

# Evidence-based Radiology: Steps 1 and 2—Asking Answerable Questions and Searching for Evidence<sup>1</sup>

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Evidence-based medicine originated at McMaster University, Hamilton, Ontario, Canada, where it was defined as “the integration of current best evidence with clinical expertise and patient values” by the Evidence-based Medicine Working Group led by Drs Gordon Guyatt and David Sackett. From this developed the McMaster University and National Health Service Centre for Evidence-Based Medicine, University of Oxford, paradigm of evidence-based practice, which consists of five steps that can be used by ordinary practitioners: formulate answerable questions with which to search for evidence, search the literature, appraise the retrieved evidence by using explicit methods, apply results to a patient or patient group, and evaluate one’s evidence-based practice and clinical performance and practice. This communication is about the first two steps of this process. Step 1 provides a framework for more effective question formulation that improves subsequent literature searches. It works equally well for questions about diagnostic and interventional radiology. A clinical scenario for a diagnostic question is used to illustrate the formulation of an answerable question. This question is then used to illustrate step 2—how and where to search for evidence.

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*The important thing is not to stop questioning.*

Albert Einstein (1)

**E**vidence-based medicine (EBM) originated at McMaster University, Hamilton, Ontario, Canada, where it was defined as “the integration of current best evidence with clinical expertise and patient values” (2) by the Evidence-Based Medicine Working Group led by Drs Gordon Guyatt and David Sackett. Many practitioners work in a clinical environment and are faced with making decisions that affect patient care on a daily basis.

The Internet has revolutionized the way in which information is accessed. It is crucial that radiologists develop skills that allow independent and critical appraisal of the literature, especially where there is conflicting evidence. These circumstances lead inexorably to the question, “How does one keep up to date with the literature and identify the evidence that should be assimilated into clinical practice?”

In one study conducted in 2001, Australasian physicians identified insufficient time (74%), limited search skills (41%), and limited access to evidence (43%) as impediments to making better use of research data (3).

Physicians need to be able to retrieve medical literature that is relevant. They also need to be able to appraise it and integrate it into their practice. D. J. Cook stated it succinctly: “We should always ask whether the right provider is doing the right thing for the right patient at the right time in the right setting with the right resources” (4).

### Step 1: Asking an Answerable Question

*Asking the right question takes as much skill as giving the right answers.*

Robert Half (5)

### Formulating the Question

The EBM framework, as outlined by the McMaster University and National Health Service Centre for Evidence-Based Medicine (CEBM) group, com-

prises five steps (2): Ask an answerable question, search for current best evidence, appraise the retrieved evidence, apply the findings, and evaluate your performance.

Formulating an answerable question is a key concept of evidence-based practice (EBP). This involves taking a clinical question and changing its format so that it forms the basis for a literature search.

The approach to question formulation in EBP is simple. In essence, it divides a clinical question relating to a diagnostic test into discrete subsections. It encourages focused consideration of a clinical problem or knowledge gap so that it can be resolved into a single question, which usually comprises four parts: (a) A specific patient group is identified, (b) the new intervention is compared with the existing reference standard, (c) other interventions or diagnostic tests specific to the problem are identified, and (d) the outcome of interest is defined. The acronym PICO can be used to describe this “answerable” question, so that “P” = patient or group of patients, “I” = intervention, “C” = comparison intervention, and “O” = outcome.

This method provides a conceptual framework for more effective searching. The finished question can always be expressed in a single, clear, and focused sentence (eg, “In patients with...how does...compare with...for the outcome[s] of...”). It is not intended to be a highly rigid “box” into which all questions must fit exactly. For example, in some radiologic circumstances, no comparison with other methods is needed (eg, “In patients suspected of having venous thromboembolism who are undergoing computed tomographic [CT] venography, what is the expected sensitivity and specificity of the test?”). A “PIO” question format is then more appropriate. In other circumstances, more than one comparison or outcome must be considered (eg, “In patients with small-bowel obstruction, how does CT compare with radiography, sonography, and barium studies for the diagnosis of the presence, severity, level, and cause of the obstruction?”).

