



Literature Search Using PubMed: An Essential Tool for Practicing Evidence- Based Medicine

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Abstract

Efficient literature search is essential to the practice of Evidence-Based Medicine. PubMed provides free access to one of the largest searchable biomedical databases. Efficient literature search using PubMed requires a good understanding of the available search strategies and tools. In this article we present a step-by-step approach for performing literature search using PubMed. Several PubMed tools including 'Single Citation Matcher', 'Clinical Queries', 'Clipboard', 'Field Tags', and 'Cubby' are highlighted using case based scenarios. ©

INTRODUCTION

Evidence-based medicine (EBM) is 'judicious application of the best research evidence integrated with individual physicians' clinical expertise and patient values'.¹ Several physician surveys suggest that most patient encounters generate one or more clinical questions that remain unanswered and need a quick and focused literature search.²⁻⁴ Thus, in an observational study at a university setting, an average of five unanswered questions were raised for every patient encounter.² With biomedical information doubling every five years,⁵ the standard textbooks and reviews usually lag behind in their ability to provide the most current information on relevant clinical questions.⁶

The practice of EBM can be summarized into four basic steps: 1) develop a focused clinical question; 2) search for the best evidence; 3) critically appraise the evidence; 4) apply the evidence and evaluate the outcome. In this review, we will present the techniques involved in formulating a well-built clinical question and searching the literature using the PubMed database.

Searching for Best Evidence: The electronic databases

Several electronic databases are available for searching citations. Most of these are subscription based and may not be freely available to the individual user. The source of biomedical information on the web can be divided into two major categories: 1) original published articles in the journals; and 2) synthesized information available as systematic reviews, synopses or decision

support systems.⁷ However, a lack of experience with search techniques often leads to missing many relevant citations that may have an impact on patient care.⁸

MedLine is the U.S. National Library of Medicine's premier bibliographic database. MedLine covers the fields of medicine, nursing, dentistry, veterinary medicine, health care system, pre-clinical sciences, and a few other areas of the life sciences. MedLine contains citations from over 4,600 journals, published in 70 countries. Over 14 million records are indexed in MedLine with most of the records from English language sources or having English abstracts.

The MedLine database can be searched with several search engines. The two most popular are Entrez and Ovid. Entrez is the life sciences search engine that is part of the National Center for Biotechnology Information's retrieval system. Entrez searches several databases including PubMed. PubMed includes MedLine, Old MedLine (1951 to 1965), articles from some non-MedLine journals and issues of journals published prior to their selection for MedLine indexing, and out-of-scope articles from 'selectively indexed' MedLine journals. Thus PubMed database is more comprehensive than MedLine. Furthermore, PubMed is more current and allows access to citations even prior to their indexing with MedLine.

Formulating the search question

The initial essential requirement for performing an effective search using PubMed is the ability to generate a well-built clinical question. The individual key components of this question can then be used as search terms in PubMed. Three basic steps are recommended for formulating the search question: 1) define the components of the search question; 2) identify the study design that will answer the search question; 3) identify

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the study type that will answer the search question.

Defining the components of the search question -

Each search question has four components remembered best by the mnemonic-PICO.⁹

1. Patient (P) – What is the patient group of interest e.g. acute cholecystitis.
2. Intervention (I) – What is the intervention of interest e.g. expectant management.
3. Comparison (C) – What is the comparison intervention of interest e.g. surgery.
4. Outcome (O) – What is the primary outcome e.g. survival.

A search is usually started with two of the four components, usually patient and intervention. Depending on the question and retrieval, the search can be further focused by adding rest of the components of the question.

Identify the study design that will answer the search question - The study design for most therapeutic interventions is likely to be a randomized double blind clinical trial (RCT). For clinical questions where several RCTs are reported in the literature, a systematic review or meta-analysis might be the most appropriate article to review. The optimal study design to assess prognosis and harm is likely to be a prospective cohort study.

Identify the study type that will answer the search question - Most clinical questions can be answered by one of the four recognized study types i.e. diagnosis, prognosis, therapy and harm. Several databases including PubMed provide appropriate search filters to retrieve citations with the particular study design.

The rest of this article will cover the important features of PubMed. Clinical scenarios will be used to elaborate the search options. Readers are encouraged to conduct the searches as they go along in the article. All the actions that readers have to take are *italicized*, with the terms that they have to type placed in double quotes. Individual PubMed options are placed in single quotes.

