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Towards a Web Based Medical Information Service for General Practice - The EVIMED Project

Rolf Gruetter
University of St. Gallen

Johann Streurer
University Hospital of Zurich

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Rolf Grütter
Institute for Media and Communications Management, University of St. Gallen, Switzerland

Johann Steurer
Horten Center for Practice-Oriented Research and Knowledge Transfer, University Hospital of Zurich, Switzerland

***Abstract*-There is an ample variety of medical information on the World Wide Web. In order to be useful for general practice, it has to be evaluated with regard to quality, relevance, design, and ease of access. This study analysis these requirements and explores existing tools and services aimed at meeting them. It further presents the EVIMED project, which is a Web-based medical information service rooted in the recent move towards evidence-based medicine, and introduces the concept of media as a framework for the design of EVIMED. Preliminary evaluation of the current implementation indicates that EVIMED properly addresses the above requirements of medical information and is perceived as useful for practice by the majority of respondents. Future work will focus on a re-design of the service based on an extended requirements specification, a methodically improved follow-up evaluation of EVIMED, and the evaluation of alternate business models.**

I. INTRODUCTION

Medical information on the World Wide Web (subsequently called the „Web“) is almost as old as the Web itself. While, in the beginning, patients constituted discussion groups as common fori where they could share their subjective experiences and insights in coping with diseases and exchange information about them, by and by also the healthcare providers began to post medical contents on the Web. This resulted in the ample variety of medical information which can be found today. For the practitioner who is looking for information which can support him or her in daily practice, it is usually an elaborate task to filter the relevant information. Even if the required information is found, it is usually not presented in a way which allows for an easy extraction of the essence. Worse, the trustworthiness of the retrieved information is often purely subject to assumption.

Thus, in order to design an information service which can support practitioners in daily routine, some basic requirements must hold for the offered information. These requirements are analyzed in a first section. An overview of existing medical information services for general practice will be provided in a next section. Thereafter, the EVIMED project will be presented and the conceptual framework applied in order to design it will be introduced. The actual implementation of EVIMED will be described in a further section including results from a preliminary evaluation of the project and its contribution to the research questions raised. In the discussion section, the methodology applied during the evaluation and alternate business models for EVIMED will be discussed. An outlook on future work will conclude the study.

II. INFORMATION FOR GENERAL PRACTICE

Providing the right information in the right quality at the right time to the right place is a catch phrase often cited in information management and cannot easily be refuted. However, when the question is „What is the right information?“ or „How can a high quality of information be assured?“ things are becoming increasingly complicated. Before entering the information provision „business“, such issues have to be carefully addressed, even more carefully when the question is about medical information for general practice. In the following, we will thus consider some general aspects affecting the provision of medical information for general practice, particularly on the Web. For a survey on the particular information needs of practitioners see [1].

A. Quality of Medical Information on the Web

Today, various providers of medical information with very heterogeneous background and intention offer their services on the Web. The complain about information overload often raised in these days particularly applies to medical information. Worse, information quality, which is a key issue in medicine, has largely been neglected so far. As a consequence, it is not surprising that a rich variety of advice can be found when searching for help in a particular problem. For instance, Impicciatore et al. showed that parents searching for information about treating a feverish child could either receive good advice or be advised to administer aspirin, putting their child at risk of Reye’s syndrome, according to which Web site they visited [2]. Several attempts to improve the quality of medical information have been made. Silberg et al. specified some basic criteria to be met by Web sites. These include explicit authorship and sponsorship, attribution of sources, and dating of material [3]. Wyatt suggests that evaluation of Web sites should go beyond mere accountability to assessing the quality of their content and structure, functions, and likely impact on clinical processes and patient outcomes, and its cost effectiveness compared with other methods for delivering the same information [4]. While this seems to sketch a promising approach for improving the quality of medical Web sites, the question of who will do such assessments and account for the results has to be answered as well.

