COMMUNITY HOSPITAL-BASED STROKE PROGRAMS: NORTH CAROLINA, OREGON, AND NEW YORK*

I: Goals, Objectives, and Data Collection Procedures

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SUMMARY In order to assess the impact of variations in stroke care on outcomes, and to make geographic comparisons, the three Community Hospital-Based Stroke Programs in North Carolina, Oregon, and New York, aggregated their data on 4,132 hospitalized stroke patients. Complete demographic data or "Major Profile" were obtained on 2,390 (57.8%) of the 4,132 stroke patients. This includes those patients on whom informed patient and physician consents were obtained during the hospitalization. Of the major profile patients, 1,490 (62.3%) were followed for periods up to one year, 502 (21.0%) were lost to followup and 398 (16.6%) died within the one year followup period. Incomplete demographic data or "Minor Profile" were observed on 1,742 (42.1%) of the 4,132 patients. Minor profile includes those who died before comprehensive interviews were completed or those for whom informed consent for an interview could not be obtained. Of the minor profile group, 813 (46.7%) died in hospital, and 929 (53.3%) were alive when discharged from the hospital.

This paper, which describes the programs, data collection procedures, and study cases, also highlights specific issues on stroke diagnosis, risk factors associated with stroke, and the influence of interventions on stroke outcomes. We conclude that: 1) the merging of data on hospitalized stroke cases from rural and urban hospitals in geographically distinct regions can be used in the study of stroke diagnosis, the use of diagnostic tests, and the effect of interventions on stroke outcomes; and 2) these data are consistent with the hypothesis that part of the national decline in mortality from stroke is due to a decline in stroke severity.

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This paper provides a description of the three CHSPs, the methods used in combining the data from the three programs, definitions of key measures, and a description of the combined data set. In addition, this paper presents a discussion of the currently available epidemiologic and demographic data on stroke in the United States. This review will also provide a basis for the observations and conclusions for subsequent papers dealing with the combined CHSP data. The second paper in this series describes the demographic characteristics of the stroke patients, while subsequent papers will present data on regional and geographic differences in stroke occurrence, factors affecting survival and recovery, and diagnostic specificity.

Although the three CHSPs were initiated with similar but not identical data collection and treatment protocols, they each identified and followed hospitalized stroke patients in defined geographic areas. The geographic areas included the coastal plains of North Carolina, the State of Oregon and Monroe County in New York. The similarities among the three programs in data collection and treatment protocols provided justification for the selection and merging of limited information from the three data bases into a single 'synthetic' data set. This combining of data across the three programs permits the systematic examination of geographic differences in stroke patients and their outcomes; additionally, combining the data sets results in larger sample sizes than would otherwise have been possible.

The specific objectives in combining the stroke data from the three programs were: (1) to examine the geo-

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*North Carolina (NC) refers to data collected from all acute care hospitals in a 15 county rural area in eastern North Carolina. Oregon (OR) refers to data collected in community hospitals with approximately one-half of the acute care hospital beds in Oregon. New York (NY) refers to data collected in all of the community hospitals in Monroe County, New York.

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RECENT STUDIES have indicated substantial reduction in stroke mortality during the past three decades. However, stroke persists as the third major cause of death and disability among adults.1-4 To gain further insight into this major health problem, particularly on the availability and efficacy of stroke-care facilities, the National Institute of Neurological and Communicative Disorders and Stroke (NINCDS) sponsored three separate and independent Community Hospital-Based Stroke Programs (CHSPs). The programs included those administered in North Carolina by the North Carolina Heart Association, the University of North Carolina School of Public Health, the Bowman Gray School of Medicine and the Research Triangle Institute; in Oregon by the Oregon Health Sciences University; and in New York by the University of Rochester.
graphic variations in the demographic characteristics of stroke patients, including age, sex and race; (2) to identify risk factors for stroke recovery and survivorship, and to document the known risk factors for stroke onset such as hypertension, diabetes, transient ischemic attacks (TIAs) and cardiac diseases; (3) to describe medical and treatment factors affecting the recovery and survivorship of stroke patients, such as diagnosis, neurologic impairment and the availability of rehabilitation services; and (4) to describe geographic variations in the selection of specific stroke diagnoses and the use of diagnostic tests.