Introduction to PubMed Homepage -

Log on to www.pubmed.gov

The PubMed homepage has three key areas that are frequently used (Fig. 1):

1. 'Query box' – The 'Query box' is used to enter the search terms as a free text entry area.
2. 'Features bar' – Immediately beneath the 'Query bar', the 'Features bar' provides access to 'Limits', 'Preview/Index', 'History', 'Clipboard', and 'Details'.
3. 'Side bar' – The blue 'Side bar' has some of the advanced PubMed features including the 'MeSH Database', 'Single Citation Matcher', 'Clinical Queries' and 'Cubby'.

In addition PubMed homepage also has a black 'Menu



Fig. 1 : PubMed Homepage

bar' at the top that allows the user to link to other Entrez databases.

MeSH Database

It is important to have a basic understanding of the MeSH database prior to exploring actual search strategies further. Medical subject headings (MeSH) database is the hierarchical library that is used to index citations. MeSH terms are arranged in a tree like structure with the more general terms representing the stem and narrower and more focused terms representing the distal branches. Each citation that is indexed with MedLine is assigned up to 15 MeSH terms based on the content of the article. An important feature of PubMed that increases search yield is 'automatic term explosion'. This means that when a search term is entered in PubMed that matches with a MeSH term, PubMed automatically includes all the specific narrower terms that are associated with the search term.

Select MeSH Database from 'Side bar'.

Type "Lung cancer" in the 'Query box' and select 'Go'.

Select 'Lung neoplasms'.

Look at the 'Subheadings', 'Entry Terms' and then scroll down to look at the MeSH tree associated with lung cancer. Typing any of these 'Entry Terms' in the 'Query box' leads PubMed to match that term to lung cancer. Selecting 'Subheadings' allows you to restrict search to the particular subheadings within the MeSH term.

Basic PubMed search features - 'Boolean logic', 'Limits', 'Display options'

Boolean logic represents relationships between search terms. The three Boolean operators are 'AND', 'OR' and 'NOT'. The operator 'AND' is used to retrieve citations that contain all the search terms, while the operator 'OR' is used to retrieve citations that contain at least one of the search terms. The operator 'NOT' is used to restrict citations containing a particular search term. The use of 'NOT' is however confusing and should be avoided. While joining two search terms using Boolean

logic, the Boolean terms should be typed in capitals (e.g. “AND” instead of “and”).

The ‘Limits’ option allows the user to narrow the search thereby retrieving fewer citations. The most commonly used ‘Limits’ are Publication Types, Ages, Publication Dates and Subsets.

CASE 1

A 50-year old male with new onset type II diabetes consults you for lipid management. Patient has an LDL Cholesterol of 96 mg/dl with HDL Cholesterol of 48 mg/dl. He recently heard that diabetic patients with even low LDL cholesterol might derive benefit from the use of statin medications. Your question is: Do patients with diabetes and low LDL cholesterol have better outcomes if they are treated with a statin medication compared to no treatment?

Log on to www.pubmed.gov

Type in the search term, “diabetes AND low LDL AND treatment”. Look at the search results. You retrieve over one thousand citations.

Select ‘Limits’ and make the following selections within ‘Limits’:

Publication types - Randomized controlled trials

Ages - All Adult: 19+ years

Publication Date - From 2002 To 2004

Subsets - Core clinical journals (Core Clinical Journals is a list of 120 clinical journals that are likely to be available at most medical school libraries)

The final screen appearance is shown in Fig. 2.

Click Go and look at the output. You have much fewer articles that are more relevant.

The article by Colhoun H et al published in Lancet in 2004 addresses the specific question that you are searching.¹⁰

Now look at the way the citations are displayed. PubMed defaults to show citations in the summary format, in a set of 20, with the citations arranged in a

chronologic order with the most recent citation shown first. The way citations are displayed, number of citations and how they are sorted can all be changed.

In the option ‘Display’ scroll down and select ‘Brief’.

In the option ‘Sort’ scroll down and select ‘Author’.

Click on ‘Display’.

Citations are now displayed in the ‘Brief’ format and arranged in an alphabetical order based on the author’s name.

