On-Line Literature Searching
in an Acute Medicine Clerkship

Jean K. Noguchi
Agneta K. Hurst
Karen Hollister

INTRODUCTION

Optimal application of medical information requires a convenient, rapid method for access of the primary literature. Computerized literature searches have traditionally required an experienced information specialist. On-line searching by the person who actually uses the information (the end user) was not considered practical because of the technical knowledge required and the high cost of equipment. In recent years, widespread availability of microcomputers with telecommunication devices has kindled an interest in end-user searching. End-user searches have the advantage of immediate answers, often at the practice site. Further, the end user's insight and knowledge of the subject material may allow more precise data input and retrieval of more relevant items.

In a discussion of technologies in pharmacy education and practice, Brodie and Smith concluded that the computerization of drug

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information is a vital aspect of contemporary health care (1). Computerized storage, retrieval, and dissemination of information increases the efficacy and efficiency of its use. The importance of pharmacist training in drug information skills was highlighted in their statement that the "shift in emphasis from dispensing medicines to dispensing information could be the single most transforming effect of technology on the profession of pharmacy" (1).

To strengthen the drug information skills of pharmacy students, a MEDLINE Training Program was established at the University of Southern California School of Pharmacy.

GOALS AND OBJECTIVES

The overall goal of the program is to enhance the students' drug information skills by training them to perform literature searches on the National Library of Medicine's (NLM's) MEDLINE[a] data base while on a clinical clerkship. Specifically, emphasis is placed on teaching basic searching skills rather than advanced, expert techniques.

The educational objectives of the program are:

A. At the conclusion of the 4.5-hour orientation session, the student will:

1. Log on and off the NLM computer using Smartcom-II[b] software
2. Construct a search strategy using the NLM publications, the Medical Subject Heading (MeSH) vocabulary, subheadings, explode command, the asterisk, and Boolean logic to:
   a. Retrieve a review article on the treatment of a disease
   b. Retrieve an article discussing an adverse drug reaction
3. Enter the strategy into the microcomputer using the NLM command language
4. Limit the retrieval to citations written in the English language with human subjects
5. Print the authors, titles, and sources for the ten most recent citations retrieved by the search.

B. During the six-week clerkship, the student will:

1. Perform on-line literature searches on topics related to individual patient care activities.

METHODS

The University of Southern California School of Pharmacy offers a four-year curriculum leading to the Doctor of Pharmacy degree. The MEDLINE Training Program is incorporated into a six-week, required clinical clerkship given in the fourth year. This clerkship, "Acute Care Medicine," is taught in inpatient areas within a major urban teaching hospital. Six instructors teach a total of between twenty-three and twenty-five students per course rotation. The course is offered 6 times per year, for a total of 140-150 students.

The MEDLINE Training Program was created through the collaborative efforts of the pharmacy school faculty and the Norris Medical Library staff (USC Health Sciences Library System). The initial step in program development was the selection of an on-line bibliographic data base. Two data bases were investigated: MEDLINE and International Pharmaceutical Abstracts.[c] MEDLINE was chosen because many of the anticipated search questions paralleled its citations (e.g., drug and nondrug therapy of specific diseases, therapeutic controversies, adverse drug reactions). Furthermore, most students were familiar with the printed version of MEDLINE, *Index Medicus*,[a] which facilitated training.

The next step was identification of a method for accessing the MEDLINE data base. Three access routes were investigated: NLM direct, BRS Colleague,[d] and PaperChase.[e] The decision to use NLM direct was based on several factors. Cost was a major consideration. Haynes and colleagues reported prime-time charges of $5.25 for NLM direct, $6.58 for BRS Colleague, and $10.38 for PaperChase for an identical search question (2). Participation in the NLM Student Code Program, which facilitates access to the MEDLARS data bases in educational settings, would allow a further reduction in computer connect-time charges.

Difficulty of learning and search retrieval were informally compared using the three MEDLINE access routes. BRS Colleague and

PaperChase were easier to learn than NLM direct. However, coordinators concluded that their use would not obviate the need for a basic understanding of the controlled vocabulary and indexing system of the MEDLINE data base. For this program, the potential advantages of BRS Colleague and PaperChase did not outweigh their additional cost.

Computer hardware and budget needs of the program include three IBM PC-XT microcomputers with modems and printers placed at the practice sites and $5,000 from the School of Pharmacy's annual budget to pay for on-line search costs, hardware maintenance, books, and supplies.

