

An Integrated Program for Evidence-Based Medicine in Medical School

SCOTT H. BARNETT, M.D.¹, SUSAN KAISER, M.D., PH.D.², LYNN KASNER MORGAN, M.L.S.³,
JEAN SULLIVANT, M.A., M.L.S.³, ALBERT SIU, M.D.⁴, DAVID ROSE, M.D.⁵, MARTA RICO, M.D.⁶, LAWRENCE SMITH, M.D.⁴,
CLYDE SCHECHTER, M.D.⁷, MYRON MILLER, M.D.⁸, AND ALEX STAGNARO-GREEN, M.D.⁹

Abstract

To provide optimal care for their patients, clinicians must be able to locate and interpret the most current literature. Teaching the necessary skills to medical students is essential, if we wish to train clinicians to be able to keep up with the expansion of biomedical knowledge for their entire working lives. In this paper, we describe our school's four-year curriculum in evidence-based medicine and the performance of three senior classes on the summative evaluation exercise devised to measure the program's success. **Key Words:** Evidence-based medicine, curriculum, library skills.

Introduction

THE RAPID EXPANSION of biomedical knowledge makes it difficult to keep up with new developments. While physicians have always needed the skills to acquire and evaluate current information, the volume of information, with its variable quality and clinical relevance, has created a formidable challenge. Evidence-based medicine (EBM), which consists of formulating clinical questions, retrieving and evaluating the evidence from the literature, and applying the obtained information to the clinical problem at hand, has gained wide acceptance as an important strategy to meet these challenges (1, 2).

We have incorporated the teaching of EBM into our four-year curriculum as part of our overall goal of training medical students to be lifelong learners, the importance of which was underscored in the 1984 GPEP Report (3). We are unaware of any published examples of comprehensive four-year medical school programs in EBM. In this paper, we describe the program introduced in 1996, and report the performance by senior students on the summative evaluation developed to assess the program's success.

Methods

The initial step in introducing EBM into all four years of our medical school curriculum was the creation, in the fall of 1995, of an Evidence-Based Medicine Working Group. It consisted of faculty from the Dean's Office, the Library, and the departments of Medical Education, Medicine, Pediatrics, Surgery, Geriatrics, Health Policy, and Community Medicine. Members met with all preclinical course and clinical clerkship directors to determine the extent to which EBM was taught in our traditional curriculum, and to explore new strategies for instruction and evaluation. The four-year curriculum (Table 1) was introduced in

From the Departments of ¹Pediatrics, ²Surgery, ⁴Medicine, ⁷Community Medicine and ⁹Medical Education, and ³The Levy Library, Mount Sinai School of Medicine, New York, NY; ⁵Department of Medicine, Long Island Jewish Hospital, New Hyde Park, NY; ⁶Department of Medicine, Montefiore Medical Center, Bronx, NY; and ⁸Department of Medicine, Sinai Hospital, Baltimore, MD.

Address correspondence to Scott H. Barnett, M.D., Department of Medical Education, Mount Sinai School of Medicine, Box 1512, One East 100th Street, New York, NY 10029.

TABLE 1
Evidence-Based Medicine Program Components

Courses	EBM Component
Library Sciences	2-hour small-group session on MEDLINE, demonstrating basic search strategies, as part of 7.5 hour course; advanced instruction integrated into the Epidemiology/Biostatistics curriculum.
Epidemiology	Students must critique articles offered as evidence in the environmental medicine module.
Microbiology	Use of the literature is required to identify unknown laboratory specimens.
Clerkships	All students attend library module on question/search formulation in first rotation of the third year.
Medicine	Each student presents the answer to a clinical question based on one of their own patients, with a critique of the evidence (3–4 students/group preceptor session); Prognosis module.
Pediatrics	Each student presents the answer to a clinical question based on one of their own patients, with a critique of the evidence (3–4 students/group preceptor session); Overview module.
Psychiatry	Each student presents the answer to a clinical question based on one of their own patients, with a critique of the evidence (3–4 students/group preceptor session); Therapy module.
Surgery	Course director and library staff present sessions on basic EBM topics; Harm module.
Ob/Gyn	Three oral presentations require use of primary sources. Students attend a housestaff journal club and 3 one-hour student journal clubs; Diagnostic Test module.
Neurology	Students perform searches based on patient encounters.
Community Medicine	Students present an in-depth critique of one article used in a research paper; MEDLINE review by Library staff in preparation for research project; small-group EBM session.
Geriatrics	Small group preceptor prepares a clinical question; students give a 15-minute oral presentation of search findings, including a critique of one article.