Now select the ‘Back’ button to reach the previous screen.

Select the article by Colhoun H et al by checking the box to the left of the citation.

Scroll down in ‘Display’ and select ‘Abstract’.

Click on ‘Display’.

The ‘Abstract’ format is now seen. You can also perform the same function by simply clicking on the authors’ names that is hyper-linked to the ‘Abstract’ format.

Looking for a specific article and expanding your search - The ‘Single Citation Matcher’ and ‘Related Articles’

‘Single Citation Matcher’ can be accessed from the ‘Sidebar’ and allows you to retrieve a single citation of interest. A simple fill-in-the-blank form allows you to enter the relevant information about the article of interest.

CASE 2

A 40-year old chronic smoker seeks your help for tobacco cessation. You counsel him about stopping smoking and plan on starting Bupropion. Patient wants to know the reported success of Bupropion based on results from previous studies. You recall that the original randomized clinical trial was published in the NEJM in mid 1990s and would like to pull up the citation.

Select ‘Single Citation Matcher’ from the ‘Sidebar’.

Enter the following information in search fields:

Journal - “NEJM”

Date - “1993:1997”

Title - “Bupropion”

(Note that a range of date is entered by putting a colon between the two years)

The final screen appearance is shown in Fig. 3.

Select ‘Search’

The second article is the one we are interested in.¹¹ ‘Single Citation Matcher’ is typically used to look for a specific citation but can also be used to search for multiple citations.

Now look to the right of the citation to find ‘Related Articles’. The ‘Related Articles’ tool helps you quickly identify articles related to the citation of interest. Several of the relevant articles are pre-selected and stored by



Fig. 2 : Using the ‘Limits’ options



Fig. 3 : Single Citation Matcher

PubMed. A pre-specified word-weighted algorithm that incorporates the assigned Medical Subject Headings (MeSH) and words from the title and abstract is used to choose the related articles. These articles are arranged from the most to the least relevant.

Select 'Related Articles'.

Look at the citations that are retrieved. Assess their relevance to your search question.

Tools for systematic review – 'Clinical Queries' and 'Clipboard'

'Clinical Queries' is accessed from the 'Side bar'. This tool gives the user an option to search using the 'Clinical Queries Using Research Methodology Filter' or the 'Systematic Reviews'. 'Clinical Queries Using Research Methodology Filter' incorporates validated search filters that are added to the search term. Search filters are available for four different study types i.e. therapy; diagnosis; etiology; and prognosis. Additionally, search can be specified as sensitive or specific depending on the question that is being asked. The 'Systematic Reviews' filter retrieves meta-analysis and systematic reviews for the search question.

CASE 3

A 35-year old female presents to you with a history of chronic backaches. MRI shows no significant abnormalities and her ESR is normal. She is seeking symptomatic relief and asks you if acupuncture is likely to help her symptoms. You would like to look up a systematic review on this topic.

Select 'Clinical Queries' from the 'Sidebar'.

Check the box to the left of 'Systematic Reviews'.

In the search box enter the term, "Acupuncture AND back pain"

Look at the number of citations and see if your search retrieves relevant articles.

Now select the 'Back' button to reach the previous screen.

Check the box to the left of 'Clinical Queries using Research Methodology Filter'.

In the 'Category', select 'Therapy' and in 'Emphasis', select 'Specific search (narrow)'.

Your search term "Acupuncture AND back pain" should already be present in the 'Query box'.

Select 'Go'.

Look at the number of citations and see if your search retrieves relevant articles. Most of the articles retrieved would be clinical trials.

Now select the 'Back' button again to reach the previous screen.

Change the Emphasis to 'Sensitive search (broad)'.

Select 'Go'.

Look at the number of citations and see if your search retrieves relevant articles. You will retrieve a greater number of articles compared to the specific search and some of the articles will likely have lesser relevance.

'Clipboard' helps you temporarily store citations for up to 8 hours. This option is particularly helpful when you are doing several different searches and would like to select and save citations and work with them together. With the citations stored in the 'Clipboard', all the functions can be performed that are otherwise possible with a standard PubMed search.

Go back to the previous search just completed.

Select the first three citations by checking the box to their left.

Go to the 'Send to' button. Scroll down to 'Clipboard' and select 'Clipboard'

Select 'Send to' button.

