Evaluating medical student searches of MEDLINE for evidence-based information: process and application of results

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Objective: To evaluate the adequacy of the MEDLINE instruction routinely given to all entering medical students at the University of Miami School of Medicine and the ability of students to search effectively for and retrieve evidence-based information for clinical decision making by the end of their third-year.

Methodology: The authors developed and implemented a strategy for evaluating the search strategies and articles selected by third-year students, who participated in the Objective Structured Clinical Examination (OSCE) in June 1996, 1997, and 1998, and reviewed the literature on evidence-based medicine and evaluation of medical student searches.

Results: A mean of 5% of the students' search strategies and a mean of 26% of articles selected were ranked "excellent" or "good"; a mean of 26% of search strategies were ranked "fair" and a mean of 69% were ranked "poor"; and a mean of 22% of articles selected were ranked "fair" and a mean of 52% were ranked "poor" based on the strategy developed to evaluate student searches.

Conclusions: Evaluating medical student searches for evidence-based information is an effective way of evaluating students' searching proficiency, and, in turn, the adequacy of the instruction they receive. Based on the results of the OSCE test, the school of medicine expanded the library's educational role and the library implemented major changes in the training program. Information on evidence-based medicine is now incorporated into the MEDLINE instruction. Library faculty evaluate the required searches performed by students for evidence-based information during their first and second years; 30% of students are identified for follow-up, individualized instruction based on the evaluation; and a new case-based curriculum has been proposed with a fourteen-week problem-based learning (PBL) block. These developments are timely in light of the evidence-based competencies recently published by the Association of American Medical Colleges.

INTRODUCTION

The Objective Structured Clinical Examination (OSCE), which uses standardized patients to measure student skills, is frequently used in undergraduate medical education [1]. The OSCE test was offered to the third-year medical students at the University of Miami School of Medicine in June 1996, 1997, and 1998. The tenth task of the examination required students to demonstrate their ability to retrieve citations and abstracts from the MEDLINE database and to select two items from the retrieval that contain evidence-based information to support decision making for the clinical case represented by the standardized patient.

Library staff was asked to evaluate the search strategies and printouts of the OSCE search and rank them as excellent, good, fair, or poor.

This paper describes the evaluation process; criteria used to evaluate and rank search strategies and printouts for evidence-based information; results of applying the criteria to the search strategies and printouts; and, based on an analysis of the results, enhancements made to the information skills instruction program for medical students at the University of Miami. Although specific errors in search statements were observed, a detailed analysis of search errors was not done. The primary aim of this study was to evaluate the strategies of student searches and the quality of the articles selected for evidence-based information to support decision making in patient care, competencies enumerated in the 1998 "Medical Informatics Objectives" of the Association of American Medical College's *Medical School Objectives Project* [2].

INFORMATION SKILLS INSTRUCTION AND ENVIRONMENT

The University of Miami School of Medicine/Jackson Memorial Medical Center (UM/JMMC), one of the nation's largest and busiest medical centers, accords medical students exposure to a highly diverse patient population and a rich clinical experience. Information skills instruction by faculty at the school's Louis Calder Memorial Library is incorporated into the school's first-year student orientation program and medical school curriculum to meet the patient care and educational needs of students, and has been a requirement since 1986 [3]. Between 1993 and 1995, the timeframe of instruction for the third-year students who participated in the 1996, 1997, and 1998 OSCEs, the concepts of evidence-based medicine were not included in the MEDLINE instruction given to entering students, and library faculty were not involved in topic selection or subsequent evaluation of practice searches or the three required searches during the first year. Based on the library's involvement in the OSCE examinations and the increased interest in evidence-based medicine during this time period, significant changes have been made to the MEDLINE instructional program beginning in the fall of 1997 and are described later in this paper.

LITERATURE REVIEW

A search of the recent literature on the evaluation of medical student searches of MEDLINE retrieved relevant articles on the need for more effective training strategies and on searches performed by third-year students to manage a clinical emergency, but none that studied student searches for evidence-based information. A study by Wildemuth and Moore, which analyzed 500 search statements of 161 third-year students, documented a need for successively more advanced MEDLINE training in the medical school curriculum [4]. A study by Mitchell et al. reported the mistakes identified in 713 analyzable searches, which were then stressed in subsequent training sessions [5]. Proud et al. studied 313 students as they performed an average of 6.9 independent searches during their first, second, and third years [6].

