Users' Guides to the Medical Literature

XXI. Using Electronic Health Information Resources in Evidence-Based Practice

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CLINICAL SCENARIO

You are a general internist reviewing the condition of a 55-year-old woman with type 2 diabetes mellitus and hypertension. Her glycemic control is excellent with metformin, and she has no history of complications. To manage her hypertension, she takes a small daily dose of a thiazide diuretic. During the examination, you note that her weight is stable, she has no evidence of peripheral neuropathy, and her blood pressure is 155/88 mm Hg. After arranging for glycosylated hemoglobin, cholesterol, and microalbumin assessments, you reassure your patient that she is doing well and ask her to return in 3 months. After she has left, you notice that her blood pressure over the past 6 months has been about the same as it was today. You wonder if she would benefit from more aggressive blood pressure control. Specifically, in this patient with diabetes mellitus, would tighter blood pressure control improve survival or delay the onset of complications? You decide to find if the medical literature can help resolve the issue.

Practicing evidence-based medicine involves integrating individual clinical expertise with the best available evidence from systematic research.[1] The necessary skills include formulating a concise question that addresses uncertainties in patient management and quickly identifying the highest-quality relevant information from the medical literature. The previous articles in this series have provided guides for the steps that follow identification of the best evidence—systematically assessing its validity and applicability. In this Users' Guide, we present an approach to choosing and subsequently searching the most efficient electronic resource for finding the best evidence. We have focused primarily on electronic resources as these are generally easier to search and more current than many print sources.[2] However, with the relatively recent appearance of many of the resources we recommend, little research specifically addresses their relative merits. The approaches we describe reflect our experiences and those of our colleagues working individually or with medical trainees and encompass a wide range of learning levels.

THE CLINICAL QUESTION

The first step in the search for evidence is to identify uncertainties in patient care and formulate these into questions. Specific questions can arise when we are not sure about the benefits and risks associated with different therapeutic approaches for a well-defined group of patients or are unaware of the value of a diagnostic test or prognosis of a disease condition.[3] More general questions deal with broader topics. What therapeutic approaches are available for a given condition? What complications can develop in people who have a certain disease? While a properly defined clinical study could answer a focused clinical question, general clinical questions are too broad to be answered by a single study or meta-analysis.

Matching Your Question to the Best Medical Information Resource

The optimal medical information resource depends, to a large extent, on the type of question that you have and time you have available.[4] To answer focused clinical questions, the most efficient approach is to begin with a "prefiltered" evidence-based medicine resource such as *Best Evidence*, the Cochrane Library, or Clinical

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Evidence that are updated with methodologically sound and clinically important studies on a regular basis and have been designed to make searching easy. To find answers to more general medical questions, electronic versions of medical textbooks are often more helpful. UpToDate and *Scientific American Medicine* provide background information on many topics, in addition to answers to more specific questions. MEDLINE, the bibliographic database maintained by the US National Library of Medicine, can be used to find answers to both focused and background medical questions. The size and complexity of this database, however, makes searching somewhat more difficult and time consuming. We review the databases suitable for answering a specific clinical question and illustrate their use with the example of the optimal blood pressure target level in diabetic patients (TABLE).

Using Prefiltered Evidence-Based Medicine Resources to Answer Focused Clinical Questions

Best Evidence. A good place to start looking for answers to focused clinical questions is *Best Evidence*. Available in CD-ROM format, this is the electronic version of 2 paper-based abstract journals: *ACP Journal Club* and *Evidence-Based Medicine*. (These journals were combined into 1 journal, *ACP Journal Club*, in North and South America in January 2000. *Evidence-Based Medicine* is still available outside the Americas.) For these publications, 150 medical journals are systematically searched on a regular basis to identify studies that are both methodologically sound and clinically relevant. By "methodologically sound" we mean that studies meet validity criteria familiar to readers of this Users' Guides series: for example, the treatment section includes only randomized trials with 80% follow-up and the diagnosis section only studies that make an independent, blind comparison of a test with a gold diagnostic standard.

