Searching MEDLINE via PubMed

FRANCES A DELWICHE

As the volume of biomedical literature has increased, so have the number and complexity of databases that index it. Learning to conduct an efficient literature search in an online database is an essential skill for today's clinical laboratory scientist. This article describes basic and advanced strategies for searching PubMed and the use of specialized features including MyNCBI.

ABBREVIATIONS: MeSH = Medical subject headings.

INDEX TERMS: abstracting and indexing; bibliographic databases; controlled vocabulary; Internet; medical technology; medical subject headings; MEDLINE; periodicals; PubMed.

Clin Lab Sci 2008;21(1):35

LEARNING OBJECTIVES

1. Identify the search feature that reveals how PubMed translated a search query.
2. Define "MeSH terms" and describe their usage.
3. Describe the order in which PubMed results are displayed by default.
4. Illustrate how a search that brought up either too many results or too few results could be modified.
5. Compare the effects of the use of the Boolean operators AND and OR.

***Frances A Delwiche MLIS MT(ASCP)** is **library assistant professor** at Dana Medical Library at the University of Vermont, Burlington VT.*

***Address for correspondence:** Frances A. Delwiche MLIS MT(ASCP), library assistant professor, Dana Medical Library, University of Vermont, Medical Education Center, Burlington VT 05405. (802) 656-4423, (802) 656-0762 (fax). frances.delwiche@uvm.edu.*

***Frances Delwiche MLIS MT(ASCP)** is the **Focus: Information Literacy** guest editor.*

Nearly thirty years ago, William D. Garvey wrote in his seminal work that "communication is the essence of science".[1] In medicine and the biological sciences, the cornerstone of scientific communication is the scholarly journal article. Although monographs, textbooks, and handbooks are crucial for answering basic background questions and providing a solid foundation in the field, the journal article serves as the primary vehicle for the dissemination of new knowledge. "Publication in a refereed scientific journal marks the completion of a project; that the project's findings have been reviewed and accepted by professional peers signifies acceptance by the scientific community and also certifies a claim on any reported discoveries."[2]

The importance of the journal article in science and medicine is borne out in sheer numbers. In 2001, it was reported that over 30,000 biomedical journals are published annually.[3] "The total body of medical information doubles every 5 years",[4] and with the increasing use of electronic publishing, the pace is accelerating with dizzying speed. There is so much literature published in the health sciences that it's become increasingly impossible to keep up. It is even difficult to keep up with a few personal journal subscriptions. As Gehlbach notes in his popular text:

"Confronted with a burgeoning pile of journals, we cannot bear the thought that any of the information packed within those glossy pages should go unabsorbed. We wait for that magical time when we can sit down and plow through it. That day never arrives, and our guilt grows proportionally with the stack, diminishing only...when a housekeeping purge assigns it all irrevocably to the attic or trash bin."[5]

A 2003 study of the literature of clinical laboratory science revealed that approximately one third of references used by authors writing in three popular journals over a three-year period came from just thirteen journal titles. The remaining two thirds of the references were drawn from over 900 different journal titles, many of which were cited only once.[6] Clearly, browsing a handful of favorite titles or reading the tables of contents from selected prestigious journals would never be sufficient to retrieve all the useful articles published on a given topic.

A better way of identifying useful articles on topics of interest (and maintaining one's sanity) is to cultivate the necessary

Downloaded from http://hwmaint.clsjournal.ascls.org/ on October 17 2026

knowledge and skills to be a competent searcher of electronic information resources, especially bibliographic databases. Owing to their convenience and superior search capabilities, the popularity of online databases has far exceeded that of their print predecessors. Academic, hospital, and public libraries offer access to these resources, and some of them are available free to anyone with an Internet connection.

As the volume of journal literature has increased, so has the number, complexity, and capability of the databases that index it. Learning to manipulate the features of online databases to find all the articles on a given topic is a skill that is essential to today's healthcare professional. This article will focus on the use of a specific database, but many of the search techniques described are readily transferable to other systems.

