CME Article

Netting the evidence: finding pearls, not sewage

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ABSTRACT

The Internet is a powerful information resource that offers access to millions of files hosted on further millions of distributed computers. Unlike many information resources, however, the Internet focuses only on technical standards for information exchange. It does not address equally important concerns regarding the content and presentation of the information it displays. There is no editorial control, no unifying mechanism for maintenance or update, nor are there sanctions for the distribution of inaccurate and dangerous information. This overview seeks to guide the busy medical practitioner in their quest for high-quality research evidence. It stresses the value of key information management principles of focusing on the original question, filtering for high-quality sources and finding evaluated information. It briefly summarises the advantages and limitations of three important sources of information: one-stop shops, general search engines and scholarly gateways. Throughout the article, key points are highlighted through the use of a realistic problem-based scenario.

Keywords: critical appraisal, evidence-based medicine, the Internet

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INTRODUCTION

Evidence-based Medicine, together with its associate Evidence-based Healthcare, is the first significant movement within medicine to coincide with the unsurpassed growth of the Internet. As Bidwell has previously commented, this has had both benefits, as in unparalleled access to information, and drawbacks in identifying relevant materials and in assessing their quality, once retrieved[1]. Jadad acknowledges the contribution of the Internet thus:

"The internet is transforming health care. It is creating a new conduit not only for communication but also in the access, sharing, and exchange of information among people and machines"[2].

This guide does not seek to impose a prescriptive framework of good and bad Internet sources. It recognises the pragmatic reality of trying to identify research to address clinical problems. In doing so, it takes the view that limited information is better than no information and that the ideal should not become the enemy of the good. Nevertheless, its starting point is that certain information management strategies can enhance the chance of success and thus support sound diagnosis and treatment choices[3]. This approach, demonstrating the longevity of principles of good information retrieval, even when links to recommended resources are long dead and gone, is far more suited to the life-long learning model which underpins evidence-based practice.

ABOUT THE INTERNET

It is common to refer to "the Internet" as if it was a single entity such as "MEDLINE" or some other information source. Such a homogeneous label belies its origins as a network of computers, each carrying distributed information, identified simply by "signposts" and "addresses". To use a familiar analogy, describing this complex source simply as the "internet" is as inadequate as using the term "aspirin" to refer not only to the drug itself but also to its packaging, its mode of administration, its active ingredients and its multiple forms, such as solution and tablets.

The Internet is a vehicle for communication of e-mail; the channel by which PubMed, the free version of MEDLINE, is accessed across the world; and the host for quality-assured subscription-only databases. The Internet is sprawling, chaotic and grows at a rate that defies classification. It has been described as:

"The world's largest library, as full of lies as truths, with no card catalog, no librarian, and someone has torn the cover off all the books[4]."

Several high profile studies have examined the quality of information on the Internet. Perhaps the seminal study is by Impicciatore et al who conducted a systematic search of web pages relating to home

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management of feverish children using the search engines, Yahoo and Excite[5]. When they evaluated this information and compared the information with evidence-based guidelines to parents on managing fever at home, they found that very few sites provided a complete and accurate picture. The authors concluded that there was an urgent need to check patient information on the Internet for completeness, accuracy and consistency. More recently, accuracy has been highlighted by Kunst et al who surveyed how five common health topics were covered by websites[6]. They increased the understanding of the complexity of the Internet by reporting that features of website credibility, namely – source, currency, and evidence hierarchy – have only slight or moderate correlation with accuracy of information. They concluded that apparently credible websites may not necessarily provide higher levels of accurate health information.

ON FOCUSING, FILTERING AND FINDING EVALUATED INFORMATION

To illustrate the potential for identifying clinical "pearls" among the sewage and detritus of the World Wide Web, let us start with a realistic scenario:

Jemima Riddell is a three-year-old girl, currently undergoing toilet training, brought to the general practitioner (GP)'s surgery by her concerned mother. She presents with a slight fever. Other than this, there appears little wrong with her although her mother does point to a slightly excessive need to urinate at night. Her GP, Dr Flo Monitor, is newly qualified and working in primary care for the first time since achieving her qualification. She wants to know how useful a dipstick test is likely to be in diagnosing Jemima's condition. Subsequently she will want to know how to treat Jemima. Flo has recently attended a course on using the Internet to answer clinical questions and decides to use this opportunity to evaluate its usefulness in patient care.