The MEDLINE Training Program orientation session is comprised of a 1.5-hour lecture followed by a 3-hour laboratory session and is given in a single day during the first week of each clerkship. The lecture is given by a pharmacy school instructor with an end-user's perspective and pharmacy-based examples. The lecture introduces the student to the basic theory and techniques of MEDLINE searching (Table 1). It is supplemented by a detailed handout that reviews the material discussed, including examples and a search strategy worksheet (Table 2).

The laboratory session is given in the medical library microcomputer classroom and is taught by an information specialist, with two to three clerkship instructors assisting during on-line time. To allow maximum experience, most microcomputer stations are used by a single student. Following a demonstration of the log-on procedure, the instructor illustrates retrieval of a single MeSH heading using the explosion command, subheadings, and the asterisk. Students duplicate the exercise on-line, assessing variation in retrieval with the different entry techniques. Next, a sample search question is given. Using the NLM publications and a search worksheet, various strategies are discussed and demonstrated on-line (Table 2) (3, 4). Finally, practice questions are offered, with students devising and entering searches on-line. Students are encouraged to experiment with different strategies and to observe the alterations in retrieval. Students conduct an average of three to five searches during the laboratory session. At the conclusion of the orientation session, students are given a test covering basic searching theory and technique (Table 3).

During the remainder of the clerkship, students perform literature

TABLE 1. OUTLINE OF ON-LINE LITERATURE SEARCHING LECTURE

I.   What are MEDLARS and MEDLINE?

     MEDLINE versus *Index Medicus*
     How we communicate with the MEDLARS data bases

II. Advantages and limitations of on-line literature searching

     Appropriate and inappropriate search questions

III. The unit record: content and function

IV. The Medical Subject Heading (MeSH)

     Basic indexing policies, hierarchical indexing
     Useful books for selecting appropriate headings

V.   The basic search strategy

VI. Boolean logic

VII. *Searching by subject*

     Explosion, the asterisk (*), subheadings
     Test word searching

VIII. Techniques for limiting searches

IX. Printing

X.   Useful commands and techniques

XI. Interpretation of common messages from the computer

searches on topics related to their patient care activities. Searches
are run at no cost to the student. There are no specific requirements
or limitations in the number of searches or amount of money spent
per student. Most students use the microcomputers located at the
practice sites with supervision by the course instructors. During
designated library "office hours," an information specialist is
available exclusively for assisting students with searches. A
MEDLINE Training Program Evaluation is completed by the stu-
dents at the conclusion of the six-week clerkship (Table 4).

RESULTS

Approximately 400 students have participated in the MEDLINE
Training Program over 3 years. After the orientation, the individual
test questions have been answered correctly by 60%-100% of the

TABLE 2. MEDLINE SEARCH STRATEGY WORKSHEET

Reference Office
Norris Medical Library
USC Health Sciences Campus

MEDLINE SEARCH STRATEGY WORKSHEET

A. Search topic (what do I specifically want):

B. Divide the topic into separate concepts or ideas:

A	B	C	D	E
				Possible
Concept	MeSH Term	Explode? (y/n)	MeSH Tree Number(s)	MeSH Subheadings

C. Construct search statements using the MeSH terms selected, the explode command if desired, the appropriate MeSH subheadings if desired, and the appropriate Boolean operators (and, or, and not) to combine the concepts.

SS 1

SS 2

SS 3

SS 4

SS 5

SS 6

SS 7

D. Alternate terms/strategies for broader or narrower retrieval:

students (Table 3). During the remaining five weeks of the clerk-ship, each student performs an average of four searches (range 1-11). On-line time and cost per search average 16.5 minutes and $3.34, respectively. Annual expenditures have averaged $3,500-$4,000, of which $2,400-$2,700 is spent for computer connect-time charges. Books, supplies, and hardware maintenance contracts account for the balance of expenses.

Student evaluations of the MEDLINE Training Program have been positive (Table 4). At the conclusion of the six-week clerk-

TABLE 3. MEDLINE ORIENTATION POST-TEST*

MEDLINE ORIENTATION POST-TEST

Please answer with the appropriate commands or a brief phrase. Some questions have more than one right answer. THERE IS NO GRADE! Please do not put your name on this post-test. The answers will be reviewed at the end of today's MEDLINE session.