B. What is the Right Information?

The problems of unsatisfactory recall and precision (which are – together with the adequacy of the query – important determinants for the relevance of information) when using the common syntactic search engines (e.g., AltaVista[1]) to explore the Web are well known. Better results can be obtained from searching over manually selected URLs (Uniform Resource Locators) as with medivista – Medizin & Gesundheit[2] or manually categorized sites as with Yahoo! Health[3]. However, in the case of medivista, sites not selected cannot be retrieved, and in both cases, because of the time delay resulting from the manual work, recently published contents are not available. (This objection applies to any search tool involving manual work including the subsequently discussed.) The recently often discussed portals build on the same basic functionality but go a step further in that they offer a personalized setting of so called channels, i.e. categories. Portals have a significant potential for the structuring of confined *Intra*nets but their benefit is smaller when applied to the open Internet. The best recall and precision are achieved by knowledge-based search tools and services such as CliniWeb International and DXplain. CliniWeb International[4] uses the Medical Subject Headings, i.e. MeSH terms, to index the Web pages. It further integrates a natural language processor capable of analyzing queries in five different natural languages. CliniWeb International also has direct links to MEDLINE searches via the PubMed system at the National Library of Medicine. DXplain[5] can produce a list of possible diagnoses for a combination of signs and symptoms. It currently incorporates information on 2000 diseases, 4700 clinical findings, 65000 interrelationships, and evaluates diagnoses with their likelihood. However, as the developer of the system, the Massachusetts General Hospital states, „the database used by DXplain should not be considered complete due to a large number of possible causes, including but not limited to a lack of complete coverage of all signs, symptoms and laboratory tests and all possible disease entities“. As a consequence, DXplain should be used as a medical education and reference system and not to make a medical diagnosis or to replace the judgement of a physician. Based on systems like CliniWeb and DXplain, searches can be combined and the findings presented in a concise Web-based interface by the use of interface software such as MedWeaver[6]. MedWeaver integrates decision support, literature searching, and Internet exploration. Particularly, it weaves together WebMedline[7], DXplain, CliniWeb, and Medical World Search[8], which uses the Unified Medical Language System from the National Library of Medicine. Because of the considerable contribution of humans adding value in terms of expert knowledge, this third group of search tools is close to what we call a medical information service (s. Section III). While supporting the user in searching for information, all these approaches require him or her to spend a confined time slice for the study of the search results. Thus, Simic and Steurer found that, although 86.2 percent from those practitioners who have access to the Internet (45 percent) use it for professional purposes, only 1.7 percent do so during the patient visit (thereby also answering the questions of the right time and right place raised at the beginning of Section II). The reason therefore were the assumed interference of the physician-patient interaction but also the complex and time-consuming information retrieval [5].

C. Information Design and Presentation Strategy

Even if a high level of quality and the right piece of information can be provided, this does not guarantee that the information is properly interpreted and induces appropriate decisions. The presentation of the information, i.e. the information design, can significantly influence interpretation and decision-making [6]. Thus, Cartmill and Thornton found an effect of the presentation of partogram information on obstetric decision-making. Simply changing the scale of the graphical presentation resulted in significantly different decisions by the examined obstetrics [7]. Likewise, the presentation strategy is an issue of interest. While, originally, pulling information from the Web was the predominant strategy, increasingly, push strategies gain more attendance. However, pushing information to people can substantially contribute to information overload and also dismiss the right time when the information is required.

III. MEDICAL INFORMATION SERVICES

A traditional problem for physicians is to do the daily routine in practice and to keep up with scientific advances simultaneously [8]. Detmer and Shortliffe, for instance, cite a study that found that more than half of general practitioners did not know about a laser surgical treatment for diabetics patients that could save their sight – two years after being widely published [9]. The exceptionally high response rate (73.2 percent out of 1500 practitioners addressed) in the study by Simic and Steurer cited in Section II implies that at least some practitioners are aware of this problem and are basically interested in services offering medical information. There are different ways how the Web can support practitioners in being up to date with regard to medical information. Common approaches include Web-based training, literature services, and evidence-based medical information services.

