Risk Factor Modification in Stroke Prevention
The Experience of a Stroke Clinic

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Background and Purpose—We reviewed Stroke Clinic data to determine the extent of risk factor modification achieved in patients with cerebrovascular disease over 2 years.

Methods—Visits to the Stroke Clinic of a tertiary medical center from July 1, 1994, through June 30, 1996, were reviewed. Obesity, smoking, hypertension, hyperlipidemia, hyperglycemia, and lifestyle changes were noted in patients with ≥2 visits (n=61) and measures (number varied) of these parameters.

Results—Fifty-six patients (92%) had primary care physicians. In the 49 patients with ≥2 weight measurements, 33 (67%) were moderately or severely overweight by weight-height correlation. Forty-four patients (90%) remained in the same weight category. Of the 60 patients with available blood pressure data, 50 (83%) were hypertensive. At their last visits, 43 of the 50 (86%) were receiving medications, and 22 of the 43 treated (51%) were controlled. Serum glucose remained elevated in 14 of 47 patients (30%) and in 11 of 16 diabetic patients (69%). Thirty-six of 47 patients (55%) had elevated lipid measurements. None of the 21 smokers quit during the study period. Few patients modified dietary and exercise practices. Of 61 patients, 29 (48%) sustained vascular events during the study, with 17 of these 29 patients (59%) having strokes or transient ischemic attacks.

Conclusions—Although most patients were asked to quit smoking, received advice regarding diet and exercise, and were medicated for hypertension, elevated glucose, and cholesterol levels, their risk factor profiles showed little improvement during the 2-year period. More effective methods of controlling stroke risk factors are needed. (Stroke. 1999;30:16-20.)

Key Words: lifestyle ■ risk factors ■ stroke prevention

Recent advances in the treatment of acute ischemic stroke offer hope in reducing its devastating effects.1–4 However, these therapies are limited in availability because of poor public knowledge of or access to them and may help only a small fraction of stroke patients.5 Prevention remains an important approach to substantially reducing the incidence, recurrence, disability, and mortality of stroke. Potent modifiable stroke risk factors have been identified for several years.6–13 Modest weight loss in the obese can bring hypertension and hyperglycemia under much improved control.14,15 Relatively mild reductions in systolic and diastolic blood pressures can significantly reduce stroke risk across all levels of hypertension, whether mild, moderate, or severe.7 Furthermore, there is a growing imperative to control even mildly elevated blood pressure, which has been implicated in a large proportion of strokes.6,16 Smoking cessation also causes the risk of stroke to decrease rapidly, becoming that of a nonsmoker between 2 to 5 years after cessation.9 Aggressive treatment of these factors can therefore help to reduce the risk of stroke and recurrent stroke.

In the Stroke Clinic at a tertiary referral medical center, we reviewed how well the preceding and other stroke risk factors were being modified in patients at high risk for stroke, a large percentage of whom had already had a stroke. We aimed to determine whether there were positive changes in behavior and therapy that might reduce the risk of stroke in these patients.

Subjects and Methods
Eighty-two patients were seen between July 1, 1994, and June 30, 1996, in the weekly Stroke Clinic of the Boston Veterans Administration Medical Center. With each visit, histories and examinations were performed to determine whether new cerebrovascular events had occurred, and special note was made of the symptoms of peripheral vascular and cardiovascular disease, gastrointestinal bleeding, other hemorrhagic events, and other systemic illnesses or complications of medications. The patients’ heights were recorded, and they were questioned regarding smoking, diet, and exercise. Pulse, weight, and blood pressures in both arms were routinely measured. Medications were reviewed, with special attention paid to anticoagulants, antiplatelet agents, or in some instances, study medications. Pertinent laboratory results (for example, the last international normalization ratio performed) were recorded, and answers to questions regarding hemorrhagic complications of hematomatologically active medications were noted. Glucose and lipid profiles were periodically monitored to further assess cerebrovascular disease risk. Referrals to a nutritionist and the Cholesterol Clinic were made when these parameters were found to be abnormal. When indicated, further imaging studies were obtained. Discharge summaries from

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Stroke is available at http://www.strokeaha.org
TABLE 1. General Profiles of the 61 Patients

<table>
<thead>
<tr>
<th>Category</th>
<th>n (%): (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (range), y</td>
<td>67 (43–84)</td>
</tr>
<tr>
<td>Sex, M/F</td>
<td>59/2</td>
</tr>
<tr>
<td>Under care of primary care physician</td>
<td>56 (92)</td>
</tr>
<tr>
<td>Average visits in study period, n</td>
<td>5.6 (2–17)</td>
</tr>
<tr>
<td>Average time between visits, mo</td>
<td>13.1 (0.5–24)</td>
</tr>
<tr>
<td>Reason for stroke clinic enrollment, n (%)</td>
<td>39 (64)</td>
</tr>
<tr>
<td>Prior stroke</td>
<td>15 (25)</td>
</tr>
<tr>
<td>Asymptomatic cerebrovascular disease</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Noncerebrovascular disease diagnosis</td>
<td>3 (5)</td>
</tr>
</tbody>
</table>

recent hospitalizations and imaging studies were obtained for review as needed.