MEDLINE/PUBMED

One of the primary databases for searching the biomedical journal literature is MEDLINE, produced by the United States National Library of Medicine in Bethesda, Maryland.[7] Originating from the print *Index Medicus* first published in 1879, today MEDLINE contains over 17 million records dating from the 1950s to present. MEDLINE covers the fields of medicine, nursing, dentistry, health sciences, healthcare administration, and veterinary medicine, as well as preclinical sciences such as biochemistry, immunology, microbiology, and molecular genetics. MEDLINE indexes over 5,000 journals published in the United States and 80 other countries, providing citations and abstracts for the articles indexed and, increasingly, links to the full text.

The MEDLINE database is a compilation of records, one for each article indexed. These records provide citation and abstract (when available), plus additional details such as language, publication type, institution of primary author, country of publication, chemical names, pharmacologic action, and subject headings. The subject headings, referred to as "MeSH" terms (**M**edical **S**ubject **H**eadings), serve to describe the key concepts discussed in the article. They constitute a standardized vocabulary that is used to find articles on any given term without having to search for every possible spelling variation, acronym, and synonym. Because they are manually assigned by expert indexers and are fully searchable, the subject headings contribute substantially to the power and search capability of MEDLINE.

MEDLINE is available in multiple forms, both free and by license through commercial vendors such as Ovid Technologies. Among the most popular ways to access MEDLINE is through PubMed, a free web-based search engine developed by the National Center for Biotechnology (NCBI) at the National Library of Medicine. As a component of NCBI's Entrez retrieval system, PubMed provides a vital link between the biomedical literature and its molecular biology and genetics databases.

Although MEDLINE makes up the largest component of PubMed, PubMed contains several small subsets that exist outside of MEDLINE. These include publisher-submitted citations that precede the date a journal was selected for indexing by MEDLINE; citations from general science journals on topics that are considered out-of-scope for MEDLINE, such as astrophysics or plate tectonics; and citations submitted directly by publishers for articles in the latest issues of their journals. Once the records for the newly submitted citations are fully annotated, they will either be added to the MEDLINE database or converted to out-of-scope status, depending upon the topic.

PubMed offers a wide range of options designed to meet the needs of searchers at all skill levels, including healthcare professionals, scientists, professional librarians, and the general public. Despite its size and complexity, even the most novice searcher will often be successful in finding at least a few useful articles. However, to use PubMed effectively and efficiently, and to find the most relevant articles on your topic, you'll need to have a solid understanding of the search tools and strategies available.

BASIC PUBMED SEARCHING

PubMed can be accessed directly at http://www.pubmed.gov. Access to PubMed is also often available through the website of academic, health sciences, or hospital libraries. If that library is registered as a PubMed "LinkOut Provider", accessing PubMed through their web page may enable you to connect directly to its online journal subscriptions from PubMed records.

Begin the search process by formulating your search question, using the most precise terms possible. Identify the searchable terms, and enter them into the search box as a word string. Click Go, or press Enter. By default, PubMed automatically combines the terms using the Boolean operator AND to bring up articles that include *all* the terms entered. Thus, use of the connector AND in your search statement is not necessary. PubMed also supports use of the Boolean operators OR and NOT when entered in a nested search statement. OR will bring up results that include at least one, but not necessarily all, of the terms, and NOT will eliminate results containing specified terms. Quotes can be used to search for exact phrases,

Downloaded from http://hwmaint.clsjournal.ascls.org/ on October 17 2026

but their use is not advised because it disables the automatic MeSH term search (described below). Use of truncation is generally not recommended for the same reason.