This method is applicable across all

patient groups and encompasses all interventions and any outcome under consideration. It works equally well for questions about diagnostic tests (6,7) and for questions about interventional radiology procedures (8). There is a short learning curve associated with this type of question formulation. Anecdotally, when teaching EBP principles, it is notable that students apparently have to relearn how to analyze a problem and structure it in such a way that will allow for efficient searching of the literature. As practitioners gain experience, proficiency at question formulation improves. At least three components of the PICO question are needed to formulate an answerable question. At the very least, a particular patient group and intervention or interventions must be identified and an outcome defined.

### Ask and Search: A Clinical Scenario

You are an abdominal radiologist at a teaching hospital. During a weekly multidisciplinary conference, one of the gastroenterologists asks for your opinion about a patient who has been admitted multiple times for investigation of occult gastrointestinal hemorrhage. To date, all investigations, including mesenteric angiography, have failed to help identify the source of hemorrhage. This gastroenterologist is considering arranging capsule endoscopy, but the procedure is not available locally. He wonders if CT enteroclysis would be useful and asks for your advice. You say that you are not immediately aware of the best answer to his question, and he agrees that you can call him tomorrow with a recommendation.

Having to focus the question more clearly identifies the issues about which information is sought.

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#### Abbreviations:

CEBM = Centre for Evidence-Based Medicine

EBM = evidence-based medicine

EBP = evidence-based practice

MeSH = medical subject heading

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In diagnostic radiology, many of the dilemmas encountered relate to identifying the best test to rule in or rule out a particular disease process (9). Converting this clinical problem into a structured PICO question reads as follows: “P” (patients) = occult gastrointestinal hemorrhage, “I” (intervention) = CT enteroclysis, “C” (comparison) = capsule endoscopy, and “O” = diagnosis. The question then becomes, “In patients with occult gastrointestinal hemorrhage, how does CT enteroclysis compare with capsule endoscopy for diagnosis?”

## Step 2: Searching for the Evidence

### Knowledge Gaps

Knowledge gaps (10) occur when practitioners encounter unfamiliar situations. It is useful to consider knowledge gaps as being related to background or foreground knowledge. Different resources are needed to address these different types of knowledge gaps. Once a specific knowledge gap is recognized, the appropriate resource can be accessed. Background knowledge gaps occur when practitioners encounter very well-established situations with which they are not familiar because of either personal inexperience or the relative rarity of the situation in question. For example, if you are a radiology resident you must learn radiologic anatomy and radiology techniques and understand how images are generated. These background knowledge gaps can be adequately addressed by studying relevant textbooks and attending tutorials given by staff radiologists.

If you are one of the staff radiologists, background knowledge gaps occur when you encounter rare or new pathologic conditions on images generated by means of familiar technology; some reading, often of textbooks, is needed to familiarize oneself with the condition. For staff radiologists, foreground knowledge gaps will relate to questions about the performance and utility of new technologies or interventions and whether they are superior to existing practices. A review of the recent literature is often needed to address these

foreground knowledge gaps. Traditionally, many practitioners “short circuit” this review process by attending refresher courses given by subspecialist experts or by consulting directly with these experts. The role of the “expert” will be discussed further in upcoming articles in this series. Effective search strategies allow independent retrieval of information from resources appropriate to the knowledge gap. Obviously, one does not need to search the literature for every decision in daily practice. This will be considered further in a later article in the series. The concept of identifying the type of knowledge gap and then searching the appropriate resource is useful because it optimizes time spent searching (11).

### The Evidence Pyramid

Haynes (12) has described an “evidence pyramid” in which the vast amount of literature available has been ranked and weighted by using scientific methods. The pyramid comprises four levels: primary literature, syntheses, synopses, and information systems.