A. Web-Based Training

Computer-based training (CBT) and, since recently, Web-based training (WBT) have reached considerable attention by the Medical Informatics community. Thus, the 44th annual meeting of the German Association of Medical Informatics (GMDS) in September 1999 dedicated an entire session to WBT (besides an additional session on CBT) with three presentations targeting the audience of practitioners [10, 11, 12]. Likewise, both GMDS and the Swiss Society for Medical Informatics (SSMI) have working groups in the areas of CBT and

[1] http://www.altavista.com/
[2] http://www.medivista.de/
[3] http://health.yahoo.com/
[4] http://www.ohsu.edu/cliniweb/index.html
[5] http://www.cpmc.columbia.edu/homepages/ciminoj/present/acmi96/dxplain.htm
[6] http://www.people.virginia.edu/~wmd4n/medweaver.html
[7] http://www.people.virginia.edu/~wmd4n/webmedline.cgi
[8] http://www.mwsearch.com/

WBT[9][10]. WBT potentially allows for interactive and multimodal training, independent from time, place, and platform, and for the control of advances [13]. On the other hand, the use of teaching/learning systems requires an explicit scheduling of training sessions and, therefore, bears the disadvantage of dissociating the training from daily practice – a problem common to any higher education. Worse, the current approaches are primarily driven by technology, thereby leaving unconsidered human factors and didactic aspects. CBT and WBT, therefore, seem to be at their very beginning, and a lot of research, particularly based on transdisciplinary cooperation, still lies ahead.

B. Literature Services

Literature services have a long tradition in medicine. The most important are MEDLINE and the Current Contents. MEDLINE is a database of the National Library of Medicine (NLM)[11]. It contains roughly 11 million references and abstracts to 30 years of medical literature. Since recently, MEDLINE can be accessed for free, for instance, through NLM's PubMed and Internet Grateful Med systems. Using PubMed's retrieval engine also allows to link to about 400 journals for full text of articles and provides pre-computed sets of relevant MEDLINE articles. Alternatively, Internet Grateful Med provides access to other NLM databases on AIDS, bioethics, history of medicine, toxicology, health services research, and other topics. In addition to MEDLINE, also the Current Contents, including the Edition on Clinical Medicine, are available on a personal subscription basis via a Web interface[12]. Although MEDLINE and the Current Contents reflect valuable resources, primarily for the scientifically interested physician, the retrieved abstracts and articles require some manual interpretation and „translation" into the language of the practitioner in order to become easily applicable to general practice.

C. Evidence-Based Medical Information Services

The term evidence-based medicine (EBM) was coined at the McMaster Medical School, Canada, in the eighties. According to Sacket, a co-founder of EBM, EBM is the conscious, explicit, and judiciously application of the currently best evidence in making medical care decisions in favor of an individual patient [14]. Practicing EBM means integrating the personal clinical experience with the best available external clinical evidence, which can be derived from systematic investigations.

The key issues differentiating evidence-based medical information services from other tools and services are the significant contribution of humans adding value in terms of expert knowledge, particularly to downstream activities such as judging the methods applied in a particular study, and the tailoring of the information according to the specific needs of the patient visit. The first issue deals with information quality, the second with its relevance and design. Improving the availability of information is not a target specific to evidence-based medical information services but touches the core of information management in general.

Evidence-based medical information services are quite new on the Web. For instance, the Cochrane Collaboration offers free abstracts of reviews by almost 50 specialized collaborative review groups[13]. In order to access the full text of these reviews, subscription is required. Currently, Ovid introduces a similar evidence-based medicine review service[14]. Ovid integrates the Cochrane database of systematic reviews and Best Evidence, a database that contains the ACP Journal Club (a publication of the American College of Physicians-American Society of Internal Medicine), and Evidence-Based Medicine (a joint publication of the ACP and British Medical Journal Group). It includes a natural language processor for the interpretation of free text queries in English. Access to the service requires a proprietary, purchasable software.

