Experiential Curriculum Improves Medical Students’ Ability to Answer Clinical Questions Using the Internet

Brian S. Alper, MD, MSPH; Daniel C. Vinson, MD, MSPH

Background and Objectives: Teaching about evidence-based medicine (EBM) is widespread, yet physicians still use rapid references preferentially over EBM techniques such as literature searching and appraisal of original research. The Internet now provides rapid access to preappraised evidence. We provided clinically integrated teaching of using the Internet to answer clinical questions for third-year medical students and assessed the change in their search skills. Methods: The curriculum included two 90-minute computer lab sessions with teaching of search skills related to clinical questions. Immediately before the first and after the second session, students recorded sites searched, time needed for searching, and answers found for three standardized questions. Pretest and posttest questions were matched and reversed with each block. Results: Eighty-six students completed pretests and posttests. For two questions about conventional medical care, posttest answer quality was significantly higher, and posttest search times were significantly shorter, by 1.6 minutes for question 1 (mean pretest search time 6.3 minutes, mean posttest search time 4.7 minutes) and 1.9 minutes for question 2 (mean pretest search time 8 minutes, mean posttest search time 6.1 minutes). For a question about herbal medicine, results were similar, but there were smaller differences that did not reach statistical significance. Students used or found significantly fewer sites on the posttest than on the pretest to find answers for all three question types (absolute difference=0.3 sites for each question). Conclusions: Introducing students to useful Web sites, practicing answering clinical questions, and integrating this process with clinical rotation experiences can reduce the effort that students need to find answers and improve the quality of answers they find.

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Evidence-based medicine (EBM) is the integration of best research evidence with clinical expertise and patient values.1 EBM teaching has become widespread, promoting the incorporation of the most valid research evidence into clinical decision making.2-5 Despite this, physicians and residents use medical references that are considered fast and likely to provide answers (such as pocket references or other people) preferentially over medical references designed to provide research evidence (such as evidence-based references or bibliographic databases).6,7

Use of electronic MEDLINE searches by clinicians early during patients’ hospitalizations has been associated with lower costs and shorter lengths of stay.8 We are not aware of direct randomized trial evidence of the effect on clinical outcomes from outpatient EBM practices generalized across all conditions, but a randomized trial of primary care clinician access to a preappraised evidence source has demonstrated a significant increase in the proportion of clinical questions answered and the proportion of questions for which an answer changed clinical decision making.9

Primary care physicians report an average of 12 questions per day of office practice, 70% of which remain unanswered.9,10,11 Half of these questions could be answered with adequate searching, and many answers would alter clinical practice.11-13 The Internet now provides physicians rapid access to preappraised evidence.13,14

Physicians begin to develop patterns of information seeking for clinical decision making in medical school. During clinical rotations, with exposure to and involvement in patient care, students learn how to combine the complex tasks of patient communication, medical decision making, and time management. The introduction of clinical medicine to medical students provides an ideal opportunity to teach efficient information-seeking behaviors and how those behaviors must be integrated with individual patient needs, clinical knowledge, and time management. If efficient information-seeking
behavior is not learned in medical school, it may not be learned later. Surveys of family physicians in the United States found that learning about Internet use begins when physicians are not constrained by a heavy patient volume.\textsuperscript{15} Stand-alone teaching of EBM improves knowledge but not skills, attitudes, or behavior. Clinically integrated teaching is necessary to improve skills, attitudes, and behavior, based on a systematic review of 23 studies of postgraduate EBM teaching.\textsuperscript{16}

We designed a curriculum for providing third-year medical students exposure to and experience with useful Internet sites and strategies during their family medicine rotation. We used matched questions before and after the intervention to determine if this curriculum improved search skills.

**Methods**

**Curriculum**

The third-year family medicine clerkship at the University of Missouri-Columbia is 8 weeks long: 4 weeks on-site in university clinics and inpatient settings and 4 weeks in the practice of a volunteer community-based family physician. We piloted and refined curricular and evaluation components with three 4-week on-site blocks of third-year clerkship students in the spring of 2003. We then maintained the same curriculum and evaluation strategies from June 2003 through May 2004, reaching an entire third-year class of 90 students during 12 4-week on-site blocks. Curricular components developed included those shown in Table 1.