Evidence identified at the higher echelons of this pyramid is scientifically better than that at lower levels, and if it answers a particular question or knowledge gap it becomes unnecessary to search for evidence at the base of the pyramid.

Scientific research that has been published in journals forms the bottom of this pyramid. This has been called the primary literature. These are the original articles found by using search engines like PubMed (13) and Google Scholar (14). The quality of the research that composes the primary literature is variable; it often proves difficult to discern what is worth appraising in detail and what is not.

Secondary evidence is frequently better than primary evidence, but in radiology there is often very little secondary evidence available about any given topic. In the four-level hierarchy of evidence described by Haynes (12), secondary evidence comprises the upper three levels.

Evidence-based reviews or syntheses form the second level of the evi-

dence pyramid. At this level are publications in which other authors have searched the literature on the topic in question and have appraised the retrieved articles—often by using explicit EBP appraisal criteria. Because of the strict criteria applied, the appraised articles are more likely to have sound methods and study design. Systematic reviews with meta-analysis (15), critically appraised topics (6,7), and reviews that use EBP methodology (16) are found on this level. This is potentially a very important level for future development of information resources in radiology. It will be considered in detail in future articles in this series by Halligan and Altman and by Medina and Blackmore. At present, although there are many such articles relevant to radiology, the bulk of the information found at this level often relates to therapy and intervention and frequently does not contain any material about diagnostic tests.

The information can be considered to be residing in databases and guidelines that are accessible through search engines and gateways (11). Specific electronic databases exist that contain literature in this level. The Cochrane Library (17), the TRIP database (18), the National Institute of Clinical Excellence (19), and the Scottish Intercollegiate Guidelines Network (20) illustrate this type of EBP resource. From the viewpoint of those practicing the McMaster-CEBM type of EBP, there is a difficulty with guidelines—that is, the way the collated evidence is analyzed may differ from group to group. EBP groups use explicit methodology. Others may use expert consensus (21,22). This problem is beyond the scope of our communication but will be addressed in more detail in an upcoming article in this series by Malone and Staunton.

PubMed is a very widely used search engine; over 70 million searches were performed in 2005 (23). SUMSearch is another search engine that selects the best resources for your question, formats your question for each resource, and performs additional searches based on results. This search engine also considers the concepts of primary and secondary

evidence when searching and when presenting its findings (24). It searches various databases and PubMed. EBM gateways (eg, the Netting the Evidence gateway [25]) are Web sites that contain many links that can be browsed by the user to find resources suitable to the particular question.

The third level of the pyramid consists of synopses. Literature at this level comprises the current best evidence combined with clinical expertise from an expert in the area. Enough information is provided to support a single, specific, clinical action. These sites require a subscription to access the information. The American College of Physicians Journal Club (26) and Evidence-based Medicine Online (27) are examples of EBM sites that offer synopses.

Resources described as information systems are at the apex of the evidence hierarchy (12). These are regularly updated electronic textbooks that aim to continually supply the best available current evidence in print or electronic formats (online, handheld computers, and CD-ROM). *Clinical Evidence* (28) and *Up to Date* (29) are examples of information systems. Again, a subscription is required.

The search overview Web page on the Web site of the Evidence-based Radiology Group, St Vincent's University Hospital, Ireland, contains information on the evidence pyramid, with links to these sites (30) and a short discussion of the limitations of the Google Scholar engine, which will not be considered further in this article. The next section of this article will illustrate the use of PubMed for systematically searching the primary literature.

### Searching the Primary Literature

For the ordinary practitioner, PubMed (13) is perhaps the most-used electronic database for systematically searching the primary literature (23). This is a bibliographic database where over 11 million articles from over 4500 journals pertaining to biomedical research are catalogued. There are inherent problems with this, because many of the articles have no abstracts or are in jour-

nals that require a subscription in order to view the complete publication.

