How to Find Evidence When You Need It, Part 2: A Clinician's Guide to MEDLINE: The Basics

Patricia E. Gallagher, MLS, AHIP*
Tracy Y. Allen, MLS‡
Peter C. Wyer, MD§

From the Library of The New York Academy of Medicine, the Augustus Long Health Sciences Library of Columbia University,‡ and Columbia University College of Physicians and Surgeons,§ New York, NY.*

Received for publication March 26, 2001. Revision received November 5, 2001. Accepted for publication December 2, 2001.

Reprints not available from the authors.

Address for correspondence: *Peter C. Wyer, MD, 446 Pelhamdale Avenue, Pelham, NY 10803; E-mail pwyer@att.net.*

0196-0644/2002/$35.00 + 0
47/1/122774
doi:10.1067/mem.2002.122774

[Gallagher PE, Allen TY, Wyer PC. How to find evidence when you need it, part 2: a clinician's guide to MEDLINE: the basics. *Ann Emerg Med.* 2002;39:436-440.]

In Part 1 of this series, we introduced you to the "ABCs" of matching, or "mapping," clinical questions to resources, databases, and search strategies and identified some of the options likely to be useful to emergency physicians.[1] Finding the best evidence is not always easy. The busy clinician faced with a computer terminal, Web connection, and a clinical question may find herself wishing instead for an easier way to find the answers, such as asking a nearby colleague. When appropriate for the question at hand, resources that reflect a selection and appraisal of relevant evidence and require a minimum of searching skills, such as *The Cochrane Library*[2,3] or *Best Evidence* (http://www.acponline.org/catalog/electronic/best_evidence.htm)[4] are extremely efficient.[5] However, when MEDLINE is the only route available, such a clinician needs a way to simplify the searching process.[6]

In this article and in Part 3, we will provide you with a primer on the use of MEDLINE. We will begin with a summary of what MEDLINE is as a database. We will proceed to familiarize you with some of the more important terminology used in connection with MEDLINE searching and with how this terminology relates to different approaches to searching the database. Finally, we will introduce you to selected special features of MEDLINE searching that are of interest to clinician users and will provide information regarding how to access MEDLINE. At the end of these 2 installments, you should be equipped to attempt relatively straightforward MEDLINE searches without assistance and, just as importantly, to effectively and efficiently use the skills of available research librarians in conducting more challenging searches. The principles and skills presented in these 2 articles will also equip you to use search engines you are likely to encounter in connection with databases other than MEDLINE.

WHAT IS MEDLINE?

MEDLINE is a database of journal article citations and abstracts. Physicians frequently confuse MEDLINE with the available means of accessing it. Originally developed as an electronic adjunct to the *Index Medicus*, MEDLINE was available only to librarians who had been specially trained by MEDLINE's producer, the National Library of Medicine (NLM). With the growth of the Internet and the development of the World Wide Web, MEDLINE was made available free of charge to the general pubic by the NLM on June 26, 1997. NLM also made their other databases available, including AIDSLINE (the NLM database of journal information on AIDS), HISTLINE (the history of medicine database), and HealthStar (the health administration database). It should be noted that many medically relevant databases (eg, EMBASE, CINAHL, the Cochrane Library) are not administrated by the NLM. Access to such databases may involve significant additional costs in both subscription and/or online fees.

Currently, MEDLINE indexes approximately 3,900 international journals,[7] and includes citations of more than 11 million journal articles, editorials, and letters to the editor.[8] MEDLINE citations list the first 10 authors of an article, the institutional affiliation of the first author, the title of the article in English (and in its original language, if from a foreign-language publication), the date of publication, volume, issue, page numbers, and in many cases, an abstract that has been provided by the journal publisher. MEDLINE does not include books, book chapters, audiovisuals, book reviews, or obituary notices from journals.

WHAT ARE MEDLINE ACCESS PRODUCTS?

A number of vendors, each with their own search interface or engine, distribute MEDLINE. How you access the database can be very important when determining how to approach your literature search. Among the current distributors of software and online packages that include access to MEDLINE are the NLM and commercial vendors such as Ovid Technologies, Silver Platter, and Aries Knowledge Finder. The NLM's Gateway and PubMed are free to the public. Commercial vendors usually require a paid subscription, and their products may only be available through your institution's library. Each product provides its own MEDLINE search interface, frequently supplemented by enhancements such as full-text links or the inclusion of other databases. PubMed, for example, provides access to the MEDLINE database and to data from 2 other NLM databases: preMEDLINE and HealthSTAR. There are many other differences between the various distributors. These will be discussed a little later.