Description of the Three Community Hospital-based Stroke Programs

North Carolina

The CHSP in North Carolina was administered by the North Carolina Heart Association in association with the Bowman Gray School of Medicine, the Research Triangle Institute and the University of North Carolina School of Public Health. The study was located in 15 contiguous, primarily rural counties in the coastal plains, some of which are included in the "Stroke Belt." The population of the 15 counties is 66% white and 52% male. With one exception, each of the counties had at least one hospital with a total of 19 hospitals in the 15 counties. The hospitals were generally small, voluntary facilities with an average of 129 beds per hospital. During the period of data collection, 1979–1980, the 15 counties had 624 physicians,9 of whom eleven were neurologists distributed among four of the 15 counties. The physician to population ratio was 66 per 100,000 population, and a hospital bed to population ratio of 260 per 100,000. During the study period there were two computerized tomography scanners (CT) in the 15 county area. The intervention program consisted of establishing teams in each of the participating hospitals to coordinate treatment services for stroke patients. The teams consisted of at least one physician, a physical therapist, a nurse coordinator and a nurse from the home health agencies in each of the counties. In addition, a team was also established at the only regionally available rehabilitation facility. The rehabilitation facility team coordinated stroke services for patients at that facility as well as for stroke referrals from other participating hospitals and provided training to stroke teams in each of the 19 participating community hospitals.

Oregon

The CHSP in Oregon was administered by the Oregon Health Sciences University in Portland, and included data collected from 31 rural and urban hospitals scattered throughout the state and one hospital in the State of Washington. The 79 hospitals in Oregon correspond in size to the population density.10 There were 29 hospitals of over 100 beds and 50 hospitals each with 100 beds or less. During the year of data collection, 1979, there were 4,918 physicians and 72 neurologists in the state.10 Unlike North Carolina, Oregon is predominantly white (94%) with only 6% minority groups. CT was available in each of the major urban hospitals.

In addition to collecting information on all stroke cases admitted to the 31 participating hospitals, the Oregon CHSP established teams to coordinate and evaluate services for stroke patients in 13 rural and urban hospitals.

New York

The CHSP in Rochester, New York, was administered by the University of Rochester School of Medicine. The program consisted of training nurses to coordinate in-hospital services for stroke patients admitted to the eight general hospitals in Monroe County. The county population is 720,000, 77,000 of whom were 75 years of age or older; 90% were white.11 This population was served by eight general hospitals, with 200 to 750 beds each. There was an average of 340 acute hospital beds per 100,000 population. There were 1,200 physicians, 20 of whom were neurologists. All stroke patients admitted to these hospitals between May, 1979, and October, 1980, were identified and further evaluated. CT was available to each of the eight urban hospitals.

Methodology: Data Collection Procedures

The three CHSPs of North Carolina, Oregon, and New York collected data on hospitalized stroke patients in their respective catchment areas during the period 1979–1980 (table 1).

In North Carolina, all stroke patients admitted to the 19 participating hospitals in the 15 county catchment area were identified at admission for the period from January, 1979, through December, 1980. Identification of new stroke cases, interviews of patients and completion of stroke forms were performed by trained nurses in the respective hospitals. Validation of a sample of stroke diagnoses was performed by staff neurologists at Bowman Gray School of Medicine. Interviews of patients were conducted three times during the initial hospitalization: at admission; following stabilization; and just prior to discharge. The nurses also abstracted the charts for additional medical information. Followup information at three, six and twelve months was obtained by nurses who were working for the local home health agency through personal interviews with patients and their family members.

In Oregon, data from 31 hospitals was collected for the calendar year 1979. The hospital records of all patients with a discharge diagnosis of stroke were reviewed by a team consisting of neurologists, psychologists, speech pathologists and trained medical students. Validation of diagnoses and the verification of intra- and inter-observer reliability were performed on a sample of stroke patients' medical records within an institution and showed excellent agreement, the subject of a later publication.

The CHSP in Monroe County, New York, collected data on stroke cases admitted to the eight community hospitals during the period May, 1979, through October, 1980. Data collection was performed by trained
nurses through personal interviews with stroke patients and their families at 30, 180 and 360 days post-stroke. All stroke diagnoses were reviewed by the program's neurologist.

In order to combine the data from the three CHSPs, instruments and data collection procedures were intensively reviewed during a twelve month period to identify common data elements with common data collection procedures and coding categories. The combined data set created from the review and merging of the individual data sets contained the following data items: (1) demographic variables: age, race, sex and marital status; (2) whether the admission was for a first or subsequent stroke; (3) employment status; (4) risk factors such as hypertension, diabetes mellitus, transient ischemic attacks (TIAs) and cardiac disease; (5) admission and discharge consciousness level; (6) stroke diagnosis; (7) length of hospital stay; (8) discharge location and location at followup; (9) Barthel scores at discharge and at each of the followup periods; (10) scores on selected other activity scales, such as ability to follow one step commands, to perform routine activities such as housework or use the telephone and to undertake general outside activities with or without assistance; (11) return to work during the one year followup period; (12) diagnostic tests: CT, cerebral angiography, brain scan, lumbar puncture, electroencephalogram (EEG) and electrocardiogram (ECG); and (13) in-hospital availability of services and equipment, including physiotherapy, speech therapy, occupational therapy and CT. The definitions of some of the variables are presented below.