### Medical Subject Headings

It is important to be aware that all articles are catalogued or indexed by using medical subject heading (MeSH) terms. MeSH terminology provides a consistent way to retrieve information that may use different terminology for the same concepts (31). In an EBP search, MeSH terms are used to represent each of the concepts of the PICO question in order to find articles on a given topic. Use of *CT* or *computed tomography* as search terms will not identify all articles relating to CT, because these are not MeSH terms. Unfortunately, indexing is not as transparent as expected, and what appear to be reasonable search terms oftentimes are not.

It is important to have formulated a robust question that addresses a knowledge gap before any search is undertaken. The question forms the basis of the search. If thought has not been given to question formulation, the search that follows will likely be frustrating and ineffective at identifying relevant articles that address the particular knowledge gap.

### PubMed

Within PubMed (13) there are many ways to search effectively. Most users enter search terms in the space at the top of the home page and link the terms with the Boolean operator AND.

**Toolbars.**—There are many toolbar headings on the home page of the PubMed search engine that can be employed for more effective searching. Anecdotally, the most useful have been Preview/Index, Limits, Display (eg, "Summary," "Abstract," and "Citation"), and Clinical Queries (30).

**Preview/Index search.**—On the home page of PubMed there is a Preview/Index tab. This facilitates a simple index search. Selecting this option allows input of specific search terms individually to identify if the entered term is a MeSH term. Doing this eliminates guessing and allows more efficient use of search time.

Consider the clinical scenario that

was described. The freestyle question would be, "How good is CT enteroclysis at diagnosing the cause of occult gastrointestinal hemorrhage?" The PICO question would be, "In patients with gastrointestinal hemorrhage, how does CT enteroclysis compare with capsule endoscopy for diagnosis?" To perform a PubMed search, it is advisable to change freestyle search terms to MeSH terms in order to retrieve all the relevant published data on this topic. The PICO question is thus revised so that it reads as follows: "P" (patients) = *gastrointestinal* OR *hemorrhage* OR *intestine, small*; "I" (intervention) = *enteroclysis* OR *enema* OR *tomography, x-ray* OR *computed OR tomography, spiral* OR *computed*; "C" = (comparison) = *capsule endoscopy* OR *video endoscopy* OR *enteroscopy*; and "O" = *diagnosis*.

These terms serve as a framework with which to search the literature. To get the most from this communication, go through the following exercise by using the following as a guide.

Open up PubMed (13). Click on the Preview/Index tab. In the search box (between All Fields and Preview) in the middle of this page enter the first search term, *gastrointestinal*. Click on the Index tab that is to the immediate right of the search box; a pull-down menu will appear. In this menu, if the search term you have entered is a term used by the librarians to index articles, it will be listed with the number of times it has been cited in brackets. On the date of our search, 176 059 studies containing the term *gastrointestinal* had been catalogued. If you are performing this search on your own computer and retrieve a larger number, do not worry, the numbers increase as time goes on and more articles are added to the database.

Click the Preview tab again. This will move the search term into the space box at the top of the screen and save the search on the same page. Next, click Clear at the top of the screen. This allows you to individually search each term in each part of the PICO question. Now repeat the steps for each of the individual search terms. Enter the term *hemorrhage* in the Preview/Index search box and click the Index tab. Again the pull-

down menu appears, and this term has been indexed 152 394 times.

Click the Preview tab, and this term appears in the search box at the top of the screen and as search “#2”. The process is repeated for *intestine, small* and it has been indexed 44 081 times. The search terms in the second subcolumn of the PICO question are entered in a similar fashion. The Index tab is clicked. *Tomography, spiral computed* has been indexed 2268 times and *tomography, x-ray computed* has been indexed 165 458 times. Similarly, *enteroclysis* has been indexed 465 times and *enema* 8224 times.

Proceed to search the terms in the third subcolumn of the PICO question. *Capsule endoscopy* has been used as an index term 435 times, *video endoscopy* 191 times, and *enteroscopy* 491 times. Finally, search the term in the fourth subcolumn of the question. *Diagnosis* has been indexed 1 731 490 times.

At the end of this process, there are 11 individual searches that can be viewed on one page by clicking the History tab at the top of the page.