Suppose you wish to conduct a search on methods of laboratory screening for gestational diabetes. Enter "gestational diabetes screening" into PubMed's search box, and click Go (Figure 1). The first page of results will be displayed, but before looking at them, click on the Details tab to see how PubMed translated your search query (Figure 2). Processing the word string from left to right, PubMed searched on the subject heading (MeSH term) that most closely matched each word or phrase entered, plus performed a text word search for every occurrence of the word(s) in the database. In this case, the word string "gestational diabetes" was translated as the MeSH term "diabetes, gestational" and was also searched as a text word. The word "screening" was translated as the subheading "diagnosis", as the phrase "mass screening" anywhere in the title or abstract of the non-MEDLINE subset of PubMed, as the MeSH term "mass screening", and as a text word. By clicking on the Details tab every time you run a PubMed search, you can see exactly how the search was executed and modify your choice of search terms accordingly.

As frequently happens, the initial set of results in our sample search is very large, with over 1900 hits (Figure 3). To reduce the number of results and identify those that are most relevant to your topic, apply limits to your search. Click on the Limits tab and scan the options available, including language, sex, human or animal, animal species, journal subset, publication date, research study design, and age group (Figure 4). Use of the Abstracts limit is not usually recommended, as many valuable articles, including review articles, do not have abstracts. In this case, select Published in the Last 5 Years, Humans, English language, and the Core Clinical Journals subset. Click Go. The resulting set of 88 citations is much more manageable and focused (Figure 5). The limits selected will remain in effect for all subsequent searches until the option is de-selected.

PubMed results are displayed in *reverse chronological order* (most recent first), rather than in relevancy-ranked order as is the case with most Internet search engines. The default Summary display provides the authors, title, journal name, date, volume, issue, and page numbers, and PubMed status. To view the abstract for one article, click on the author line or abstract icon for that article. To view the abstracts for all the records on that page, click on the Display drop-down box and select Abstract. To view the MeSH terms assigned to the articles, change the Display drop-down

Figure 1. PubMed homepage

National Library of Medicine. Used with permission.

Figure 2. PubMed details

National Library of Medicine. Used with permission.

Figure 3. Results of PubMed search before applying limits

National Library of Medicine. Used with permission.

Downloaded from http://hwmaint.clsjournal.ascls.org/ on October 17 2026

box to Citation (Figure 6). By reading the abstract and noting the range of topics covered by the MeSH terms, you can gain a fairly accurate sense of the content of the article.

Often, in the Abstract or Citation display, you may notice one or more icons for online access of the full article. These may include an icon for the publisher's website, PubMed Central, or for participating LinkOut libraries and institutions (Figure 6). Except for PubMed Central, the presence of an icon does not imply that the article is necessarily available free to the general public. Most publishers require either an individual or institutional subscription to their journals, but frequently they will offer non-subscribers the option to pay per article. Icons for individual libraries indicate that the library has obtained a subscription to that journal. Unaffiliated patrons are generally not able to access the full article through these links unless logged in onsite. Many academic, health sciences, and hospital libraries welcome walk-in traffic from members of the community, and have professional librarians available to assist patrons regardless of affiliation.

Figure 4. PubMed limits

National Library of Medicine. Used with permission.

After applying limits, browse the results, and check the boxes next to those you wish to keep. Then click the Send To drop-down box and choose from the available options. The Text option will convert the citations to plain text, removing all PubMed graphics. The File option can be used to save citations to your computer or travel drive. For printing or emailing, select the appropriate option and complete the dialog box. The Clipboard option can be used to temporarily save your selected citations, up to a maximum of 500, for later action.

REFINING A PUBMED SEARCH

Often an initial search will bring up only a small number of useful ("relevant") articles. An easy method of expanding your search is to click the Related Articles link located on the right margin for each citation. This will launch a pre-fabricated search, generating a set of *relevancy-ranked* citations based on an algorithm applied to the original citation. Each of those citations will have a Related Articles link that will bring up its own unique set of related articles. Using your browser's Back button to navigate, click on the Related Articles link for each of the relevant citations, making your selections and sending them to Clipboard, thus creating a composite set of highly relevant citations.