We retrieved data from the clinic charts of these patients in the year after the study period. Of the 82 patients seen over the 2-year period, 61 had ≥2 visits. These 61 patients became the focus group of our analysis (Table 1). The basis for enrollment in the Stroke Clinic—sometimes predating the study period—was noted for each patient.

The presence of hypertension was based on blood pressure measurements and the use of antihypertensive medications during the study period. Only 1 patient had isolated diastolic blood pressure elevation with repeated visits, and 1 other patient taking antihypertensive medications had a single episode of isolated high diastolic blood pressure. Other patients with diastolic hypertension also had systolic hypertension. For the uniformity of comparisons over time, therefore, we analyzed systolic blood pressures (SBPs) only. SBP was categorized according to the National Institutes of Health Fifth Joint National Committee standards. 17 We further grouped the 6 Fifth Joint National Committee SBP categories into 3 categories designated normal/high-normal SBP, mild/moderate hypertension, and severe/very severe hypertension (Table 2).

The height and weight of patients according to US Department of Agriculture guidelines18 determined obesity. Designations of healthy weight or moderate or severe overweight were made accordingly. Total cholesterol, triglycerides, HDL, LDL, and the total cholesterol/HDL ratio were determined to be elevated according to parameters described elsewhere.19–21 Elevated serum glucose levels were determined on the basis of the normal distribution of glucose levels for the population of that institution; a level >7.6 mmol/L (137 mg/dL) was designated abnormally high.

For purposes of communication, we noted whether each patient had a primary physician. A Stroke Clinic visit note was routinely added to each patient’s medical record, and primary care physicians were occasionally contacted directly regarding vascular risk factors or other pertinent medical problems.

We determined whether patients were compliant with behavior and pharmaceutical modification and whether improved lifestyle habits and the use of medications improved stroke risk profiles.

Results

Sixty-one patients were seen ≥2 times over the course of 24 months for a total of 341 visits. The average number of visits per patient was 5.6 (range, 2 to 17), and the average time between visits was 13.1 months (range, 0.5 to 24 months). (The patient with 17 visits was on a study medication requiring almost monthly follow-up visits. The patient seen next most frequently, 14 visits, was also in the same study. Other patients had visits more in keeping with the mean number of visits [5.6±2.88, mean±SD].) The mean age was 67 years (range, 43 to 84 years), and 59 of the 61 patients were men. Fifty-six patients (92%) were under the care of a primary physician. Fifty-four (89%) had sustained a prior stroke or transient ischemic attack (TIA) (Table 1).

Blood Pressure Control

Fifty (83%) of 60 patients with available blood pressure data were known hypertensives (see Subjects and Methods). Forty-five of the 50 (90%) and 43 of the 50 (86%) were receiving antihypertensive medications at the first and last visits, respectively. The remaining hypertensive patients were not taking such medications. Of those treated, 17 of 45 (38%) and 22 of 43 (51%) had controlled blood pressure at these respective visits.

Regardless of an established diagnosis of hypertension, 35 of 60 (58%) and 30 of 60 (50%) had elevated blood pressure at the first and last visits (Table 2).

Weight Control

Thirty-three (67%) of the 49 patients with ≥2 documented weight measurements were overweight at both their first and last visits. Forty-four patients (90%) did not change weight categories during the study period. With little variation from the first visit, 13 (27%) were moderately overweight and 20 (41%) were severely overweight at the last visit. The charts of 20 overweight patients (61%) had written documentation of advice given to help them improve diet, exercise, and weight control. Only 1 of these 20 patients lost weight substantially, improving from severely to moderately overweight. Of the 61 patients in this study group, 16 (26%) indicated that they had modified at least 1 lifestyle practice in an attempt to achieve weight control during the 2-year period.

Glucose Control

Forty-seven of 61 patients had ≥2 serum glucose measurements during the study period. Of these 47 patients, the level was elevated in 15 (32%) and 14 (30%) at the first and last measurements, respectively.

Of the 61 patients, 21 (34%) were known diabetics, 17 (28%) of whom were taking insulin, an oral hypoglycemic agent, or both. Forty were not taking any hypoglycemic agents. The lowest measured serum glucose at any point in these 21 diabetic patients was >7.6 mmol/L (137 mg/dL) in 9 individuals (43%), and the range of serum glucose levels was 3.9 to 16.1 mmol/L (70 to 289 mg/dL). Of the 16 diabetics with ≥2 glucose measurements, 10 (63%) and 11 (69%) had levels >7.6 mmol/L (137 mg/dL) at the first and last visits, respectively (Table 3).

