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Educating the Next Generation of Physicians About Stroke

Incorporating Stroke Prevention into the Medical School Curriculum

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Background and Purpose—In response to the need to educate physicians about stroke, we have implemented an educational program on stroke prevention for undergraduate medical students within the first-year neuroscience course. This study investigated whether first-year students learned and retained key information about stroke, and used students' feedback both to identify effective curricular components and to explore their attitudes regarding stroke prevention.

Methods—Stroke knowledge and self-assessed confidence in that knowledge before, immediately after, and 8 months after participation in the stroke curriculum were analyzed and compared for 3 classes, using paired *t* tests and repeated-measures ANOVA. Student feedback about the effectiveness of specific parts of the curriculum and about the importance of stroke prevention was solicited and evaluated.

Results—First-year medical students in 3 classes more than doubled their overall stroke knowledge scores (pretest total mean of 8.2; posttest mean 18.0), and retained significant improvement 8 months later (mean 15.7). Subscores in all 4 areas of stroke knowledge tested significantly increased ($P<0.001$). Students' confidence in their knowledge of stroke risk factors and warning signs, as well as in their knowledge itself, increased ($P<0.001$). Each of the 3 cohorts demonstrated similar improvements. Feedback indicated heightened awareness and interest in stroke prevention, which was maintained after completion of the curriculum.

Conclusions—These results demonstrate that when instruction on stroke prevention is incorporated into the first-year curriculum, students learn and retain key information. Because entire classes of medical students are involved, this type of approach has the potential to reach all future physicians and therefore to meaningfully impact future stroke care. **(*Stroke*. 2001;32:2854-2859.)**

Key Words: curriculum ■ education, medical ■ stroke prevention

Stroke is currently, and is likely to remain, a leading cause of death and disability among adults in the United States.[1–3] Medical school provides a unique opportunity to reach all future physicians and to ensure that all have at least a minimal knowledge about stroke, regardless of their future specialty. This is important because general internists, family practitioners, emergency physicians, cardiologists (and other medical specialists), surgeons, obstetricians and gynecologists, as well as neurologists, all have opportunities to provide effective stroke prevention, patient education, and treatment interventions.[4–8] If medical students learn about new approaches to stroke prevention and treatment early in their training, the skills, knowledge, and attitudes that they acquire are likely to have a positive impact on the care they provide to patients in residency and beyond.

In spite of the importance of stroke as a national health problem, there have been relatively few studies published to date addressing training about stroke in the undergraduate curriculum. A single study published in 1995 surveyed the amount, but not the content, of stroke teaching in just 31 medical schools in the United States and Canada. Of this small sample, composed primarily of academic medical centers with active stroke programs, 84% provided some preclinical instruction on stroke (mean of 3.2 hours of didactic teaching and 2 hours of case presentations covering unspecified content) and 61% provided clinical training for medical students.[9] The results of this limited survey suggest that at best, medical students receive a modest amount of stroke training. Thus, there continues to be a need for innovative approaches that can increase the amount of undergraduate medical training in stroke, especially programs highlighting stroke prevention and acute stroke interventions.

See Editorial Comment, page 2858

In 1997 we first introduced new material on stroke prevention into the neuroscience course for first-year medical

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***Stroke* is available at http://www.strokeaha.org**

TABLE 1. Presenting Information About the Common Warning Signs of Stroke to First-Year Medical Students

Educational Method	Content—Questions posed and discussed
Table and text in syllabus (new)	What are the common warning signs? What should you advise patients to do if they experience them? What may be the meaning of transient problems, and what should patients do?
Syllabus, lecture, take-home exercise (modified)	Can you relate each warning sign to abnormal functioning of specific gray or white matter structures? Branches of what artery supply each named structure? (review of neuroanatomy)
Syllabus, conference discussion (modified)	Why are these particular warning signs likely to be so common? (review of vascular anatomy and neuroanatomy)
Syllabus, patient videos, clinical conference (new)	How may patients experience these warning signs or describe them to you, their physician?
Clinical conference (new)	What points might you want to emphasize in giving anticipatory guidance to a high-risk patient?

Modified indicates that related material already presented in the neuroscience course was modified to emphasize stroke prevention; new indicates that new material was added to the neuroscience course.

students, with the stated goal of encouraging medical students to take an activist approach to stroke in their own future practice of medicine.[10] Objectives included knowledge of stroke risk factors, warning signs, and basic information relevant to appropriate prevention and treatment interventions as well as introductory skills related to risk assessment and patient education. Using educational materials developed by a multidisciplinary group, we integrated teaching of these stroke-related objectives with more traditional basic neuroscience.