Frequently you may have one "known" article and wish to find others like it. Click on the Single Citation Matcher link on the blue sidebar, and complete at least one field. When you bring up the record for the original article, you can click on the Related Articles link for that article to expand your search.
A more sophisticated method of expanding a search is to take advantage of the MeSH terms assigned to each article (viewed in the Citation display). For example, in the results

Figure 5. Results of PubMed search after applying limits

National Library of Medicine. Used with permission.

Downloaded from http://hwmaint.clsjournal.ascls.org/ on October 17 2026

for the gestational diabetes screening search, you may have noted that some articles were assigned numerous MeSH terms in addition to "diabetes, gestational" and "mass screening". These may include closely related MeSH terms such as "prenatal diagnosis", "early diagnosis", or "glucose tolerance test". A search on any of these terms, alone or in combination, could potentially bring up useful citations that were not found with the original search strategy.

Figure 6. PubMed's citation display showing MeSH terms

Note publisher's icon and icons for the University of Vermont library's journal holdings. Also note MyNCBI highlighting of search items. National Library of Medicine. Used with permission. Abstract used with permission from Elsevier.

To perform a search using MeSH terms in the PubMed record, begin by going to the Citation display for the desired record. Clear the search box and remove any limits. Click on the desired MeSH term and select PubMed from the drop-down box. Now click on the History tab to view a list of searches you have run in this session. Using the syntax, #1 AND #2, combine the appropriate searches using the Boolean operators AND, OR, or NOT. By experimenting with different combinations of terms, you can determine which produces the most relevant results for your particular search question.

The full power of MEDLINE can best be utilized by searching via the MeSH Database. With this method, you must search on each concept separately. Click on the link on the blue sidebar, and enter a word or phrase representing the first concept. From the list provided, select the MeSH heading that most closely matches your term. Read the Scope Note (a definition of the term as used by MEDLINE) and the available subheadings. Scroll down to view the hierarchical arrangement of MeSH terms, observing that with each indention to the right, the terms become progressively more specific (Figure 7). By default, all MeSH term searches in PubMed automatically include not only the term selected, but also all more specific terms nested beneath it, a process referred to as "exploding". If you do not wish to capture articles indexed under these more specific terms, check the box to turn off the Explode feature.

Downloaded from http://hwmaint.clsjournal.ascls.org/ on October 17 2026

Also, note the check box to restrict the search to major topic headings only. Both functions have the net effect of reducing the total numbers of results, albeit through different mechanisms.

Make your selections, then in the "Send To" drop-down box, choose "Search Box with And". Then click PubMed Search. Repeat for the next concept. Finally, click on the History tab and combine sets as described above (Figure 8). In Figure 8, compare sets #2 and #16, noting the dramatic reduction in number of results obtained by restricting the search to MeSH terms. By using this more sophisticated method of searching, you can increase your chances of finding relevant articles in the database while effectively screening out most of the irrelevant articles.

Figure 7. MeSH database

National Library of Medicine. Used with permission.

One important caveat to keep in mind when searching via MeSH terms is that new records for citations supplied directly by publishers do not initially contain MeSH terms. During the one to four weeks that it takes to complete the annotation process, these articles would be missed by restricting the search to MeSH terms only, but would be found with a basic text word search.

In addition to the search strategies described in this article, searches can also be conducted using the Preview/Index tab, traditional command line language, or by running a Clinical Queries search via the tab on the blue sidebar. The Clinical Queries feature is designed for busy clinicians to bring up rigorous, high-quality, clinically-relevant articles, while eliminating non-research articles and weaker forms of research. For more information on these specialized methods of searching, consult the PubMed Help pages or tutorials, or ask a professional librarian for help.