The advantage of a properly formulated question is that it allows for easy searching of the terms generated by the question. The theory is that a very wide search is performed initially to retrieve all possible articles in relation to each term, and the search is then narrowed down by linking the terms with the Boolean operators OR and AND. OR is used to retrieve records containing any of a set of terms; AND is used to retrieve records containing all of a set of terms anywhere in the records (11).

OR can be described as a “logical union of sets” and is used to link all the MeSH concepts in the same column (ie, all MeSH terms that apply to “P” in the PICO format). AND can be described as a “logical intersection of sets” that is used to link all the MeSH concepts across the columns (ie, “P” AND “I” AND “C” AND “O”) (11).

The Figure shows what we now want to do by using PubMed. We begin with the first column, linking *gastrointestinal* (search #1) with *hemorrhage* (search #2) and with *intestine, small* (search #3) by using the Boolean operator OR. Enter “#1 OR #2 OR #3” in the

search bar at the top of the screen and select the Preview tab.

By doing this, the PubMed database is searched for any article containing any of these terms. Obviously the sum of the number of articles identified is going to be large (335 171 hits in our search). The reason for doing this is to ensure that as little as possible on this topic is missed. We then repeat the process for the other columns, linking the terms in the second subcolumn with the Boolean operator OR. This links the terms *enteroclysis* (search #4) OR *enema* (search #5) OR *tomography, x-ray computed* (search #6) OR *tomography, spiral computed* (search #7), which again yields a large number of references (175 441 hits). Repeat the process for the third subcolumn of the question by linking *capsule endoscopy* (search #8) OR *video endoscopy* (search #9) OR *enteroscopy* (search #10). This yields 1016 hits. Finally repeat the process for the term *diagnosis* (search #11) in the last subcolumn of the structured question (1 731 490 hits).

Next, combining the above four searches by using the Boolean operator AND gives “#11 AND #12 AND #13 AND #14.” This links all the search terms used in the PICO question, which results in a comprehensive search of PubMed.

Again, the Figure illustrates in tabu-

lar form what has just been done with the MeSH terms derived from the PICO question format. At the end of this Preview/Index search (which should perhaps be termed an “Index/Preview” search, since that is the order in which we do it), 61 articles have been identified that may be relevant to the knowledge gap.

At initial review of the retrieved articles, many of them appear relevant, but you consider that there are too many to appraise in detail. If at the end of a Preview/Index search too many articles have been retrieved, limits can be applied to reduce the returns to a reasonable number.

**Limits.**—This toolbar is at the top of the PubMed home page screen. When Limits is selected, a pull-down menu appears with options for restricting the search. In this case, you decide to limit your search to (a) items with abstracts, (b) human studies, and (c) articles published within the last 2 years.

Select the Preview/Index tab again and click on Preview with these limits applied. This reduces the number of retrievals to 24. Adding a language limit (eg, English) can be done but should be reserved for the end stage of searching as it may cause you to lose valuable articles. In this case, limiting the search to English-only articles also reduces the number of retrievals to 23. As you have only until tomorrow to reply to the clin-

Patient		Intervention		Comparison		Outcome
Gastrointestinal		Enteroclysis		Capsule endoscopy		Diagnosis
OR	AND	OR	AND	OR	AND	
Hemorrhage		Enema		Video endoscopy		
OR		OR		OR		
Intestine, small		Tomography, x-ray computed		Enteroscopy		
		OR				
		Tomography, spiral computed				

Setting up a PubMed search by using the PICO question format. Search terms are linked down each column by the Boolean operator OR and across the columns by Boolean operator AND. The advantage of this technique is that all possible articles relating to these topics are linked in each column by OR, which results in retrieval of a large amount of articles. The columns are then linked by AND, which reduces the number of articles retrieved so that only those relevant to the question will be identified.

ical question, you would like to further reduce the number of retrievals.

