Clinical extracts of biomedical literature for patient-centered problem solving*

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This paper reports on a four-part qualitative research project aimed at designing an online document surrogate tailored to the needs of physicians seeking biomedical literature for use in clinical problem solving. The clinical extract, designed in collaboration with three practicing physicians, combines traditional elements of the MEDLINE record (e.g., title, author, source, abstract) with new elements (e.g., table captions, text headings, case profiles) suggested by the physicians. Specifications for the prototype clinical extract were developed through a series of relevance-scoring exercises and semi-structured interviews. For six clinical questions, three physicians assessed the applicability of selected articles and their document surrogates, articulating relevance criteria and reasons for their judgments. A prototype clinical extract based on their suggestions was developed, tested, evaluated, and revised. The final version includes content and format aids to make the extract easy to use. The goals, methods, and outcomes of the research study are summarized, and a template of the final design is provided.

INTRODUCTION AND BACKGROUND

Problem solving in a medical setting requires that information from diverse sources—including personal observations, patient interviews, laboratory test results, and the published biomedical knowledge base—be selected and integrated into a cohesive whole. While there is no generally accepted definition of an “acceptable” use level, the perception is widely held that practicing physicians do not make adequate use of the biomedical journal literature to support patient care, preferring to rely upon colleagues, textbooks, office files of notes, and patient records. The growing emphasis on evidence-based medicine [1] places new pressures on physicians to employ the published knowledge base in clinical problem solving.

The use of literature for clinical problem solving requires, at some point, a match between the physician’s information need and the data available in the published knowledge base. The environment in which this match is made is bounded by many factors, including the physician’s medical expertise, the availability of appropriate published knowledge, and the search system used to find information. The specifics of the case, and the way the physician builds them into a mental image of the problem, are also important factors. The study reported in this paper is grounded in one area of this multifaceted context. The study examined the form and content of medical literature that a physician views when using an online system such as MEDLINE. The purpose of the review was to determine how the physician’s chances of finding relevant articles for patient care could be improved.

When a question arises during patient care, the physician must identify an appropriate information source, frame the question appropriately, search some collection or system of information resources, and retrieve items of potential relevance before actually sitting down to hunt through a book or article for an answer. If the physician is using MEDLINE, then a search is requested or conducted, and the citations are examined to find those relevant to the problem at hand. For a search that retrieves forty-one items, a complete review could take twenty minutes at thirty seconds per item. If twenty-seven citations appear relevant, and it takes three minutes to determine the

value of any article once it is in hand, then another fifty-four minutes must be spent eliminating the irrelevant items. If three of the articles are applicable, then extracting the essential information could add another quarter hour to the exercise.

Estimates vary with regard to the number of questions that arise during patient care, but if only two questions that require a search of the literature arise during a ten-patient workday, then the physician must commit about four hours to information seeking. Whether the physician will do this depends on his or her assessment of the probable usefulness of the answer relative to the cost in terms of fees, retrieval time, and utilization time [2].

Physicians face a very real practical problem when they use MEDLINE to find articles: Some items that appear relevant on the basis of the citation turn out to be irrelevant. The study reported here tested an alternative online record, the clinical extract, which is designed to incorporate elements of information that have high utility for clinical problem solving. The goal was to design an online record that would improve a physician’s chances of making a good choice of clinically relevant items from the world biomedical knowledge base represented in MEDLINE.

INFORMATION NEEDS IN PATIENT CARE SETTINGS

In the most comprehensive examination of this issue, Wilson et al. used the critical incident technique to study the way MEDLINE was used in patient care settings [3-4]. They gathered 1,158 reports of situations in which a physician tried to locate current literature through a MEDLINE search. About 43% of these searches were undertaken to support patient care, mostly to assist with diagnosis and treatment decisions. Treatment or prognosis questions accounted for 51% of the patient care searches, and diagnosis or etiology accounted for 41%. The remaining 8% of the searches concerned effective doctor-patient relationships, disease prevention, and third-party payment procedures. Other studies offer varying percentage breakdowns for similar categories [5-7].

