Short Communications

Level of Function Predicts First Stroke in the Elderly

A. Colantonio, PhD; S.V. Kasl, PhD; and A.M. Ostfeld, MD

Background and Purpose: Our aim in this study was to assess physical function as a predictor of stroke incidence in a probability sample of noninstitutionalized elderly subjects with no previous history of stroke.

Summary of Report: The data were obtained from a prospective longitudinal study of 2,812 individuals aged 65 years of age and older living in New Haven, Connecticut. Incidence of stroke was monitored from the baseline interview in 1982 until December 1988 (n=167). Physical function was measured by the Katz scale of activities of daily living and a three-item scale measuring gross mobility function (Rosow scale). Both measures of impairment of function were independently associated with stroke incidence controlling for age, sex, diabetes, hypertension, and angina (p<0.001).

Conclusions: Our findings suggest that in elderly persons, physical disability is a newly identified risk factor for stroke. (Stroke 1992;23:1355–1357)

Although epidemiological studies have provided useful information on stroke risk factors, most of our present knowledge is based on relatively younger populations. The pursuit of new risk factors specifically in older populations may lead to a better understanding of risks for older age groups. Physical function is an important means of assessing general health and disability in geriatric populations. The purpose of this study was to assess the role of baseline physical function as a predictor of stroke incidence, controlling for other known risk factors.

Subjects and Methods

Subjects

The data for this study came from a large, longitudinal research project, the Yale Health and Aging Project. The study is based on a probability sample of 2,812 noninstitutionalized men and women 65 years of age and older living in the city of New Haven, Conn., in 1982. The sample was stratified by three housing types that characterized housing in New Haven: public elderly housing, private elderly housing, and general community housing. Because of a preponderance of elderly women in this population, men were oversampled to achieve their adequate representation. More information on study design can be found elsewhere.

Some 208 respondents who reported having had a stroke or whose medical records indicated a stroke before the beginning of the study were eliminated, leaving a sample size of 2,604. Stroke-free participants were followed from the baseline interview in 1982 until December 1988. Twenty-four (1%) individuals in this time period were lost to follow-up.

Overall respondents were, on the average, 74 years old at the initial interview; they were primarily female (59%) and white (79%). Fifty-five percent of the population had grade school education only. Of the individuals who reported income, 40% had annual incomes (for self and spouse if applicable) of under $5,000. These results reveal the generally lower socioeconomic status of the elderly, which is typical of most communities.

Stroke incidence was ascertained by the following four overlapping methods: hospital admissions of Yale Health and Aging Project subjects in the two New Haven hospitals at which nearly 90% of all hospitalizations of the cohort occurred, death certificates, Health Care Financing Administration data, and self-reported strokes from annual Yale Health and Aging Project home or telephone interviews. In all these sources of information on stroke, hospital records were sought and evaluated to confirm stroke incidence.

Stroke incidence was ascertained predominately by monitoring hospitalizations of study subjects. A trained nurse–research assistant regularly monitored admission records of these two hospitals for hospitalizations of study subjects. If the records of participants indicated admission or discharge for stroke between 1982 and November 1988 according to the specified International Classification of Diseases, revision 9 (ICD-9) codes, medical records were examined to ascertain diagnosis. Medical records were reviewed by the trained nurse–
researcher. Computed tomographic scans were available for 77% of cases and were used to confirm the diagnosis. A total of 136 incident strokes were ascertained by this method.

Death certificates of all study subjects were also reviewed for ICD-9 codes that indicated stroke. Death certificates of the Connecticut State Department of Health Services were regularly checked for the deaths of Yale Health and Aging Project subjects, and out-of-state death certificates were obtained by mail. They were coded by a single, specially trained nosologist. All death certificates that indicated stroke or cerebrovascular disease as an underlying, immediate, or contributing cause of death were reviewed by a study physician (an expert in cerebrovascular disease) to confirm diagnosis. Fifteen additional individuals were identified by this method. Hospital records were then sought to verify stroke diagnosis and date of stroke. In three cases, hospital records could not be retrieved. The type and date of stroke were taken from the death certificate.

Included in our number of strokes were also self-reports of strokes from annual interviews that were confirmed by medical records (n=13) or by Health Care Financing Administration data (n=1). Furthermore, Health Care Financing Administration data identified two patients that were hospitalized outside of New Haven. All these methods of ascertaining stroke combined yielded a total of 167 strokes.

The following ICD-9 codes were used to include strokes in the study: 431, 432.9, 433.0–434.9, and 436–437.1. These codes covered intracerebral hemorrhage, unspecified intracranial hemorrhage, occlusion and stenosis of precerebral and cerebral arteries, acute but ill-defined cerebrovascular disease, cerebral atherosclerosis, and other generalized ischemic cerebrovascular disease. The study excluded subarachnoid hemorrhage, nontraumatic extradural and subdural hemorrhage, and transient cerebral ischemia.