Demographic variables were defined as follows: race (white or non-white; note that >95% of non-white were black in this study); marital status (married or not married). First or subsequent stroke was defined by either a statement in the medical records that the patient had a previous stroke or the patient's report of a previous stroke. Employment status was defined by the patient's report of employment outside the home (ie, housewives were defined as not employed). Risk factors were based on any of the following: (a) patient's report of previous diagnosis or treatment of the risk factor; (b) the presence of a diagnosis of the risk factor in the medical records; or (c) report in the medical record of medication for the treatment of the risk factor. Admission and discharge consciousness level were classified using the following three categories: a) alert, b) disoriented or lethargic and c) stuporous or comatose. Stroke diagnoses in all three programs included the following three categories: a) infarction, b) hemorrhage and c) stroke not otherwise specified (NOS). Two of the programs further classified diagnoses into thrombotic, embolic, infarction (NOS), subarachnoid hemorrhage (SAH), intracerebral hemorrhage (ICH), hemorrhage (NOS) and stroke (NOS). (See Appendix A for the criteria used in classifying strokes). Length of hospital stay was coded in days. In-hospital availability of equipment and services was coded as yes if these services were available on the hospital grounds. Discharge location and location at followup were categorized as: a) home, b) institution, or c) died. Standard Barthel Index scores were used for classifying patients according to activities of daily living (range 0–100, with normal activity level equal to 100). Scores on the selected other activity scales were calculated on the basis of performing the activity independently or not independently. Return to work was determined only on those patients who were employed at the time of their stroke.

**Results and Discussion**

The preceeding section provided information on the purpose, goals, and data collection procedures of the three CHSPs. The merging of the three CHSP data sets resulted in information on 4,132 hospitalized stroke patients. The Major Profile patients in figure 1 included 2,390 patients. In order to be classified as a Major Profile patient the stroke patient had to be eligible for followup by surviving the initial hospitalization and providing informed consent (from both the patient and the physician). The remaining 1,742 cases were not eligible for followup (Minor Profile) as a result of either in-hospital death or failure to obtain informed consent (from either the patient or the physician). Of the 2,390 patients eligible for followup (Major Profile), because they survived the acute stroke and were willing to be followed, 1,490 (62%) were interviewed

<table>
<thead>
<tr>
<th>Hospitals</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC 23 Rural community 15 counties in eastern NC Within the 15 counties Admission Dx of stroke Jan 1979–Dec 1980 admissions</td>
</tr>
<tr>
<td>OR 1 University 30 Community* Major cities and towns of Oregon (50% of hospital beds in OR) Not restricted Discharge Dx ICD9 1979 admissions</td>
</tr>
<tr>
<td>NY 8 Urban general Monroe County Within 30 miles of county Admission Dx of stroke May 1979–Oct 1980 admissions</td>
</tr>
</tbody>
</table>

N = number.

*Includes one hospital in Washington.
at 6 or 12 months, 502 (21%) were lost to followup (or became ineligible for followup by moving outside of the catchment areas), and 398 (17%) died during the 12 month followup period.

Since the combined CHSP data set is the largest to date in terms of the number of stroke cases and contains information on hospitalized stroke patients from three distinct geographic areas, it may be particularly useful to compare the CHSP data set to those from other studies\(^4\) on stroke (table 2), and in particular, to three major studies: the Harvard Stroke Registry,\(^6\) the National Survey of Stroke\(^5\) and the Stroke Data Bank.\(^6\)

The National Survey of Stroke, sponsored by the NINCDS and published in 1981,\(^5\) represents a comprehensive national study on stroke. This survey was undertaken to: a) provide national estimates of stroke incidence and prevalence; b) fulfill the need for economic data on the costs of stroke; and c) provide information on stroke that would be useful in setting priorities for research, resource allocation and health care planning. Since regional epidemiological studies cannot be generalized to the national population, and large scale national household epidemiological surveys for relatively rare diseases are prohibitive in costs, the National Survey of Stroke used a two stage national probability sample by first sampling hospitals and then sampling medical records for stroke diagnoses. To correct for the varying quality of medical records, the survey design included a diagnostic protocol for arriving at a specific stroke diagnosis.