academic year 1996–1997; the Class of 2000 is the first to be exposed to this program in its entirety. Faculty development occurred on a number of different levels, including a full-day retreat at which four faculty members from McMaster University trained twenty-four course and clerkship directors to teach EBM. These individuals acted as trainers for the remainder of the faculty in their departments.

The preclinical years introduce the students to medical informatics and the skills needed to appraise the literature, and allow them to practice their presentation skills. The Library Science and Medical Informatics Course, presented in the first month of the first year, was expanded from 4 to 7½ hours to allow for more comprehensive small-group, hands-on discussions of information resources and services, the use of the MEDLINE database, computer-assisted instruction, and Internet applications. Librarians teach advanced on-line search strategies for evidence-based medicine prior to the Epidemiology course, which teaches critical appraisal skills in its environmental medicine module (4). In 1998, the Library staff began assisting in the Microbiology course, providing small-group, hands-on instruction in MEDLINE searching and assisting students in finding articles needed to identify unknown laboratory specimens.

The curriculum for the clinical years is based on the principles developed at McMaster University and published in the “Users’ Guides to the Medical Literature” (5–14). Their group has developed a model that teaches medical students how to ask a clinical question based on an individual patient, search for articles in a database, appraise the articles retrieved, and apply the information to the patient’s problem, for a variety of issues (therapy, harm, diagnostic tests, etc.). A one-hour session during orientation to the third year is used to define the goals and objectives of the curriculum and to describe the components in each rotation. Since the students in the classes of 1998 and 1999 were not exposed to the expanded Library Science curriculum during their first two years, library staff provided those students instruction on MEDLINE use during the Surgery and Pediatrics third-year clerkships.

The curriculum in the third year uses a two-pronged approach. Each department teaches one of the McMaster modules, and students must demonstrate proficiency in the application of evidence-based medicine to patient care. In Pediatrics, students are taught the methodology for appraising an overview article, in a large group lecture. The preceptors help each student define a clinical question related to a case presentation. Students are required to do a literature

search and present the findings, including a critique of the evidence, at a small group session later in the rotation. In Medicine, students are given an article on the prognosis of untreated hypercholesterolemia, a handout explaining the appraisal methodology for this type of article, and a worksheet. Preceptors review student critiques one week later, in a small-group session, and also evaluate their ability to apply EBM in an exercise identical to the one described above. In Psychiatry, a small-group session is devoted to the analysis of an article on the therapy of obsessive-compulsive disorder; EBM is applied clinically as it is in Pediatrics and Medicine. The harm module is taught in the Surgery clerkship. Students generate a clinical question, identify pertinent articles from MEDLINE, and critique the evidence, using the McMaster methodology. The methodology needed to evaluate an article on diagnostic tests is taught by lecture in Obstetrics/Gynecology, and students use the literature to prepare presentations for rounds, small groups, and journal club. Students use the literature to prepare for case-based presentations in Neurology.

Small-group sessions on evidence-based medicine have been added to the curriculum of the fourth-year Community and Preventive Medicine course, and students must now provide a formal critique of one of the articles used to prepare their required preventive medicine papers. The library staff provides an additional two hours of instruction in MEDLINE use during this course. In the fourth-year Geriatrics clerkship, a question prepared by the course director is the basis of a small-group discussion.

Evaluation Strategies

In collaboration with the clerkship directors, the Working Group developed strategies to analyze students' exposure to medical informatics both prior to and during medical school, and to assess the success of the new curriculum. A questionnaire was developed to assess incoming and senior students' computer literacy and the extent of exposure to formal instruction. Student performance in each of the EBM exercises described earlier is evaluated, and the result contributes to the overall grade for the course or clerkship.