ACP Journal Club and *Evidence-Based Medicine* present structured abstracts of studies that meet these criteria, along with an accompanying commentary by an expert who puts the study findings into clinical perspective. Clinicians can find other studies that meet methodological criteria, but have been judged less relevant, in a section of *Best Evidence* entitled "Other Articles Noted." *Best Evidence* is updated annually and now includes more than 1600 abstracted articles related to general internal medicine dating back to 1991. After 5 years, the editors review each article to make sure that it has not become outdated in light of more recent evidence. In addition to general internal medicine, *Best Evidence* includes a broader range of articles published since 1995 encompassing obstetrics and gynecology, family medicine, pediatrics, psychiatry, and surgery.

Because *Best Evidence* contains only methodologically sound articles, it is substantially smaller than many other medical literature databases and thus easier to search. To locate information on blood pressure control in people with type 2 diabetes, we used the *search* option in *Best Evidence 3*. We entered the terms *hypertension*, *diabetes*, and *mortality*, resulting in a list of 90 articles. Many of these citations, however, dealt with the prognosis of patients with diabetes and were not directly relevant for our question. We therefore returned to the search option, entered the same terms, but clicked on the *Therapeutics and Preven-*

Table. Medical Information Resource Contact Information

Resource	Internet Address	Annual Cost, $
Best Evidence	http://www.acponline.org/catalog/electronic/best_evidence.htm	110 (CD-ROM)
Cochrane Library	http://www.updateusa.com/cochrane.htm	225
UpToDate	http://www.uptodate.com	495 (CD-ROM)
MEDLINE		
PubMED	http://www.ncbi.nlm.nih.gov/PubMed	Free
Internet Grateful Med	http://igm.nlm.nih.gov	Free
Other sources	http://www.medmatrix.org/info/medlinetable.asp	Free
Scientific American Medicine	http://www.samed.com	245 (print and online versions) (159 for online access only)
Clinical Evidence	http://www.evidence.org/index-welcome.htm	To be announced (115 in print)
Harrison's Online	http://www.harrisonsonline.com	89
eMedicine	http://www.emedicine.com	Free
Medical Matrix	http://www.medmatrix.org/reg/login.asp	Free
ScHARR Netting the Evidence	http://www.shef.ac.uk/uni/academic/R-Z/scharr/ir/netting.html	Free
Medical World Search	http://www.mwsearch.com	Free
Journal listings	http://www.nthames-health.tpmde.ac.uk/connect/journals.htm http://www.pslgroup.com/dg/medjournals.htm	Free Free
Clinical practice guidelines	http://www.guidelines.gov http://www.cma.ca/cpgs	Free Free
MD Consult	http://www.mdconsult.com	199.95
EBMR Reviews (OVID)	http://www.ovid.com/products/cip/ebmr.cfm	1275 (institutional price for 1 user)

tion option before asking *Best Evidence* to complete the search. This yielded a shorter list of 19 articles, all pertaining to therapy. An article entitled "Diuretics Reduced Cardiovascular Disease Events in Diabetic and Nondiabetic Patients"[5] looked promising. Double-clicking on this title produced a structured abstract indicating that diabetic participants in the Systolic Hypertension in the Elderly Program trial had a significant reduction in cardiovascular events with diuretic therapy. This interesting study did not, however, answer the question of the optimal blood pressure goal for people with diabetes.

As in this case, searching *Best Evidence* will not always be successful. This may be because high-quality evidence is not available. Alternatively, a relevant trial may have been published after the most recent edition of *Best Evidence* was released or before 1991. Well-done studies published since 1991 also may not appear in *Best Evidence* if the topic was felt to pertain more to subspecialty care than to general internal medicine. Despite these limitations, searching *Best Evidence* will often be rewarding.

Cochrane Library. The Cochrane Collaboration, an international organization that prepares, maintains, and disseminates systematic reviews of health care interventions, offers another electronic resource for locating high-quality information quickly. The Cochrane Library focuses primarily on systematic reviews of controlled trials of therapeutic interventions and thus provides little help in addressing other aspects of medical care, such as the value of a new diagnostic test or a patient's prognosis.