1. How do I disconnect from the NLM computer? (87% correct response)

2. How do I print the author, title, and source from the results of a search statement? (89% correct response)

3. How do I limit my results to just English language articles? (100% correct response)

4. How do I limit my results to just human studies? (100% correct response)

5. How do I limit my results to just review articles? (89% correct response)

6. What are the searching abbreviations for the MeSH subheadings for the concepts of:

Drug Therapy	_____	Toxicity	_____
Adverse Effects	_____	Administration and Dosage	_____
Poisoning	_____	Therapeutic Use	_____

(overall 94% correct response)

7. When do I put an asterisk (*) directly in front of a MeSH heading? (66% correct response)

8. Can I get my own MEDLINE password? (60% correct response)

*Percentage of students with correct response given in parentheses

ship, most students express confidence in selecting appropriate search questions, devising strategies, reviewing strategies with librarians or instructors, and executing simple searches independently. There is general satisfaction with search results. Students view on-line literature searching as a useful skill, with potential for use in other clerkships and after graduation. Post-graduate access to a computer with modem is an uncertainty for most students, but, nonetheless, they think knowledge of search principles is valuable.

DISCUSSION

This report describes a training program for on-line bibliographic data base searching, which is co-taught by pharmacy faculty and information specialists (librarians). Programs using information

TABLE 4. MEDLINE TRAINING PROGRAM EVALUATION*

MEDLINE TRAINING PROGRAM EVALUATION

Date: _____

1. How many searches did you do while on this rotation? (4.3, range 1-11)

2. Where did you do the searches? (clerkship site 60%, library 40%)

On a scale of 1 (no) to 5 (yes) please answer the following:

3. Were the orientation lectures helpful? (4.6)

4. Can you now recognize a question that is appropriate for a search? (4.1)

5. Did you get adequate help setting up and running a search strategy? (4.5)

6. Are you now comfortable discussing a search strategy with a librarian? (4.2)

7. Can you now run a search by yourself (once you've been logged on)? (3.9)

8. Were you satisfied with the results of your searches? (4.1)

9. How useful was computer searching in the Acute Care Medicine rotation? (4.3)

10. How useful will it be in future rotations? (4.3)

11. How useful will it be after graduation? (4.0)

12. Will you have access to a computer with a modem after this rotation? (3.1)

13. If you do not have access to a computer later on, was this nonetheless a worthwhile experience? (4.3)

Comments:

*Mean student response to questions given in parentheses

specialists alone have been described for health science professionals and in the social sciences (5-10). The use of expert searchers as trainers allows instruction in advanced skills and techniques. Training by end users offers the advantage of an end user's perspective. Knowledge of the subject matter may allow more precise data input and retrieval. Furthermore, the clinical faculty end user offers a role model for the students. A training program using both pharmacy faculty and an information specialist incorporates all desirable aspects.

A second significant aspect of the MEDLINE Training Program is the use of direct access to the NLM MEDLINE data base. Most

programs have employed user-friendly menu-driven or front-end systems such as Bibliographic Retrieval Service (BRS) Colleague,[d] BRS After Dark,[d] or SearchMaster[f] (5-10). Only a limited number of reported programs have used the NLM direct (11).

As stated above, several factors contributed to the selection of the NLM direct. In addition to cost considerations, coordinators thought that a basic understanding of the NLM subject headings and indexing system was important for successful searching. Moreover, knowledge and skills gained using the NLM direct can be transferred readily to other systems. This assessment of MEDLINE access routes has been noted by others. Haynes and colleagues compared cost, search time, precision in retrieving relevant articles, and difficulty of learning for 17 microcomputer access routes to the MEDLINE data base (2, 12). All methods were judged equivalent in their sensitivity (i.e., retrieval of key articles). Access using NLM direct was judged more difficult to learn than most methods (although not the most difficult). However, this route also presented the lowest cost, a shorter search time, and the highest yield of relevant articles. The authors concluded it was well worthwhile to learn and to use NLM direct.

The orientation session is designed to teach basic search strategy and commands. Several measures have been incorporated to minimize confusion. Automatic log-on macros facilitate access to the MEDLARS system. To improve understanding of the indexing system and command language, analogies to common biologic and mathematic concepts are used. Simple, common questions are identified and analyzed in advance. Only those skills necessary to solve these problems are taught during the sessions; discussion of more advanced techniques is avoided. As assessed by the orientation post-test, the ability of the students to accomplish the educational objectives has been encouraging. Student evaluations indicate the session has been appropriate in content and duration. Many think the early laboratory experience is especially helpful.