WHY IS MEDLINE DIFFERENT FROM OTHER DATABASES?

Searching the MEDLINE database for studies in relationship to a specific question arising from patient care poses special challenges to the clinician. In contrast to smaller databases designed for clinical use, such as Best Evidence, MEDLINE is intended to be used by any and all of the readers of the approximately 3,900 biomedical journals that it indexes. As a result, the efficient use of MEDLINE requires a more detailed knowledge of the database structure and a greater mastery of some basic search skills than do smaller resources such as the Cochrane Library, Best Evidence, and Emergency Medical Abstracts (http://ccme.org).

HOW IS "PICO" USED TO FORMAT QUESTIONS FOR SEARCHING MEDLINE?

To search MEDLINE effectively for studies relevant to patient care, a clinician must construct an answerable question. The question is then converted into a set of searchable concepts that can be recognized by the computer search engine. The PICO (patient or population, intervention, comparison, and outcome) model, which was introduced in Part 1 of this series,[1] is a useful and easy-to-learn method of focusing the clinical question for this purpose and can assist in narrowing down a complex clinical question into 3 or 4 phrases or concepts (Figure 1).[9,10] As an example: "Does the use of central venous

Figure 1.
A 4-part format facilitates turning clinical questions into searchable queries.

P	**P**atient or **P**opulation
I	**I**ntervention
C	**C**omparison
O	**O**utcome

catheters impregnated with various antibiotics reduce the rate of catheter-related bloodstream infection in children who have had a tracheotomy?" would be presented in PICO form as shown in Figure 2.

The PICO categories will change with the question type. For example, for a therapy or harm question, "C," for "comparison," is the therapy against which the study therapy is being measured. This could be a different medicine or "standard therapy" with a placebo. For a study of a diagnostic test, the comparison is the criterion standard against which the test of interest is measured. In the case of a prognosis question, a comparison is not inherent to the question, and the "C" category will usually remain blank. A systematic use of the PICO format points the way to the choice of search terms and strategies. It also forces the clinician to think about what kinds of studies she should be looking for and sets the stage for the use of quality filters discussed in the next installment.

WHAT ARE BOOLEAN OPERATORS?

Before discussing the details of what kinds of search terms to use, it is useful to understand a few things about connecting them in a search. Individual terms can be connected by "AND," by "OR," or, on occasion, by "AND NOT." These are often referred to as "Boolean operators" because they correspond to relationships between sets of citations within the MEDLINE database. Two terms connected by "OR" result in retrieval of all citations that are matched to either of the 2 terms. All of the involved citation sets are included, and the resulting total retrieved is usually larger than that retrieved by either term alone. Connecting terms by "AND" effectively restricts the search to citations that are matched to both. This may be seen as a new, smaller set representing the intersection of the citation sets corresponding to the individual terms. "AND NOT" is rarely used by librarians and has the effect of excluding a subset of citations found by the primary term that has been selected.

Figure 2.
A clinical question presented using the PICO format.

PATIENTS:	Children who have had tracheotomy
INTERVENTIONS:	Central venous catheters impregnated with various antibiotics
COMPARISON:	Antibiotic-impregnated catheter
OUTCOMES:	Reduction in the amount of catheter-related blood stream infections

WHAT IS THE MEDICAL SUBJECT HEADINGS (MeSH) SYSTEM?

After formatting her question, the searcher must then create a workable search strategy. This may be approached in a number of ways. One approach is to first determine whether any or all of the concepts correspond to MeSH and to use the MeSH system. The NLM created a lengthy list of subject headings in order to simplify the searching process. MeSH headings are determined by indexers, who are librarians specifically trained to read the articles published in the MEDLINE journals, and to decide which headings are relevant to that particular article. Although many clinicians may be accustomed to text word searching, MeSH headings make the searcher less dependent on the words the author of an article chooses to use in the abstract or title and allow the searcher to rely more on the actual content of the article. This requires that the clinician become acquainted with the MeSH terms relevant to a particular question. These may be different from those she would have otherwise been inclined to use. Most MEDLINE search engines allow the user to "browse" the MeSH–relevant terms for this purpose.

As an example, assume you are interested in a question concerning esophageal cancer. Did the author refer to it as "esophageal cancer," "esophageal neoplasm," "cancer of the esophagus," or "oesophageal cancers"? To conduct a text word search, the searcher would need to put in all the synonyms and spellings for each term. However, using MeSH, the searcher only needs to use the term "esophageal neoplasms" to search for each variant term in that concept. Most search engines (ie, PubMed or Ovid) permit the searcher to search for specific subject headings and will suggest related terms if an exact match does not exist.