In order to obtain a national probability sample of stroke cases, 124 of the 6,140 short-term hospitals in the continental United States in 1974 were selected for

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### Table 2

Diagnosis of Hospitalized Patients with Stroke in the United States

<table>
<thead>
<tr>
<th>Study</th>
<th>Thrombosis (%)</th>
<th>Embolic (%)</th>
<th>Intracerebral Hemorrhage (%)</th>
<th>SAH$ (%)</th>
<th>NOS (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Eisenberg 1964</td>
<td>48% (56%)</td>
<td>2% (2%)</td>
<td>36% (42%)</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>B. Kannel 1965</td>
<td>63% (67%)</td>
<td>7% (7%)</td>
<td>22% (22%)</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>C. Parrish 1966</td>
<td>57% (62%)</td>
<td>7% (7%)</td>
<td>22% (22%)</td>
<td>15%</td>
<td></td>
</tr>
<tr>
<td>D. Kurzweil 1969</td>
<td>60% (67%)</td>
<td>20% (22%)</td>
<td>10% (11%)</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>E. Alter 1970</td>
<td>38% (58%)</td>
<td>4% (6%)</td>
<td>16% (25%)</td>
<td>7% (11%)</td>
<td></td>
</tr>
<tr>
<td>F. Whisnant 1971</td>
<td>75% (81%)</td>
<td>3% (3%)</td>
<td>10% (11%)</td>
<td>5% (5%)</td>
<td></td>
</tr>
<tr>
<td>G. Stallones 1972</td>
<td>65% (72%)</td>
<td>15% (17%)</td>
<td>10% (11%)</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>H. Matsumoto 1973</td>
<td>73% (77%)</td>
<td>8% (8%)</td>
<td>10% (11%)</td>
<td>6% (6%)</td>
<td></td>
</tr>
<tr>
<td>I. Ostfeld 1974</td>
<td>84% (88%)</td>
<td>2% (2%)</td>
<td>11% (11%)</td>
<td>— (0%)</td>
<td></td>
</tr>
<tr>
<td>J. Mohr 1978</td>
<td>53% (82%)</td>
<td>31% (6%)</td>
<td>10% (6%)</td>
<td>6% (6%)</td>
<td></td>
</tr>
<tr>
<td>K. Wolf 1978</td>
<td>63% (82%)</td>
<td>18% (6%)</td>
<td>4% (6%)</td>
<td>11% (3%)</td>
<td></td>
</tr>
<tr>
<td>L. National Stroke Survey 1981</td>
<td>41% (82%)</td>
<td>3% (6%)</td>
<td>3% (6%)</td>
<td>3% (6%)</td>
<td></td>
</tr>
<tr>
<td>M. Stroke Data Bank 1984</td>
<td>30% (40%)</td>
<td>21% (28%)</td>
<td>11% (15%)</td>
<td>13% (17%)</td>
<td></td>
</tr>
<tr>
<td>N. CHSP 1985</td>
<td>60% (65%)</td>
<td>22% (22%)</td>
<td>10% (10%)</td>
<td>4% (4%)</td>
<td></td>
</tr>
</tbody>
</table>

All percents in () represent those excluding unknown or uncertain diagnoses. Percentages are rounded; row totals approximate 100%.

*The Framingham Study reported by Wolf et al had 3% of all strokes (including 11% with TIA as which were not included in this table) classified as those from "other causes."

†Excludes TIA as which accounted for 19% of the total number of strokes.

‡Includes 11% lacunar strokes; 15% if "unknown" strokes are excluded.

§ = subarachnoid hemorrhage.

|| = diagnosis not otherwise specified.
study by the National Survey of Stroke on the basis of hospital size. For the years 1971, 1973, 1975 and 1976, 2,170 charts of stroke patients were identified by screening for stroke related diagnoses. For a variety of reasons, such as the occurrence of brain tumor or trauma to account for the charted diagnosis, only 68% or 1,846 records met the survey’s criteria for stroke.

The Harvard Cooperative Stroke Registry, described by Mohr and colleagues,4 was a hospital-based prospective study begun in 1972, with a description of the first 694 patients and reported in 1978. The Harvard Cooperative Stroke Registry was the first registry of stroke patients established after the widespread availability of diagnostic techniques including angiography and computerized tomography (CT). The use of angiography and CT in the Harvard Registry resulted in a dramatic increase in the percentage of accurate diagnoses, as well as the recognition of lacunes as a new diagnostic category. The Harvard Registry was based on data from urban hospitals known for their special interest in stroke care, included referrals, and was not population-based. Nonetheless, comparisons with the CHSP data are useful since both were based on hospitalized stroke patients only.