Pao et al. examined searches done by forty-nine third-year students in a rotation. Students were presented with a specific case and asked to do a high precision subject search of MEDLINE to retrieve a few citations and abstracts that contained the information needed to manage the clinical emergency presented in the specific case. At the time of the search assignment, the forty-nine students had performed an average of 46.1 search sessions. The study found that 80% of students retrieved at least one relevant citation with information to make a clinical decision in an emergency [7]. A subsequent study by the same authors examined the searches of 184 third-year medical students performed as part of a Comprehensive Clinical Assessment Examination administered at the beginning of their fourth year. Eighty-three percent retrieved at least one item of definite relevance to diagnosing and treating patients in a clinical emergency. This study concluded that the odds were 4.82 times greater for an experienced searcher to retrieve at least one relevant article than a nonexperienced searcher [8].

METHODOLOGY AND RATIONALE

The process of evaluating the searches for evidence-based medicine articles conducted for the OSCE by students at the end of their third years began with three reference librarians each doing an independent search and printout in February 1997 to support decision making for the clinical question given on the OSCE:

> You are seeing a 65-year old man with well controlled hypertension and a six month history of atrial fibrillation that has failed to convert with DC conversion. Despite his otherwise normal cardiac status (no coronary or valvular heart disease) you are considering the use of anticoagulants in his care. The patient is quite compliant but is concerned about taking any new medications that might do more harm than good. You remember that there is a significant body of literature on the long-term and short-term use of oral anticoagulants.
>
> Use MEDLINE to structure a literature search on the above problem. Print out the two best references you find describing clinical evidence which you feel is useful in helping you make decisions regarding the patient's management. Include your search strategy with your printout.

A fourth librarian reviewed recent documents on evidence-based medicine [9–11], examined the three librarian-constructed search strategies for common elements, and reviewed the citations and abstracts selected and printed by the students in June 1996 and by the three librarians in February 1997 from the current four-year segment of the Ovid MEDLINE database. This librarian compiled a list of citations and abstracts that contained the information necessary to make the best clinical decision on the use of anticoagulants to control atrial fibrillation in older patients with a history that includes hypertension and met the criterion of evidence-based medicine. There were nine citations and abstracts on the list.

The librarians as a group agreed that the search strategy should use a Boolean "AND" for Medical Subject Headings (MeSH) terms for the main parameters of the above clinical question: "atrial fibrillation," "anticoagulants," and "hypertension"; use the "explode" feature for the anticoagulants terms for comprehensive retrieval; and limit the search retrieval to articles indexed with "aged," "male," or one of the MeSH terms or publication types available to retrieve evidence-based articles on therapies, such as "clinical trials" (exploded to include "clinical trials, phase I-IV"; "controlled clinical trials"; "randomized controlled trials"; and "multicenter studies"), "guidelines" (exploded to include "practice guidelines"), "meta-analysis, risk" (exploded to include "risk factors" and "risk assessment"); or corresponding text words. Although the librarians deemed it unnecessary, further limiting could be done, such as weighting MeSH terms, applying subheadings, and so on. The citations and abstracts selected for printing should be recently published, primary journal articles that report appropriately analyzed, original research and that include an assessment of the strength of the evidence behind recommendations that are specific to the above clinical question. "Original research reports, appropriately analyzed, and not seen through the lens of a second party reviewer, remain the best information on which to base clinical practice" [12].

Based on these components of an appropriate search strategy and the list of nine citations and abstracts, the following criteria were established for each of the four requested rankings: excellent, good, fair, and poor.

Excellent

The search strategy was ranked "excellent" if it had the following *minimal* components:
- SS1 atrial fibrillation
- SS2 hypertension
- SS3 explode anticoagulants
- SS4 1 AND 2 AND 3
- SS5 limit 4 to aged

and used subject headings or publication type terms or text words appropriate for articles that report the results of therapeutic trials. The subject headings previously enumerated also existed, for the most part, as publication types, such as clinical trial, randomized controlled trial, multicenter study, meta-analysis, guideline, and practice guideline. Text words appropriate for therapy trials included the following truncated terms: "random," "double" and "blind," "mask," "placebo," "control," and "trial," as well as "sham," "efficacy," and "effectiveness" [13, 14]. The printout was ranked excellent if the two citations and abstracts selected for printing both appeared on the list of nine items previously described.