We created an exercise designed to quantify fourth-year students' skills in information retrieval and critical reasoning. In order to allow standardization of the exercise, clinical questions, with known answers that could be searched using EBM strategies, were designed. The Working

Group developed four clinical questions (Table 2), identified relevant articles with good study design, and determined appropriate answers to each question. These questions were based on cases in the fourth-year Clinical Competency Examination, a mandatory standardized patient exercise that assesses students' communication, history taking, physical examination and clinical reasoning skills. Each student was randomly assigned one question and given four weeks to submit a printout of their literature search strategy and five relevant citations, along with a one paragraph answer to the question which must include a critique of the single most relevant article.

Staff librarians use a five-point scale (not demonstrated/limited/good/very good/excellent) to rate the efficiency and accuracy of students' search strategies. A five-point scale (not demonstrated/poor/adequate/very good/complete) is also used to rate how well the student addressed three core issues: validity (whether the relevant methodological questions were addressed), results (the findings of the study), and relevance (whether the study applied to the question at hand).

The class of 1997 served as a baseline group because they had completed their first three years of medical school prior to the introduction of formal EBM instruction. Participation was optional for this class, and only 56 of the 120 students in

TABLE 2

Evidence-Based Medicine Exercise Questions

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1. JR is a two-year-old child with asthma. You have recommended treatment with beta- adrenergic agonists, but the mother is concerned that these drugs may have an adverse effect on her child's health. Conduct a MEDLINE search to determine if there is any evidence which refutes or supports her concerns.
 2. KB is a forty-one-year-old woman with acute right upper quadrant pain. As the surgical consultant, you need to determine if she has a gallbladder disorder. Using the most recent MEDLINE segment, formulate and run an effective search to determine the best way to diagnose gallbladder disease in this patient.
 3. MH, a patient with sickle cell anemia, presents in painful crisis to the Emergency Room (ER). He has been in the ER six times in the past two months, and received oxygen and IM Demerol. You need to determine an alternative pain management regimen that will keep him out of the ER and shorten the duration of his crisis. Use MEDLINE to identify literature on this topic, and formulate a treatment plan.
 4. JT is a fifty-one-year-old patient with Type II diabetes mellitus. He has concerns about the likelihood that he will have loss of vision or a heart attack. Conduct a MEDLINE search to help you answer his concerns about developing either of these complications.
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the class (47%) participated; subsequent classes have been required to perform the exercise.

Results

Medical Informatics questionnaires: Beginning with the class of 2000, incoming students have filled out a medical informatics questionnaire. The classes of 2000, 2001, and 2002 have reported extensive experience with computers, e-mail, and literature searches. However, more than 60% of the students received no formal instruction in the skills required for evidence-based medicine.

At graduation, more than 97% of the senior students in the classes of 1997 and 1998 reported extensive experience with literature searching. Not surprisingly, only 3% of the class of 1997, which served as the baseline year, reported formal instruction in evidence-based medicine skills.

Fourth-Year EBM Exercise: The fourth-year exercise has been given to the classes of 1997, 1998, and 1999; data were analyzed using chi-square. Fig. 1 presents the results of the library skills' evaluation. Overall, there has been a slow but steady improvement in search skill strategies used to locate articles needed to answer the clinical question. We have seen statistically significant improvement in student use of keywords to identify main concepts, appropriate

MeSH headings (Medical Subject Headings), subheadings, combined multiple headings, and limiting search strategies by publication type and to English-language journals.

Fig. 2 presents the data for the classes of 1997, 1998 and 1999 on the use of EBM methodology. Over the course of the years, the students have shown increasing ability to address issues of validity and results. The class of 1998 addressed the relevance of the articles better than did the baseline class; this improvement was not sustained for the class of 1999.

As demonstrated in Table 3, more than 95% of students in the three cohorts submitted the full-text articles used as the basis for their answer. There was improvement over the three years in the percentage of students performing a critique, but there was not a significant improvement in the number of students who reached the correct conclusion. The percentage of students in the class of 1999 who omitted relevant articles tended to be smaller.