The Stroke Data Bank,4 reported in 1984, has similar parallel interests for stroke data collection as this study, and was concerned with the development of common data collection protocols, the use of common operational definitions for stroke syndromes and the ability to optimize the use of computer technology for information storage, transfer and retrieval. Four university centers began to enter stroke patients in 1980 and accrued over an 18-month period a total of 938 stroke patients with infarction or hemorrhage and 220 patients with TIA. For this study, patients will be followed regularly for up to two years. Assisting in establishing a diagnosis was use of CT in 90% of the cases and angiography in 42%. When TIA are excluded from the series, cerebral infarction accounted for 76% of the strokes and cerebral hemorrhage for 24% (table 2). Of the patients with infarctions, 19% were “atherosclerotic” (the range in the four centers varied from 9 to 43%); 21% were embolic (range was 13 to 27%), 11% were lacunar (range was 4 to 19%), and 25% were of unproven etiology (range was 7 to 35%). Of the 24% with hemorrhagic strokes, 11% were intracerebral hemorrhages and 13% were due to subarachnoid hemorrhages. The average age of the stroke patients was 63, nearly a decade younger than the average age, is influenced by the deletion of patients to account for the charted diagnosis, only 68% or 1,846 records met the survey’s criteria for stroke.

Compared to the inhospital death rate in the National Survey of Stroke of 30.7% the rate for the CHSP was substantially lower at 19.7%. This difference in the mortality rates between the CHSP and the National Survey of Stroke extends to one year, with the CHSP one year mortality rate being 36% (as calculated by life table methods) compared to 48% in the National Survey of Stroke. While the analysis of mortality data in the CHSP will be discussed more fully in a later paper, some preliminary comments can be made regarding the 813 in-hospital deaths among the 4,132 hospitalized stroke patients.

The CHSP inhospital death rate reflects the influence of a variety of factors, including the distribution of specific stroke diagnostic categories, the age of the patients, and hospital characteristics, all of which may influence referral and treatment patterns. For example, ischemic brain infarction due to thrombosis had a 25.8% inhospital mortality rate in the National Survey of Stroke1 compared to 29.3% for embolic strokes of cardiac origin, 54.7% for subarachnoid hemorrhage, and 67.9% for intracerebral hemorrhage. Increased numbers of hospitalized patients with diagnoses of subarachnoid or intracerebral hemorrhage would tend to raise mortality rates in any series of consecutive stroke cases. In addition to the effects of different stroke diagnoses, inhospital death rates are influenced appreciably by age, particularly in the younger (<45 years) and older (>85) age groups. In the National Survey of Stroke,2 patients under 45 years experienced on aggregate death rate of 23.9% while it was 44.9% for those over 85 years. For those in the four decades between 45 and 85 years, the inhospital death rate in the Survey ranged between 26.1% and 31.2%. Referral hospitals typically receive more severe patients which increases the probability of death. Smaller hospitals, on the other hand, may experience higher mortality rates among stroke patients due to a lack of equipment, supplies and expertise in dealing with complications from stroke. The higher (23%) mortality rate in the NY CHSP with its primarily urban hospitals and the lower (16%) mortality rate in the rural hospitals of eastern NC may be due in part to differences in referral patterns and hospital characteristics. The CHSP’s aggregate inhospital death rate of 18.7%, which is considerably lower than the National Survey of Stroke’s rate of 38.7% may be due to similar factors.

However, if one exercises potential selection bias in the interpretation of differences in the mortality rates between the CHSP and the National Survey of Stroke, these data are consistent with the hypothesis that the national decline in stroke mortality may be due, at least in part, to a decline in the severity of stroke, rather than simply a decline in stroke incidence. Both the inhospital and one year death rates in the CHSP are approximately 12 percent lower than the death rates reported by the National Survey of Stroke. Furthermore, the percentage of patients who were stuporous or coma to admission also differed substantially between the CHSP (21%) and the National Survey of Stroke (49%). Further research is necessary, however, to determine the exact contributions of a declining stroke incidence, the possible reduction in severity of stroke, improved intensive care management or the changing hospitalization practices to explain the overall absolute
decline in stroke mortality. For example, death due to strokes outside the hospital, such as the home or nursing facility, was not specifically addressed in the CHSP study.

While accurate stroke diagnoses and the identification of the underlying pathologic processes should influence the choice of therapies, the current absence of reliably effective treatments for reversing the neurologic deficits resulting from stroke may mitigate against extensive diagnostic procedures by practitioners. For example, fifty percent of the cases in the National Survey of Stroke, and 30 percent of the cases in the CHSP had a diagnosis of stroke NOS (not otherwise specified). These relatively high rates occurred even after the application of diagnostic algorithms in both studies. This high rate of stroke NOS diagnoses suggests a lack of sufficient diagnostic testing to assign a more specific stroke diagnosis. We are examining the use of diagnostic tests in assigning specific stroke diagnoses.