There were six to eight students in each scheduling block. A faculty family physician tutored the computer lab sessions. The tutor guide included (1) an opening question to discuss the variety of sites and approaches used and to focus on the varying quality of answers found, (2) an introduction to the Internet portal, (3) sample questions to practice rapid searching of different question types, and (4) reminders of the assignment over the next 2 weeks. The tutor guide was not prescriptive, and the tutor could vary the lab session to address current clinical questions that the students had encountered or address other issues that came up during group discussion. This session occurred on the first Friday of the 4-week on-site rotation.

The students recorded a clinical question from a physician with whom they were working, the sources students used to seek answers, the time spent, the answers found, and any impact on patient care. Students completed two assignment sheets during the on-site rotation.

Assignments were submitted 2 days prior to the follow-up computer lab session, which occurred 2 weeks after the first session. The second computer lab session used the questions collected by students to share experiences and discuss additional search strategies, interpretation of answers, and integration of information with individual patient data and values for clinical care.

**Assessment**

We assessed this curriculum using a before-after study design that was approved by the Institutional Review Board of the University of Missouri Health Sciences Center. We used three pairs of questions representing three general question types.

The first type was an efficacy question for a common condition for which students were unlikely to have already memorized a treatment pathway. We used “What treatments have been shown to reduce symptoms in patients with fibromyalgia?” and “What treatments have been shown to reduce symptoms in patients with carpal tunnel syndrome?”

The second type of question was broader, requiring a management plan that might incorporate diagnostic testing, considerations of harm and costs, and recommendations in addition to efficacy data. A clinical scenario was provided, describing a patient with either acute bronchitis or acute otitis media, then followed by the question, “How do you manage [this illness]?”

The third type of question was about herbal medicine. This question would not be answered well in traditional medical references. We used “Does bilberry improve night vision?” and “Is chaparral safe and effective for arthritis?”

In the computer lab, students took a pretest during the 30 minutes prior to the first session and a posttest during the 30 minutes following the second session. On the pretest, students received either the fibromyalgia, bronchitis, and bilberry questions and then received the other three questions on the posttest (A-B order) or vice versa (B-A order). Question order was alternated by scheduling block. Students had up to 10 minutes per

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**Table 1**

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<tr>
<th>Curricular Components</th>
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<td>• Free Internet portal at <a href="http://www.myhq.com/public/a/l/alper">www.myhq.com/public/a/l/alper</a> that lists more than 300 sites that can be used for answering clinical questions and is organized for rapid selection of types of Internet sites</td>
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<tr>
<td>• Previously published review of general use of the Internet for answering clinical questions\textsuperscript{17}</td>
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<tr>
<td>• Previously published review (available at <a href="http://www.aafp.org/fpm/20030700/49prac.html">www.aafp.org/fpm/20030700/49prac.html</a>) of five useful Web sites for rapid evidence searching\textsuperscript{4}</td>
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<tr>
<td>• Handout of “Teaching Points” covering 23 practical points for searching and interpreting answers*</td>
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<td>• Two 90-minute computer lab sessions 2 weeks apart during the 4-week rotation</td>
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<td>• Two single-page assignment sheets that students used to record two clinical questions*</td>
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<td>• Tutor guide for facilitating the first computer lab session*</td>
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<td>• The tutor guide, “Teaching Points” handout, and assignment sheets are available in the Family Medicine Digital Resources Library, a new resource being developed by the Society of Teachers of Family Medicine for sharing curricular resources (<a href="http://www.fmdrl.org">www.fmdrl.org</a>).</td>
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question to find an answer. They recorded the sites used in the search, the number of minutes spent searching, and the answer found.

The seminar was graded but only on each student’s level of participation, and we emphasized immediately before each pretest or posttest that we were measuring our effectiveness as teachers, not using the test to grade the students. Therefore, there was no incentive for a student to try to learn in advance which questions would be presented on the posttest.

One author evaluated the quality of answers the students found. He was blinded to whether the question was part of the pretest or the posttest and blinded to the specific Internet sites used in searching for an answer. The criterion standard he used in assessing quality was from his clinical knowledge, supplemented by review of several sites that were used. Quality was assessed on a 5-point ordinal scale (1=higher quality, 5=lower quality).