This study had 2 primary purposes: first, to determine whether this curriculum was effective in teaching first-year medical students key information about stroke prevention, and second, to identify curricular components that first-year medical students found most helpful in learning about stroke. In addition, we explored student attitudes about stroke prevention.

Methods

Participants

Three consecutive classes of 100 medical students at the University of Massachusetts Medical School received specific instruction in stroke prevention during the neuroscience course.

Intervention

The first-year neuroscience course is presented over a 10-week period in the spring semester. The educational intervention studied here included an expanded syllabus with new stroke-related objectives and written material on stroke and stroke prevention distributed to students on the first day of class; incorporation of stroke content into course lectures and interactive conferences, as appropriate; a laboratory in which students studied stroke-related specimens and radiographic material together with patient cases; and a clinical patient conference. Many of these changes were modifications of existing course activities, such as adding information related to risk factors and prevention to cases that had previously focused only on identifying the site of damage. Table 1 provides an example of ways the common warning signs of stroke were presented, which is illustrative of how new materials were added and existing materials were modified.

Measurement

A 20-item test was used to assess stroke knowledge. Test items included short-answer questions concerning stroke risk factors (4 items), warning signs (4 items), and localization (relating symptoms to specific gray or white matter regions and their blood supply; 8 items), as well as multiple-choice questions about stroke prevention and treatment (4 items). Each student received a total score for stroke knowledge and subscores in specific areas. For the items on risk factors and warning signs, students also self-assessed their confidence in the accuracy of their knowledge using a 3-point Likert-type scale (with 1 as the lowest rating and 3 the highest).

In addition, students completed an end-of-course evaluation containing specific questions concerning the format, content, and effectiveness of the stroke curriculum. This instrument included specific questions designed to gather students' opinions regarding stroke prevention, and students rated each item using a 4-point Likert-type scale. Students were also invited to identify and comment on specific strengths and weaknesses of the stroke curriculum.

The study was approved by the institutional review board and was discussed with each group of student participants.

Data Collection

The stroke pretest was administered on the first day of the neuroscience course. Posttest 1 was given at the conclusion of the course, and a second posttest was administered to the same cohort of students at the beginning of the second-year neuroscience course 8 months later. No material on stroke was presented in the medical school curriculum during the interval between the first and second posttests. Students completed evaluations of the stroke curriculum at the end of the first-year neuroscience course.

Analysis

Changes in mean scores between pretest and the 2 posttests were compared by using paired *t* tests. Each of the stroke knowledge subtests and self-assessments was analyzed separately. Data from each class were evaluated individually, because we were interested in how effective this approach might be for different groups of students and because the curriculum was slightly modified each year. Overall performance of the 3 consecutive classes that participated in the curriculum was examined using a repeated-measures ANOVA. To examine possible differences between students with complete data and students who were eliminated from the study because they missed 1 or more test administrations and/or did not provide a correct identifying code for data matching, mean neuroscience course grades were compared. In addition, to identify any major effect of the stroke curriculum on students' learning of basic neuroscience, course grades of the 3 classes participating in the stroke curriculum were compared with course grades of the 2 previous classes. Feedback about the curriculum from the 3 cohorts of students was summarized through use of descriptive statistics and compared directly. Student comments from each year were grouped according to the particular components of the curriculum that they addressed.

Results

Overall, more than 83% of students participated in each test administration. Because we required paired data, we included in the study only those students who had completed all 3 test

TABLE 2. Total Stroke Knowledge Score (maximum 20 points)

Class	Pretest	Posttest 1	8-mo Posttest
2000	7.95 (3.09)	18.16 (1.85)	15.14 (3.62)
2001	8.55 (2.99)	18.82 (1.45)	16.11 (3.11)
2002	8.11 (3.38)	17.06 (1.98)	15.94 (2.62)
Total	8.20 (3.15)	18.02 (1.91)	15.72 (3.16)

