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# Organising access to Evidence-Based Medicine resources on the Web

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## Abstract

The continuing education is a challenge for health care professionals, considering the growing amount and variable quality of information in this field. In this context, we developed a method allowing clinicians to have a centralised access to the best current medical evidence supporting medical decision-making. Relevant data has been gathered according to the rules stated for Evidence-Based Medicine (EBM) and organised in a free-of-charge Web site, created by using common software applications. The general aim of our study was to encourage individual practice of EBM by providing tutorials as well as a selection of free access tools for searching medical information on the Web. In addition to the education part, we provided clinicians, through a Web interface, with up-to-date, accurate and quality data obtained from heterogeneous sources and presented in a full text format when available. The developed methodology has been applied to human prostate cancer. URL address: <http://www.ebm.lib.ulg.ac.be/prostate/index.htm>. © 2002 Elsevier Science Ireland Ltd. All rights reserved.

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## 1. Introduction

Evidence-Based Medicine (EBM) is the integration of best research evidence with clinical expertise and patient values [1–3]. Medical associations and commercial editors participate in the success of EBM by developing strategies for efficiently tracking down and appraising evidence for its validity and relevance, developing high quality systematic reviews (e.g. the Cochrane Collabora-

tion), abstracting evidence-based key references, and creating freeware computing systems [3]. However, most physician information needs are not met for several reasons. These include the growing body of medical knowledge, inexperience in searching the literature, lack of time, poor quality of indexing of some medical databases, poor organisation of journal articles and the low validity of their content for clinical application [4–6].

The purpose of this study was to compile, on a single interface support, tools and advice for the practice of literature searching, retrieval and analysis as well as a selection of evaluated resources

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and relevant medical information. As a model, we chose human prostate cancer, as this field has been addressed as a fast moving and controversial subject requiring frequent updates. The present article describes the methodology, software and electronic devices used for the creation of an Evidence-Based Medicine Web site, which integrates EBM tutorials, bibliographic databases about major prognostic factors and literature synthesis about human prostate cancer. It can be found at the following URL address: <http://www.ebm.lib.ulg.ac.be/prostate/index.htm>.

## 2. Background efforts on EBM methodology

As the site is intended to support clinical decision-making, our major concern was to guarantee the quality of the information provided. We followed an EBM methodology, which consist in searching with a maximum efficiency and critically appraising the best evidences for their validity (closeness to the truth), importance (size of effect) and usefulness (clinical applicability).

### 2.1. Searching with a maximum efficiency

Search exhaustiveness was warranted by combining data obtained from as many complementary sources as possible. Core information was retrieved from Medline and Pre-Medline (Medline citations not yet indexed) through Ovid [7], PubMed [8] or SUMSearch [9]. The latter tool combines built-in search filters with multiple database accesses. It decides where to search, adapts the strategy for each database and organises the results in a single, easy to read document. The resources accessible from these three sites are presented in Table 1.

### 2.2. Searching the best evidences

Physicians are increasingly assisted in evidence retrieval and evaluation by scientific societies that publish systematic reviews, structured summaries commented by experts and practice guidelines.

#### 2.2.1. Systematic reviews

All publications concerning a medical subject, although applicable, do not necessarily have a clinical interest. For this reason, it is preferable to consult available systematic reviews on the subject, preferably established according to the rules of meta-analysis [10].

Since systematic reviews are not indexed as such in Medline, it was necessary to retrieve them, to search for terms, such as 'meta-analysis', 'systematic reviews', 'systematic overviews', 'methodological reviews', 'methodological overviews', 'quantitative reviews', 'quantitative overviews', 'medline', etc.