The message will appear on the left side of the window stating, '3 items were added to the Clipboard' (Fig. 4).

Select 'Clipboard' again from the 'Features bar'. Look at the 3 citations.

You can change 'Display' or 'Sort' these items like



Fig. 4 : Storing searches using 'Clipboard'

any PubMed search output. Note that if you want to send all the citations obtained from a search to the 'Clipboard', do not select any of the citations and select the option 'Send to' 'Clipboard'. All the citations up to a total of 500 will be sent to the clipboard.

While in the 'Clipboard', scroll down in the 'Send to' button and select 'Clip Remove'.

Select 'Send to'.

Select 'Clipboard' again.

'Clipboard' should now be empty.

Work with other options in the 'Send to' button including Text, File, E-mail and Order. You can order full text of the articles using service provided by 'Loansome Doc'. You will need to first set up an account and the service is for fee.

Advanced PubMed search features – 'Field Tags' and 'Cubby'

Most of the search options that are used to do a focused search can be performed using the 'Field Tags'. Field tags instruct PubMed to perform a search in the specified fields. These tags are enclosed in square brackets and typed at the end of the search term. Some of the most useful tags are: author;⁶ publication date;¹⁰ institutional affiliation of the author;⁶ journal title;⁶ and title of the citation.⁶

CASE 4

You are a general internist and would like to spend one year of research time at the Nicotine Dependence Center at the Mayo Clinic. You are advised to develop research ideas and contact Dr. Richard Hurt. You would like to find out the articles that Dr. Hurt has been publishing in the last 10 years.

Enter the search term "Mayo[ad] AND Clinic[ad]" in the 'Query box'.

Select 'Go'.

Look at the output. The results show all the publications from the Mayo Clinic that are indexed in the PubMed.

Add to the search term "hurt r[au]". The final search term will be, "Mayo[ad] AND Clinic[ad] AND hurt r[au]".

Look at the output. The results show all the publications from the Mayo Clinic authored by Dr. R Hurt.

Add to the search term "1994:2004[dp]". The final search term will be, "Mayo[ad] AND Clinic[ad] AND hurt r[au] AND 1994:2004[dp]".

Look at the output. The results show all the publications from the Mayo Clinic authored by Dr. R Hurt between 1994 and 2004.

Add to the search term "smoking". The final search term will be, "Mayo[ad] AND Clinic[ad] AND hurt r[au]

AND 1994:2004[dp] AND smoking".

Look at the output. The results show all the publications on smoking from the Mayo Clinic that are authored by Dr. R Hurt and published between 1994 and 2004.

A list of all the 'Field tags' is available on the PubMed Help/FAQ page.

Select 'Help' in the 'Side bar'.

Scroll down to 'References.'

Select 'Search Field Descriptions and Tags.'

'Cubby' helps the user to store search strategies for future reference. The most useful feature of the 'Cubby' is to review the recent articles published on the topic since the last search was completed. 'Cubby' feature is available for free but does require setting up a user name and password.

CASE 5

You are an expert on the drug therapy of pulmonary tuberculosis. You would like to remain current with the literature on this topic.

Select the 'Cubby' feature from the 'Side bar'.

Set up your own 'Cubby' account.

Now go back to PubMed homepage and enter the search term "pulmonary tuberculosis AND drug treatment" in the 'Query box'.

Log on to your 'Cubby' account. Your search term is present in the 'Cubby Search Name' box.

Select 'Store in Cubby'.

The search is stored in your 'Cubby' account. The date and time the search was performed is also stored.

Re-access your 'Cubby' account a few days from your first search.

Select the search by checking the box to the left of it.

Now select the option 'What's New for Selected'.

The output would comprise of citations added to PubMed since your last search.

Table 1 : Web Based Databases of Biomedical Information

1	Original Studies	Individual Journals Searchable Databases	MedLine ^F PubMed ^F EMBASE ^S CINAHL ^S PsycINFO ^S CANCERnet ^F SPORTDiscus ^S
2	Synthesized databases	Cochrane Collaboration ^S ACP Journal Club ^S Clinical Practice Guidelines ^{S or F} UpToDate ^S TRIP database ^S EBM Reviews ^S	

F = Free; S = Subscription based

CONCLUSIONS

Physicians practicing Evidence Based Medicine will find it helpful to develop a well thought out literature search strategy. PubMed is one of the most comprehensive biomedical database, is available for free and offers several tools for performing a focused literature search. Familiarity with these search tools will help users perform efficient citation retrieval. PubMed provides an online tutorial that might be helpful for both new and experienced users.