TABLE 3
EBM Exercise Evaluation

	1997 n = 56	1998 n = 100	1999 n = 100
full-text article submitted	95	97	97
correct answer	66	87	75
critique done	71	75	91
relevant articles omitted	69	79	57

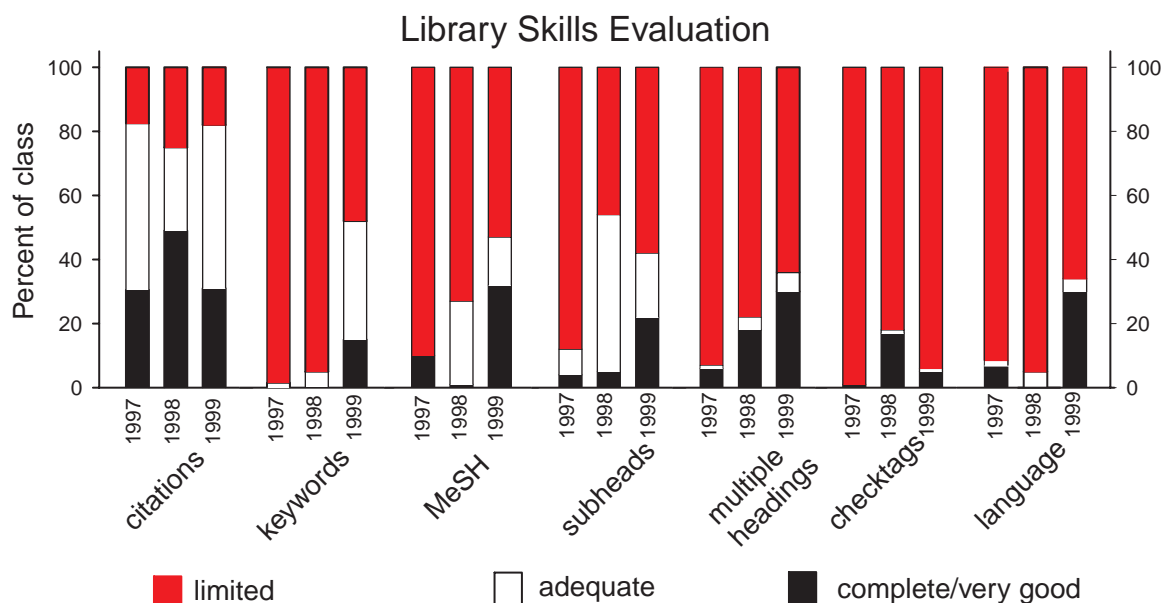


Fig. 1. Library Skills Evaluation. The graph shows data from the classes of 1997 through 1999. The n's are as shown in Table 3. The five-point scale described in the body of the paper was collapsed by grouping under the heading of "limited" those students who did not demonstrate usage of the MEDLINE filters with those who showed limited ability. There appears to be a trend toward improvement in the use of keywords, MeSH, subheadings, combined multiple headings and limiting to English language journals. There is not much difference in the ability to identify relevant citations or in the use of checktags.

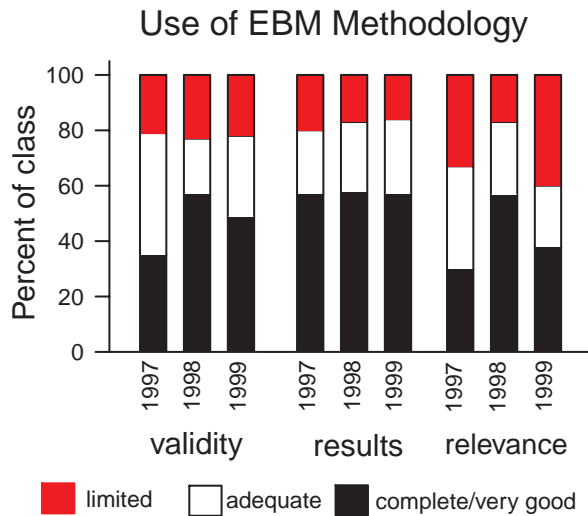


Fig. 2. Use of EBM methodology. The numerical symbols and definitions are as described in Fig. 1. There appears to be a trend toward enhanced ability to identify the validity (whether the relevant methodologic questions have been addressed) and results of studies.