A number of researchers have attempted to characterize the nature of the information sought by physicians for patient care. House staff physicians interviewed by Woolf said they were looking for treatment recommendations; data to support differential diagnosis; examples of diagnostic criteria; drug information; and guidance for interpreting laboratory test results, physical signs, and symptoms [8]. Timpka found that the 32% of physicians’ information needs calling for medico-scientific knowledge concerned performance of physical examinations, interpretations of symptoms and signs that fit no familiar illness model, and approaches for treating psychosomatic complaints [9]. Florance concluded that, in addition to seeking facts about disease conditions, demographic characteristics of patients, and treatment issues, physicians needed information to support decision making, addressing issues such as the strength of association between factors and weighting criteria for decision options [10].

Mental models in patient-centered decision making

When physicians use published literature in patient care settings, they are engaging in problem-oriented reading: Their goal is to find specific meaning within a document, even though much of the text may not be relevant to the problem. In his study of goal-oriented reading, Guthrie found that the problem (or goal) was internalized as a framework—a mental expression of the situation—against which concepts from the text were matched [11]. The notion of the situation model, a mental construct of a case or problem, is also used by Patel in discussing the cognitive differences between basic scientists and clinicians, differences that affect the way a physician reads a scientific study [12].

The work of Nygren et al., focusing on the way physicians read patients medical records, adds another dimension to the problem—the structure of the document. Nygren posited that “in all kinds of target search the reader uses knowledge about structure, sorting order and textural layout to limit the searches space as far as possible” [13]. Rennels noted that experimental evidence is presented in a “study-centered model” in which knowledge is structured around scientific studies, rather than around patients or diseases or decision-making processes [14]. By “study-centered,” Rennels meant that the facts and assertions in scientific literature are reported in a framework that highlights the scientific process; a good example is the well-known introduction-methods-results-discussion-conclusion structure of research articles. This type of organization presents problems for the physician who comes to the literature with a conceptual model of a problem that is shaped by a patient case. In the physician’s conceptual model, the organizing elements might be chief complaint, patient’s family history, probable diagnosis, and so on.

If Patel and Rennels are correct, then the mental model and the process of reasoning employed by a practicing physician differ from those represented in much of the published biomedical research literature. Thus, to utilize published research in clinical problem solving, a physician must somehow rearrange the information to match the patient-centered conceptual
framework developed during the clinical evidence-gathering that takes place during a case.

USING A SURROGATE TO FIND CLINICALLY APPLICABLE INFORMATION

It is not always the article that a physician sees first. Typically, the document encountered first when a physician seeks literature for problem solving is a surrogate, a stand-in for the actual document. In bibliographic databases such as MEDLINE, the surrogate is an online record consisting of a bibliographic reference embellished with additional information including subject headings, institutional affiliation, and article type. The most important of the additional fields is the abstract, which offers the reader a glimpse of the article’s contents. For many physicians, the abstract is the determining factor in an article selection decision.

Not all abstracts are created alike. There are important differences between the two types of abstracts that predominate in scholarly journals. An indicative abstract alerts the reader to the existence or gist of an article, while an informative abstract summarizes the article’s content. While DeBakey and DeBakey maintained that informative abstracts are most appropriate for scientific literature, Fidel argued that indicative abstracts, which also frequently appear in scientific journals, are probably more effective in database searching [15-16].

In 1987, a committee of physicians proposed that informative, structured abstracts be used for articles with clinical implications [17]. This structure was seen as a way to help the physician quickly judge the scientific quality of an article without reading the entire text. Several major medical journals and subspecialty journals have adopted the committee’s recommendations. Whether structured abstracts have helped physicians critically evaluate the results of clinical research has not been reported, but there is another dimension to clinical information seeking that this format does not address: the match between content in the article and the physician’s problem-oriented conceptual model. If structured abstracts remain “study centered,” highlighting the scientific process rather than details relevant to the clinician, then they may still fall short in helping the physician locate relevant knowledge for problem solving.

