Precis-Based Navigation for Familiarization

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Abstract

A patient's medical record can be a complex, diverse, disorganized, and often geographically distributed collection of documents. Sorting through this collection to find needed information can be a formidable and time-consuming task. The electronic medical record (EMR) offers some hope of improving access to patient information, but may create new problems for the health professional who must navigate through digital information, where traditional document boundaries are not necessarily easy to discern.

We are focusing on the problem of familiarization *where a physician or other healthcare professional is presented with the medical record for a new patient. How can the physician get a feeling for the overall medical condition of this patient? How can a physician locate the information relevant to the patient's current problem? More generally, how can a physician become familiar enough with the case and cross the threshold of uncertainty in order to feel comfortable making a decision regarding the patient?*

To assist with the task of familiarization, we are developing precis-based navigation tools, where a precis is a concise summary of information and metainformation from an individual document in the medical record. Precis are introduced for each document in a new layer of technology, superimposed over the various sources of medical records such as various EMRs and paper-based systems.

Using the precis, a clinician or other user may search and sort through a complex document collection to find the information relevant to the problem at hand. In this paper we outline our user model, describe the features and functions of the precis technology at its present stage of development, and discuss the technical research questions that arise in this work.

Keywords:

Medical Record Systems, Computerized Forms and Records Control Models, Theoretical Medical Informatics, Computing Physicians, Discriminative Learning, Attitude to Computers.

Introduction

An essential initial task of the clinician attempting to solve a patient's clinical problem is to familiarize himself or herself with the information in the patient's medical record. In the case of complex, chronically ill patients, this task may be a formidable one. The medical records of such patients tend to be large, complex, diverse, often poorly organized document collections, frequently geographically distributed across multiple sites of care. Patients with multiple chronic illnesses generally receive care from numerous specialists, each maintaining a separate medical record in his or her office. Over time, such patients tend to be hospitalized or treated at multiple institutions, leaving a trail of separate records in each location. Even within an institution, components of the patient's record may be stored in diverse locations, either due to the diverse media needed for storage (diagnostic images in radiology, cineangiograms in cardiology lab, etc.), different reimbursement and financing requirements (inpatient records in the hospital records room, outpatient records in the ambulatory clinic record room), or social and organizational factors (mental health and other specialized treatment units' records separated from the other hospital records).

Ongoing changes in the health care system further contribute to the complexity and fragmentation of the medical record. Managed care organizations and third party payors add an assortment of documents to the medical record relating to establishing the need for health services and authorizing payment. Competition among managed care organizations leads to an increased transfer of patients among health systems, as patients and their employers shop for the best health insurance values, with the result that medical records and medical care become more fragmented than in the past when physician-patient relationships tended to be more long standing.

Even as medical records become more diverse, clinician familiarity with individual patients may be diminished. Clinicians, driven by market forces, are also more prone to move among health systems, taking on a new population of patients and leaving most of their former practices behind. To meet the demand for timely access to care, patients are often seen in urgent care and same-day appointment settings, usually by a clinician who is unfamiliar with the patient and often without the medical record, which may not be obtainable on short notice.

As a result of these factors, the task of familiarizing oneself with the facts of a patient's case can be a difficult one. Navigation through this collection of documents can be inefficient and time-consuming. In such a large, diverse document collection, much of the information in the record may be redundant or irrelevant with respect to the clinical problem at hand. Many important pieces of information may not be physically present in the medical record, for the reasons enumerated above. Tang, et al. have shown that even when needed information is physically present in the medical record, it very often cannot be located by the clinician because of poor organization of the paper documents. [1]

The advent of the EMR offers the promise of improving on some of these problems, as many users of such systems will attest. However, many other problems with medical record complexity and fragmentation are not solved by use of the EMR, and new ones may be created. Clinicians used to handling collections of paper documents may not be able to recognize the structure and organization of the EMR content, a problem indexing and retrieval can only partially solve. Use of the EMR lends itself to an increase in the size of the medical record, as clinicians and other health care workers increasingly use forms-based charting and documentation, yet much of this information, and even the size of the document collection itself, may not be apparent to the EMR user, who sees only one screen at a time. It is not known whether the inefficiency of reading from a computer screen compared to reading from paper will lead to less thorough perusal of the record than may have occurred in the past. Traditional cues to the source and purpose of entries in the record, such as a consultant's letterhead, a familiar clinician's handwriting, or the use of underlining, colored ink, and other variations in handwritten entries used to draw attention or emphasize information in paper records, may be lost in the EMR with its uniform display appearance and font. As a result, clinicians may be less able to discern which documents and entries to examine and which to ignore. Even the definition of a document becomes lost in an EMR, where information presented on the computer screen may be a composite of many separate entries by different individuals in different places at different times.