Discussion

We have developed a four-year, integrated EBM curriculum that uses the basic science courses to teach basic EBM skills and the clinical clerkships to teach a more sophisticated approach. The ability to use EBM in patient care is one of the factors used by the preceptors when they grade the students. Finally, an outcome measure was developed to gauge the success of our program and to identify weaknesses to be addressed in the future.

To our knowledge, this is the first attempt at a four-year, integrated EBM curriculum. There are a few reports that describe the integration of EBM skills into selected components the preclinical years (15–19). Other reports describe the teaching of information retrieval skills as part of the curricula for the clinical years (20–25). Furthermore, a four-year curriculum limited to teaching information retrieval skills has been described (26, 27), as have instructional programs limited to critical appraisals (28–33).

It is also apparent that EBM cannot be taught dependably in residency training programs. Residents currently in training do not have these skills (34), there are few published curricula for housestaff (34, 35), and residents exposed to critical appraisal curricula have not shown significant improvement in their skills (33).

Our ability to create an EBM curriculum resulted from two factors. Most important, both basic science and clinical faculty cooperated to

develop and implement a comprehensive EBM curriculum. Second, the faculty development that preceded implementation was an important foundation. There is, however, much work that remains to be done. Although students seemed to have performed better on our assessment measures, we believe that more data in subsequent years will be required before any definite conclusions can be made regarding the effectiveness of our current approach. We believe that students must identify the relevance of articles and improve their ability to reach the appropriate conclusions. Furthermore, the reliability and validity of the fourth-year assessment tool that we created has not been formally assessed. Like many schools, we are in the process of implementing a new curriculum, which will include a longitudinal clinical component from the first day. Incorporating the teaching of EBM into all components of the new curriculum, increasing the use of literature articles instead of textbooks as primary sources, and nurturing and rewarding teachers who use EBM in an innovative manner are challenges we are eager to meet.

In conclusion, using data from the EBM exercise, we will continue to refine and expand our program in evidence-based medicine. We believe that through this curriculum, we will be able to train students who will be more effective residents and, ultimately, practicing physicians, best able to handle the explosive growth of biomedical knowledge.

References

- Rosenberg W, Donald A. Evidence-based medicine: An approach to clinical problem solving. *BMJ* 1995; 310:1122–1126.
- Evidence-Based Medicine Working Group. Evidence-based medicine: A new approach to teaching the practice of medicine. *JAMA* 1992; 268(17):2420–2425.
- Muller S (chairman). Physicians for the twenty-first century: Report of the project panel on the general professional education of the physician and college preparation for medicine. *J Med Educ* 1984 Nov; 59(11 Pt2):127–128.
- Wrosch JA, Morgan LK, Sullivant J, Lewis DM. Instruction of evidence-based medicine searching skills during first year epidemiology. *Med Ref Sources Q* 1998; 17(3):49–57.
- Oxman AD, Sackett DL, Guyatt GH for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: I. How to get started. *JAMA* 1993; 270:2093–2095.
- Guyatt GH, Sackett DL, Cook DJ for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: II. How to use an article about therapy or prevention: A. Are the results of the study valid? *JAMA* 1993; 270:2598–2601.
- Guyatt GH, Sackett DL, Cook DJ for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: II. How to use an article about therapy or prevention: B. What are the results and will they help me in caring for my patients? *JAMA* 1994; 271:59–63.