Previous articles in this series have advocated use of the so-called PICO (Patient, Intervention, Comparison, Outcome) formula in formulating an answerable question[7]. This requires identification of four essential elements of an information need – the Patient, the Intervention, the Outcome and, optimally, a Comparison. This sound information management technique applies equally to use of the Internet. There is a temptation, especially with access to the World Wide Web so readily available, simply to type a select few words into a Google search engine. Such an "instant answers" approach bypasses the discipline of thinking about the problem itself and typically results in the ineffective use of clinician time. It is true that some Internet-based sources only require the searcher to use one or two elements of the PICO formulation. Others require a precise question to narrow down large volumes of potentially-relevant items of information into a manageable few. Regardless of whether the PICO formulation is used primarily for narrowing down the initial enquiry or to aid in subsequent judgments of relevance for retrieved items, time spent focusing on the question is time well spent.

The above scenario encapsulates at least two separate main questions. The first is a diagnosis question and might be framed thus: In a three-year-old female with suspected urinary tract infection (Patient), what is the value of the urinary dipstick (Intervention) in terms of the positive predictive value of the test (Outcome) compared with other available tests (Comparison)? The second question is dependent on the first: In the same three-year-old female but with confirmed urinary tract infection (Patient), what are the most effective treatments (Interventions) when viewed in terms of alleviation of symptoms and prevention of recurrence (Outcomes)?

The second stage of an evidence-seeking strategy involves identification of filters to highlight clinically-relevant material over and above multitudes of available low-quality web pages[8]. In the first instance, for the diagnosis question, this would involve terms inextricably linked with the quality of the diagnostic test such as "sensitivity and specificity" and "positive predictive value". For the therapy question, these "value-added" terms would be associated with the randomised controlled trial design. To illustrate, if you simply type in "urinary tract infection" into an Internet search engine, you retrieve a considerable variety of items from medical information to patient discussion pages. However, combine "urinary tract infection" with "randomised controlled trial" and, by implication, you only retrieve more technically robust pages – members of the public do not tend to drop the phrases "randomised controlled trial" or "sensitivity and specificity" into their everyday conversation! Such filter terms have primarily been devised to improve retrieval from formal bibliographical databases such as MEDLINE and EMBASE but again, because they employ sound information management principles, this technique can be transferred to the use of Internet search engines.

Finally, we do not need to consider all

information to be of equal value when planning an Internet search strategy. Certain sites are more likely to yield a positive result for a specific question than others. In particular, sites that provide information that has been pre-selected against explicit inclusion criteria are more likely to be of value for a clinical question than those that do not hold to a quality threshold. Just as a clinician keeps in mind certain algorithms or decision-making rules, when faced with a particular symptom or condition, so too should an evidence seeker devise specific information strategies when seeking to answer a particular type of question. Such information-seeking "protocols" differ according to whether a question relates to therapy or diagnosis (or indeed aetiology or prognosis), whether a question relates to new treatments or established interventions or indeed whether a question is more likely to be asked in a primary care or an acute secondary care setting.

ONE-STOP SHOPS

A starting point for many "real time" searches for evidence – that is where a clinician seeks an answer, rather than conducts a systematic review of the literature – is the "one-stop shop". Such resources seek to provide access through a single interface to multiple evaluated sources. Foremost among such resources is the TRIP database (http://www.tripdatabase.com). This database seeks to provide links to a wide range of evidence-based sources. Although the database includes significant numbers of evaluated resources, its coverage certainly falls a long way short of the millions of bibliographic records contained in the MEDLINE database. We thus start with a broad search using "urinary tract infection" from the Patient component of the PICO formula. As we might suspect, this results in over 1,500 records. Of these just over 100 fall in the category "Evidence Based Summaries". A further 70 represent clinical question answering services while about 200 results exist for the categories "Systematic Reviews" and "Guidelines" respectively. Within seconds, therefore, we have narrowed millions of items of evidence of variable quality down to just over 500 high quality sources.

A quick glance among items retrieved under "Evidence Based Summaries" (Table I) identifies a summary produced by the BestBETs team in Manchester "Negative urinalysis to exclude urinary tract infection"[9]. Although written over five years ago, this is the result of a search of the literature conducted in response to a very similar case to our own, in a four-year-old girl. Also prominent in the results is a review article, "Review: specific combinations of symptoms effectively rule in the diagnosis of urinary tract infection based on history alone", that has been summarised in both the *Evidence Based Medicine* and *Evidence Based Nursing* secondary journals[10, 11]. These journals review the cream of medical literature in one page summaries with accompanying commentaries. Frustratingly, however, a quick look at this summary reveals that this review deals only with adult women, excluding children or adolescents.