Smoking

Various details about smoking were available for 60 of the 61 patients. The majority, 39 of 60 (65%), were nonsmokers.
Only 3 of these 39 nonsmokers (8%) quit smoking during enrollment in the Stroke Clinic, doing so before the study period, however. Of the 21 current smokers (35%), 15 (for whom we had pack-year histories) had an average 61.7 pack-year history of smoking. All smokers were advised to discontinue smoking, and this was documented in writing in the records of 14 of the 21 (67%). None of the 21 stopped smoking during the study period.

### Cholesterol Control

We obtained ≥2 cholesterol measurements in 47 patients during the study period. Of the 47, 20 had ≥2 full lipid profiles. Table 4 shows that fewer than half of these patients had target cholesterol levels at their first and last visits. Of these 47 patients, 36 (77%) met the criteria for hyperlipidemia. Of these 36 patients, 15 (42%) were treated with lipid-lowering agents at some point in the study.

Of these 15 patients treated with lipid-lowering drugs, 7 (47%) had cholesterol levels >5.2 mmol/L (200 mg/dL), and 6 (40%) had LDL levels >3.4 mmol/L (130 mg/dL) for >50% of the measurements.

### Patient Events

In the 24-month follow-up period, 2 patients (3%) had strokes, and 15 patients (25%) had TIA.s. One patient sustained a retinal artery occlusion. Eight patients (13%) had manifest heart disease that included ongoing/episodic congestive heart failure, angina, coronary artery bypass surgery, or development of atrial fibrillation. There were no documented myocardial infarctions. Of the 3 patients with peripheral vascular disease, 2 had recurrent claudication, and 1 had a nonhealing foot ulcer.

During the study, 56 of 61 patients (92%) were receiving antiplatelet or anticoagulant medication. Fifteen (25%) were taking warfarin at the beginning of the study, and 12 (20%) were on warfarin at its end. Two patients had gastrointestinal hemorrhages. The first occurred in a patient who was taking warfarin, with a blood transfusion. The second hemorrhage occurred in a patient taking 81 mg/d aspirin. There were also minor hemorrhagic events such as epistaxis in 2 patients and trace genitourinary bleeding in 1 other patient. There were no fatalities in the 61-patient focus group.

### Discussion

During 2 years of follow-up in the Stroke Clinic, the control of hypertension, obesity, diabetes, hypercholesterolemia, and smoking was not notably improved. This was observed even though 43 of 50 patients (86%) with hypertension were on antihypertensive medications, 20 of 33 overweight patients (61%) received documented recommendations regarding healthier diets and exercise, 14 of 21 smokers (67%) had documented advice to stop smoking, 15 of 36 hyperlipidemic patients (42%) were taking cholesterol-lowering agents, and 56 of 61 patients (92%) had a primary care physician with whom the Stroke Clinic was in touch. Furthermore, nondocumented recommendations regarding dietary changes, exercise, and smoking were routinely made to all patients. Despite these efforts to control vascular risk factors and the use of anticoagulant and antiplatelet medications in 90% of patients, 29 (48%) had events attributable to atherosclerotic disease; slightly more than half affected the cerebral circulation. Clearly, this group of patients was not adequately protected from the sequelae of atherosclerotic disease.

It is worth emphasizing that this study is retrospective, focusing on a specific veteran population. Thus, its findings may not apply to the general population.

Of particular disappointment was the schism between the high rate of antihypertensive therapy and the comparatively low proportion of individuals with controlled blood pressure, when it is likely that control of hypertension may have the greatest potential benefit of reducing stroke. This parallels the National Health and Nutrition Examination Study (NHANES) III observations that of hypertensive individuals in the United States, 55% are treated and 29% are actually controlled. Although our hypertensive patients were more aggressively treated (86%) and controlled (51%) than the general population of hypertensives, there remained an unacceptable gap between medicated and effectively treated patients. This is of concern when we consider that 58 of 61 patients (95%) already had manifest cerebrovascular disease (Table 1).

The finding that more than two thirds of the diabetics and about one third of the entire study group had a serum glucose >7.6 mmol/L (137 mg/dL) was indicative of the unsatisfactory control of blood sugar. In the event of an acute stroke, serum glucose >7.8 mmol/L (140 mg/dL) is associated with a greater likelihood of early mortality or recurrence. Not only were many of our patients at high risk for stroke, recurrent stroke, and other atherosclerotic disease; they were also more likely by virtue of their diabetes to do poorly after having a stroke or recurrence because of the poor control of their diabetes.