Study methods

The design, testing, and revision of the clinical extract were accomplished through a four-part study [18]. The participants were three male physicians, each actively involved in general practice patient care. Each was asked to select two questions from a list of nineteen clinical questions (see Appendix A for those selected).†

Part One of the study involved gathering background information on the participants’ training and current practice patterns, their opinions about the clinical applicability of biomedical articles, and the way they used MEDLINE records to make relevance judgments. In Part Two, participating physicians assigned relevance scores to sets of MEDLINE citations and articles for two clinical questions each, commenting on their decisions and marking up the printed documents. In Part Three of the study, participants assigned relevance scores to sets of MEDLINE citations and articles for four additional clinical questions. Clinical extracts were inserted in place of MEDLINE records for several records in each search output. In Part Four, the physicians were asked to evaluate a prototype clinical extract for each of four publication types by comparing the clinical extract to a MEDLINE record for the same item.

Because the study involved creating and testing something new, a qualitative methodology was chosen. Emphasizing exploratory, incremental, and developmental characteristics of research, qualitative approaches have been used with good results in numerous information studies. Park’s empirical study of relevance factors in information retrieval is a recent example [19].

Data were gathered primarily through semi-structured interviews and document analysis. In all, forty-two interviews were held during the research study; in each, a standard set of questions was asked, but free-flowing discussion also occurred. An informal follow-up session was held at the end of the study, at which all three participants, together for the first time, offered observations about their experience in the study and its effect on their own literature selection practices.

For purposes of this study, relevance was defined as clinical applicability, meaning that any information retrieved was to be judged in terms of its use in finding a successful solution to the patient problem at hand. The five-point relevance scoring scale provided three scores for relevant items, each defined in association with cognitive operations required for the application of retrieved information. The three scores were

- 1—High Relevance: immediately applicable (e.g., “plug-in” data);
- 2—Medium Relevance: applicable with some cognitive effort (e.g., simple logical or arithmetic calculation); and
- 3—Low Relevance: applicable with complex logical

† All questions were taken from the Wilson, Starr-Schneidkraut and Cooper (1989) report, Appendix F.
or statistical operations or additional information. The two additional scores were
- 4—Irrelevant, and
- 5—Not Enough Information.

For each of the six questions, the process followed was identical. In the first interview session of Part Two, each participant was presented with a written question he had chosen from the original question set. He was asked to restate the question in his own terms, to characterize the information problem, to describe an ideal answer, and to comment on what he expected to find in the literature. A print-out of search results from MEDLINE was then presented to the participant, along with a written copy of the question and a copy of the relevance scoring scale.‡ The physician was asked to read each citation aloud, explaining his review process and judgment criteria. He was also asked to underline important concepts and to mark a relevance score beside each citation. At the end of the review, the physician indicated which articles he would retrieve for further review.

Two days later, in a second interview session for the same question, up to eight articles were presented to the participant for review. The article review process followed the model of the search review, requiring the participant to verbalize his thoughts and mark up the article by underlining or circling important information and assigning a relevance score. The physician was asked to go back to the citation in the search output for each article and indicate what additional information, if any, he wished to see in the MEDLINE record. Finally, he was asked to assess the success of the information-seeking effort, indicating what additional steps, if any, were needed to answer the question.

This process was followed for each of the six questions, two questions per participant. During the twelve question-centered interviews, the participants reviewed a total of 141 MEDLINE citations and thirty-seven articles. Analysis of the data from these sessions resulted in the design of the prototype clinical extract. Clinical extracts constructed for each of the thirty-seven articles reviewed were inserted into the search outputs to be used in Part Three, replacing MEDLINE records for the same items.

In Part Three, twenty-four additional interview sessions were held, in which each participant replicated the process outlined above for four additional questions. In these sessions, all search outputs contained at least five clinical extracts. The same articles were presented for review that were presented in Part Two, and the same relevance scoring scale was used for citations and articles. At the final interview session for each question, each physician assessed the clinical extract by comparing it to the original MEDLINE record and to the article he had just reviewed. At the end of Part Three, all six questions had been completed by each participant.