In addition, there are systematic reviews realised by an international organisation, called the Cochrane Collaboration, which started up in 1993 as a response to Archie Cochrane's call for systematic, up-to-date reviews in healthcare. The Collaboration is built specially on the principles of collaboration, avoiding duplication, minimising

Table 1  
Resources available from Ovid [7], PubMed [8] and SUMSearch [9]

#### Ovid

(I) Medline-Pre-Medline

(II) EBM reviews:

- (1) ACP Journal Club
- (2) Cochrane Controlled Trials Register
- (3) Cochrane Database of Systematic Reviews
- (4) Database of Abstracts of Reviews of Effectiveness (DARE) [12]

#### PubMed

(I) Medline-Pre-Medline

(II) EBM automatic searching system: Clinical queries

#### SUMSearch

(I) Multiple database access:

- (1) Medline
- (2) National Guideline Clearinghouse [13]
- (3) DARE [12]
- (4) Full texts available from BMJ and NEJM
- (5) Merck Manual
- (6) FDA (Food and Drug Administration)
- (7) Bedside Diagnosis
- (8) AIDS Knowledge Base
- (9) Canadian Task Force Heart Preventive Services
- (10) Cancernet

(II) EBM automatic searching system: methodological filters

Table 2  
Origin of structured abstracts commented by experts

Database	Producer	Web availability
ACP Journal Club	ACP-ASIM <sup>a</sup>	Ovid under the name: 'EBM Reviews—ACP Journal Club' [7]
Evidence-Based Medicine	ACP-ASIM/BMJ Publishing Group	Ovid under the name: 'EBM Reviews—ACP Journal Club' [7]
Database of Abstracts of Reviews of Effectiveness (DARE)	NHS Centre for Reviews and Dissemination (CRD), University of York (UK)	(1) Ovid under the name: 'EBM Reviews—Database of Abstracts of Reviews of Effectiveness' [7] (2) University of York under the name: 'DARE' (free-of-charge) [12]

<sup>a</sup> ACP-ASIM: American College of Physicians—American Society of Internal Medicine.

bias, keeping up to date, ensuring relevance, ensuring access, continually improving the quality of its work and continuity. Systematic reviews produced by this Collaboration follow a rigorous scientific process to gather relevant data, critically appraise and synthesise all applicable and sometimes contradictory studies concerning a specific clinical problem, while limiting bias. They are published by the Cochrane Library [11] or on the Ovid site [7], under the name of 'EBM Reviews—Cochrane Database of Systematic Reviews' (Table 1).

### 2.2.2. Structured summaries commented by experts

Various organisations, as presented in Table 2, publish structured summaries commented by experts about a selection of high quality or innovative articles. These full text documents are pooled into databases named 'EBM Reviews—ACP Journal Club' [7] and DARE [12].

### 2.2.3. Practice guidelines

Practice guidelines are also considered as reliable information sources if they are established according to a methodology based on the level of evidence. We have selected two sites containing practice guidelines under the 'EBM' label: National Guideline Clearinghouse [13] for the English-speaking part and ANAES [14] for the French-speaking part. These guides are sorted by illness, treatment, organisation or speciality.

### 2.3. Selection of clinical interest publications from Medline

As EBM resources are still limited to a set of clinical questions, we complete our investigations by searching Medline by means of specific tools, called 'methodological filters', to retrieve clinically relevant articles quickly. First, we turned to the Clinical Queries (PubMed, NLM, USA) [15], which are intended for clinicians and have built-in search filters [16]. Four study categories (therapy, diagnosis, aetiology and prognosis) are provided in combination with two options allowing to optimise the question. Emphasising 'sensitivity' includes most relevant articles with the risk of dragging some less relevant ones, while emphasising 'specificity' includes mostly relevant articles, but probably omits a few. These filters give direct access to relevant literature concerning one of these categories. For example, by clicking on 'Prognosis' and 'Specificity' and by introducing 'prostatic neoplasms' in the search field, one immediately obtains the most relevant references concerning prognosis of prostate cancer.

Besides the PubMed's 'Clinical Queries', SUM-Search [9] provides additional filters corresponding to 'Physical findings', 'Adverse treatment effects' and 'Screening/prevention'. Contrary to the PubMed's 'Clinical Queries', SUMSearch automatically limits a search that supplies too many results to the documents from the last 10 years published in the best clinical journals (AIM Jour-

nals), taking the introduced subject as a major concept.

In any case, the use of methodological filters is transparent for the user. Alternatively, when no filters are available, it is possible to locate the evidences from classical databases, such as Medline, by using available searching options [16].