Updated quarterly, the Cochrane Library is available in CD-ROM format or over the Internet and contains 3 main sections. The first of these, the Cochrane Database of Systematic Reviews (CDSR), includes the complete reports for all of the systematic reviews that have been prepared by members of the Cochrane Collaboration (663 reviews in the fourth issue for 1999) and the protocols for Cochrane systematic reviews that are under way. A second part of the Cochrane Library, the Database of Reviews of Effectiveness (DARE) includes systematic reviews that have been published outside the collaboration: the fourth issue for 1999 included 2470 such reviews. The third section of the library, the Cochrane Controlled Trials Registry (CCTR), contains a growing list of more than 250000 references to trials that Cochrane investigators have found by searching a wide range of sources. The sources include the MEDLINE and EMBASE (*Excerpta Medica*) bibliographic databases, hand searches, and the reference lists of potentially relevant original studies and reviews. While most citations refer to randomized trials, the database also includes a small number of observational studies. In addition to the 3 main sections, the Cochrane Library also includes information about the Cochrane Collaboration and information on how to conduct a systematic review.

To search the Cochrane Library, you can simply enter terms in the first screen that appears after selecting *search*. Alternatively, if you have access to the CD-ROM version, you can create more complex search strategies that include Medical Subject Heading (MeSH) terms and logical operators (see the section on MEDLINE, for an introduction to MeSH terms and logical operators). To find information about blood pressure control in people with diabetes, we entered the search terms *diabetes*, *hypertension*, and *mortality* using the 1999 version of the Cochrane Library (issue 4). This yielded 35 reports in the CDSR, 3 citations in the DARE, and 112 citations in the CCTR. A Cochrane review entitled "Antihypertensive Therapy in Diabetes Mellitus"[6] appeared promising. Double-clicking on this item, we found an entire Cochrane Collaboration systematic review, including information on the methods, inclusion and exclusion criteria, results, and a discussion. The results presented the findings in both textual and graphical forms. As was the case with the article found in *Best Evidence*, however, this review did not help resolve the issue of the optimal blood pressure goal for people with diabetes mellitus.

Turning to the CCTR (we double clicked on the *CCTR* option to make the citation titles appear), we found an article entitled "Effects of Intensive Blood-Pressure Lowering and Low-Dose Aspirin in Patients With Hypertension: Principal Results of the Hypertension Optimal Treatment (HOT) Randomised Trial"[7] and another entitled "Tight Blood Pressure Control and Risk of Macrovascular and Microvascular Complications in Type 2 Diabetes: UKPDS 38."[8] These were both within the first 20 citations listed in the CCTR for our search. Selecting the first of these yielded an abstract of the Hypertension Optimal Treatment (HOT) study,[7] a randomized controlled trial that compared 3 different blood pressure management strategies in persons with hypertension. Selecting the second citation produced an abstract for the UKPDS 38 study, a randomized trial enrolling persons with type 2 diabetes and hypertension and evaluating the effect of aiming for a blood pressure of less than 150/85 or 180/105 mm Hg. After an average of 8.4 years of follow-up, the tight blood pressure control arm had a 32% reduction in the risk of death related to diabetes (95% confidence interval, 6%-51%; $P=.02$).

UpToDate. One electronic textbook, UpToDate, is carefully updated every 4 months and is very well referenced. While UpToDate, unlike *Best Evidence* and the CDSR, does not have a set of explicit methodological quality criteria that must be met for articles to be included, it does reference many high-quality studies. To locate information on blood pressure control in people with type 2 diabetes, we entered the term *diabetes* in the search window. We found a list of 20 options and selected *diabetes mellitus, type 2*. This yielded 49 titles, including 1 entitled "Treatment of Hypertension in Diabetes." The chapter reviewed the pathogenesis and treatment of hypertension in people with diabetes. It also had a section on the "goal of blood pressure reduction"; including a detailed description of the 2 large randomized trials[7,8] that we found in the Cochrane

Library specifically addressing the clinical outcomes associated with more aggressive compared with less aggressive blood pressure management strategies. The text summarized the design and findings of these 2 studies, and we could retrieve the study abstracts by simply clicking on the references. Currently, UpToDate is available only on CD-ROM, but an Internet version is planned for late 2000.