Data Analysis

Non-parametric analyses were conducted because some of the variables measured were skewed. The Wilcoxon signed ranks test was used to compare the differences between pretest and posttest values for the time it took to find an answer to the clinical question, the number of Internet sites searched while looking for an answer, and the quality of the answer found for each of the three question pairs.

Results

Ninety students participated; 45 took the pretest/posttest in the A-B order, 45 in the B-A order. Four students missed the posttest session. One student failed to complete the search time data on question 2 on the posttest, and one student did not provide data for question 3 on the posttest. Consequently, analysis included matched data from 85 or 86 students for each assessment.

Compared with pretest measures, posttest results showed that the time students took searching for an answer was significantly less for two of three question types (Figure 1), and the number of Internet sites searched was significantly fewer for all three question types (Figure 2). The quality of the answer found was significantly higher for two of three question types (Figure 3). The test order had no substantial effect on outcome measures.

Student feedback was unanimously positive, with frequent recommendations for introducing this curriculum in the first year, where students are introduced to problem-based learning. Some students increased time and number of sites searched from pretests to posttests; they reported the perception that they found answers more quickly but wanted to search additional sites to verify answer validity.

Discussion

We found that an intervention of introducing students to useful Web sites and practicing answering clinical questions could reduce the effort needed (time and number of sites used) to find answers, while improving the quality of the answers found.

Improving medical students’ ability to quickly find answers to clinical questions should have many benefits for education, clinical practice, and professional development. Student searches for clinical answers can
provide all students with similar educational experiences. Because we did not use a randomized design, improvements in student skills could be related to factors other than our intervention. We did, however, attempt to minimize recognized potential biases. Data about time and number of sites used were collected in the same way at the time of the pretests and the posttests. Evaluation of the quality of answers was blinded as to whether it was on a pretest or posttest and to which sites the student used. One investigator conducted all subjective assessments; the other investigator could not be blinded to sites used because he is editor in chief of a frequently used Internet site.

Conclusions
Acquiring knowledge management skills is important in undergraduate medical education. Curricular activities that improve students’ abilities to quickly find high-quality information can help individual students transform from the traditional student role of storing information to the role of managing knowledge (Table 2), which is an essential part of becoming a skilled clinician.

Table 2
Roles in Knowing and Managing Information

<table>
<thead>
<tr>
<th>Knowledge Repository</th>
<th>Knowledge Manager</th>
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<tr>
<td>Learn information “just in case”</td>
<td>Learn information “just in time”</td>
</tr>
<tr>
<td>Memorize information for future use</td>
<td>Become aware of useful information sources</td>
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<tr>
<td>Rely on recall for information use</td>
<td>Rely on information systems</td>
</tr>
<tr>
<td>Use a pocket notebook as memory aid</td>
<td>Learn or review information when it is needed</td>
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<tr>
<td>Information only useful if already learned</td>
<td>Information accessible when previously unlearned</td>
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<tr>
<th>Apprentice-style Learning</th>
<th>Evidence-based Practice</th>
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<tbody>
<tr>
<td>Trusted if in print</td>
<td>Use sources that critically evaluate information quality</td>
</tr>
<tr>
<td>Trusted if spoken by a professor</td>
<td>Apply critical thinking to individual information needs</td>
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Limitations
The key limitations of our study are the lack of randomization and the use of a single rater for answer quality. Randomization was considered impractical due to scheduling complexity and a perceived need to bring additional content into consideration for learning. Observations of patients, preceptors, and practice patterns provide many educational experiences that can be disconnected from the best available evidence. Student searches can provide opportunities for incorporating evidence into these educational experiences.

Student searches can provide additional evidence that might change clinical management. Preceptors could integrate student search results with their clinical experience and patient knowledge to guide clinical decision making. A minute or two saved in the search process might determine if an answer is found during the window of opportunity for clinical decision making during a patient visit.

References

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Dr Alper is the founder and editor-in-chief of DynaMed, an evidence-based clinical reference. Dr Vinson declares no competing interests.

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Figure 3
Quality of Answers Reported

Table 3
Mean values graphed. P values based on Wilcoxon signed rank test.