The high rates of stroke NOS in the CHSP and the National Survey may also reflect, in part, another problem: namely, the relative unavailability of diagnostic tools, such as CT scans and angiography. For example, in the National Survey of Stroke, specific stroke diagnoses were made in 50% of the hospitalized strokes. In this national sample of 1,846 stroke cases from 124 hospitals selected from within the continental United States, 74 hospitals, or nearly 60%, were community hospitals which may not have had access to neurologic expertise or equipment. The lack of equipment or expertise may account for only 5% of the National Survey of Stroke cases receiving CT scans, since there was a lack of CT scans in community hospitals during the period of data collection, 1971-1976.

Similar factors may have influenced the proportion of cases of stroke NOS in the CHSP. In the 19 hospitals included in the CHSP from NC, only two hospitals had CT scans. In addition, there were only a total of eleven neurologists practicing in four of the fifteen counties served by the hospitals.

By excluding the stroke NOS cases, Table 2 indicates strong similarities in the specific stroke diagnoses for the CHSP and several of the more recent stroke studies from the United States, such as the Harvard Stroke Registry, the National Survey of Stroke and the Framingham Study. For example, in the combined CHSP data, the majority of strokes were diagnosed as infarction. This confirms the dominance of atherosclerotic disease of extra and intracranial vessels and of the heart in causing thrombotic and embolic strokes. When unspecified strokes of all variety are excluded from the CHSP data, 23% embolic strokes, defined as cardiac in origin, approximates the 18% figure from the population-based Framingham study. The lower 6% incidence rate for embolic strokes in the National Survey of Stroke cannot be as easily explained, since similar criteria of a recognized cardiac lesion capable of embolism were used. The 50% rate of unspecified strokes does not appear to affect the percentage of embolic strokes, since approximately 95% of these unspecified strokes were, on review, diagnosed as thrombotic. In the Harvard Stroke Registry, undertaken by five experienced neurologists specializing in stroke, the following specific diagnoses were made among 694 strokes: 53% thrombosis (large and small vessel, the latter designated as lacune, which appears as a diagnostic entity for the first time in any large series), 31% embolism, 10% intracerebral hemorrhage, and 6% subarachnoid hemorrhage. It is particularly noteworthy that the embolism category combined both cardiac and extracranial vascular sources of embolism in this series, since this appears to be the primary source of variations in the percentages of embolism between the CHSP and the Framingham Study. General similarities exist for the percent of intracerebral hemorrhage and subarachnoid hemorrhage in both the CHSP and the Harvard Stroke Registry. The reasons for the low incidence of intracerebral hemorrhage and the conspicuous inversion of the usually higher incidence of intracerebral hemorrhage to subarachnoid hemorrhage in the Framingham Study are unclear. This low incidence may reflect the impact of more effective hypertension treatment; however, stroke still occurs commonly despite hypertension control efforts.

The concern over diagnostic imprecision of stroke cases, reflected in a variety of studies in the United States, has been the focus of epidemiologic analyses. Although consensus exists for the classification of stroke into two broad categories, infarction and hemorrhage, subdividing infarctions into thrombotic and embolic and subdividing hemorrhages into intracerebral and subarachnoid varieties is not frequently adhered to by practitioners. Compounding the problem is the inability to distinguish precisely "thrombotic," "thrombo-embolic" or "atherothrombotic" brain infarction" from embolic strokes of cardiac origin which may present identically and lead to their aggregation in some studies. Alternatively, when the clinical distinction is uncertain, these strokes are frequently identified as "undiagnosed" or "unspecified" (National Survey of Stroke). Further complicating the diagnosis of "embolic" stroke is the grouping of artery-to-artery emboli from extracranial vessels with emboli of cardiac origin. The necessity of distinguishing these latter entities is more than academic; for example, emboli of cardiac origin may be effectively treated with anticoagulation to prevent re-embolization, while thromboembolic strokes originating from extracranial occlusive disease may best be treated with anti-platelet aggregation drugs to prevent stroke recurrences.

With intracerebral (ICH) and subarachnoid hemorrhages (SAH), a similar grouping has occurred in the past, only because a common mechanism for both is a rupture of cerebral vessels. However, since hypertension is related to the pathogenesis of ICH, antihypertensive therapy is an important and perhaps crucial means of reducing its incidence and recurrence. Subarachnoid hemorrhages which result from the rupture of congenital aneurysms are etiologically unrelated to blood pressure, and perhaps even asymptomatic ones.
of critical size are best treated with surgical extirpation. 