Although these patients varied with respect to complexity of their cerebrovascular disorders, in general, they had medical problems that were fairly difficult to manage. The detection and diagnosis of new symptoms and decision-making with respect to safety and efficacy of therapeutic

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### TABLE 3. Serum Glucose Control

<table>
<thead>
<tr>
<th>Serum Glucose</th>
<th>n</th>
<th>(%)</th>
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</thead>
<tbody>
<tr>
<td>&gt;7.6 mmol/L (137 mg/dL)</td>
<td>% (n/total)</td>
<td></td>
</tr>
<tr>
<td>All patients, first measurement (n=47)</td>
<td>32 (15/47)</td>
<td></td>
</tr>
<tr>
<td>All patients, last measurement (n=47)</td>
<td>30 (14/47)</td>
<td></td>
</tr>
<tr>
<td>Diabetics, first measurement (n=16)</td>
<td>63 (10/16)</td>
<td></td>
</tr>
<tr>
<td>Diabetics, last measurement (n=16)</td>
<td>69 (11/16)</td>
<td></td>
</tr>
</tbody>
</table>

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### TABLE 4. Lipid Control

<table>
<thead>
<tr>
<th>Desirable Lipid Parameter, mmol/L (mg/dL)</th>
<th>n</th>
<th>Patients at First Measure, n (%)</th>
<th>Patients at Last Measure, n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cholesterol &lt;5.2 (200)</td>
<td>47</td>
<td>16 (34)</td>
<td>18 (38)</td>
</tr>
<tr>
<td>LDL cholesterol &lt;3.4 (130)</td>
<td>20</td>
<td>6 (30)</td>
<td>9 (45)</td>
</tr>
<tr>
<td>Triglycerides &lt;1.7 (150)</td>
<td>20</td>
<td>7 (35)</td>
<td>9 (45)</td>
</tr>
<tr>
<td>HDL cholesterol &gt;1.2 (45)</td>
<td>20</td>
<td>4 (25)</td>
<td>4 (25)</td>
</tr>
</tbody>
</table>
interventions often dominated much of the ≈30-minute visits. Occasionally, the urgency of specific problems eclipsed these patients’ nonurgent primary and secondary issues. Although it was routine practice of the Stroke Clinic staff to review and query patients about stroke risk factors, in a few instances, time did not permit discussion of preventive measures. In these situations, plans were made to approach the topic at the next appointment. Primary care physicians were also relied on to reinforce lifestyle modification advice and to implement our recommendations to adjust blood pressure and other medications.

As a courtesy to primary physicians, we rarely prescribed or altered blood pressure, lipid-lowering, or hypoglycemic medications except when it was expedient that we do so. In some settings, however, the neurologist or other specialist may need to do this routinely. This is already widely accepted and expected in cardiology circles. Specialists who treat patients with diseases that are largely preventable should become well versed in the measures and medications required to prevent them and when appropriate should use their expertise judiciously. A Stroke Clinic like ours may be an ideal forum to aggressively treat these vascular risk factors. Among physicians, there is a wide range of views on what are significant risk factors and how aggressively they should be managed. Improved educational approaches are needed to integrate the basis for treatment with routine practical interventions to effectively reduce these factors. When physicians are given evidence-based hypertension guidelines and later surveyed, they consistently treat hypertension in keeping with those guidelines. Still, many objections to more aggressive control of risk factors must be acknowledged and the issues rectified. For example, there is still a demand for more easily tolerated medications that may improve patient compliance and the control of hypertension.

Even if pharmaceutical therapy is optimized to modify risk factors for stroke, the most effective means of reducing stroke risk are those incorporating lifestyle changes. When feasible, this should be the first approach taken with patients. Gorelick has discussed “windows of opportunity” for the reduction of stroke risk. In his paradigm, the optimal time to control risk factors is in preadolescence or adolescence when lifelong behaviors are being ingrained. Furthermore, findings from studies of risk factor treatment also suggest that positive or negative patient attitudes and behavior (and perhaps outcome) may cluster. Habit may be a stronger guarantor of behavior than motivation. Barring established habit, however, strong motivation may be the only entity available to induce positive change. Unfortunately, older patients are often unable to achieve control of risk factors by behavior modification and may require treatment with a strong emphasis on medications.

New strategies for the control of stroke risk factors should be considered. In a telecommunications study in which patients checked in weekly and received feedback on the control of their hypertension, those who were previously nonadherent to treatment registered a mean 6.0 mm Hg decrease, whereas control subjects had a 2.8 mm Hg increase in diastolic blood pressure. Physicians and patients need to be amenable to the use of new systems.

In summary, despite distinctly identified vascular risk factors and attempts to achieve their control in our study group, these factors were inadequately modified. A more aggressive dual focus on not only identification but also control of these factors, the introduction of strong incentives to improve both patient and physician behavior, and a team approach, perhaps widening the patient-doctor circle to include nurses, physicians’ assistants, and other ancillary staff, may result in more careful and frequent follow-up and definitive control of stroke risk factors.

**Acknowledgment**

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**References**


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