MEDLINE. If a search of UpToDate, *Best Evidence*, and the Cochrane Library does not provide a satisfactory answer to a focused clinical question, it may be time to turn to MEDLINE. The US National Library of Medicine maintains this impressive bibliographic database that includes more than 9 million citations to both clinical and preclinical studies. A complementary database known as PreMEDLINE includes citations and abstracts for studies that have been published recently and have not yet been indexed. MEDLINE is an attractive database for finding medical information because of its relatively comprehensive coverage of medical journals and ready accessibility. Anyone with Internet access can search MEDLINE free of charge using PubMed or Internet Grateful Med, and most health sciences or hospital libraries provide access to MEDLINE.

These positive features are balanced with a disadvantage that relates to MEDLINE's size and the range of publications it encompasses. Searching MEDLINE effectively requires careful thought and a thorough knowledge of how the database is structured and publications are indexed. Understanding how to use MeSH terms, textword searching and exploding, and the logical operators AND and OR to combine different search results is essential. If you are unfamiliar with MEDLINE searching techniques, an article by Greenhalgh[9] presents a good introduction. Readers who suspect that they may have gaps in their searching skills should also strongly consider spending some time with an experienced medical librarian or taking a course on MEDLINE searching. Another potential source of information on searching techniques is to visit an Internet Web site designed to introduce the topic. A listing of tutorials designed to assist users of different MEDLINE systems and at different experience levels is available at http://www.docnet.org.uk/drfelix/medtut.html. More detailed information on searching MEDLINE and a number of other large bibliographic databases, including EMBASE (*Excerpta Medica*), is also available in a recently released reference book.[10] In this article, we present only the most crucial and basic MEDLINE searching advice.

MEDLINE indexers choose MeSH terms for each article. These headings provide one strategy for searching. It is important to note, however, that indexers reference articles under the most specific subject heading available (for example, *ventricular dysfunction, left*, rather than the more general term *ventricular dysfunction*). The implication of this for searching is that using a more general heading (*ventricular dysfunction*) risks missing many articles of interest. A command known as *explode* can be used to address this. Using the *explode* command identifies all articles that have been indexed using a given MeSH term as well as articles indexed using more specific terms.

Another fundamental search strategy substitutes reliance on the decisions made by MEDLINE indexers with the choices of study authors regarding terminology. Using *text word* searching makes it possible to identify all articles in which either the study title or abstract includes a certain term. Experience with MEDLINE allows clinicians to develop their preferred search strategies. Comprehensive searches will usually use both MeSH terms and text words.

To search for information pertaining to blood pressure control targets in people with type 2 diabetes, we used the National Library of Medicine's new PubMed MEDLINE searching system. We began by entering the term *diabetes mellitus* and clicking the *Go* button. This yielded a total of 139223 citations dating back to 1966. Notice that before searching MEDLINE and PreMEDLINE, the PubMed system processed our request. Rather than simply completing a textword search, PubMed developed a more comprehensive strategy that also included the most appropriate MeSH term. To further increase the yield of citations, PubMed also automatically exploded the MeSH term. PubMed searched MEDLINE and PreMEDLINE using the strategy: *diabetes mellitus* (textword) OR *explode diabetes mellitus* (MeSH term)

The *OR* in the strategy is called a *logical operator*. It asks MEDLINE to combine the publications found using either the first search term or the second search term to make a more comprehensive list of publications in which diabetes is a topic of discussion.

We then searched using the term *hypertension* (175063 references) and the term *mortality* (305978 references). To combine these 3 searches, we initially clicked on the *History* button, which showed us a summary. By entering the term *#1 AND #2 AND #3* in the search window, we were able to ask PubMed to locate those citations in which diabetes mellitus, hypertension, and mortality were all addressed.