REFERENCES

1. Sackett DL SS, Richardson WS, Rosenberg W, Haynes RB. *Evidence based medicine: How to Practice and Teach EBM*. Second Edition ed. London: Churchill Livingstone; 2000.
2. Osheroff JA, Forsythe DE, Buchanan BG, Bankowitz RA, Blumenfeld BH, Miller RA. Physicians' information needs: analysis of questions posed during clinical teaching. *Ann Intern Med* 1991;114:576-81.
3. Green ML, Ciampi MA, Ellis PJ. Residents' medical information needs in clinic: are they being met? *Am J Med* 2000;109:218-23.
4. Covell DG, Uman GC, Manning PR. Information needs in office practice: are they being met? *Ann Intern Med* 1985;103:596-9.
5. Mattox DE. Welcome to ARCHIVES CME. *Arch Otolaryngol Head Neck Surg* 2000;126:914.
6. Antman EM, Lau J, Kupelnick B, Mosteller F, Chalmers TC. A comparison of results of meta-analyses of randomized control trials and recommendations of clinical experts. Treatments for myocardial infarction. *JAMA* 1992;268:240-8.
7. Haynes RB. Of studies, syntheses, synopses, and systems: the "4S" evolution of services for finding current best evidence. *ACP J Club* 2001;134:A11-13.
8. Haynes RB, McKibbon KA, Walker CJ, Ryan N, Fitzgerald D, Ramsden MF. Online access to MEDLINE in clinical settings. A study of use and usefulness. *Ann Intern Med* 1990;112:78-84.
9. Oxman AD, Sackett DL, Guyatt GH. Users' guides to the medical literature. I. How to get started. The Evidence-Based Medicine Working Group. *JAMA* 1993;270:2093-5.
10. Colhoun HM, Betteridge DJ, Durrington PN, *et al*. Primary prevention of cardiovascular disease with atorvastatin in type 2 diabetes in the Collaborative Atorvastatin Diabetes Study (CARDS): multicentre randomised placebo-controlled trial. *Lancet* 2004;364:685-96.
11. Hurt RD, Sachs DP, Glover ED, *et al*. A comparison of sustained-release bupropion and placebo for smoking cessation. *N Engl J Med* 1997;337:1195-1202.

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Evidence-Based Medicine Judicious incorporation of the best available evidence, in conjunction with the values and preferences of those involved and with the circumstances of care in clinical decision-making. Evidence alone is not enough. You want to review the literature before you decide on amoxicillin for Carlitos and possibly changing your standard practice.

6 Anatomy of a Focused Clinical Question Patient or Problem Patient or Problem

How would I describe a group of patients or problem similar to mine? How would I describe a group of patients or problem similar to mine?

17 PubMed- Search Strategies Combining keywords using boolean operators (AND, OR, NOT) and applying limits. Combining keywords using boolean operators (AND, OR, NOT) and applying limits. Background

The practice of evidence-based medicine requires efficient biomedical literature search such as PubMed/MEDLINE. Retrieval performance relies highly on the efficient use of search field tags. The purpose of this study was to analyze PubMed log data in order to understand the usage pattern of search tags by the end user in PubMed/MEDLINE search. [7]. Other PubMed filters (limits) were included because they have been described in the literature on evidence-based searching as helpful tools for narrowing a set of retrieved articles [26, 27]. As the limits used in our study and the Clinical Queries filters are both filters by definition and PubMed handles them comparably, they will all be referred to here as filters. ... Evidence Based Medicine combines research evidence with patient values and clinical skills to solve medical problems and improve patient outcome.

The next steps consist of searching for the most appropriate information to arrive at the possible solution, a careful assessment to make sure that the information/solution is correct, application of the most apt or suitable information/solution to the situation, followed by monitoring the effects of implementation practices to ensure the desired improvement or outcome has been achieved, and then lastly incorporating.

Why it is Important to Use Evidence Based Practice? EBP is important because it aims to provide the most effective care that is available, with the aim of improving patient outcomes.