In Part Four, an interview was held with each participant to obtain data for evaluation of the prototype clinical extract. At these sessions, the participants completed an evaluation checklist and answered open-ended questions about the clinical extract. They also designed custom models of the clinical extract suited to their personal preferences. These data, along with those from the Part Three, resulted in the revised clinical extract described later in this paper.

RESULTS

As an example of study results, following is a summary of activities carried out for one of the six study questions, case 39. Although the six questions were very different, common themes surfaced in the comments, evaluations, data sought, and factors influencing relevance judgments. The initial written question presented to the physicians for comment is shown below:

39. Had patient with a chordoma in sacral area who had been treated surgically, but tumor had not been totally excised. Physician needed information on whether radiation therapy would be useful in this situation.

The following summary statement integrates responses from the three participants concerning the question, the ideal answer, and their expectations for finding useful information in the literature:

In this question, I want to know more about therapy for chordoma. Specifically, I want to know if radiation would be useful in treating this patient. The best possible answer to the question would be a life table or curve showing the course of sacral chordoma in patients who had partial resection followed by radiotherapy. Ideally, I want the information to come from a randomized, prospective double-blind trial of radiation therapy in partially excised sacral chordoma. Alternatively, a review article on the pathophysiology and treatment of chordomas would be helpful. What I expect to find are case reports or a limited series (i.e., ten patients or less) on chordoma patients treated with radiation. I probably will not find an article that deals only with partial resection, radiation therapy, and chordoma—it might deal with lots of therapies for chordoma or radiation therapy in a number of cancers. I doubt that I will find a good description of chordoma, either.

For case 39, each participant reviewed twenty-nine citations, of which fourteen had abstracts. Eighteen

‡ A MEDLINE search was performed separately for the question by an expert searcher at a medical library. The searcher was given the question in written form and asked to search MEDLINE, beginning with the current file, and to retrieve the twenty-five to thirty most current citations. Searchers did not interact directly with participants to refine their search strategies.
were judged relevant at some level. Of these, three were identified unanimously as "best." Eleven were judged unanimously to be irrelevant. Appendix B summarizes information about the citations in the search output; a similar table was constructed for each question. As judged by their citations, the "best" articles for this case (1) covered at least twenty-five to thirty cases over a long period of time, (2) gave survival rate and outcome data in the abstract, and (3) addressed precisely the topics desired (sacral chordoma and post-surgical radiotherapy). The irrelevant articles for this case (1) were on effects or techniques of surgery, not radiotherapy; (2) discussed the wrong type of tumor or wrong body location; (3) covered only one or several cases; or (4) appeared in an unfamiliar foreign journal.

Data relevant to the clinical decision (whether to give radiation therapy to this patient) were found primarily in the Fuller and Azzarelli articles (see Appendix B), in which life tables for two series of patients seemed to indicate improved survival rates for radiated chordoma patients. Fuller and Cummings documented their success when high dosages were employed. Azzarelli reported his hospital's standard practice of radiotherapy following partial chordoma resection. Cummings and Mindell emphasized the palliative effect of radiotherapy for these patients. All authors mentioned above reinforced the concept that radiotherapy produces symptom relief but not cure.

At the end of the article review session, each physician was asked to comment on the current status of the search for information to treat this patient. All three felt that they had sufficient information to take action (i.e., that the question had been answered.) Their comments are integrated into the following concluding summary statement:

I've definitely learned something. I have answered my question. From my standpoint, from these papers, you can come to an answer to this question. I would irradiate this patient. I'm satisfied. It would guarantee to give palliation at the high dose, and it should improve survival.

Throughout the citation and article review processes, the participants stated reasons for choosing or rejecting items for further consideration. Table 1 summarizes factors that influenced relevance decisions. Factors are listed in order of frequency of use. Although Table 1 presents factors only for case 39, similar factors operated across the six questions.