Unfortunately, the list of publications that MEDLINE identified included 1838 references, prompting us to take advantage of another searching technique designed to help identify particular types of clinical studies. *Search hedges* are systematically tested search strategies that help identify methodologically sound studies pertaining to questions of therapy, diagnosis, prognosis, or harm. A complete listing of the strategies is available, along with the sensitivities and specificities for each different approach.[11,12] While the strategies tend to be complex, many MEDLINE searching systems now have them automatically available for use. The PubMed system even has a special section with these strategies entitled *Clinical Queries*. As an alternative to the hedges, clinicians can use *single best terms* for finding higher quality studies. These terms include *clinical trial* (publication type) for treatment; *sensitivity* (text word) for diagnosis; *explode cohort studies* (MESH term) for prognosis; and *risk* (text word) for harm.

Combining our previous strategy with the term *clinical trial* (publication type) yielded a list of 108 publi-

cations. Once again, we found references to the UKPDS trial[8] and the HOT trial[7] in the citation list.

Finding Answers to More General Questions: Textbooks and the Internet

Clinicians sometimes have general questions that are unlikely to have been answered by a single study or meta-analysis. This often occurs if they encounter a patient problem they have not seen recently and need to review the differential diagnosis, complications, or the range of therapeutic options. In these situations, prefiltered evidence-based medicine resources such as *Best Evidence* and the Cochrane Library are unlikely to be helpful. Referring to a textbook that is well referenced and updated frequently is likely to be faster and more rewarding. We have already referred to UpToDate. *Scientific American Medicine* is also updated regularly and supplies references for many statements so that you can assess how current the material is and even read the original articles. Other textbooks available in electronic formats, such as *Harrison's Principles of Internal Medicine*, can also provide valuable general background information. Additionally, new textbooks that are entirely Internet-based, such as eMedicine, are now appearing.

This brings us to the World Wide Web, which is rapidly becoming an important source of medical information. A vast number of resources can now be accessed using the Internet—some for a fee, some free-of-charge. To make these resources more accessible, certain Web sites have been specifically designed to provide links to medical information locations or to facilitate searching for medical information on the Internet. Examples of such Web sites include Medical Matrix, ScHARR, and Medical World Search (Table). The Internet can also be used to access medical journals as well as clinical practice guidelines. We must, however, issue a "user beware" caveat: some of these guidelines may fail to meet Users' Guides criteria for evidence-based guidelines.[13,14] An example of a site that provides access to many resources, including journals, textbooks, and guidelines, albeit for a fee, is MD Consult. Lastly, Web sites produced and maintained by reputable organizations such as the American Cancer Society (http://www.cancer.org) or the American Diabetes Association (http://www.diabetes.org) provide another approach for finding information.

RESOLUTION OF THE SCENARIO

Finding the articles that addressed your clinical question required 5 to 30 minutes, depending on the resource used.[4] A full assessment of the validity and applicability required an additional half hour. The UKPDS study[8] is the closest match to your patient and her clinical situation. The study shows a clear reduction of diabetes-related mortality with tight blood pressure control in persons with type 2 diabetes mellitus and hypertension. You decide to initiate treatment with an angiotensin-converting enzyme inhibitor at her next appointment with the goal of lowering her blood pressure.

CONCLUSION

The health sciences literature is enormous and continues to expand rapidly. To the extent that this reflects ongoing research and identification of potential improvements for patient care, this expansion is very promising. At the same time, however, it makes the task of locating the best and most current therapy or diagnostic test more challenging. The emergence of new information products specifically designed to provide ready access to high-quality, clinically relevant, and up-to-date information is thus timely and encouraging. An additional electronic product we are looking forward to in 2000 is Clinical Evidence, produced by the BMJ Publishing Group and American College of Physicians–American Society of Internal Medicine. It is a growing compendium of evidence pertaining to treatments of specific conditions. Also, electronic resources that facilitate simultaneous searching of MEDLINE, *Best Evidence*, and the Cochrane Library are now available through services such as OVID Technology's Evidence-Based Medicine Reviews. Many health sciences libraries subscribe to this service and individual subscriptions can be started. Active research and development continues for integrated products. Among the challenges for staying up-to-date, clinicians can therefore add the task of keeping current their knowledge of optimal search strategies and resources.

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