While diagnostic precision may improve stroke care through preventing subsequent morbidity, its effects on other outcomes, such as functional status, are unclear. In terms of functional recovery, outcomes may be primarily dependent upon the initial neurologic deficits, compounded by underlying risk factors, more than upon specific diagnosis and treatment. While some authors have suggested that only mild to moderately impaired stroke cases benefit from extensive rehabilitation services, others have indicated that rehabilitative services for stroke cases improve communication skills and physical functioning which results in improved benefit-cost ratios through increased proportions of stroke cases returning to the home environment. However, another investigator has questioned the value of rehabilitation interventions. These issues will be addressed in a subsequent paper from the CHSP data base.

Stroke risk factor identification and reduction may be, as preventive interventions, the most effective form of stroke therapy. While the significance of risk factors can only be analyzed in population-based studies, hospitalized stroke studies can provide useful associations. As Mohr discussed, data on stroke recovery from rehabilitative programs may be biased toward survivors, while postmortem studies may present the opposite bias. This dilemma emphasizes the importance of population-based studies in assessing risk factors but, nonetheless, special attention must be given to hospitalized stroke cases, since it is precisely in this group that intervention therapies may best be identified. In the Harvard Stroke Registry a history of hypertension is strongly associated with intercerebral hemorrhage (72%), a virtually identical percent as hemorrhage (72%), a virtually identical percent as found in the National Survey of Stroke (70%). With thrombotic strokes, the percents are again similar: the Registry, 55%, the Survey, 60%. Diabetes mellitus is present in 26% and 25% of thrombotic strokes in the two studies, respectively. A comparison of data from these sources with data from the CHSP will be addressed in a subsequent study.

In summary, this introductory paper on the three Community Hospital-Based Stroke Programs in North Carolina, Oregon and New York outlines the goals and objectives in merging data from the three sites on 4,132 stroke patients. The goals include assessing regional differences in: demographic characteristics, associated risk factors, diagnostic categories, functional impairment, and outcomes. Our study identified a number of important needs in stroke research.

We conclude that data on hospitalized stroke cases drawn from geographically distinct regions can be meaningful when merged and analyzed. Despite the advances in technology and the increased availability of diagnostic equipment, specific stroke diagnoses are frequently not established. Few community physicians diagnose lacunar syndromes. A substantial number of patients experience stroke without a history of characteristic risk factors (17% in CHSP had no history of hypertension, diabetes, previous transient ischemic attacks or cardiac disease, four strong risk factors for stroke). Our data point out the need for further educational and research efforts for specific stroke diagnoses, pathophysiologic mechanisms and definitive therapies.

References
Appendix A
Diagnostic Criteria to Classify Types of Stroke

Infarction, Not Otherwise Specified:
1. Presence of the typical clinical syndrome (defined as a neurologic deficit with sudden onset, expressed as hemiplegia or hemiparesis, vertigo, numbness, aphasia and dysarthria, or other deficit, lasting more than 24 hours and often followed by permanent neurologic damage).
2. Computerized tomographic scan (CT scan) showing no evidence for tumor, subdural hematoma, parenchymal hemorrhage (hemorrhagic infarction excluded).
3. Ambiguous or insufficient information to resolve underlying cause of infarction (ie, cardiac or vascular pathology).

B. Thromboembolic Stroke:
1. Presence of one or more of the following:
   a. Ipsilateral bruit
   b. Evidence of carotid, intracranial or vertebrobasilar stenotic atheromatous lesion as shown by angiography or reliable noninvasive testing
   c. Nonemolic stroke at autopsy
   d. Hollenhorst plaques present in retinal arteries
   e. Onset of symptoms preceded by transient ischemic attack (TIA) or transient monocular blindness (TMB)
   f. Nonlacunar infarction by CT scan
2. Absence of obvious cardiac source for emboli
3. Absence of evidence for multiple cerebral emboli or lacunar infarctions on brain CT scan.

C. Cardioembolic Stroke:
1. Absence of ipsilateral TIA or carotid bruit
2. Absence of stenotic atherosclerosis of cerebrovascular or severe internal carotid ulceration by angiography or reliable noninvasive test.
3. Presence of one or more of the following:
   a. History of other embolic episodes (usually systemic) prior to the marker event
   b. Bilateral nonlacunar infarctions by CT scan
   c. Clinical diagnosis of cardiac disease consistent with cardioembolism.