**Physician comments**

The practice patterns of the three participating physicians varied: Physicians 1 and 2 saw patients for about 20% of their time, while Physician 3 saw them for about 50% of his day. All reported that questions for which they sought literature arose in 10% to 20% of the cases they saw. Participants cited a number of reasons for turning to the published literature during patient care: to find a match for a complex case; to defend a point; to get the latest information in what they perceived to be a rapidly changing area; to learn about a current therapy approach; to obtain drug information, especially on new drugs; to find information out of their area of specialty; to find additional information about a presenting condition.

All three participants had searched MEDLINE previously, and two reported that they regularly performed MEDLINE searches for patient care. Each had developed a method for scanning a MEDLINE record or finding information in an article [20]. Reviewing citations was described as a step-wise elimination process. If the article title looked good, then a physician might stop the review there and decide to retrieve the paper. If uncertain on basis of the title alone, then he would move on to the next element in his preferred approach, usually the abstract or source, and attempt to make a select-or-reject decision. If still uncertain, then he would move to the next decision element, and accept, reject, or continue reading citations. When reviewing retrieved articles, the physicians always began by reading the title. Then, they read the abstract or opening paragraph. Following that, their approaches varied. They might scan section headings to locate potentially fruitful areas of the article (such as the discussion section), or flip to tables and figures and examine the data, or skip to the list.
of references, or read the first sentence in each paragraph. Rarely did they simply begin reading from the beginning.

Within the MEDLINE abstracts and in the articles themselves, the physicians sought particular types of information (Table 2). They looked for information that would allow them to judge the match between their patient and those described in an article (patient-related information). They looked for information with which to judge the scientific credibility of the article (study-related information). They also looked for hints about the nature of the article’s content (article-related information).

Development of a model clinical extract

On the basis of the comments and article mark-ups by participants during Parts One and Two of the study, a model clinical extract was designed. Early in the interview sessions, it became clear that article type was an important factor in selection decisions. Accordingly, clinical extract templates were designed for four different article types: time series (a report on a series of cases covering a number of years), review article, study (a report of experimental evidence), and case report (Table 3). Some features in the prototype clinical extract were common to all article types. Common features included title, author, publication type, number of references, source, institutional affiliation of the authors, and abstract.§

The publication type was made as specific as possible. For example, a study assigned the type “journal article” in MEDLINE was given a more specific type, such as “time series” or “prospective study.” For case reports, the number of cases was listed as the publication type.

In addition to the common features, clinical extracts for certain article types displayed unique information. All included table titles and figure captions if they were present in the article. Review articles included section headings. Case reports included a brief profile of the case, extracted from the text of the article.

Thirty-seven clinical extracts were constructed by expanding and reorganizing information from the MEDLINE record. Appendix C, an example of a prototype clinical extract for a mixed article, displays the added elements in boldface type. All new information was extracted directly from the article, without rewriting. Extracts were formatted to match MEDLINE citations and inserted into the search outputs used for citation review in Part Three of the study.

§ If no abstract was present in MEDLINE, then an introductory or concluding paragraph that summarized the article was extracted from the article and added to the online record.
**Table 4**

Performance scores for the prototype clinical extract

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Study</th>
<th>Case</th>
<th>Review</th>
<th>Time series</th>
<th>Avg score</th>
<th>Ideal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>.66</td>
<td>1</td>
<td>1</td>
<td>.66</td>
<td>.83</td>
<td>1</td>
</tr>
<tr>
<td>Amount relevant info</td>
<td>.66</td>
<td>1</td>
<td>1</td>
<td>.66</td>
<td>.83</td>
<td>1</td>
</tr>
<tr>
<td>Amount useful info</td>
<td>.83</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>.95</td>
<td>1</td>
</tr>
<tr>
<td>Usability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of use</td>
<td>.66</td>
<td>.33</td>
<td>.66</td>
<td>.33</td>
<td>.49</td>
<td>0 or &gt;</td>
</tr>
<tr>
<td>Amount time to use</td>
<td>-.66</td>
<td>-.66</td>
<td>-.66</td>
<td>-.33</td>
<td>-.58</td>
<td>0 or &gt;</td>
</tr>
<tr>
<td>Mental effort to use</td>
<td>.33</td>
<td>-.16</td>
<td>.66</td>
<td>-.33</td>
<td>.12</td>
<td>0 or &gt;</td>
</tr>
<tr>
<td>Confidence</td>
<td>.66</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>.91</td>
<td>1</td>
</tr>
</tbody>
</table>