During the remainder of the six-week clerkship, students are encouraged to perform on-line literature searches whenever suitable questions arise. To emphasize use and increase proficiency, some course instructors designate one student per week to perform all searches for a particular group of students. Other faculty have pre-

pared abbreviated manuals consisting of excerpts from the NLM publication *The Basics of Searching MEDLINE: A Guide for the Health Professional* (13).

Most students require assistance with the first few searches, then become progressively more independent. Coordinators initially thought that students might have difficulty learning the hierarchical indexing system, Boolean logic, and the explode and subheading commands, as suggested by Sewell (14). Students seem to grasp these concepts readily, however, and they are usually able to devise initial search strategies. A major difficulty has been a lack of problem-solving abilities when retrieval is inappropriate or inadequate. This may reflect a limited understanding of the indexing system and command language and/or poor problem-solving skills in general. At the conclusion of the clerkship, most students are able to perform simple searches independently. Some can search fairly complex subjects, and others continue to require assistance. This degree of proficiency has been accepted as a suitable outcome in view of the time limitations of the clerkship. Students are encouraged to refine searching skills during subsequent clerkships.

The decision to integrate the MEDLINE Training Program into a clinical clerkship was based on the premise that it would enhance interest in searching. Limitations of this training are also acknowledged. While enrolled in the clerkship, students are assigned to medical teams for provision of clinical pharmacy services. Activities include participation in therapeutic decision making, patient monitoring, assistance with drug dosage adjustment, patient education, and provision of drug information. Students must, therefore, incorporate MEDLINE searching into many other activities.

The positive aspects of on-site training have been reflected in the enthusiastic response of the students. In contrast to traditional classroom (or drug information center) training, search questions originate from patient problems encountered on a clinical clerkship. This creates great interest in finding the answers and emphasizes the importance of information-seeking skills. Moreover, the convenience of on-site searching and prompt availability of information allows the pharmacy students to have a more active role in patient care. Physicians find this a very useful resource, and it improves their

perception of the pharmacy student as a member of the medical team.

Program evaluation comments indicate that students view on-line literature searching as a novel, contemporary skill. Some have previous MEDLINE searching experience with Compact Cambridge CD-ROM[g] or GRATEFUL MED.[a] Those with experience on multiple systems have expressed a general preference for NLM direct because of better and faster retrieval, ease in searching files of more than one year's citations, and convenience of searching at the practice site. Several students have applied for individual NLM MEDLARS codes at the conclusion of the clerkship. Some felt searching skills were beneficial in obtaining post-graduate pharmacy residency positions or other employment.

Other positive student outcomes have included an improved ability to formulate the questions they ask librarians. Search requests on subsequent clerkships have reflected a better understanding of the advantages and limitations of on-line literature searching and often include a proposed search strategy. An improved relationship with librarians has also been noted, with enhanced respect for their expertise as on-line data base searchers.

Problems encountered during the program have included technical difficulties, student computer anxiety, and unsuitable search retrieval. Hardware failure and telecommunication problems have caused technical difficulties. Although some students initially approach the computers with trepidation, the incorporation of a friendly, unintimidating approach with strong faculty support has allowed most students to overcome uncertainties. Frustration with unsuitable retrieval is minimized with one-to-one assistance during searches. The availability of an experienced librarian for expert consultation during office hours has been an invaluable resource.

CONCLUSION

The MEDLINE Training Program is an innovative, contemporary method for teaching drug information skills. Students gain insight into the data available on-line, as well as techniques for accessing the information. Program success has been optimized through collaboration of pharmacy faculty with information special-

ists, emphasizing basic skills for simple searches, and incorporation of the program into a clinical clerkship. Student acceptance has been expressed through a high level of enthusiasm and interest. The reasonable costs associated with the program allow application in educational as well as post-graduate pharmacy practice settings.

NOTES

[a]National Library of Medicine, U.S. Department of Health and Human Services, Bethesda, MD.

[b]Hayes Microcomputer Products, Inc., Norcross, GA.

[c]American Society of Hospital Pharmacists, Bethesda, MD.

[d]Bibliographic Retrieval Service/Saunders, New York, NY.

[e]Beth Israel Hospital, Boston, MA.

[f]SDC, Santa Monica, CA.

[g]Cambridge Scientific Abstracts, Bethesda, MD.

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