MeSH uses a detailed tree structure of terms that enable the searcher to look for many related topics with one term. For a patient showing symptoms of a diseased gallbladder, "cholecystitis" might be the correct search term. However, a more careful examination of the MeSH tree structure shows that there are several related diseases (Figure 3).

HOW CAN MeSH BE USED TO BROADEN OR NARROW A SEARCH?

Referring to the preceding example (Figure 3), depending on the nature of the clinical question, it might be relevant

to use only the term "cholecystitis" or it might be worthwhile to examine articles about "cholelithiasis" or "gallbladder neoplasms." By using the term "explode" (or "exp") in front of the MeSH term "gallbladder diseases," the program will search for all the articles about gallbladder diseases in general and about any of the terms listed under it in the MeSH tree. If the MeSH heading "gallbladder diseases" were used without exploding, the searcher would miss all the articles that just discussed cholecystitis.

The MeSH structure also allows one to focus (or "major") a MeSH term. Each article in the MEDLINE database has a number of terms affixed to it. For example, an article on the use of serial ECG monitoring of patients with chest pain[11] was indexed as illustrated in Figure 4. Notice that there are asterisks (*) within the terms "myocardial infarction/*diagnosis" and "electrocardiography/*instrumentation/methods." The asterisk notes that these 2 concepts define the major focus and concerns of the article in question. In other words, these concepts (hopefully) describe to the reader what the article is really about. Although focusing or "majoring" a term is not always desired, it can be useful when a search results in more citations than a clinician wishes to sort through.

WHAT ARE SUBHEADINGS?

In the preceding example, within the term "myocardial infarction/*diagnosis," "diagnosis" is a subheading. It has been used in this case to indicate that the article is about the diagnosis, rather than the treatment, etiology, or mortality, of myocardial infarction. Subheadings can be attached directly to a particular MeSH heading, as in the aforementioned example, or they can be searched (or "floated") as independent entities. For example, the subheading "diagnosis" could be included as a search term, even if it were attached to another, different, term by the MEDLINE indexers.

We advise searchers who wish to minimize the likelihood of missing relevant articles to explode everything the first time they perform a search with respect to a particular question. Cast a big net, and evaluate what you get back. From this standpoint, we encourage the use of synonyms linked by the "OR" operator. In the evaluation of your results, look at the MeSH headings of articles that are on target. This will enable you to see how your topic of interest was indexed and to use those headings and subheadings. Finally, we expect that you will rapidly discover that your first search is rarely your last search, particularly when using a large database such as MEDLINE. However, it may well be your best search. You will find it prudent to routinely save or otherwise record the details of your search strategies for future reference.

WHAT IS TEXT WORD SEARCHING?

MeSH headings and subheadings are not the only way to search MEDLINE. Searching for text words can be a valuable method for refining, redirecting, or clarifying a MEDLINE search. The 2 terms "text word" and "key words" have long been misunderstood by end users and vendors alike and may mean different things in different MEDLINE access packages. Years ago "key words" were routinely attached to articles. They were supplied by the

Figure 3.
The MeSH tree structure encompasses "cholecystitis" under "digestive system diseases."

All MeSH categories
  Diseases category
    Digestive system diseases
      Biliary tract diseases
        Gallbladder diseases
          Cholecystitis
          Cholelithiasis
          Gallbladder neoplasms

Figure 4.
Example of MEDLINE indexing for "Usefulness of automated serial 12-lead ECG monitoring during the initial emergency department evaluation of patients with chest pain."[11]

MH—Adult
MH—Aged
MH—Aged, 80 and over
MH—Angina, unstable/*diagnosis
MH—Automation
MH—Comparative study
MH—Diagnosis, differential
MH—**Electrocardiography/*instrumentation/methods**
MH—Emergency service, hospital
MH—Female
MH—Human
MH—Male
MH—Middle age
MH—Monitoring, physiologic
MH—**Myocardial infarction/*diagnosis**
MH—Prospective studies
MH—Sensitivity and specificty

authors to make it easier for searchers to find the material. Key words were not necessarily words within the body of the title and/or abstract. Although part of the language used by physicians on a daily basis, key words usually referred to the overall concept of the paper. Improvements in the MeSH vocabulary in recent years have largely rendered authors' key words obsolete. "Text words" have a uniform meaning in the MEDLINE lexicon and refer to any words found within the title, abstract, or MeSH of a MEDLINE citation. The text word is a powerful tool for finding information on articles that have not been given a MeSH heading or have not yet been indexed.