D. Lacunar Infarction:
1. Presence of one of the following of the typical clinical syndrome for lacunar infarction:
   a. "pure" motor stroke (motor deficit with no sensory deficit)
   b. "pure" sensory stroke (sensory deficit with no motor deficit)
   c. Particular miscellaneous syndromes, such as dysarthria and homolateral clumsy hand
   d. Ataxia and cranial paresis.
2. Normal CT scan or CT scan showing typical small "lacunar" infarction.
3. Absence of ipsilateral carotid bruit.
4. Absence of cardiac source for emboli
5. Absence of significant carotid, vertebrobasilar or intracerebral arterial stenosis or thrombosis as demonstrated by angiography or other reliable noninvasive vascular examination.

E. Hemorrhagic Stroke (Hemorrhage, Not Otherwise Specified):
1. Presence of neurologic deficit lasting more than 24 hours.
2. Bloody or xanthochromic CSF.
3. Insufficient additional information to resolve the cause for hemorrhage (ie, aneurysmal bleed, arterovenous malformation or parenchymal hemorrhage).

F. Subarachnoid Hemorrhages:
1. Characteristic clinical syndrome of neurologic deficit which may progress to coma, usually with headache.
2. Nuchal rigidity.
3. Retinal subhyloid hemorrhages.
4. Nontraumatic bloody or xanthochromic CSF.
5. Subarachnoid blood on CT scan.
6. Demonstrated aneurysm by angiography or postmortem examination.

G. Intracerebral Hemorrhage (ICH):
1. Appropriate clinical syndrome with neurologic deficit.
2. Hyperdense lesions on CT brain scan consistent with parenchymal hemorrhage.
3. ICH at postmortem.
4. A probable diagnosis was made if an avascular mass by angiography existed in association with the appropriate clinical syndromes and poorly controlled hypertension.

H. Stroke, Not Otherwise Specified:
1. Characteristic clinical syndrome for stroke, with neurologic deficit lasting more than 24 hours.
2. Objective neurologic deficit present at 24 hours after onset.
3. No other systemic or neurologic explanation (ie, tumor, abscess, cardiovascular collapse).

Criteria for Risk-factor Definition

A. Hypertension
Hypertension was accepted if the diagnosis occurred in the past or the patient was treated with anti-hypertensive medication. For the diagnosis of hypertension during the hospitalization, a diastolic blood pressure of greater than 90 mm Hg was required or a systolic blood pressure of 155 mm Hg or more for those less than 35 years, more than 160 mm Hg for those between 35 and 60 years of age, and more than 180 mm Hg for those over 60 years was required. If several blood pressure recordings during a single day were both hypertensive and normotensive, an average of the readings was used for classification. If the patient was hypertensive on admission and no known nor recent blood pressure record-
ings were available to verify hypertension, the additional criteria of one of the following was required: (1) left ventricular hypertrophy by electrocardiogram (ECG) or (2) arteriovenous narrowing or nicking on fundoscopic examination.

B. Diabetes Mellitus

The diagnosis of diabetes mellitus was accepted if the diagnosis was made in the past or the patient was being treated by anti-diabetic medication. Laboratory criteria for the diagnosis required the fasting or two-hour post-prandial blood glucose to be 140 mg/dl or greater. Since stroke can cause an elevated blood glucose as a reflection of stress, an elevation found on admission was not considered sufficient for a diagnosis; in these patients, a repeat test was necessary to establish a diagnosis of diabetes. Patients on steroid therapy could not be classified as diabetic patients without evidence to the contrary.

C. Hyperlipidemia

Hyperlipidemia was accepted if the diagnosis was made in the past or the patient was treated with a low cholesterol diet or with anti-hyperlipidemic therapy. Laboratory criteria for hypercholesterolemia required a cholesterol level of 260 mg/dl or above and a triglyceride level of 150 mg/dl or above.

D. Arteriosclerotic Heart Disease (ASHD)

ASHD was accepted if the diagnosis of either myocardial infarction or ASHD was made in the past and ECG evidence for ASHD included evidence of myocardial infarction or of myocardial ischemia (ST segment elevation or T wave inversion).

E. Cardiac Arrhythmia

Arrhythmia was accepted if the diagnosis was made in the past by a physician or the ECG disclosed such arrhythmias as atrial fibrillation, premature atrial or ventricular contractions.

F. Other Cardiac Diseases

Other cardiac disorders were identified by the diagnosis of rheumatic heart disease, aortic or mitral stenosis or insufficiency or mitral valve prolapse. Congestive heart failure was accepted by its past diagnosis, treatment or symptoms indicating failure (pitting edema of the ankles, exertional dyspnea or two-pillow dyspnea).
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