MyNCBI

PubMed offers a wide range of customization options through use of a MyNCBI account. For example, under MyNCBI User Preferences, you can enable the highlighting feature to help you spot the search terms at a glance. Under MyNCBI Filters, you can choose LinkOut institutions and organizations, and set a filter for their journal holdings. You can set filters to group records according to various properties, such as publication type, age groups, or language. In this example (Figure 6), the author set a filter

Downloaded from http://hwmaint.clsjournal.ascls.org/ on October 17 2026

for her home library, as well as one for review articles. Your MyNCBI account permits you to save search strategies and request automatic email updates to be sent on a weekly or monthly basis. Registration for a MyNCBI account is free, and cookies must be enabled on your browser.

CONCLUSION

Having obtained a list of citations and abstracts from your PubMed search, the final step is to obtain the actual articles. In some cases, the full text of the articles may be available for free online in PubMed Central or directly from the publisher. More often, journals are sold by subscription to individuals or libraries in print, online, or both. Access to online journals subscribed to by libraries is typically restricted to their patrons, although many libraries permit walk-in users to access their collection.

Some journal articles are now being published in their full form online, with the print version being abridged. However, in most cases, the content is identical regardless of format. Therefore, when online access is denied, a photocopy from the print journal may be a satisfactory substitute. For articles in journals not subscribed to by your library, a copy may be requested via interlibrary loan. Whereas interlibrary loan requests once required as long as a week to arrive, today they are frequently filled with very short turnaround times, sometimes the same day.

As one of the premier databases in the biological and health sciences, PubMed serves as an excellent starting point for searching the journal literature. Depending on the topic and level of comprehensiveness required, a PubMed search may be augmented with a search in one of many other bibliographic databases, such as BIOSIS, CINAHL, Cochrane Database of Systematic Reviews, EMBASE, or Web of Science. Each of these resources fills a unique niche and indexes publications not covered by the others. Google, Google Scholar, Sirus, or other Internet search engines may contain preprints, technical reports, meeting abstracts, and other forms of "grey" literature not found elsewhere. The professional staff at your academic, health sciences, or hospital library can help you search these and other useful resources.

It takes time and practice to learn to conduct an efficient and productive literature search, but it is an endeavor well worth the effort. Many of the PubMed features and search techniques described in this article can readily be applied to other software platforms. As you become more adept at navigating online databases and other electronic resources, you'll discover that you have cultivated a knowledge base and skill set that will serve you well throughout your career.

Clin Lab Sci encourages readers to respond with thoughts, questions, or comments regarding this article. Email responses to ic.ink@mchsi.com. In the subject line, please type "CLIN LAB SCI 21(1) FO DELWICHE". Selected responses will appear in the Dialogue and Discussion section in a future issue. Responses may be edited for length and clarity. We look forward to hearing from you.

Figure 8. PubMed history

National Library of Medicine. Used with permission.

REFERENCES

1. Garvey WD. Communication, the essence of science, facilitating information exchange among librarians, scientists, engineers and students. Oxford, New York: Pergamon Press; 1978.
2. Hurd J. Communication in science: the impact of information technology. In: Malinowsky, HR editor. Reference sources in science, engineering, medicine, and agriculture. Phoenix: Oryx; 1994:10.
3. McQueen MJ. Overview of evidence-based medicine: challenges for evidence-based laboratory medicine. Clin Chem 2001;47(8):1536-46.
4. Mattox DE. Welcome to ARCHIVES CME. Arch Otolaryngol Head Neck Surg 2000;126(7):914.
5. Gehlbach SH. Interpreting the medical literature. 5th ed. New York: McGraw-Hill; 2006.
6. Delwiche FA. Mapping the literature of clinical laboratory science. J Med Libr Assoc 2003;91(3):303-10.
7. PubMed. Bethesda, MD: National Library of Medicine. Available from http://www.ncbi.nlm.nih.gov/sites/entrez?db=PubMed. Accessed 2007 May 29.

Downloaded from http://hwmaint.clsjournal.ascls.org/ on October 17 2026