Let's go back to the previous example of cholecystitis. If the term were used only as a text word, the searcher would miss articles that did not refer to cholecystitis but, nonetheless, pertained to gallbladder disease or a specific gallbladder disease. There are, however, situations in which text words can and should be used. For example, when AIDS was first being described, there was no appropriate term within the MeSH system.

Text word searching was the only effective way to access the information. Text words are also preferable when searching for information from preMEDLINE, the unindexed subset of MEDLINE.

Effective text word searching requires the application of specific rules. Some important steps in text word searching are:

1. When MeSH does not contain a subject relevant to the clinical question, determine whether a similar subject heading exists. This subject heading can be included in the search, along with the text words, to clarify the search by connecting the textword and MeSH heading by the Boolean "OR" operator.

2. Does the word or phrase have synonyms (eg, AIDS, acquired immune deficiency syndrome, acquired immunodeficiency syndrome)? If so, the searcher will need to include all those terms in the search, linked together with the Boolean operator "OR."

3. Does the word or phrase occur sometimes as a singular and sometimes as a plural (eg, woman or women)? If so, the text words will need to be linked together with the Boolean operator "OR" or the stem of the word may need to include a symbol, which may differ from system to system, to indicate that the term is truncated.

4. Does the word or phrase have alternate spellings (eg, esophagus or oesophagus)? If so, all spellings will need to be included, with the Boolean operator "OR."

Although MeSH headings allow the searcher to ignore spelling variations or pluralizations, text word searching does not. The computer will search for exactly what it is told to search for. It is dependent on the searcher to provide it with more options and to properly link them via the Boolean operators "OR," "AND," and "NOT."

Search engines offered by different vendors will differ with respect to how they deal with text words. Both PubMed and Gateway will search for any term entered on the subject line as both a text word and, if it exists, as an exploded MeSH heading. Ovid, a commercial MEDLINE vendor, will do this only when the term is selected as a "keyword" under an automatic mapping feature check box. To search for a text word only using OVID requires that ".tw." be typed after the word (eg "cancer.tw.").

In summary, with a basic understanding of MEDLINE and of the process required to use it effectively, the clinician is equipped to search not only MEDLINE but many other resources and databases as well. In the next installment, we will provide the reader with a number of techniques available to fine-tune a search, that is, to get fewer, but better, results.

REFERENCES

1. Corrall CJ, Wyer PC, Zick LS, et al. How to find evidence when you need it, part 1: databases, search programs, and strategies. *Ann Emerg Med.* 2002;39:302-306.

2. *Cochrane Library*, Issue 2. Oxford, United Kingdom: Update Software; 2000.

3. Rowe B, Alderson P. The Cochrane Library: a resource for clinical problem solving in emergency medicine. *Ann Emerg Med.* 1999;34:86-90.

4. Best Evidence [CD-ROM]. Philadelphia, PA: American College of Physicians; 2000.

5. Hunt DL, Jaeschke R, McKibbon KA, for the Evidence-Based Medicine Working Group. Users' guides to the medical literature: XXI. Using electronic health information resources in evidence-based practice. *JAMA.* 2000;283:1875-1879.

6. McKibbon A, Eady A, Marks S. *PDQ Evidence-Based Principles and Practice.* Hamilton, Ontario, Canada: BC Decker; 1999.

7. National Library of Medicine. Fact Sheet: journal selection for Index Medicus MEDLINE. Available at: http://www.nlm.nih.gov/pubs/factsheets/jsel.html. Accessed February 6, 2002.

8. National Library of Medicine Web site. Finding medical information in MEDLINE: question: what is MEDLINE, and how do I use it to find information? Available at: http://www.nlm.nih.gov/services/usemedline.html. Accessed February 6, 2002.

9. Richardson WS, Wilson MC, Nishikawa J, et al. The well-built clinical question: a key to evidence-based decisions. *ACP J Club.* 1995;123:A12-A13.

10. Sackett DL, Straus SE, Richardson WS, et al. *Evidence-Based Medicine: How to Practice and Teach EBM.* 2nd ed. New York, NY: Churchill Livingstone; 2000.

11. Fesmire FM, Percy RF, Bardoner JB, et al. Usefulness of automated serial 12-lead ECG monitoring during the initial emergency department evaluation of patients with chest pain. *Ann Emerg Med.* 1998;31:3-11.