Good

The search strategy was ranked "good" if it had the following *minimal* components:
- SS1 atrial fibrillation
- SS2 hypertension
- SS3 anticoagulants
- SS4 aged or geriatric or elderly or old
- SS5 (1 AND 2 AND 3) AND 4 or LIMIT (1 AND 2 AND 3) by aged

and used publication types or text words appropriate for therapy trials included in excellent above. The printout was ranked good if it included at least one of the nine articles on the list previously described.

Fair

The search strategy was ranked "fair" if it had at least three of the four search statements in the minimal search strategy for good above. The printout was ranked fair if it had at least two articles with abstracts that each had at least three of the five parameters in the clinical question: atrial fibrillation, hypertension, anticoagulants, aged, and male. The fair ranking was given solely on the basis of subject, and represented a failure by the student to search for, identify, and retrieve evidence-based information. In most cases, but not all, the citations and abstracts on the printouts ranked fair were also not specific to the clinical question. For example, the two articles selected did not report on the use of antibiotics in the elderly or in patients with a history of hypertension, critical considerations in whether or not to prescribe anticoagulants.

Poor

If the search strategy and printout had less than the minimal requirements given above for fair, it was ranked "poor." The information in the citations and abstracts ranked poor were wholly inadequate for clinical decision making.

A librarian then examined each of the usable search strategies and corresponding printouts submitted by students and ranked the search strategy and articles

Table 1
Ranking of medical student searches

	Search strategy				Articles printed			
	1996	1997	1998	Mean	1996	1997	1998	Mean
Excellent	0	0	0	0	6.5%	5%	1%	4%
Good	2.5%	8%	5%	5%	26.5%	19%	21%	22%
Fair	18.5%	24%	34%	26%	16%	27%	23%	22%
Poor	79%	68%	61%	69%	51%	49%	55%	52%

retrieved, selected, and printed per the guidelines established. These steps were repeated in January 1998 and October 1998 for the search strategies and selected references submitted by the 128 third-year students who participated in the June 1997 OSCE and the 139 third-year students who participated in the June 1998 OSCE, respectively. At all times, there were at least three articles in the current segment of the Ovid MEDLINE database that met the criteria for the rankings described above.

The strategies and printouts of the 1996 OSCE were further examined for specificity, comprehensiveness, and evidence-based information. Although the 1997 and 1998 strategies and printouts were reviewed for these features, analyses of the results were not performed.

RESULTS

Table 1 displays the rankings by search strategy and printout for each of the three third-year medical student classes. As is evident from Table 1, only 26% of the usable printouts submitted were either good or excellent. Seventy-four percent were ranked either fair or poor and were inadequate for clinical decision making. None of the search strategies submitted was excellent. An average of only 5% were ranked good, and an average of 95% were ranked fair or poor. There were 125 usable search strategies and printouts for the 1996 OSCE, 114 for the 1997 OSCE, and 116 for the 1998 OSCE. The only identifiable difference between the 1996 and the 1997 and 1998 OSCEs was a lecture on evidence-based medicine delivered by the director of undergraduate medical education prior to the 1997 and 1998 exams, which seems to have somewhat raised the 1997 and 1998 rankings.

Specificity

Although forty-four students (35%) selected articles in the 1996 OSCE that addressed the use of anticoagulants to treat atrial fibrillation in old men with hypertension, this level of specificity was not reflected in their search strategies, with the exception of three students (2.5%). One-third of the students achieved a desirable level of specificity in article selection by using a Boolean "AND" with two of three fundamental parameters of the search: atrial fibrillation, anticoagulants or the name of a specific anticoagulant such as aspirin, and hypertension as MeSH headings or text words; limiting the relatively large results of this initial strategy by "human," "English language," "review," "abstracts," "local holdings," or "current update"; and then visually searching the set of articles and abstracts retrieved for considerations of age and hypertension. Of perhaps greatest concern, however, were the eighty-one students (65%) who did not select articles with the needed specificity in 1996. Most of these students ignored hypertension and age as complicating factors, which the evidence-based literature indicates must be addressed to make the best possible decision and deliver the highest quality of patient care in the OSCE clinical question.

Comprehensiveness

None of the students used the explode feature for anticoagulants or the truncation feature for text words in 1996, although these features had been explained and illustrated in the MEDLINE tutorial and its manual. In 1997, one student used the explode feature for anticoagulants. In 1998, ten students used the explode feature for one or more of the terms in their strategy. In all three years, most used anticoagulant or anticoagulants, either as a MeSH term or a text word; none used a Boolean "OR" for MeSH terms and text words; and some used only specific anticoagulants, such as aspirin or warfarin.