**Instruments and Variables**

Almost all independent variables were measured by means of a structured interview at baseline in 1982. Sociodemographic characteristics that were recorded included age, sex, education, race, and housing stratum. Health status measures were obtained mainly by self-report. The presence of hypertension, however, was based on actual blood pressure readings taken in 1982 by interviewers trained according to the Hypertension Detection and Follow-up Program protocol. The presence of hypertension was coded as a binary variable. Subjects were coded as negative if systolic blood pressure was less than 140 mm Hg and diastolic blood pressure was less than 90 mm Hg and they were not taking antihypertensive medication. If the blood pressure of subjects exceeded these cutoff points or they were taking antihypertensive medications, the respondents were coded as hypertensive. Use of antihypertensive medication was determined by trained interviewers who examined all medications the respondents were taking within the 2 weeks before the interview.

Cardiovascular comorbidity was measured by asking respondents whether a doctor had ever told them they had a heart attack, coronary, myocardial infarction, coronary thrombosis, or coronary occlusion. Responses to the London School of Hygiene Cardiovascular Questionnaire were used to ascertain angina and intermittent claudication.

Smoking, measured as a dichotomous variable, was based on whether the individual reported being a smoker at the time of the interview or in the past. Former smokers were placed in a category with smokers. Body mass was assessed by Quetelet’s Index.

Physical functioning was measured by two instruments: the Katz Activities of Daily Living Scale, expanded to include walking; and a scale of gross-mobility function based on three items developed from the work of Rosow and Breslau. The latter scale measured higher levels of physical function than the Katz scale and includes items measuring the ability to walk half a mile, go up and down stairs, and do heavy work around the house. Each of these items was adapted and used previously in the Framingham Disability Study. This scale will be referred to as the Rosow scale throughout this paper. For the Rosow scale, a score of 0 was given to each of the items assessed if the respondent performed the activity independently and a score of 1 if the respondent needed assistance or was unable to perform the task; thus, a score of 0–3 was possible. The Katz scale was dichotomized so that a score of 0 meant no impairment and 1 indicated limitations in one or more activities of daily living.

Cox proportional hazards model using the computer program package BMDP was used for univariate and multivariate modeling. The aim of the analysis was to establish the contribution of physical function over and above known risk factors or what we refer to here as control variables. Many of the health and sociodemographic variables that could be used as control variables were highly correlated; to have included all of them in the model would have led to problems of multicollinearity. To establish a set of control variables upon which we could assess the impact of physical function, we performed a stepwise regression on the following factors: age; sex; housing stratum; race; education; the presence of hypertension, angina, intermittent claudication, myocardial infarct, or diabetes; smoking; and body mass. Sex and housing stratum were retained in the model to control for the sampling design that was based on housing types of the New Haven elderly and oversampled men.

**Results**

Table 1 presents the distribution of incidence by Katz and Rosow scores for females and males. Incidence
TABLE 2. Selected Variables and Stroke Incidence Multivariable Cox Regression With Rosow Scores Controlling for Housing Stratum and Sex

<table>
<thead>
<tr>
<th>Variable</th>
<th>Relative risk</th>
<th>90% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (10-year intervals)</td>
<td>1.57</td>
<td>1.29, 1.91</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1.56</td>
<td>1.14, 2.12</td>
</tr>
<tr>
<td>Diabetes</td>
<td>2.26</td>
<td>1.73, 3.07</td>
</tr>
<tr>
<td>Angina</td>
<td>1.59</td>
<td>1.01, 2.40</td>
</tr>
<tr>
<td>Physical function (Rosow scale)</td>
<td>1.49*</td>
<td>1.31, 1.69</td>
</tr>
</tbody>
</table>

Log likelihood = -1109.53. Global $\chi^2 = 104.43; df = 9; p < 0.0001.

Contribution of Rosow scale scores to the above model: $\chi^2 = 24.89; df = 1; p < 0.0001.

*Relative risk for each increase of 1 point in the Rosow scale, which goes from 0 to 3.

clearly increases by number of limitations for both sexes.

Our stepwise regression indicated that age, hypertension, angina, diabetes, and sex were predictive of stroke incidence ($p < 0.05$). Although it was not significant in the stepwise regression, we also controlled for housing stratum to control for the study sampling design. Measures of physical function were added to this model. When either the Katz or the Rosow scale were in the model controlling for age, sex, and the presence of diabetes, hypertension and angina, they each made a significant ($p < 0.001$) contribution. However, because they are well correlated, when both measures of physical function are in the model, only the Rosow scale remained a strong predictor of incidence ($p < 0.001$). Table 2 presents relative risks and confidence intervals for the model that includes Rosow scores and shows the contribution of this variable to the model in terms of change in log-likelihoods. In the model in which the Katz and not the Rosow scale is included (not shown in Table 2), the odds ratio is 2.03 for this item.

**Discussion**

Few studies to date have published data on stroke risk factors in populations exclusively composed of elderly individuals 65 years of age or older. The Yale Health and Aging Project data provided an opportunity to examine physical function prospectively as a predictor of stroke incidence in a sample of community-dwelling elderly. This type of analysis can only be done properly prospectively because retrospective information in a case–control design on prior physical function obtained from stroke victims can be biased or impossible to obtain.

Our results suggest that measures of physical function may be useful in improving estimates of the probability of impending stroke in those 65 years of age and older. Gross-mobility function more so than limitations in activities of daily living is a unique explanatory variable in this analysis because the effects of established risk factors such as hypertension, age, sex, diabetes, and other cardiovascular comorbidity have been controlled. Our findings suggest that, in very old persons, a measure of disability or frailty is a newly identified risk factor for stroke.

**Acknowledgment**

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**References**

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