To help address these problems, we are developing the *precis*, a tool to assist clinicians in efficiently navigating and manipulating the large, complex document collection that is the medical record.

User Model

Imagine that you are a physician on call. You are telephoned by a panic-stricken patient whom you've never met, a patient of one of your colleagues. As you quickly discover, the patient has a complex medical history with multiple medical problems and is taking numerous medications. How can you get a handle on this patient's medical history in order to assess the patient's current problem in the context of other potentially relevant conditions? How can you become sufficiently familiar with the patient, his current condition, coexisting conditions, and medication regimen to feel comfortable making a recommendation about a course of treatment? In short, how can you adequately *familiarize* yourself with the case?

In this work, we assume the user is a clinician, unfamiliar with the patient, whose task is to solve an active clinical problem. The clinician is a health professional that possesses specialized knowledge and experiential training in a specific domain of health care, deals directly with individual patient care problems, and makes decisions or recommendations about patient management. Examples might include 1) a urologist, consulted because of difficulty with urination, who must cull from the patient and the medical record the details of current and past medical history that might be relevant to this problem or its treatment; 2) a cardiologist, called in to see a postoperative patient because of an emergent cardiac condition, who must extract from the medical record those facts which are germane to cardiac diagnosis, treatment, and prognosis; or 3) a home health nurse, who must review the medical record for issues relating to home health care needs, the resources available to meet them, and related issues.

In each case, the task of the user is to navigate efficiently through a complex collection of documents to familiarize him or herself with the case, identifying information relevant to the problem(s) at hand, while ignoring non-relevant material. Clinicians will often jot down brief notes, sorting, selecting, and recombining items of information, and subsequently organize them into a high-level summary, such as a dictated consultation note. This process of organizing the facts into higher-order structures is consistent with our understanding of expert reasoning [2] and analogous to the information 'funnel' described by Blois [3]. In doing this the clinical problem solver must negotiate the tension between being comprehensive versus being efficient, becoming sufficiently familiar with the case to decide on a course of action, but not devoting more resources to the task than is absolutely necessary. In this task more information is not always better; studies of diagnostic reasoning have shown that, when performing a diagnostic task experts actually acquire less information, following a more efficient path to the diagnosis than nonexperts [4,5].

Each user thus creates a unique subset of the medical record, determined by the clinical problem at hand and the expertise of the clinician. This subset can become the beginning of what amounts to a thread, as a clinical problem evolves over time, attended to by various clinicians in related domains. Often multiple clinicians are attending to the patient during the same time period, each using a domain-specific subset of the information in the medical record and largely ignoring the remainder.

To create this problem-specific subset of information, each clinician must sort through the document collection, assessing the probable value of each document prior to actually examining the document's content. Some documents will receive minimal attention; some will be scrutinized with care. A cardiologist is likely to personally inspect each electrocardiogram, (ignoring any written interpretation), while simply scanning the interpretation of a hip radiograph (not personally examining the films). An orthopedist is likely to do the opposite. Each may simply make note of the fact that the alcohol treatment team has seen the patient, without actually reading any of the relevant documents. The relative value, or utility, of any document in the medical record will differ according to the user and the context, and will often change over time. What is needed in the EMR is a concise set of descriptors that enable a clinician to estimate the relative utility of each element of the medical record; the precis is such a set of descriptors.

Precis-Based Navigation and Browsing

We are developing precis-based navigation and summarization techniques to allow clinicians as well as other caregivers to easily become familiar with a patient medical record. A *precis* is an abstract or summary used to represent one document in the underlying medical record. The themes of this work are:

- Precis-based navigation is superimposed over existing paper and electronic medical record systems, and does not disturb the underlying, participant medical record sources. We do not require that all relevant information be placed within a single system.
- Precis-based navigation is document-centric. That is, we believe that a medical record consists, conceptually, of a progression of documents (for example, physician's notes, lab tests, and prescriptions). Note, these documents need not be on paper.
- Precis-based navigation parallels what caregivers actually do when they have access to a complete medical record, for example, a paper medical record in a folder, for the first time.

The idea is to have a simple, explicit precis for each (conceptual) piece of paper in a medical record. We provide a simple, visual user interface to allow a caregiver to navigate and browse through the patient folder, represented as a collection of precis. Examples of questions that precis-based navigation can answer are: How much medical activity has there been? (How thick is the folder?) How does the medical activity in the folder cluster by date? Can we pinpoint key medical events in the life of this patient? Which documents (which precis) relate to cardiac problems? Has this patient ever had a cardiogram? A precis contains high-level information such as date, document type, and caregiver (author) so that flipping through or visualizing the precis allows a clinician to get a sense of the patient's medical history. We want the process that a physician already uses to become familiar with a patient to be enhanced and more efficient.