Tab. 1 summarizes the described requirements and medical information services for general practice and provides a semi-quantitative evaluation of the degree of matching between the two. Note that the requirements are to be read in view of the patient visit. Thus, e.g., availability means ease of access just in time and place.

TABLE 1
REQUIREMENTS AND MEDICAL INFORMATION SERVICES FOR GENERAL PRACTICE

Requirements	Medical Information Service		
	Web-Based Training	Literature Service	Evidence-Based Medicine
Quality	+	+	+
Relevance	-	+/-	+
Design	+/-	+/-	+
Availability	-	-	+/-

IV. THE EVIMED PROJECT

The EVIMED project aims at providing general practitioners in the German speaking countries with relevant and reliable information for daily practice, thereby supporting the practitioners in making appropriate medical decisions. To achieve this, a group of physicians who are trained in evidence-based medicine systematically reviews published studies with respect to practical relevance and trustworthiness. These reviews are published together with the respective articles in the database of EVIMED[15]. Currently, this information is freely accessible.

A. Conceptual Framework

The framework applied to analyze EVIMED and to design its service is the concept of media as defined by

[9] http://link.medinn.med.uni-muenchen.de/gmds-cbt/
[10] http://www.sgmi-ssim.ch/activities/culmed/culmed.htm
[11] http://www.nlm.nih.gov/databases/freemedl.html
[12] http://connect.isihost.com/
[13] http://www.cochrane.de/cc/cochrane/revabstr/mainindex.htm
[14] http://www.ovid.com/products/cip/ebmr.cfm
[15] http://www.evimed.ch/

Schmid [15, 16]. Thereby, EVIMED is understood as a medium for the transfer of medical knowledge from research into practice. According to Schmid, cooperating agents exchanging information or other objects like goods or services require a medium as a platform for exchange. Such agents can be humans as well as artificial agents. A medium includes a system of channels performing the transportation of the exchangeable objects over space and time, a „logic“, i.e. a syntax or language with common semantics, and an organization (roles and protocols resp. processes).

The *system of channels* connects the cooperating agents. It must be capable of incorporating the objects to be transmitted and to transport them over space and time. A channel is also called a carrier, and often the concept of media is identified with it. For instance, in the case of information, one talks about print media or electronic media. Although such an understanding of media addresses an important component, it is not complete.

Logical space. The exchanged contents require a structuring allowing their identification and which must be known by the potential senders and receivers. In communications engineering, this structuring is called the syntax. Syntactic rules include typeface, grammatical rules, layout rules, etc. They are required by the channels in order to fulfill their functions. Successful communication requires, in addition, a common interpretation of the exchanged object by the receiver and sender. In communications engineering, one talks about the semantics. The semantics is neither part of the (physical) channel nor of the syntax. It refers to the context, which is referenced by the transmitted message [17].

Organization. Apart from the receiver and sender, usually, additional agents participate in a medium, such as providers of transmission services, public authorities, etc. The profiles of these agents, their rights and obligations, are called roles. Thus, also a system of coordinated roles is part of a medium. The roles define the structure as part of the organization of the medium. In order to process transactions, i.e. to use the medium according to its destination, work flows have to be defined. This is done by processes and protocols. Processes are sequences of activities. The protocols control the processes, they contain the transaction rules of the medium.

A medium is a constituting element of a community of agents. *Communities* are associations of agents which share a common language and world as well as values and interests and use media in order to communicate with each other by taking over (predefined) roles. *Online* or *net communities* use (interactive) electronic media, particularly the Internet, in order to communicate with each other [18].

Taken together, the above described concept of media represents a complete mapping, i.e. a metaphor, of the real-world environment and the community onto an artificial world based on information and communication technology and capable of mimicking human communication. Agents of the community can enter the medium by taking over one of the roles defined as part of the organization.

The requirements for the design of media are derived from the shared values and interests of the agents participating in the community and from the claim made with regard to an encompassing automation. The latter rests upon Church’s thesis, stating that the computer can mimic all describable processes and, in principle, execute them automatically.