#### 2.4. *Critically appraising the evidences*

Even if the quality and validity of evidence-based information resources are guaranteed by international organisations, one must appraise the retrieved article(s) for soundness and identify the results. The process that should be used when evaluating the different types of individual articles has been formalised and outlined in a series of articles published in *JAMA* since 1993, named 'Users' guides to the medical literature' [17]. Appraisal checklists, adapted from these evaluation grids by ANAES (France) [18], has helped to identify articles with a sufficient level of evidence, e.g. meta-analyses, randomised controlled clinical trials and systematic reviews.

### 3. Methods

#### 3.1. *Construction of the Web site*

The site was constructed with HTML editors, such as FrontPage 2000 ('Microsoft') and Dreamweaver 4 ('Macromedia'), in compliance with a predefined graphic charter. This charter provides the site with a visual identity adapted to its purposes and users. The site was published on a Web server ('Microsoft Internet Information Server (IIS) 4.0') and registered by several search engines manually or through meta reference robots. The registration process first required to rigorously complete the METADATA terms at the head of HTML pages, in compliance with the Dublin Core metadata standard [19].

#### 3.2. *Creation and publication on the Web of locally maintained bibliographic databases*

Two locally maintained databases were created

and published on the Web.

The first one provides detailed bibliographies focusing on prostate tumour markers. They are intended to attract attention to the most recent insights of medical research and to update knowledge on clinically relevant biological markers.

The second one corresponds to a searchable selection of evidence-based publications on prostate pathologies with hyperlinks to full text data. Access to full text is limited to authorised users.

The method of creating such databases followed several relatively simple steps:

1. Develop appropriate search strategies to retrieve relevant citations.
2. Search several databases, like Medline or EBM databases.
3. Import or introduce manually the retrieved citations into a bibliographic database manager, like Reference Manager Version 9 ('Research Information Systems'), which allows to detect duplicates. Citation format for import from the different sources and the corresponding filters are described on the site at the URL address: <http://www.ebm.lib.ulg.ac.be/prostate/refman.htm>.
4. Format the Reference Manager databases as tab-delimited text files.
5. Import these text files into a database management software application, like File Maker Pro, version 4.1 or more ('FileMaker Inc. '), which allows to publish information on the Internet through the File Maker Pro Web Companion integrated in the program.
6. Publish the databases on the Web server ('Microsoft IIS').
7. Monthly update the databases.

#### 3.3. *Automatic filtering of information*

Automatic filtering of information was used to give access to complementary data focusing on diagnosis, prognosis and treatment of prostate cancer. It is activated through home-made hyperlinks that perform searches in medical databases. Every hypertext link is constructed in the form of a question specifying, for example, the database,

markers, cancer types, the period or type of publication. By clicking on this hyperlink, the references corresponding to the query can be instantly visualised on the browser.

Hyperlinking is highly facilitated on the PubMed site [8] by the use of the 'URL button' on the details screen, which generates URL addresses corresponding to searching profiles (Fig. 1). The option of manually constructing URL remains and is described in the instructions for use at the URL address: <http://www.ncbi.nlm.nih.gov/80/entrez/query/static/linking.html> (Accessed: 13 November 2001).

The site SUMSearch [9] offers the possibility to search simultaneously in several medical data-

bases (Table 1) and to reuse the corresponding generated URL, as a hyperlink.

### 3.4. Complying with Web site quality standards

Structure and content of this Web site were designed in compliance with quality standards for Web conduct published by the Health On the Net Foundation (HON code) [20] and by other studies in the literature [21,22]. Criteria relate to credibility, content, quality of internal and external links, design, interactivity, impact on users and accessibility. They have been compiled in a single evaluation grid, proposed at the URL address: <http://www.ebm.lib.ulg.ac.be/prostate/grille.htm>.

#### 1) Use the "URL button" on the details screen

The screenshot shows the PubMed website in a Microsoft Internet Explorer browser window. The address bar displays <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?CMD=Details&DB=PubMed>. The search bar contains the query: `((("prostate specific antigen"[MESH] AND "prostatic neoplasms"[MeSH Terms]) AND Review [ptyp]) AND ("1999"[Pdat] : "2001"[Pdat]))`. Below the search bar, the 'URL' button is highlighted with a mouse cursor. The 'PubMed Query' section shows the same query, and the 'Result' section shows '132' results. The 'Database' is 'PubMed' and the 'User Query' is the same as the search bar.