### Levels of Evidence

A resource has been developed by the CEBM that allows rapid assignation of an appropriate level of evidence to any retrieved articles pertaining to diagnosis, therapeutic benefit and harm, and prognosis (32). The levels of evidence can be used to rank articles according to their study design and methodology. It is sufficient to read only the article with the highest level of evidence. A future article in this series by Dodd will address this in detail.

Recalling that the highest level of evidence in the McMaster-CEBM diagnostic hierarchy of evidence is a systematic review of studies (32), you add a final limit to the search approximating to this publication type: "Meta-Analysis." You now find that a meta-analysis comparing capsule endoscopy versus other modalities for investigating the small bowel was published in *American Journal of Gastroenterology* in 2005 (33). You decide to retrieve this article, appraise it in detail, review its bibliography, and go back to the larger numbers of retrievals from earlier stages of your search process only if your question has not been adequately answered.

As only steps 1 and 2 of the McMaster-CEBM EBP paradigm are addressed in this communication, it is beyond the scope of this communication to appraise the retrieved meta-analysis at this time. Another article later in this series by Halligan and Altman will deal with this topic.

### PubMed: Tips and Tricks

**Displaying retrieved articles.**—It is possible to change the way in which the retrieved articles have been presented by clicking yet another useful tab on the home page. To review the abstracts for each of the articles that has been retrieved, click on the Display tab at the top left of the screen. Highlight "Abstract" in the pull-down menu that appears, and the abstracts for all 23 retrieved articles will appear on one page that can be easily scrolled through.

**Citation search.**—Usually the retrieved articles are displayed in sum-

mary format—that is, the title of the article, the authors, the journal, the issue, and the year of publication are displayed. If an abstract is available, this is also listed. The language of the article is also listed. This format can be changed to "Citation" display format. This can be useful because the citation display format shows not only the abstract but also the MeSH terms under which the article was filed.

To obtain these MeSH terms, on the PubMed home page click on the Display tab and highlight "Citation." This displays the MeSH terms used to index these articles, and they appear at the bottom of each article. In this way it is possible to verify that the search terms used in the PICO question are cited in the retrieved articles. The index reference with which a citation display begins can be a known journal article, a textbook chapter reference, or an article retrieved during a Preview/Index (PICO) search. It allows review of the MeSH terms that were used to catalog the pertinent article. These terms can then be substituted in any PICO question or added to existing search terms.

If you have already performed a Preview/Index search by using the PICO method described, these terms can be used to improve your own search, which can be repeated after adding new MeSH terms identified by using the "Citation" display option to the terms linked by OR within columns and then linking the new columns with AND. In a very short time, familiarity develops both with the terminology used to index articles and with the more commonly used MeSH terms.

**Related article search.**—In the top right of the screen beside each of the retrieved citations there is a Related Articles tab. Selecting this option opens a new pull-down menu that identifies articles that contain similar information to the retrieved article. It is possible to find an almost inexhaustible number of related articles. In practice, this option can reintroduce a large number of minimally relevant articles, generate confusion, and negate the "focusing" value of a Preview/Index search with the PICO

format and supplemented by using the Limits tab. In practice, reviewing the bibliographies of the best retrieved publications is probably more useful.

**Clinical queries search.**—While the Preview/Index search is useful and educational, there is a shortcut. On the toolbar on the left of the PubMed home page (under the heading "PubMed Services") click on the Clinical Queries heading. This opens another page, which was designed by Haynes and Wilczynski (9), with two search options that are relevant to radiologists. Search methodology filters are already in place. The first of these involves "Search by Clinical Study Category." Enter *gastrointestinal hemorrhage AND enteroclysis AND capsule endoscopy* in the search box and select the category of "diagnosis" and the scope "broad, sensitive search" from the options below the search box. Clicking on "Go" yields nine articles, all of which are relevant to the PICO question. The nine retrieved articles include the meta-analysis retrieved by using the Preview/Index search (33) and the reference from its bibliography that is most relevant to the PICO question (34).