**USING THE PROTOTYPE CLINICAL EXTRACT**

In their informal comments, physicians praised certain elements of the prototype clinical extract and also suggested improvements. The publication type categories, institutional affiliation data, number of references, and case profiles were referenced extensively in the participants' verbal comments. Section headings were only occasionally underlined or noted verbally. Table titles and figure captions were seldom mentioned and were often skipped over entirely, particularly when the abstract was long.

In several instances, particularly in cases 39, 62, and 73 (see Appendix A), the clinical extract appeared to be effective in helping the physicians to filter out irrelevant articles. However, it was not possible to verify this finding empirically in the transcript and mark-up data.

The following comments illustrate the value of various elements in the prototype clinical extract:

- Publication type: All three physicians said the specific publication categories were better than the more general "journal article" notation in many MEDLINE records.
- Section headings: Headings were thought to be a burden to read, but useful if the reviewer was unable to decide whether to retrieve an article based on a reading of the title and abstract. One physician suggested adding any content-laden headings appearing in scientific articles that employ the introduction-methods-results-discussion format.
- Table titles and figure captions: The table titles and figure captions were judged to be less useful than section headings, helpful only in determining the type or level of data presented. One physician suggested providing a direct link from table titles and figure captions to the actual graphics.
- Abstracts: Two physicians suggested using some kind of abstract structure. They also wished the abstract could indicate the type and age of data given in the text. One suggested providing a link to the raw data. They wanted abstracts to be shorter, to highlight important conclusions, and to give some indication of how far conclusions go.

- Case profiles: The case profiles were unanimously the favorite element. All three participants said the profiles helped them decide whether to bother retrieving an article. They wished that case reports used a standard structure that included patient age, sex, type of treatment, and chronology of events. They also wanted the case profile to highlight unusual conditions.

All three participants suggested that a different presentation should be developed for the section headings, table titles, and figure captions, to make the extract shorter. Two suggested that an "on demand" capability be developed to provide a formatted list of headings or captions upon request. Participants also noted the importance of breaking long sections of text into chunks. One suggested that using bold type for key terms in a long abstract might help the reader skim it quickly.

**EVALUATING THE PROTOTYPE CLINICAL EXTRACT**

MEDLINE is the de facto standard against which any online bibliographic record for biomedical literature must be judged. Accordingly, performance goals were established for the prototype clinical extract by using the MEDLINE record as a baseline. Specifically, the prototype was designed to improve upon MEDLINE's content without reducing the usability of the record. The purpose of the three content goals (provide more relevant information, provide more useful information, provide a more useful picture of the content) was to improve upon MEDLINE, while the purpose of the four usability goals (be as easy and as fast to use as MEDLINE, do not require more mental effort than MEDLINE, leave user as confident about choices) was to "do no harm."

In a formal evaluation of the prototype clinical extract, the participating physicians rated the content...
and usability of the prototype clinical extract as compared to a MEDLINE record by using a three-point scale. The three points were “easier,” “same,” “harder”; or “more,” “same,” “less.” Each physician completed a comparison checklist for four publication types. The prototype was most successful in terms of usability, but the added length of the record made unwanted time demands on the user. In the content dimensions, the clinical extracts for case reports and reviews were rated as ideal. For study and time series publication types, for which clinical extracts often differed very little from the MEDLINE record, it was difficult to achieve the ideal score.

DISCUSSION

While the clinical extract is a surrogate, it is also a document in its own right, a text that physicians must read. Thus, the design of the document is important to its success. Wright notes that usable documents should be “compatible with the perceptual strategies, the conceptual knowledge, and the information processing resources of the user” [21]. In this sense, utility is an overarching goal for the clinical extract, a goal that embraces dimensions of form and content. Analysis of participant comments and behavior in the four parts of this study suggested that the important factors affecting the utility of a document in clinical problem solving are (1) time constraints on physicians and (2) decision processes and conceptual models they employ when caring for patients.