#### 2) Automatic generation of the URL address corresponding to the searching profile

The screenshot shows the browser address bar with the generated URL: [http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?CMD=PureSearch&db=PubMed&details\\_term=26%2626%26](http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?CMD=PureSearch&db=PubMed&details_term=26%2626%26).

#### 3) Reuse the corresponding generated URL as a hyperlink

Fig. 1. Generating URL addresses corresponding to search profiles through PubMed [8].

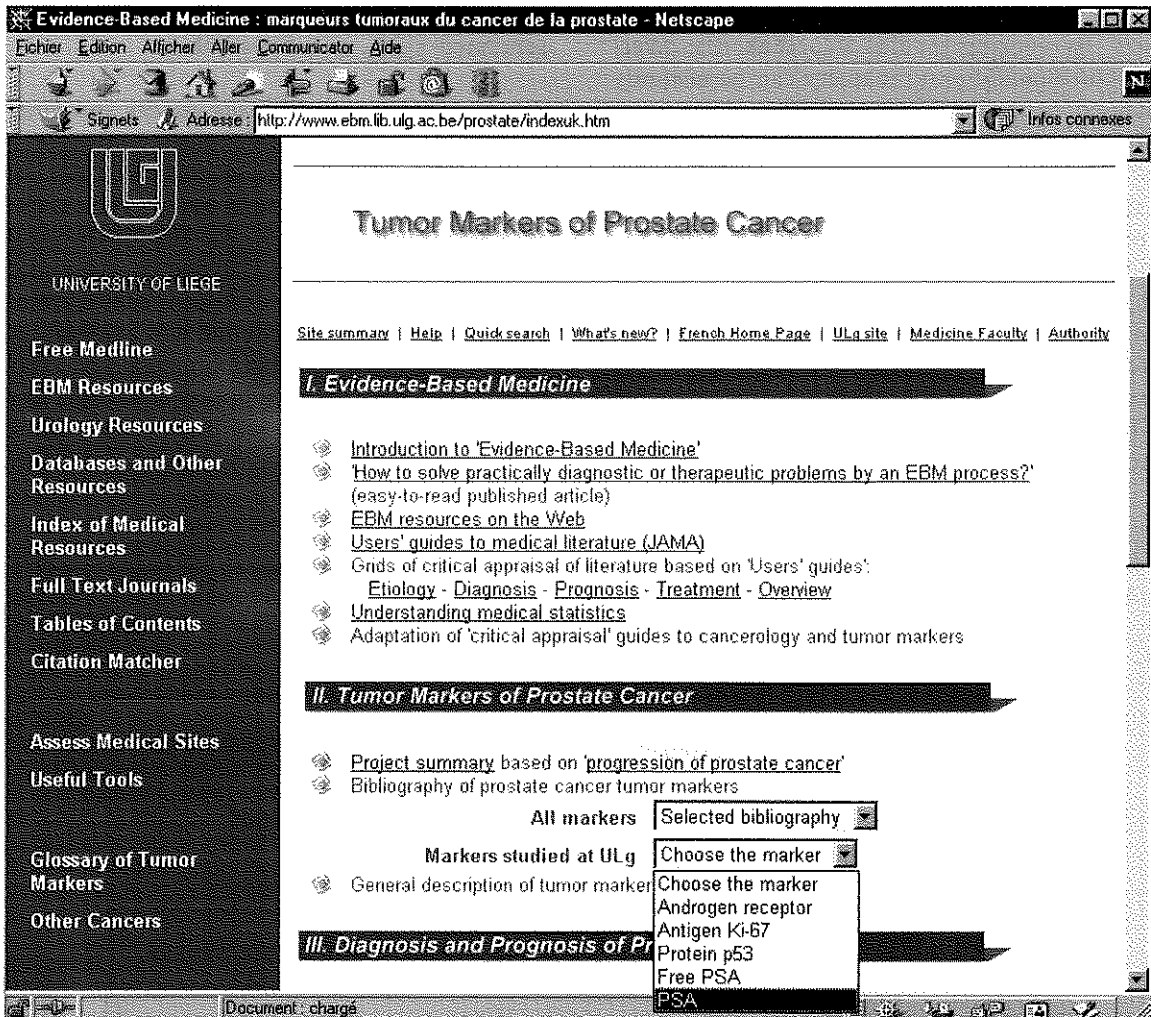


Fig. 2. English homepage of the site.