Changing the scope to "narrow, specific search" and clicking "Go" yields no articles. The second Clinical Queries option involves searching for systematic reviews. Use this section of the page and enter the same terms as above to yield the meta-analysis article that was retrieved by using the Preview/Index search (33).

It seems likely that the Clinical Queries section of PubMed was designed to deal with medical topics (eg, hypertension) that have a huge amount of associated literature. It is a very useful resource for radiologists seeking a quick literature "hit" for a specific knowledge gap or a starting place for a search of the secondary literature (eg, when dealing with a knowledge gap during a reporting session) or a comprehensive PICO search of the primary literature (eg, while preparing to deliver a refresher course lecture). One or two good "hits" on the relevant topic, with the help of the Display "Citation" option (see above), can yield all the MeSH terms needed to focus an answerable question without time-consuming guesswork.

**History.**—The History tab on the PubMed home page numbers all of the performed searches. Clicking this tab at any time shows all of the searches.

**Other functions.**—There are other functions as follows:

1. Select only a few of the retrieved citations: To do this, click the small box to the left of the preferred articles. Select the Send To tab (on the same line as the Display tab) and select “Clipboard” from the pull-down menu. Highlight it and click the Send To tab again. These searches can be printed or saved as preferred.

2. Find a known publication: If there is a specific article or reference from a textbook or article that is known, there is another tab on the left toolbar of the PubMed home page (13) called Single Citation Matcher. Highlight this option and a search box appears. Not all fields need to be filled in to find the relevant article.

3. Save a search (once off): A simple method of saving searches is to click on the Send To tab when Display “Summary,” “Abstract,” or “Citation” is in use, and send to “Text” for easy printing, “File” to be saved on the computer you are using, or “E-mail” to be viewed on another computer later or by a colleague.

4. Save a search (for automatic repeat): There is another useful tab on the side tool bar of the PubMed home page called My NCBI. It saves searches and can be formatted to send relevant articles from automatically updated searches on the same topic to a selected e-mail address. Online tutorials are provided that explain how to do this. To access an online tutorial click on the Overview tab on the left toolbar of the PubMed home page. This opens another page. Select the phrase “Customize with My NCBI.” This opens a My NCBI page with useful links to frequently asked questions.

### Searching the Secondary Literature

Are there any other methods that can be used to quickly and effectively find some relevant information? Accessing any of the secondary evidence-based resources outlined in the evidence pyramid may identify relevant information with minimal searching.

For this question, entering the

search terms *gastrointestinal hemorrhage AND enteroclysis AND endoscopy* in the search box on the SUM-Search home page (24) and selecting “Diagnosis” from the options to focus the search will identify 18 articles, some of which are reviews of clinical problems performed by using McMaster-CEBM methods. These are available at many Web sites, for example. The critically appraised topic, or CAT, is another form of secondary evidence that can be easily checked online. BestBETs (35) and the Oxford CATbank (36) are probably the best known EBM sites. The CAT Crawler searches for a particular topic across eight CAT banks simultaneously (37). The Canadian Association of Radiologists Journal (38) publishes CATs in individual issues but does not collect them in a CAT bank for easy access. These URLs can be accessed from a single Web site (30).

### Other Search Options

#### Searching with a Librarian

It may be beneficial to supplement a search with one performed by a librarian, especially when learning to search the literature yourself. If articles are identified that are relevant and that were not identified in your own search, the librarian can often explain how they were missed.

#### Electronic “Hand Search” of the Literature

If performing a search of a particular topic for a systematic review, it will be necessary to “hand search” key journals identified during preliminary electronic searches (39). This can be done by using PubMed (D. Malone, written communication, December 4, 2005). The “Journals Database” link on the PubMed services sidebar is used to retrieve the key journals one at a time. Clicking on “Links” on the right side of the screen offers several options.