Consider the system overview shown in Figure 1. Existing medical record systems are shown across the bottom of the figure. We focus on the various folders for patients, each consisting of a set of documents, as shown in the figure. The middle layer of the figure shows the information that is introduced to support precis-based navigation. Each folder of interest from an underlying medical record system, and each document in the folder, is echoed in the precis layer by a folder proxy and a set of precis. A dotted arrow indicates the correspondence between the underlying information and its precis or folder proxy.

As well as browsing through a set of precis, the user may create collections of precis for his or her own use. We use the term *bundle* to indicate an arbitrary collection of precis and other bundles. The idea is that a clinician may wish to browse the precis of a given folder, or the union of several folders, and select certain precis of interest, for example, the documents pertaining to cardiac events. The clinician may wish to create a cardiac bundle consisting of bundles, each corresponding to a particular cardiac event, etc.

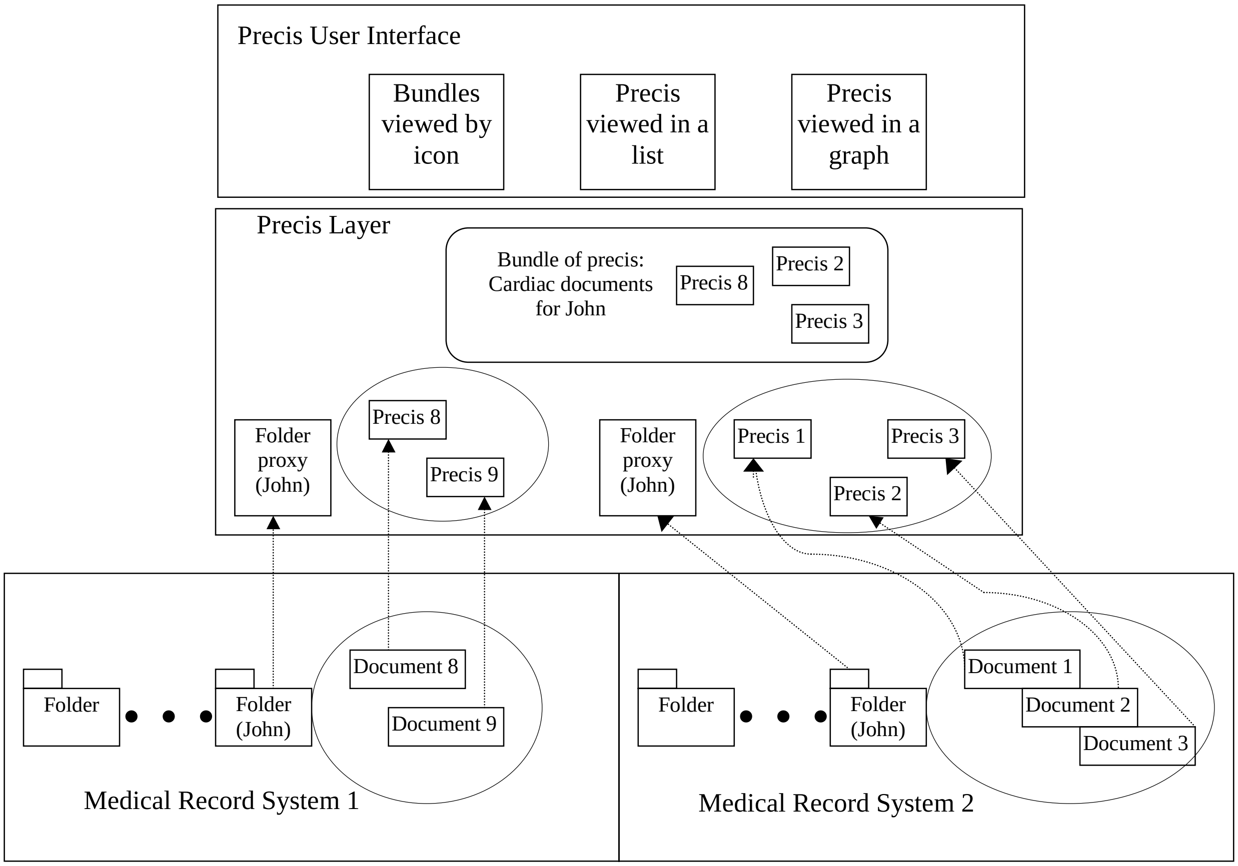
Bundles may be built manually, or by grouping, sorting and filtering operations, or as the union, intersection, or set difference of other bundles. Bundle may also be annotated, to describe their purpose, and to describe the relationships between their components.

The actual information in a precis will likely evolve as we work with more clinicians. At present, precis contain the author's name and role (nurse, cardiac specialist, and so on), date, document type (lab report, problem list, prescription, consent form, and so on), 'thickness' (number of pages), institution, and 'information category'. The last is designed to give the user a general idea of what kind of information might be in the corresponding document. Presently, these categories are "administrative", "problem list / diagnosis", "lab result", "medication", "procedure", "referral", "symptom or complaint", and "treatment". A document may have information in more than one of these categories.