B. Application of the Concept

Designing a medium for EVIMED means identifying and defining the above described components of a medium.

The (online) communities participating in the medium are the general practitioners, the experts who provide the contents (i.e. the reviews), and the people running the service. As the service is targeted towards the general practitioners, this community is identified as being predominant with respect to the shared values and interests of the participating agents. Thus, general practitioners are interested in high quality, relevant, easy interpretable and accessible medical information, which supports them in making appropriate care decisions (s. Section II).

The system of channels includes a database, where the reviews can be stored, as well as printouts of the reviews and articles. Likewise, feedback forms and mailto functionality supporting interaction are a part of it.

The logical space is defined by the language which is used in order to code the provided information. It primarily refers to the specific medical terminology. Based on the feedback of practitioners, in addition, also the natural language is important. Thus, it was required that the reviews be provided in German only. As a consequence, reviews in foreign languages, e.g., in English, must be translated. This is a basic difference to the Cochrane Collaboration and to Ovid, which offer their contents in English only.

The roles include „general practitioner“, „expert“, and „service provider“. They can be further detailed (e.g., if various practitioner communities are distinguished). Although these seem to be identical with the defined communities, this is not the case. For instance, an individual agent can enter the medium as a practitioner or as an expert, depending on the actions he or she wishes to perform. Likewise, the (aggregated) role of the service provider can be implemented as a set of software agents. For instance, interface agents can assist practitioners in accessing the desired information, e.g., by analyzing and processing natural language queries (s. MedWeaver, Ovid). The processes include the review of articles, the publishing of the reviews, and the retrieval of reviews and articles.

For the individual components of the concept of media hold Church’s thesis mentioned in Section IV. A. They should be entirely represented electronically and dissociated from humans as far as possible. This does not mean that artificial agents are intended to replace humans completely, but the former should free the latter from mere information processing tasks, thereby allowing them to concentrate on knowledge-intense, high-value, and contents-oriented work.

V. CURRENT IMPLEMENTATION

A. Structure and Functionality of the Web Site

The core of the EVIMED Web site is the Journal Club, which is a database currently storing 120 reviews of selected articles published in various medical journals. The reviews are categorized according to 19 specialties and can either be browsed or be accessed via a (syntactic)

search engine. The Web site includes a separate section with articles on the subject of EBM. EVIMED also includes a discussion forum aimed at furthering knowledge sharing among practitioners and a glossary with currently 26 definitions of EBM-specific terms. Further services include free access to MEDLINE, links to literature (including an order service) and other EBM-related sources (e.g., a calendar of events related to further education in EBM), and a guest book offering the possibility to post comments and to subscribe for a free newsletter. The comments together with the names, functions, and e-mail addresses of the respective authors can be displayed in a chronological order. A mailto functionality allows to give feedback to the editor in chief. All text of the Web site is in German.

The Web site uses frames in order to separate the navigation elements from the contents. Each of the above listed services is directly accessible via a hyperlink in the navigation frame.

B. Evaluation of EVIMED

The current implementation of EVIMED has recently (in March 1999) been evaluated in a doctoral thesis [19]. Therefore, 400 persons which had registered themselves in the guest book were asked by e-mail to fill in an electronic questionnaire. From the 167 persons answering (corresponding to a reply rate of 40 percent), the majority were practitioners (63.5 percent) and an additional 22.2 percent were physicians working in hospitals. 67.7 percent of the persons answering had Internet access in their office, whereas 72.5 percent had private access to the Internet.

Overall, the information provided by EVIMED was judged as useful for practice by 61.1 percent of the persons answering. The clinical relevance of the studies offered in the Journal Club was rated as high by 55.7 percent and as very high by 26.9 percent. The trustworthiness of the information offered was rated as high by 56.3 percent and as very high by 35.3 percent. These figures indicate that EVIMED properly addresses the requirements of medical information described in Section II. The following sections of the Web site were perceived by the majority as significant: Journal Club (55.7 percent), articles on EBM (46.1 percent), access to MEDLINE (37.7 percent), and links to literature and other sources (41.3 percent). The frequency of the site visits was 1 - 3 times per month on the average.