8. Jaeschke R, Guyatt GH, Sackett DL for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: III How to use an article about a diagnostic test: A. Are the results of the study valid? *JAMA* 1994; 271:389–391.
9. Jaeschke R, Guyatt GH, Sackett DL for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: III. How to use an article about a diagnostic test B. What are the results and will they help me in caring for my Patients? *JAMA* 1994; 271:703–707.
10. Levine MS, Walter SS, Lee HN, et al. for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: IV. How to use an article about harm. *JAMA* 1994; 271:1615–1619.
11. Laupacis A, Wells G, Richardson WS, Tugwell P for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: V. How to use an article about prognosis. *JAMA* 1994; 272:234–237.
12. Oxman AD, Cook DJ, Guyatt GH for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: VI. How to use an overview. *JAMA* 1994; 272:1367–1371.
13. Richardson WS, Detsky AS for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: VII. How to use a clinical decision analysis: A. Are the results of the study valid? *JAMA* 1995; 273:1292–1295.
14. Richardson WS, Detsky AS for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: VII. How to use a clinical decision analysis: B. What are the results and will they help me in caring for my parents? *JAMA* 1995; 273:1610–1613.
15. Reidelbach MA, Willis DB, Konecky JL, et al. An introduction to independent learning skills for incoming medical students. *Bull Med Libr Assoc* 1988; 76(2):159–163.
16. Zarookian MH, Haf JJ, Alfano MA. MEDLINE computerized literature searching using GRATEFUL MED: A pilot instructional project for entering medical students. *Teaching and Learning in Medicine* 1990; 2(4):205–211.
17. Burrows S, Ginn DS, Love N, Williams TL. A strategy for curriculum integration of information skills instruction. *Bull Med Libr Assoc* 1989; 77(3):245–251.
18. Moore GF. Development of information retrieval skills for freshman medical students. *Med Educ* 1988; 63:870–872.
19. Kolner SJ, Dalrymple PW, Christiansen R. Teaching skills in medical information retrieval to medical students. *Med Educ* 1986; 61:906–910.
20. Schwartz DG, Schwartz SA. MEDLINE training for medical students integrated into the clinical curriculum. *Med Educ* 1995; 29:133–138.
21. Haynes RB, McGibbon A, Walker CJ, et al. Online access to MEDLINE in clinical settings. *Ann Intern Med* 1990; 112:78–84.
22. Markert RJ, Parisi JJ, Barnes HV, et al. Medical student, resident and faculty use of a computerized literature searching system. *Bull Med Libr Assoc* 1989; 77(2):133–138.
23. Rodnick JE, Simrin SM, Yang MG, Attman DF. Teaching medical students to do bibliographic searching. *Med Educ* 1988; 63:728–730.
24. Port J, Meiss HR. Teaching library skills in third-year clerkships. *Med Educ* 1982; 57:564–566.
25. Mueller MH, Foreman G. Library instruction for medical students during a curriculum elective. *Bull Med Libr Assoc* 1987; 75(3):253–256.
26. Graves KJ, Selig SA. Library instruction for medical students. *Bull Med Libr Assoc* 1986; 74(2):126–130.
27. DaRosa DA, Mast TA, Dawson-Saunders B, et al. A study of the information-seeking skills of medical students and physician faculty. *Med Educ* 1983; 58:45–50.
28. Riegelman RK. Effects of teaching first-year medical students to read medical literature. *Med Educ* 1986; 61:454–460.
29. Landry FJ, Pangaro L, Kroenke K, et al. A controlled trial of a seminar to improve medical student attitudes toward, knowledge about, and use of medical literature. *J Gen Intern Med* 1994; 9:436–439.
30. Bennett KJ, Sackett DL, Maynes RB, et al. A controlled trial of teaching critical appraisal of the clinical literature to medical students. *JAMA* 1987; 257:2451–2454.
31. Bordley DR, Fagan M, Theige D. Evidence-based medicine: A powerful educational tool for clerkship education. *Am J Med* 1997; 102:427–432.
32. Bordley D. 1996. When and how to use the original medical literature: An introduction to evidence-based medicine. Available from: University of Rochester School of Medicine and Dentistry. <<http://www.urmc.rochester.edu/smd/Medicine/imclerk/literature.htm>>, accessed 2/13/97.
33. Norman GR, Shannon SI. Effectiveness of instruction in critical appraisal (evidence-based medicine) skills: A critical appraisal. *CMAJ* 1998; 158(2):177–181.
34. Caudill SC, Johnson MS, Rich EC. The need for curricula in evidence-based medicine. *Acad Med* 1995; 70(9):746–747.
35. Grimes DA. Introducing evidence-based medicine into a Department of Obstetrics and Gynecology. *Obstet Gynecol* 1995; 86(3):451–457.