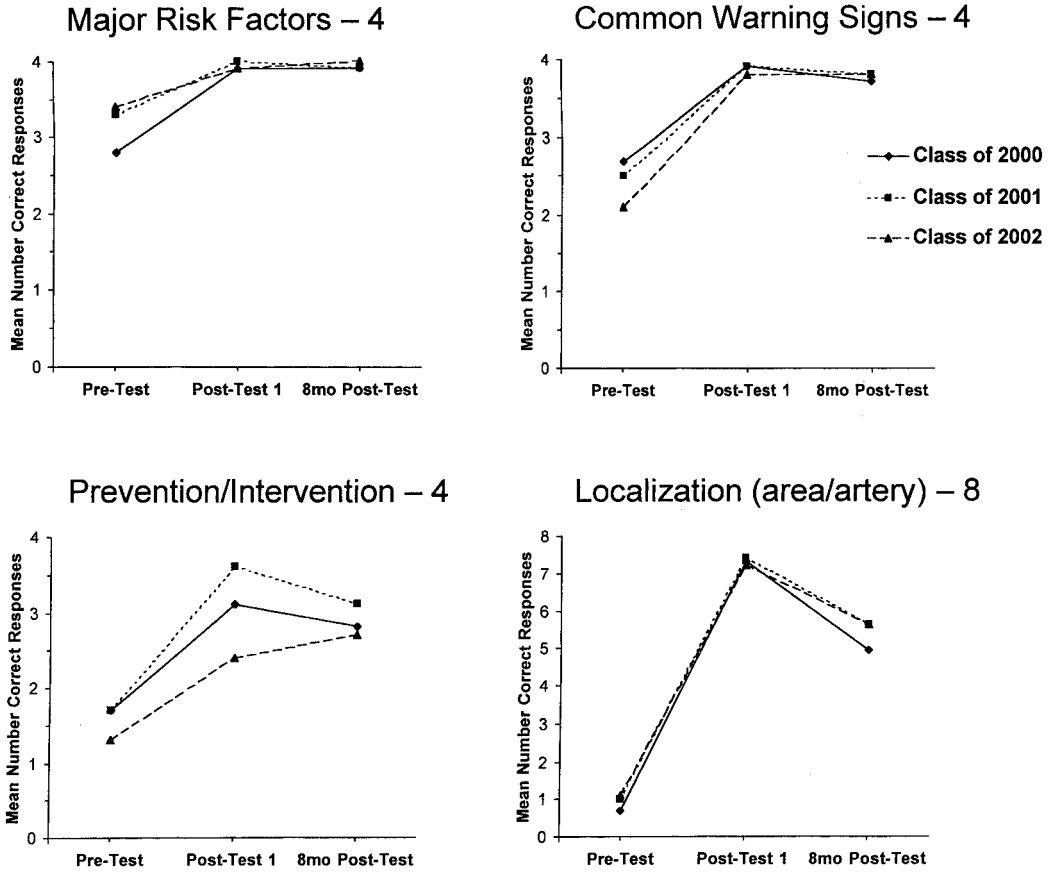
Values are mean (SD).

Repeated-measures ANOVA shows there were significant increases in knowledge in each class after taking the stroke curriculum ($P<0.001$) and that the performances of the 3 classes were not significantly different ($P=0.06$).

measures (pretest, posttest, and 8-month posttest) and supplied correct codes for matching data from all of the administrations. For this reason, our final study group consisted of 71 students from the class of 2000, 57 students from the class of 2001, and 56 students from the class of 2002. A test for bias in the sample based on neuroscience grades indicated no difference between the students who had complete data and those with missing data ($P>0.01$).

With respect to stroke knowledge prior to the intervention, stroke pretest scores for all 3 cohorts were comparable, indicating no difference between years. In each of the 3 classes, students' overall stroke knowledge score means more than doubled from pretest to post-test 1, and remained significantly elevated over pretest levels 8 months later, as measured by the 8-month posttest (Table 2). Results of the repeated-measures ANOVA indicate that all 3 classes showed similar significant overall increases in stroke knowledge from pretest levels ($P<0.001$). Although the curriculum was changed slightly each year, there was no significant difference between the performances of the 3 classes ($P=0.06$).

Figure 1 summarizes student performance on the 4 subtests: risk factors, common warning signs, preventive measures/therapeutic interventions, and localization of vascular lesions. Mean scores for all 3 classes show significant increases on each of the 4 subtests immediately after completion of the neuroscience course ($P<0.001$) compared with scores at the start of the course. These increased mean scores were fully or partially maintained 8 months later ($P<0.001$). Mean scores on the localization subtest remained significantly higher than pretest scores at 8 months but declined sharply when compared with the immediate posttest scores in each class ($P<0.001$). Review of item responses revealed that the decreases were primarily attributable to incorrect responses when names of specific neuroanatomical structures were required. A smaller decline in knowledge about prevention/intervention also occurred at 8 months compared with



Mean scores on the 4 subtests of stroke knowledge before (pretest), immediately after (post-test 1), and 8 months after (8 mo post-test) students participated in the stroke curriculum. For each of the 3 classes, all pretest to post-test 1 and all pretest to 8 mo post-test differences are significant ($P<0.001$). Subtests on stroke risk factors, warning signs, and localization required students to recall information and were in a short-answer format; the subtest on prevention/intervention required recognition of information and was in a multiple-choice format. For each subtest, the maximum possible score is indicated to the right of the heading.