By clicking on the phrase “links to full-text web sites” on the Journals Database page, the recent publications in each key journal can be retrieved in chronologic order. Use of the “Summary” option from the Display tab

pull-down menu, with “Show 500” selected (to the right of the Display tab), makes it easy to scroll back through the list of contents from that period online, and Send To can be used to send the information to “E-mail” for a reviewer or to “Text” for printing and subsequent perusal by a reviewer (eg, use of “Show 500” for *Radiology* in December 2005 yielded the information that there were 28 514 *Radiology* articles in PubMed, 466 of which were reviews, and gave article titles from April 2005 to January 2006 in chronologic order).

#### Searching with Handheld Devices

It is now possible to own a handheld device that functions not only as a telephone, a scheduler, a calculator, and a memo pad but also as a portal with which to access the Internet.

For radiologists and other health care practitioners, the prospect of being able to access the literature at the point of care has endless possibilities. The University of Toronto has a downloadable option on its EBM Web site that allows users to record and archive clinical questions as they occur in the course of daily practice (40). Another excellent resource for searching for current best evidence is offered by the National Library of Medicine (41). It provides wireless access to Medline. Downloadable appraisal tools are also available (40,42). The use of these is beyond the scope of this communication but is relevant to the appraisal methods that will be described in future articles in this series by Dodd and by Maher and Kalra.

#### Searching by Using the RSNA Web Site

The Radiological Society of North America, RSNA, offers useful Web-based resources for obtaining current best evidence (43) as one of the benefits of membership. Alternatively, members can access the RSNA Web site and select Publications from the toolbar on the left of the screen. *Radiology* and *Radiographics* can be accessed; one can also search across multiple journals. The search engine is more basic than PubMed. Another very useful Web site

for searching the literature is HighWire Press (44). On the date HighWire Press was reviewed for this article, free access was offered to the full text of 1 109 783 articles from 919 journals that composed an archive containing 2 961 066 articles (44). It is an easy to navigate Web site. There are many useful search options within the site, and a “favorite journals” list can be created. It has a specific subsection for radiology. Courses on searching by means of the RSNA Web site are provided during the RSNA Annual Meeting.

### How to Obtain Full-Text Articles

It is now possible in many instances to download the full-text article from the many online journals available. The HighWire Press Web site (44) has already been mentioned.

At PubMed (13), full-text articles can be obtained by using LoansomeDoc. Once an article is identified, click the box to the left of the selected article. Click Send To and select “Order” from the pull-down menu. Users will be directed to the LoansomeDoc home page. A user account must be created. Users will be asked to identify the most convenient library to them and will be directed online to order the article from the most appropriate library directly. The library charges a fee for this service.

For those who have a university subscription to online archives (eg, with the Athens system [45]), free full-text downloads may be possible. The Royal Society of Medicine Library is the largest postgraduate biomedical library in Europe (46). Access to its services is available to members.

Traditional methods are still useful, of course. Radiologists with access to a university departmental library can order an article in the usual manner. Many of the evidence-based resources require a subscription to access any information; these may be personal or institutional.

### Discussion

“Evidence-based medicine represents an evolution in the tools that are used to

practice scientific medicine” (47). Effective search strategies will be an essential “noninterpretative” skill for the 21st century radiologist (48). EBP methodology can enhance our ability to retrieve good evidence when we encounter a knowledge gap. Many of the published articles are on studies that have poor methodology and a level of data analysis that falls short of EBM standards. This naturally leads us on from steps 1 and 2 of the EBP process (ask and search) to step 3: Appraise the retrieved literature. This will be the subject of subsequent articles in this series by Halligan and Altman, by Dodd, and by Maher and Kalra.

Oftentimes poor evidence is found or no new evidence is available, in which cases clinical expertise is even more important for decision making. “Evidence does not make decisions, people do” (49). This important topic has been the subject of much discussion in the literature (49) and will be considered in more detail in another article in this series by Malone and Staunton. For 21st century practitioners, technology will play an ever-increasing role in clinical settings. A system is needed to allow speedy identification of the best evidence, either from a personal computer or from a handheld device.

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