This grid, which corresponds to our 'quality charter', is used to evaluate our own site as well as other Web sites to which links are proposed.

## 4. Results

### 4.1. Site description

The home page is divided into two independent frames (Fig. 2).

The left frame presents a selection of free access tools for searching medical information on the

Web, including, among others, a description of free Medline sites, a selection of EBM resources [23], biomedical databases and catalogues of useful addresses and validated medical sites. Tables of contents of journals indexed in Medline and links to available full text articles are provided, as well as various educational supports such as glossaries, dictionaries or the commented grid for web site evaluation mentioned above.

The right frame provides access to several types of information:

1. A tutorial review of EBM principles and techniques [24] is proposed with links to EBM

resources [23] and to the 'Users' Guides to the Medical Literature', first published in JAMA in 1993 [17], as well as with basic knowledge of medical statistics.

2. Information about biological tumour markers is presented in a fully searchable bibliographic database implemented according to a working model defined a priori, called the 'prostate carcinogenesis model' [25]. Complementary bibliographies based on different criteria, such as publication type and date (review articles from the past 2 years, catalog records for book and serials, meeting abstracts, full text articles), or clinical relevance, are also proposed.
3. Publications from reference institutions, news in urology, full text evidence-based publications about prostate pathologies (around 300 articles) and practice guidelines are referenced in a list of annotated links. Information intended for patients is also provided, as it could have a favourable impact on the evolution of their illness and help them to actively participate in health care decisions [26,27].

#### 4.2. Comparison with other products

We compared our prototype with other projects intended to collect relevant medical information, such as HONselect [28] and OMNI [29] (Table 3).

As shown in Table 3, the site presented here is rather dedicated to provide continuing medical education by the use of tutorials about EBM, critical appraisal of literature, searching tools and guidelines. In addition, our project is related to a specialised field of medical practice and serves the specialised needs of urologists and other practitioners interested by tumour markers of human prostate cancer. Moreover, different data retrieval tools are provided to facilitate the access to relevant data, based on the type of tumour markers, publication types and clinical aspects of prostate cancer. Supplementary information types are also proposed, including full text and EBM reviews.

In contrast, the other sites have been developed for a larger audience and provide only general information accessible from the MeSH terms. As the combination of these terms is impossible, searching for specific information is not allowed.

Although the three methodologies used to filter relevant data insist on the validity of the information, we have considered that the more adapted methodology is the EBM process for the identification of the most recent results of the research in clinical practice.

#### 4.3. Web site evaluation

An audit was performed for a period of 4 months by using a pop-up form to be filled in and submitted. In function of results (845 responses), it can be deduced that the targeted public was well the expected one: physicians and other health care professionals (50%), students and scientists (29%), information specialists and patients (7% each), others (7%). Concerning the sought-after information, it is interesting to note that the aspect of continuing medical education was well represented, since 33% of visitors came for Medline, 28% for tutorials and EBM tools, and 33% for prostate information.

### 5. Discussion and conclusion

Internet has generated new opportunities to present medical information to clinicians. Within this context, several projects have been recently developed. They concern specialised portals intended to collect significant information about medical problems [30] or guides to help physicians to find relevant biomedical resources on the Internet, such as HONselect [28], OMNI [29], CISMef (Catalogue et Index des Sites Médicaux Francophones, University of Rouen, France) [31] and Medical Matrix (USA) [32]. The aim of all these sites is to guarantee free access to high quality data by filtering relevant information. However, they only give information on general subjects corresponding principally to the MeSH terms and not on specific topics such as tumour markers for specific cancers.