TABLE 3. Self-Assessed Confidence in Knowledge (3-Point Scale)

	Stroke Risk Factors			Stroke Warning Signs		
Class	Pretest	Posttest 1	8-mo Posttest	Pretest	Posttest 1	8-mo Posttest
2000	2.07 (.61)	2.97 (.10)	2.86 (.25)	2.14 (.64)	2.93 (.17)	2.78 (.35)
2001	2.26 (.46)	2.96 (.01)	2.80 (.29)	1.99 (.66)	2.99 (.01)	2.73 (.40)
2002	2.23 (.51)	2.88 (.22)	2.81 (.22)	2.16 (.59)	2.94 (.17)	2.77 (.29)

Values are mean (SD), with scores from 1 (indicating very insecure) to 3 (very confident).
All pretest to posttest 1 and all pretest to 8-month posttest differences are significant ($P<.001$).

immediately after intervention, but again the scores remained substantially higher than at pretest.

Increases in students' confidence in their knowledge were also noted. Although a number of students were able to accurately name some of the major risk factors and warning signs of stroke at pretest, their self-assessed confidence in the correctness of their knowledge significantly increased from pretest to posttest 1 ($P<0.001$) and remained increased 8 months later (Table 3).

In terms of learning traditional basic neuroscience, multiple comparisons of course grades found no differences between the 2 classes immediately before the addition of the stroke curriculum and any of the 3 classes participating in the curriculum ($P>0.05$).

Students in all 3 classes remarked that the topic of stroke prevention complemented their first-year neuroscience experience. Sample comments included: "The stroke curriculum reflected true integration—not just more information"; "The stroke curriculum seemed very relevant to our course"; and "I think this curriculum was very well suited to our level and our needs." A number of comments reflected enthusiasm about its practical clinical content. For example, one student wrote, "I felt for the first time like I was really going to be a doctor. I will never forget about stroke."

With respect to student responses to the close-ended course evaluation items, virtually all of the 266 responding students in the 3 classes (97% to 100%) "agreed" or "strongly agreed" that the curriculum increased their awareness of ways that physicians can reduce stroke risk and improve outcomes. One hundred percent of the responding students in all 3 classes "agreed" or "strongly agreed" that primary prevention and patient education are critical components of stroke care.

The 4 curricular elements that students found most helpful, based on 141 specific responses to an open-ended question, were (1) a clinical conference in which patients described a TIA or onset of acute stroke (38%), (2) a multistation laboratory in which students related brain specimens and radiographic images to patients' histories of stroke (24%), (3) clinical cases to practice neuroanatomical localization that included feedback on correct answers (17%), and (4) written syllabus materials about stroke and stroke prevention (10%). The 3 ways that students most frequently suggested for improving the curriculum, based on 26 specific suggestions, were (1) present material through an interactive computer program, (2) provide more practical tips on patient education for primary risk reduction, and (3) include more information on current treatments for acute ischemic and hemorrhagic stroke.

Discussion

By assessing student knowledge and soliciting student feedback, we have demonstrated that first-year medical students learned and retained key information about stroke and stroke prevention that was presented within the neuroscience course, and that most were enthusiastic and motivated about doing so. This study documents both immediate and sustained increases in the students' stroke knowledge and in their confidence about the correctness of their knowledge, which suggests that they may be more likely to apply this information in clinical settings. Finally, student performance in other content areas of the neuroscience course did not seem to be negatively affected by the addition of the material on stroke prevention, a consideration for course directors who might be thinking about adopting this approach.

Students overwhelmingly reported that the curriculum succeeded in delivering information about stroke prevention. Furthermore, the curriculum has had a substantial impact beyond the classroom. Some students immediately began incorporating their knowledge of stroke prevention into patient encounters in the offices of their longitudinal preceptors. Students in the class of 2000 organized a well-attended voluntary session on "Acute Stroke in the ED," several initiated a research project on time from stroke symptom onset to hospital in our area, and 20% of the class of 2002 applied to join the planning board of a new Web site devoted to educating medical students about stroke prevention.

The importance of an effective curriculum on stroke and stroke prevention targeted to first-year students is that it can reach virtually all future physicians. While only some students will take a clinical clerkship in neurology, and fewer will receive formal education in stroke prevention as residents, even in specialties such as medicine[9,11] all students take neuroscience during the first or second year of medical school. The consistency of our results across 3 consecutive classes provides strong evidence that integrating instruction in stroke prevention into a first-year neuroscience course is an effective and feasible approach.