Table I. Sample resources accessed via the TRIP database one-stop shop.

BestBETs	http://www.bestbets.org
Clinical Evidence	http://www.clinicalevidence.com/
Evidence Based Medicine	http://ebm.bmjjournals.com
Evidence Based Nursing	http://ebn.bmjjournals.com

BestBETs addresses the diagnosis question. It concludes that:

"Children who present with fever and who have positive dipstick testing for leukocyte esterase and nitrite should be started on antibiotics and referred for further investigation. Dipstick testing would appear to have the sensitivity for children with negative testing to be discharged, with the urine being sent for gram stain and culture the following day rather than arranging urgent microscopy."[11]

Although the summary has been performed to the agreed quality standards of the BestBETs team, a word of caution is appropriate. The posed question focuses only on the utility of dipstick testing. However, the conclusion also states that children who test positive should be started on antibiotics – which lies outside the original question. A further note of caution lies in the fact that time-constrained searches to produce digests usually establish the presence of isolated examples of confirmatory (or disconfirmatory) evidence. As they are not systematic reviews, they are neither predictive of the existence of contradictory evidence or that the overall balance of evidence points in the same direction as the retrieved study. Such limitations underlie Coomarasamy et al's verdict on these types of products: "sometimes irrelevant, occasionally invalid."[12]

Clinical Evidence focuses on treatment, and so the section on "Urinary tract infection in children"[13] provides a picture of potential answers to our second question. Helpfully this publication groups candidate interventions under the headings – Likely to be beneficial, Unknown effectiveness, Unlikely to be

Table II. Findings from Clinical Evidence: urinary tract infection in children.

Likely to be beneficial
Antibiotics (more effective than placebo)
Oral antibiotics (as effective as initial intravenous antibiotics in children without severe vesicoureteric reflux or renal scarring)
Unknown effectiveness
Immediate empirical antibiotic treatment (unclear benefit compared with delayed treatment, based on microscopy and culture)
Unlikely to be beneficial
Longer (7–14 days) courses of initial intravenous antibiotics (no more effective than shorter [3–4 days] courses of intravenous antibiotics in children with acute pyelonephritis)
Longer (7–14 days) courses of oral antibiotics (no more effective than shorter [2–4 days] courses for non-recurrent lower urinary tract infections in the absence of renal tract abnormality)
Likely to be ineffective or harmful
Prolonged delay in antibiotic treatment (>4 days)
Single dose of oral antibiotics (less effective than longer course [7–10 days])

beneficial. and Likely to be ineffective or harmful (Table II).

Further information is also provided about prevention of recurrence, with immunotherapy and prophylactic antibiotics holding potential benefits. Additional information indicates that results are based on a December 2005 search.

A further one-stop shop is SUMSearch (http://sumsearch.uthscsa.edu/) from the Society of General Internal Medicine[14]. This resource searches several high-quality resources simultaneously and produces a categorised list of its retrieval results. These are grouped by publication type. SUMSearch uses the methodological filters mentioned earlier. For our scenario, a fairly crude search using the keywords "urinary tract infections" and "children" and specifying the radio button for "Intervention" yields at least two useful-looking systematic reviews from the MEDLINE database with many other items of interest. Again this retrieval emphasises the importance of caveat surfer – let the surfer beware. The first review is fully relevant[15] but the second review, despite having a very promising-looking abstract, reveals upon inspection of full-text to employ children as an exclusion criterion[16]. Our foray onto the Internet in search of evidence therefore reveals the limitations of what has been derogatively described as "abstract-based medicine".

Our final one-stop shop is the CAT Crawler (http://www.bii.a-star.edu.sg/research/mig/cat_search.asp), rightly considered one of Singapore's finest contributions to the international community of evidence-based healthcare[17]. This provides access to critically-appraised topics, as previously described in this series[18]. It searches nine individual CATbanks across three countries (United Kingdom, United States and Singapore). 15 results are retrieved from a broad search on urinary tract infections. The value of searching multiple sources is seen in retrieval of a critically appraised topic with the following informative title: Oral antibiotics equal to intravenous for some children with urinary tract infections. This originates from the specialist paediatric CATbank of the University of Michigan.