Evidence-based

Although clinical trials, randomized clinical trials, and meta-analyses are regarded as excellent from an evidence-based perspective and there are corresponding MeSH and publication terms in MEDLINE, only one of the students used an evidence-based term in 1996, specifically randomized controlled trials. None used any evidence-based medicine headings in 1997. In 1998, however, four students used randomized controlled trials, clinical trials, meta-analysis, practice guidelines, or treatment outcome. However, many students limited their retrieval to review articles, which frequently contain information about clinical trials, and many of the articles they selected did contain evidence-based information. However, as indicated above, more than two-thirds of the printouts did not contain articles with information specific to the clinical question.

TRAINING IMPLICATIONS

The library's part in the information instruction program for freshmen students prior to the administration and evaluation of the first OSCE exam in June 1996 and February 1997, respectively, consisted solely

of a two-hour, introductory course on the scope, MeSH vocabulary, and indexing rules of the MEDLINE database; the search features of the Ovid search engine; and routines, such as downloading, printing, etc. Although students were required to perform MEDLINE searches during the remainder of their first year, the results were turned into the school's first year coordinator and not graded.

Based on the results of the 1996 OSCE, obtained in the spring of 1997, the instruction given by library faculty during first year orientation was deemed inadequate to train students to search the literature for evidence-based information to support decision making for patient care and was therefore expanded. Beginning with the 1997 first-year orientation, the library's director for education:

- incorporated information on and examples of evidence-based information needs, similar to the question on the OSCE, into the manual given to all students and the sample searches performed during the one-half-hour hands-on component of the two-hour tutorial
- designed the first three of six MEDLINE searches required during the first year and incorporated evidence-based medicine strategies into each search
- graded the first three of six searches performed during the first year and returned the searches to the students with written comments on their search strategy and retrieval
- conducted two one-and-one-half-hour, large group sessions of the entire first-year class in the fall semester, during which problems common to a significant number of student searches, as evident from the evaluation of the first three searches performed during the first year, were reviewed
- conducted individual follow-up sessions and instruction in the spring semester, based primarily on the last three of the six required MEDLINE searches, and continued during the second year

In 1997/98, 133 individualized sessions were conducted for first and second year students. By 1998/99, approximately 30% of students were identified for follow-up instruction based on the searches they submitted.

The follow-up instruction during the two large group and numerous individual sessions have focused on using the explode command to achieve comprehensive retrieval and on using evidence-based medicine terms. The individual search sessions have focused on developing flexible search strategies to retrieve highly specific articles and on selecting articles with evidence-based information and recommendations for patient care. The OSCE examination given in 2000 will be the first OSCE taken by third-year students who have been involved in the expanded intervention of the library's director for education services, beginning with orientation and continuing through the entire first year.

CONCLUSIONS

Evaluating medical student searches for evidence-based information is an effective way of evaluating students' proficiency in searching MEDLINE and selecting the best articles for a specific patient care problem. When library faculty evaluated third-year student searches for the Objective Structured Clinical Evaluation (OSCE) given in 1996, 1997, and 1998, and reviewed the literature on evaluating medical student searches, the need to expand the library's educational role, to include information on evidence-based medicine in the MEDLINE instruction given to medical students, and to incorporate evidence-based medicine searching throughout the curriculum were well documented. Beginning with the 1997/98 academic year, the first year after the first OSCEs were evaluated by the library, the director for education services' role throughout the first and second years was significantly expanded.

Based on this study, the library also recommended that required searches, with evaluation and feedback, be incorporated into the third and fourth years to give students the practice and individual instruction necessary for them to become proficient at retrieving highly specific articles with information valid for patient care decision making. Although this recommendation was not specifically implemented, the task force on medical education, appointed by the dean in 1996, recommended in 1997 that the feasibility of a problem-based learning (PBL) curriculum be examined. In 1999, a second task force on medical education unveiled a new four-year curriculum model, which includes sixteen weeks of a "transitional problem-based learning block" at the end of the second year and a case- and problem-based environment for a merged third- and fourth-year curriculum. The need for frequent and ongoing opportunities for student searches, and for instruction for house staff and practicing physicians on retrieving, selecting, and applying evidence-based information in the millions of searches now being performed in the many free sources of this excellent database were further documented when a recent study of searches by practicing physicians concluded that "most searches retrieve only one-fourth to one-half of the relevant articles on a given topic," and little was known about how the information in the retrieved articles was interpreted or applied [15].

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