We have continued to modify the stroke prevention curriculum with each iteration of the neuroscience course, incorporating our students' suggestions where appropriate. We have now developed a Web site that presents our curricular objectives and approaches online, guided by lessons learned in these first 3 years.[12]

While this study is limited due to the fact that it involves a single medical school and follows students only into their second year, our results were positive. Our experience suggests that the first year of medical school provides an important opportunity to educate all future physicians about stroke and the benefits of proactive approaches, regardless of their future specialty. Programs such as the one described here can complement courses that are already part of the curriculum, while providing memorable clinical exposure and practice. If instituted widely, this approach could dramatically impact future stroke care and public health in general.

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Editorial Comment

Changing Culture About Stroke

Most medical training programs give strikingly little attention to one of the most devastating and frequent pathological events. This may at least in part reflect a sort of cultural bias deeply rooted in our societies that is unconsciously transferred into medical school curricula. This bias, in fact, prevents appropriate emphasis from being placed on the subject during medical education.

The term *stroke* (ie, the translation of the Latin word *ictus*) has a quite inaccurate meaning, because it includes events with diverse etiologies. In fact, cerebral ischemia and hemorrhage are biologically opposite events with similar symptoms and are clinically grouped together under the same term as to underline that, whichever the etiology, therapeutic options are so limited that there is no practical need to distinguish them.

Of course, this cultural bias has no scientific basis: an active and brave approach to stroke management may limit its devastating consequences, allow some degree of neurological function preservation, and maximize the likelihood of being self-sufficient.

Most importantly, a better understanding of the underlying causes of stroke has prompted the development of primary and secondary prevention strategies, especially of ischemic stroke; in fact, risk-factor-based prevention has been shown to effectively reduce the number of these events.

We thus need to make any effort to change the disappointing way we think about stroke, ie, a condition for which very little, if nothing, can be done. Major efforts have gone into trying to change the cultural bias of health professionals and develop clinical guidelines.[1,2] The first and most important step, however, is to make sure that medical schools implement this concept into their curricula.

The students attending medical school are going to become future physicians who will be given the opportunity to influence directly the health state of their patients: for this reason, they might change first their cultural attitude about stroke.

Modifying acquired mental habits is a long-standing process that requires students to make a greater effort than the acquisition of new knowledge. Even the tutor may have difficulties accepting and internalizing a more optimistic view of pathological processes of which stroke is the final event: nevertheless, this optimistic view is of crucial importance to implement enthusiasm into the students and to achieve a good educational result.

The primary message of a neuroscience course dealing with cerebral ischemia should be that stroke is a disease, just like others, in which the most relevant component of management lies in the control of modifiable risk factors, ie, hypertension, embolizing heart disease (atrial fibrillation, postinfarction hypokinesia, valvular disease), diabetes, smoking, hyperlipidemia, carotid artery atheromata, and alcohol abuse.

Moreover, the student should be open to the possible identification of new risk factors for ischemic stroke. These may

consist of lifestyle changes deriving from positive actions—ie, campaigns against obesity, hypertension, or diabetes—or from unexpected or unforeseeable events, such as environment changes, new diseases, changes in life expectancy, and availability of drugs such as antiaggregants, hormones, or others. The effect of more frequent population shifts and genetic mixing may alter the distribution of known and unknown risk factors within western society. The latter has been documented by a recent epidemiological survey[3] and represents a further stimulus to transfer as early as possible to students the concept that stroke is an event modifiable by prevention strategies and current and forthcoming therapies.

When is the best time to present stroke-preventing programs? Cultural change may be very difficult to penetrate the way we have been dealing with this common problem for many years, while the *habitus mentis* of medical trainees may be more likely to be unbiased.

When a deep-rooted cultural behavior needs to be modified, early educational intervention is critical. This, however, has to take into account the ability of the student to appropriately comprehend and acquire specific information on the subject.

The preceding article reports an interesting teaching experiment that assesses the effect of early introduction to stroke risk factors and prevention models. The results of this investigation are encouraging and deserve attention: students are capable of comprehending basic concepts of stroke prevention early, resulting in solid knowledge acquisition.

In Italy, as in other western countries, stroke is perceived as a severe healthcare and social problem that requires increasing national health system investments; this has resulted in more medical education courses on stroke.

The credit structure of medical education allows students to self-organize up to 30% of their medical education: in this portion more detailed studies on specific topics, such as those pertaining to stroke, may be included. A formal neuroscience course is provided during the last 3 years of medical training, and most medical schools offer education relating to stroke during this period.

Educational models may not be transferred easily from one training system to another. Medical schools, however, should consider as a high priority a change in the way stroke and its prevention strategies are perceived by future physicians.

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