VI. DISCUSSION AND OUTLOOK

A. Evaluation of EVIMED

Although the evaluation of EVIMED points towards a high degree of satisfaction of the practitioners, some limitations in the methodology have to be discussed. First, the participating persons had already previously documented some kind of interest in EVIMED (by signing the guest book) and, of these, a self-selected sample answered. As a consequence, their answers might be biased towards support of EVIMED if compared to all practitioners who visited the site. Although it is difficult to get a good sample of persons visiting EVIMED (and probably impossible to get a perfectly representative one), this objection must be considered in the design of the follow-up evaluation which will be discussed in Section VI. C. Second, if practitioners are often unaware of recent scientific advances (as claimed in Section III), it is questionable how they correctly evaluate the quality and relevance of the information provided by EVIMED. Third (and this is closely related to the second objection), the evaluation reflects subjective opinions rather than objective measures. Alternatively, Silberg's quality criteria raised in Section II could provide such „hard" measures. Applying them to an arbitrary sample of reviews provided by EVIMED shows that they are met by the current implementation with the provision that the attribution of sources could be improved.

B. Business Model

Currently, all services provided by EVIMED are freely available. As mentioned, the Cochrane Collaboration offers free abstracts of reviews, but in order to access the full text of these reviews, subscription is required. This could be a business model also applicable to EVIMED in the future. Whether charging per subscription or per view will be preferred is subject to further exploration of the practitioner's interests and preferences. Alternatively, a professional service could be financed by sponsoring. As the thesis on the evaluation of EVIMED cited in Section V reveals, currently, this latter approach would be favored. Thus, 71.9 percent of the persons answering would accept sponsoring to support an improved service. Alternatively, 59.3 percent would be willing to pay for it.

The approach to a business model as pursued by Ovid, i.e. allowing access to information exclusively via a proprietary software, is considered as not very promising, as the need to install and regularly update an additional software might prevent a lot of practitioners from subscription.

C. Future Work

Future work will include a more detailed evaluation, preferably on a broader basis, of the degree of fulfillment of the described requirements of medical information for general practice (s. Section II). As mentioned, in addition to subjective opinions, also objective criteria should be specified and measured. Likewise, the evaluation should attempt to go a step further towards assessing the likely impact on clinical processes and patient outcomes as suggested by Wyatt [4]. The evaluation should also take into account, that the values and interests of the practitioners may change with time and as a result from the interaction with the current implementation, resulting in changing or additional requirements. Finally, a future evaluation must include benchmarks of newly established evidence-based medical information services on the Web such as the mentioned Cochrane Collaboration and Ovid.

The current implementation of EVIMED offers a considerable potential for automation. Therefore, a re-design project has recently been initiated. Based on a detailed requirements specification including selected practitioner communities, its objective is to evaluate existing products supporting the editing and publishing on the Web and to select the one meeting the requirements of EVIMED best, thereby also improving the look and feel of the site. Using the terms of the conceptual framework introduced in Section IV, the re-design project primarily affects the organizational structure and the system of channels. Publishing software allows for the implementation of the identified roles, e.g., as user profiles, and for the automation of the processes.

User profiles will also be required in order to implement a business model. Implementations of both roles and processes can further be combined as shown by Yu who specified an Internet peer review process in a multi-agent framework for the NetAcademy [20].

With respect to the logical space of the conceptual framework, the glossary can be extended and the semantic relationships between the terms made explicit and exploitable by computer programs similar to knowledge-based systems. These terms can then be used to attribute the reviews thereby allowing for a semantic search, also for related reviews, in addition to the existing syntactic search (a similar approach is pursued by the NetAcademy[16], which is a research platform for the world-wide scientific community, hosted at the Institute for Media and Communications Management, University of St. Gallen, Switzerland). Recently, a sub-project pursuing these objectives has been initiated.

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