The user interface representations for precis-based navigation are shown at the top of Figure 1. We support three types of browsing: through tables and time series of precis, and through an icon-based view of bundles. Some novel aspects of these views are described briefly below.

The caregiver can see the "thickness of the folder" by seeing a stack of precis icons. Clinicians find the thickness of folders or documents an important clue about complexity and about what to look at first

Figure 1: Overview of the system



Another visualization of the precis for a patient is as a time series. Since a cluster of medical documents often accompanies medical events, the caregiver may easily see major episodes in the patient's medical history.

The user interface makes extensive use of color to represent the categories of a given precis field. For example, the points representing precis in a time series may be colored according to the document type or information category. For example, all administrative forms might be colored gray; pharmacy-related information might be colored red; physician's notes might be colored blue; and lab reports might be colored green. Coloring the points of a time series to indicate a categorization by disease or affected organ system would be particularly interesting in uncovering episodic structure of the patient's medical history.

The system allows the user to easily select and browse precis, "drill down" to the underlying document, and create and manipulate bundles.

Discussion

Our approach to precis-based navigation presents a number of questions and research issues. We discuss some of these important questions here.

Why do we focus on documents? Why does an individual precis correspond to an individual document? We believe that the medical record, in its most commonly used form, consists of a time-ordered progression of discrete information entries. As a simplified example, a paper-based medical record has a document (often a single piece of paper) for each office visit, consultation lab result, prescription, etc. Even when there is no paper, the medical record documents the time-ordered progression of discrete entries representing decisions, actions, or opinions of healthcare professionals.

How much information, particularly medical information, belongs in a precis? At one extreme, a precis might consist only of a pointer to a document, without any data associated with the precis. At the other extreme, a precis might repeat all of the information from the underlying document (although we probably wouldn't call it a "precis"). In this work, we choose a middle ground position where the precis contains a small number of explicit fields, including the information category to give an indication of what sort of medical information can be found in the underlying document. The use of the information category leads to the next question.

What are the proper information categories to be used in precis? Which classification system will be most useful to users is an empirical question, to be answered in controlled settings where the effect of the information on the user or on task performance can be compared. One approach is to use existing course typologies, such as classic organ system or disease categories (heart, lung, brain, and so on), that have appeal because of their simplicity. Another is to use a richer and more granular controlled vocabulary, such as MeSH, SNOMED, etc., and take advantage of automated text processing techniques to perform the classification. An important problem is that relevance is context dependent; thus a classification that is helpful in one circumstance may not be helpful in another.

How will precis be created? And how will information categories be assigned to individual documents or entries? We envision a spectrum of approaches ranging from a manual process to an automated one, based on information retrieval techniques. We see the issue of how to create precis as an important but orthogonal one to the question of whether precis-based navigation is useful, particularly for the problem of familiarization. A companion project [6] is considering techniques for classification of medical documents that could be used to associate information categories with precis.

When will precis be created? This issue is also somewhat separate from the question of whether precis-based navigation is useful. For the purpose of familiarization, a clinician focuses on the records of a particular patient, often gathered from multiple source medical record systems. We envision that relevant precis can be created as needed. Other uses for precis may require precis and folders from multiple patients at once. Note that the issues of consistency and completeness of a set of precis with the underlying information source(s) are very important, although we have not yet focused our attention on these issues. They must be considered if the underlying documents are updated while the precis are being browsed and manipulated.

Why are we prototyping the navigation aspects of precis first? We focus here because we believe that it is necessary to demonstrate the utility of precis-based navigation, e.g., for familiarization) before we address the supporting issues such as the creation of precis.

Why do we introduce precis-based navigation as a superimposed layer? One alternative would be to introduce precis-style browsing directly into an EMR. We believe that it is hardly ever the case that all relevant medical information will reside in a single system. A superimposed, precis-based layer presents a simple, uniform summary over a diverse set of medical record sources. Work in progress is addressing the development of superimposed information [7].

This paper reports on initial results from a collaborative research project involving both clinicians involved in assessing the information needs of clinicians [8] as well as computer science professionals focusing on the information models and technology for superimposed information. The overall challenge for this work is to investigate the utility of familiarization technology to support healthcare professionals.

One important function of the precis is to enable clinicians to *chunk* information contained in the medical record. Chunking refers to higher-order cognitive structures, such as diagnosis *scripts* [9] which enable experts to manipulate complex information more efficiently. By using precis, or bundles of precis, clinicians can achieve similar efficiency in a manner analogous to human cognition. We will use *think-aloud* methods with expert clinicians reviewing complex medical records in the laboratory and in the clinic, to learn more about this process and to modify the precis accordingly.

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