The value of these one-stop shop approaches, as illustrated by this single clinical scenario and three such resources, is seen in broad level searching, coverage of multiple sources and speed of searching. In fact, a clinician with these three resources bookmarked could probably search them in real time between consultations.

GENERAL SEARCH ENGINES

By way of a contrast to the one-stop shop, we shall briefly consider the use of general search engines. For the so-called "Amazoogle" generation, named from the popular Amazon online bookstore and the ubiquitous Google search engine[19], there is an increasing expectation that you simply type in a few keywords to retrieve key items of relevance. In reality, approaches to searching the Internet as a whole require very specific search strategies rather than the sensitive searches used for the one-stop shop. Type in "urinary tract infections" to Google and you can expect nearly two and a half million results or "hits". Such an approach retrieves results from a wide range of sources ranging from US Government sources to commercial and patient sites. At least "urinary tract infections" is a fairly technical term unlike common disease terms, such as diabetes, which are adopted by the medical profession and the public alike. How could we narrow our results to a more relevant set?

The first approach would be to use the PICO

Table III. Assessment of quality of different evidence routes.

	One-stop shops	General search engines	Scholarly resource search engines
Examples	TRIP, SumSearch, CAT-Crawler	Google, Alta Vista	Google Scholar, Scirus
Completeness	Sources as pre-selected by resource editor	Gives semblance of comprehensiveness but no search engine contains more than about 1/3 of the visible Web[25]	Limited to specific domains but unclear on inclusion criteria
Accuracy	Items individually of high quality but no attempt at synthesis	Items of variable authority. No editorial control.	Usually some form of quality control (e.g. peer review) but variable quality.
Relevance	High yield evidence sources for healthcare	General resources – no specific clinical relevance	Scholarly output but not necessarily clinically relevant
Timeliness	No date restrictions	No date restrictions	Time lags in recognition of citations

formulation covered above. Adding "child*" to our "urinary tract infections" search (i.e. two terms from the Patient component of PICO) narrows the number of results significantly to just over 70,000 hits (see footnote below). Add further terms such as a specific Outcome or a specific Intervention or treatment and the results at last start to become manageable. This is where filtering comes into its own. Add terms reflecting the type of evidence required, e.g. "systematic review*" or "meta-analys*" for research syntheses, "randomised controlled trial*" for therapy studies or "sensitivity" or "specificity" for diagnosis studies, and combine them with the subject terms above and you start to get the degree of precision required to answer clinical questions. Furthermore, in a cross-sectional survey of smoking cessation information, Ademiluyi et al have demonstrated that sites containing some evidence-based information had significantly higher quality scores than sites containing no evidence-based information[20].

Another approach is to restrict Internet searches by the types of site being searched. Studies have found that the quality of health information is related to the type of organisation owning the web pages[21,22]. For example, Griffiths and Christensen[21] evaluated the quality of Internet information on depression using several different scales. Sites owned by commercial and non-commercial organisations scored significantly higher for content than those owned by individuals. In addition, sites owned by organisations were significantly more likely to cite scientific evidence in support of their claims than sites owned by individuals. Kunst and Khan also found that the overall quality of non-commercial websites was better than that of commercial websites[23]. These findings can be taken into account when searching the Internet. For example, searching only the .gov, .gov.uk or .gov.sg or the .edu, .ac.uk or .edu.sg sites will restrict retrieval to governmental or educational sites, respectively. This can be effected either by using the Advanced search facility or by using the "site:" command as in "site:edu".

A final strategy is to use the increasing number of search tools that aim to provide coverage of scholarly resources. Among these, the high-profile Google Scholar (http://scholar.google.com/) is probably the best known. Others include Scirus (http://www.scirus.com/) which limits itself to "scientific information". Using the search string: "(urinary tract infections) and child and (systematic review)" on Scirus, for example, retrieves just over 1,000 references to web pages of generally authoritative information.

CONCLUSION

Within public health, it is common to evaluate the quality of health information using the mnemonic CART – for completeness, accuracy, relevance and timeliness[24]. Such criteria seem equally appropriate when considering the characteristics of Internet-based evidence. Table III provides an overview of the three main approaches to evidence retrieval and how each performs against these four criteria.

