obesity	61	30	2.0
Cholesterol >250 mg%	33	35	0.9
Left Ventricular Hypertrophy (EKG)	18	6	3.0

*Proportions derived from baseline data for persons enrolled in the Hypertension Detection and Follow-up Program[8,13]

stroke blood pressure data obtained from physician office records on 89 of the 129 HBP associated cases in this study showed that over 80 per cent had at least one recorded DBP or SBP that exceeded these levels; in 45 per cent of cases, such elevations were recorded at half or more physician visits in the year prior to the stroke. These data strongly suggest that many, if not all, of the latter cases and some of the former cases resulted from poor control of HBP.

Since 89 per cent of cases involved persons already under regular medical care and there was longitudinal evidence of poor control of HBP among nearly 50 per cent of those cases, it is clear that the greatest potential for reducing HBP-associated strokes lies in improved management of known hypertensives rather than community education and screening to bring unattended cases under care. This finding is consistent with recently published conceptual arguments regarding rational community approaches to hypertension.[11,12]

Pre-stroke profiles of the HBP-associated cases under 70 years of age provide a further basis for identifying the type of individuals most in need of attention, among the thousands of known hypertensives in the community. The high proportion of cases with one or more underlying conditions or risk factors in addition to HBP is of particular note. Table 5 compares the frequencies of certain of these attributes observed among the hypertensives in Monroe County who had strokes with the reported frequencies among the broadly representative general population of hypertensives between 50-70 years of age enrolled in the Hypertension Detection and Follow-up Program in the mid-1970s.[8,13] The estimated ratios shown in the right hand column of Table 5 indicate that persons with HBP who have strokes are three to four times more likely to have had a history of prior stroke, myocardial infarction, diabetes, cigarette smoking or have left ventricular hypertrophy than the general population of hypertensives of equivalent age. The independent contribution of high blood pressure to occurrence of stroke cannot be directly ascertained from such a comparison; however, based on these observations, the greatest impact in preventing "unnecessary" HBP-associated strokes would appear to be realized by enhancing community HBP control efforts among the subgroup of known persons with mild to moderate hypertension, who have co-existing high risk conditions. This recommendation is reinforced by the Veterans Administration Cooperative Study on Antihypertensive Agents and the Hypertension Detection and Follow-up Program, both of which specifically documented reduction of strokes through effective treatment of such complicated hypertensives.[14,15]

REFERENCES

1. Soltero I, Kiang L, Cooper R, *et al*: Trends in mortality from cerebrovascular diseases in the United States, 1960-1975. Stroke 1978; 9:549-555.
2. Garraway MW, Whisnant JP, Furlan AJ, *et al*: The declining incidence of stroke. N Engl J Med 1979; 300:449-452.
3. Levy RI: Stroke decline: implications and prospects. N Engl J Med 1979; 300:490-491.
4. Kannel WB, Dawber TR, Sorlie P, *et al*: Components of blood pressure and risk of atherothrombotic brain infarction. Stroke 1976; 4:327-331.
5. Rutstein DD, Berenberg W, Chalmers TC, *et al*: Measuring the quality of medical care: a clinical method. N Engl J Med 1976; 294:582-588.
6. Report of Working Group on Heart Disease Epidemiology: US Department of Health, Education, and Welfare. NIH Pub. No. 79-1667, Bethesda, MD, 1979.
7. Freis ED: The Veterans Administration Cooperative Study on Antihypertensive Agents: Implications for stroke prevention. Stroke 1974; 5:76-77.
8. The Hypertension Detection and Follow-up Program Cooperative Group: Five-year findings of the Hypertension Detection and Follow-up Program. JAMA 1979; 242:2562-2577.
9. Weinfeld FD (ed): The National Survey of Stroke. Stroke 1981; 2:I3-I91.
10. Report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure: a cooperative study. JAMA 1977; 237:255-261.
11. Gillum RF, Stason WB, Weinstein MC: Screening for hypertension: a rational approach. J Comm Hlth 1978; 4:67-72.
12. Brook RH, Berman DM, Lohr KN: Conceptualization and Measurement of Physiologic Health for Adults. *Volume 3: Hypertension*. Santa Monica, CA: The Rand Corporation, 1980.

13. The Hypertension Detection and Follow-up Cooperative Group: Mild hypertensives in the Hypertension Detection and Follow-up Program. Ann NY Acad Sci 1978; 304:254-266.
14. Veterans Administration Cooperative Study Group on Antihypertensive Agents: Effects of treatment on morbidity in hypertension, III. influence of age, diastolic pressure, and prior cardiovascular disease; further analysis of side effects. Circulation 1972; 45:991-1004.
15. The Hypertension Detection and Follow-up Program Cooperative Group: Five-Year Findings of the Hypertension Detection and Follow-up Program, III. Reduction in stroke incidence among persons with high blood pressure. JAMA 1982; 247:633-638.

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