Guthrie suggested that the best ways to support a search for specific information improve the reader’s accuracy while reducing the time required to search [22]. Throughout the study reported here, the participants skimmed over large blocks of text, seeking target words or phrases. Typically, they stopped reading as soon as they thought they had found an answer.

One shortcoming of the prototype clinical extract was the length of the record; the participating physicians wanted to read less, not more.

Nygren reported that physicians encode document structures and store them in unconscious memory, a process that reduces the cognitive demands of searching for data [23]. It follows that many physicians have stored memories of commonly encountered document structures (e.g., the Introduction-Methods-Results-Discussion [IMRAD] headings style and the MEDLINE record format), and that these structures play a role in the physicians’ information-processing behavior. In the study reported here, all three participants used citation structure (e.g., knowledge of the general arrangement of parts) and article structure (e.g., section headings and paragraphs) to guide their reading. All three suggested using “buttons” to provide on-demand access to information they found of secondary importance. Buttons are a common structural feature of graphical user interfaces; they provide both a visual cue and an access method. Evaluation scores for the utility of the prototype clinical extract suggest that changing a familiar structure (i.e., the MEDLINE record) can have undesired consequences. The revised clinical extract includes familiar interface elements of electronic as well as text documents.

Several authors have noted that typography and spacing are important aids to finding information in a text [24–27]. In light of these findings, the revised clinical extract was designed to have spacing and typography that help the reader move quickly through the record. The extract supports quick scanning through standardized structure and through visual signals such as bold typeface.

Figure 1 shows a design template for the revised clinical extract. The unique elements of the prototype (headings, table titles and figure captions, case profiles, special publication types) are retained, but buttons have been added to enable on-demand access to some elements. Bold type, paragraph breaks, and bulleted lists help the reader scan quickly for pertinent information. “Link” buttons (represented by • in Figure 1) provide direct access to sections of the article text; the reference list; and tables, figures, and data files. The revised clinical extract can be viewed as an electronic gateway to the article itself, allowing the user as much or as little access to information as needed.

Empirical studies of relevance judgments in work settings have not always informed the ongoing debate about the meaning of relevance. It seems clear that the utilitarian notion of relevance as applicability is the only cogent definition for the criterion physicians employ in choosing literature for clinical decision making. This definition has implications for database searching, suggesting that searchers extend and refine their topical search strategies to capture
terms and data elements important to clinicians. Recent work by McKibbon and Walker-Dilks supports this thesis [28].

Through MEDLINE, Grateful Med, Loansome Doc, and the National Network of Libraries of Medicine, the National Library of Medicine has made significant progress in overcoming the technological and geographical barriers that can come between a physician and access to the biomedical knowledge base. The present study addressed a different kind of barrier, seeking to improve physicians' intellectual access to the published biomedical knowledge base. The testing and evaluation of the prototype clinical extract provided a proof of concept to support design initiatives for user-centered clinical information systems. The clinical extract is a solution for a single kind of information need, that of the physician seeking published knowledge to improve patient care. A full-featured clinical interface should also support other clinical information uses, such as continuing education, current awareness, and hypothesis testing. The needs of other health care professionals must also be explored to determine additional needs for customized interfaces.

CONCLUSION

For most physicians, choosing articles for clinical problem solving involves matching a problem statement against a document surrogate to choose a potentially relevant article. The research reported here proposes a new kind of surrogate, customized to improve the physician's chances of making a good choice. In the clinical extract, the form and content of the biomedical literature is configured to fit the unique demands of patient-centered problem solving. By employing principles of good screen design, the clinical extract helps reduce the time and effort needed to choose articles. By providing clinically relevant specifics, the clinical extract can also improve the physician's chances of finding the right information.

As technologists improve the telecommunications and computing resources that store and transmit medical information, librarians and other information specialists, authors, publishers, and editors must keep pace to improve representations of the knowledge. The design of customized interfaces, such as the clinical extract, is one facet of this ongoing enterprise.