The Internet has much to offer practitioners of evidence-based medicine. Nevertheless, it carries the same cautions that have been previously asserted for more formal information sources. The discerning reader will filter items for overall quality and then apply the same principles of critical appraisal to ascertain the extent to which these individual items are likely to be free from bias[26]. Above all, they should recognise that, in many instances, the Internet simply provides multiple access points or channels to the same materials whereas in the past, a single route had to suffice. The efficacy of such multiple channels

The *(asterisk) symbol in Google indicates a facility known as truncation – that is, it allows Google to search not just "child" but also other variants such as "children". The truncation symbol should be placed as near to the end of the word as common sense will allow (avoiding irrelevant results such as "chill" or "chilblains".

is diluted somewhat by the presence of increasing numbers of "false hits". Such a disadvantage is offset, however, by the overwhelming virtue of increased access to full-text in the form of articles, digests, systematic reviews and guidelines. Surfing the net is definitely an activity worth pursuing – as long as the searcher avoids the sewage and emerges with clinical pearls!

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EDITOR'S NOTE

This article, "Netting the evidence: finding pearls, not sewage" concludes the "Evidence-based Medicine and Healthcare" (EBM) series of the Singapore Medical Journal (SMJ). The SMJ wishes to thank our Associate Editor, Dr Pwee Keng Ho, for coordinating this well-received series over the past two years. Dr Pwee will continue to serve on the SMJ Editorial Board as the resident EBM expert.

Professor Wilfred CG Peh
Editor
Singapore Medical Journal

SINGAPORE MEDICAL COUNCIL CATEGORY 3B CME PROGRAMME
Multiple Choice Questions (Code SMJ 200612A)

	True	False
Question 1: Which of the following statements about the Internet are true?		
(a) The Internet is an entity that is formed from a homogeneous network of computers – this allows consistent provision of information for evidence-based practice.	❑	❑
(b) The Internet is a good medium for communication and information sharing.	❑	❑
(c) MEDLINE is a quality-assured subscription-only database available on the Internet.	❑	❑
(d) Studies have shown that apparently credible websites may not necessarily provide higher levels of accurate health information.	❑	❑
Question 2: The PICO elements that are useful for formulating an answerable clinical question are:		
(a) The Patient.	❑	❑
(b) The Intervention.	❑	❑
(c) The Cost-effectiveness of the intervention.	❑	❑
(d) The Outcome.	❑	❑
Question 3: You decide to do a search on the Internet for information on a medical topic. Which of these Internet resources are likely to be useful for your search?		
(a) A one-stop shop like the TRIP database.	❑	❑
(b) A general search engine like Google.	❑	❑
(c) A scholarly resource search engine like Scirus.	❑	❑
(d) Someone's daily blog.	❑	❑
Question 4: When using a general search engine to locate information to answer a clinical question,		
(a) it is advisable to use the same search strategy as used for the one-stop shop, in order that results are consistent.	❑	❑
(b) using an unrestricted search with a few search terms is most efficient as it locates all relevant items in a short time.	❑	❑
(c) using the PICO elements to do the search helps filter out irrelevant material.	❑	❑
(d) using the PICO elements ensures that all hits are relevant to your search.	❑	❑
Question 5: In relation to the quality of information on the Internet:		
(a) The CART (Completeness, Accuracy, Relevance, Timeliness) criteria are a useful guide to evaluating the quality of health information.	❑	❑
(b) Information located through a scholarly resource search engine has usually been subjected to some form of quality control, although the quality may be variable.	❑	❑
(c) Sites that provide information that has been pre-selected against explicit inclusion criteria are more likely to be of value for a clinical question than those that do not hold to a quality threshold.	❑	❑
(d) Items found through a one-stop shop search will be of high quality and do not require further critical appraisal.	❑	❑

Doctor's particulars:

Name in full:____

MCR number:____________________ Specialty:____________________

Email address:____

Submission instructions:

A. Using this answer form

1. Photocopy this answer form.
2. Indicate your responses by marking the "True" or "False" box ☑
3. Fill in your professional particulars.
4. Post the answer form to the SMJ at 2 College Road, Singapore 169850.

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2. Select your answers and provide your name, email address and MCR number. Click on "Submit answers" to submit.

Deadline for submission: (December 2006 SMJ 3B CME programme): 12 noon, 25 January 2007

Results:

1. Answers will be published in the SMJ February 2007 issue.
2. The MCR numbers of successful candidates will be posted online at http://www.sma.org.sg/cme/smj by 15 February 2007.
3. All online submissions will receive an automatic email acknowledgment.
4. Passing mark is 60%. No mark will be deducted for incorrect answers.
5. The SMJ editorial office will submit the list of successful candidates to the Singapore Medical Council.