Our project, which is intended to serve more specialised needs of urologists and other practitioners interested in human prostate cancer, works towards the same goal of information selection and

puts the emphasis on the controls of quality. First, it follows a methodology based on the EBM principles to guarantee thoroughness, relevancy, and objectivity of the data supplied. Secondly, it is regularly checked by two independent reviewers, supervised by an editorial committee for the clinical aspects and for its compliance with the above-mentioned published quality criteria.

The aim of this added-value product is to make French-speaking clinicians more sensitive to EBM, as opposed to the English-speaking coun-

tries where the EBM practice is already well implemented. In consequence, we have created French-speaking tutorials explaining the detailed method of seeking data and available resources, as well as the literature evaluation process. These tutorials can be considered as tools for continuing medical education. However, mastering the entire EBM process requires specialised training and may be time consuming.

Consequently, we have organised an easy access to current best evidence by creating adapted bibli-

Table 3  
Comparison of our EBM site with HONselect [28] and OMNI [29]

	EBM Site	HONselect	OMNI
Medical portal	Specialised	General	General
Data retrieval	Based on the type of tumour markers, the publication types and the clinical aspects of prostate cancer	Based on MeSH <sup>a</sup> terms, like as prostatic neoplasms and prostate-specific antigen	Based on MeSH <sup>a</sup> terms, like as prostatic neoplasms and prostate-specific antigen
Project methodology	Evidence-Based Medicine	HONcode <sup>b</sup>	BIOME <sup>c</sup>
Education part	Tutorials about: (1) EBM (2) Critical appraisal of literature (3) Tools for seeking relevant data on the Web Guidelines	None	Learning material
Information types			
Articles references	Yes	Yes	Yes
Web sites	Yes	Yes	Yes
Healthcare news	Yes	Yes	Yes
Conferences/reports	Yes	Yes	Yes
Clinical trials	Yes	Yes	Yes
Patient information	Yes	Yes	Yes
Full Text articles	Yes	No	Yes
EBM Reviews	Yes	No	No
Price	Free	Free	Free

<sup>a</sup> MeSH: vocabulary of medical and scientific terms assigned to documents in Medline by a team of experts of the National Library of Medicine.

<sup>b</sup> HONcode: guidelines designed to raise the quality of Web-based medical and health information. These guidelines encourage the authority, complementarity, confidentiality, proper attribution, justifiability and validity of the information provided.

<sup>c</sup> BIOME evaluation guidelines: guide to quality Internet resources in the health and life sciences. The quality of an information resource within the context of BIOME relates to contextual factors (scope and intended audience, authority and reputation and how the resource compares to others), content of the source (coverage, accuracy, currency), format of the source (accessibility, design and layout, ease of use).



ographic and full text databases, as well as by generating hyperlinks that perform optimised searches in several medical databases.

Gathering all available relevant bibliographic references in a single, searchable database accessible on the Web allows to eliminate duplicates, to manually filtrate the information and to present an interface identical for all publication types. Home-made hyperlinking has the advantage of offering a personalised and updated search from multiple sources with a single click, but requires the physician to choose the most relevant references in the references lists generated. However, the most interesting resources are not free, because of their high added value and remain inaccessible to the health care professionals outside of an academic and hospital environment. In addition, the application field of EBM resources is limited to a set of therapeutic questions. Therefore, the use of Medline remains the only possible option in many cases.

To reach a wide audience, the site is promoted by the Department of Pathology and Cytology and the Department of Laboratory Medicine of the University of Liege, which make reference to its URL address on every protocol returned to practitioners. The site has been also registered by the major French-speaking search engines.

The preliminary audit that we performed confirmed that the objectives of our project were met. The targeted public is the one expected. Visitors come for continuing medical education and to find information on prostate cancer. In addition, the site is regularly used as a tool for teaching advanced Medline in several clinical departments of the hospital. Even if the site is visited, further studies are, however, needed to prove the effectiveness of these technologies in the decision making process.

In conclusion, this project illustrates the importance of collaborations between physicians and information managers. By using inexpensive, easy-to-use and widely available common software applications, we created a prototype Web site, which may be easily adapted to other fields of medicine and allows clinicians to overcome some of the difficulties that prevent them from consulting the literature.

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