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APPENDIX A

Questions used in the Clinical Extract Study

All questions taken from Wilson, Starr-Schneidkraut & Cooper, 1989, Appendix F.

11. Had young patient with symptoms which appeared like multiple strokes and wanted information on the cause of the strokes; needed information on specific collagen vascular disease which might be the cause.

23. Had patient with severe intestinal problems and extreme depression and needed information on depression caused by the physical problems (as well as information on chronic pain management).

39. Had patient with a chordoma in sacral area who had been treated surgically, but tumor had not been totally excised. Need information on whether radiation therapy would be useful in this situation.

51. Had a general practice patient who was also being treated for IgA deficiency by a pulmonologist (using gamma globulin) and wanted general information about the condition and its treatment.

62. Had patient admitted to the emergency room with snakebite and wanted current information on the trend toward or away from recommending universal use of antivenin because of the high rate of anaphylaxis and delayed allergic reaction to antivenin.

73. Had a six-month-old patient with complete neuroblastoma lesion of the upper thoracic spine and needed the most recent prognostic information for children on the relationship between the length of the interval between symptoms, surgery, and the recovery of function.

Received July 1995; accepted November 1995
APPENDIX B

Summary of citation information, case 39

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* This score assigned on the basis of the clinical extract. Italicized items represent articles chosen for the review process. Article types are those reflected in the original MEDLINE file. In the actual clinical extracts, article types for Fuller, Azzarelli, Halpern, Johnson, and Spratt were made more specific. Where abstracts were present, case coverage is indicated.

APPENDIX C

Sample prototype clinical extract for a mixed article

AU—Levy MH
TI—Integration of pain management into comprehensive cancer care.
PT—5 cases + review
RF—49 refs
SO—Cancer 1989 Jun 1;63(11 Suppl):2328–35
IN—Pain Management Center, Fox Chase Cancer Center, Philadelphia
AB—Pain management is an integral component of comprehensive cancer care. Designing an effective pain control strategy for the individual patient requires knowledge of the ways in which a patient’s cancer, cancer therapy, and pain therapy can interact. Two important aspects of cancer that affect the way in which pain is managed are the cancer’s treatability and components of its pathophysiology that themselves do not cause pain (the cancer’s nonpain pathophysiology). Cancer treatability modifies the need for pain management and the appropriateness of invasive pain procedures. Cancer nonpain pathophysiology can interfere with the oral administration of medications, narrow the patient’s therapeutic window for analgesic drugs, limit the effectiveness of psychologic pain therapies, and complicate or preclude invasive pain-relieving procedures. In addition, cancer therapy can interfere with or enhance pain therapy and vice versa.

[Text of abstract truncated for display purposes]

HD—Effect of Cancer Treatability; Effect of Cancer Nonpain Pathophysiology; Interaction of Cancer Therapy and Pain Therapy (Interference of Cancer Therapy with Pain therapy; Enhancement of Pain Therapy by Cancer Therapy; Interference of Pain Therapy with Cancer Therapy; Enhancement of Cancer Therapy by Pain Therapy); Case Reports; Conclusion
PF—Case 1: 57 y old white man who had non-small cell carcinoma of the lung metastatic to the brachial plexus and bone. Case 2: 60 y old white man with non-small cell cancer of the lung metastatic to the peri-pancreatic lymph nodes. Case 3: 53 y old white woman with carcinoma of the colon that was locally recurrent, had invaded the pelvis, and had metastasized to the liver and lung. Case 4: 60 y old white man with adenocarcinoma of the lung metastatic to the pleura and chest wall. Case 5: 61 y old white man with an unknown primary lesion that had metastasized to the bone and lung.
TB—#1=Information on Patients Receiving MS Contin in Long-Term Guidelines Study; 2=Preliminary Observations in Patients Participating in Long-Term Guidelines Study with MS Contin
FG—#1=Course of treatment, case 1; #2=Course of treatment, case 2; #3=Course of treatment, case 3; #4=Course of treatment, case 4; #5=Course of treatment, case 5.