Methods of Information in Medicine

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Online Medical Records: A Decade of Experience

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Abstract: The electronic patient record at the Beth Israel Deaconess Medical Center has fundamentally changed the practice of medicine in ways that its developers never foresaw. This type of highly interactive and work flow enabled program is creating new collaborative roles for computers in complex organizations [4]. With the system able to supervise and monitor care, computers are able to perform many care coordination and documentation functions, freeing people to concentrate more on interpersonal interactions and provision of health care services. One of the challenges in the design of electronic patient records to assist health care providers is how to support collaboration while not requiring that people meet face-to-face. Moreover, a greater challenge for each of us as clinicians is to use this technology as a bridge (rather than a barrier) towards better patient-doctor relationships.

Keywords: Electronic Patient Records, Guidelines, Collaborative Practice Models

1. Introduction

We developed an extensive online patient record as a part of a heavily used integrated hospital information system for use in an ambulatory primary care practice with the goals of facilitating workflow, supporting collaborative practice models, delivering clinical practice guidelines, and making the ambulatory office paperless. Since 1988, we have deployed it in more than 61 practices of many different specialties and its use continues to grow. Since its inception 10 years ago, clinicians have entered more than 392,000 problems, 1,400,000 medications, and 1,300,000 notes into our computer system. In 1997 over 800 different physicians and nurses entered information on over 53,000 patients; an increase of 22% for clinician users and 30% for new patients. We describe the design of the system, its use over time, security and confidentiality features, and its future evolution.

2. Methods

2.1 The Center for Clinical Computing (CCC) System

Beth Israel Hospital is served by a mature clinical computing system that began to evolve in the late 1970s. This system is one of the most widely used in the USA and is available from over 5000 terminals in both inpatient and outpatient settings [1-3]. Physicians use the computing system to look up the results of all diagnostic studies, to send and receive electronic mail [4, 5], and to perform a variety of decision support tasks [6], including online literature searching via PaperChase, clinical database retrieval [7], computer-assisted expert consultation, and online clinical calculation.

2.2 Early Development of OMR

In 1988, Healthcare Associates (HCA). a large primary care faculty practice, had outgrown its space in a hospital building. It needed to be split into two sites: while one would remain at Beth Israel, one would be located in a separate building one block away. Although the hospital's information system would still be accessible, the medical records department did not have the ability to deliver the paper records to this location. The practice asked the Center for Clinical Computing for assistance. They required simply a way to store patient problems and medications online and share this information with the physically separate emergency room. By 1988, researchers in Europe and USA had already well demonstrated the value and importance of electronic patient records [8, 10-29]. Thus was born the rudiments of what became today's online pafient record (OMR).

The OMR has been designed around three general principles: 1) the clinician should interact frequently with the system; 2) there should be no transcription from paper forms; and 3) data entry should be kept to a minimum and shared among clinicians, others on the hospital's staff, and even patients themselves [30-33]. Having clinicians interact directly with the computer system in-

creases the accuracy of data capture and, more important, dialogue with the computer system provides an opportunity for education, documentation, and action. It is this opportunity that will allow us to effect changes in practice guidelines and to disseminate this information.

The OMR is organized around a central, integrated patient registry that contains information on more than 1 million patients that is the core of the CCC system. Clinicians keep problems lists, medication lists, screening and flow sheets, and progress notes online. In addition, physicians and nurses can order selected laboratory and diagnostic procedures and consultations online from any of the terminals located throughout the hospital – in every examining room and in all ambulatory care clinics and offices.

During the past decade of work on OMR, there has been a continuous evolution of our philosophy toward the representation of clinical data such as clinical problems. As multiple uses of the data have evolved (from provider communication to aggregate analysis to decision support) data capture has evolved, from complete free-text to selection from a local dictionary. Our work in 1997 has continued this evolution of our understanding of terminology services with ongoing development of the Problem List Toolkit (PL/Tk) in conjunction with Lexical Technologies, Incorporated (LTI) and Mayo Clinic [29, 34]. The OMR system is an integrated module of the CCC system and to date operates on the Open M Technology (MUMPS) platform.

A prototype of the OMR system was introduced at Healthcare Associates, the general medicine practice at Beth Israel Hospital, in late 1988. The one-fifth of Healthcare Associates who practiced at a satellite clinic had the ability to keep a problem list and a medication list on the computer. No manual was written, but several demonstrations were conducted. In July 1990, the OMR system was introduced at the remaining practice locations. The OMR system is now used in 61 practice locations at the medical center and at satellite clinics within about a 12-mile radius.

2.3 System Use

Since the system was first introduced in late 1988, over 800 different staff physicians, nurses, resident physicians, and psychiatric social workers have noted 391,897 problems and written 1,367,450 prescriptions for over 53,000 patients. Clinicians also documented health promotion and disease prevention (such as recording a patient's blood pressure, indicating that a prostate examination was completed, or indicating that a tetanus shot was given) over 100,000 times on screening sheets. The computer automatically added 150,000 additional items to these screening sheets – cholesterol levels and the results of mammography and cervical cytology. Since 1991, clinicians typed or dictated with later transcription 1,278,484 progress notes.

During 1997, 61 different primary care and specialty clinics entered 117,779 and 153,111 notes respectively; 42 different primary care and specialty clinics entered 1,087,437 and 280,013 prescriptions respectively; and 38 clinics wrote 30,730 new entries onto primary care problem lists and 8,106 new entries onto problem lists of specialty clinics, The growth of use of the OMR seems to be exponential with the most rapid growth now occurring in non-primary care areas.

2.4 Knowledge-Based Medical Records

Building upon the working infrastructure of the CCC system and the OMR system, we developed a knowledge-based medical record (KBMR) designed to allow the online patient record to play an active role in the care process [33, 35]. These programs integrate the online patient record, rule-based decision support, and full-text information retrieval into a clinical workstation for the practicing clinician.

We developed computer programs ***to alert*** the clinician about these clinical events, to help the clinician ***to act*** on the information, and ***to document*** the clinician's response in the medical record. The computer programs indicate whether the rule calls for urgent attention (e.g., "your patient's white blood cell count has dropped and you should consider adjusting the AZT dose"), or prompt attention (e.g., "your patient's CD4 count has been below 200 on two occasions and you should consider prophylaxis for ***Pneumocysfis curinii*** pneumonia"), or the information can wait until the next scheduled visit (e.g., "your patient needs an influenza vaccination"). If alerts are pending, the clinician is informed every time the main options are displayed: "You have MEDICAL ALERTS".

In addition to providing timely information, the HIV alerts are designed to help the clinician carry out the intended action. For instance, when the clinician is told that an AZT dose should be modified, seven choices are offered: 1) modify the dose, 2) indicate that the alert is inappropriate or inapplicable, 3) indicate that the alert was sent to the wrong person, 4) forward the alert to a specific person, 5) calendar the alert until the next appointment, 6) display the on-line medical record, or 7) display test results. If the clinician chooses "modify the dose", the computer offers to print a new prescription, send a letter to the patient, or schedule an appointment with the patient. The patient's telephone number is also prominently displayed.

As a by-product of delivering an alert or reminder on the computer and assisting in an action to carry out the practice rule involved (e.g. order the test, print the prescription, gather the data), documentation is established in the OMR. This helps create not only well-documented individual care, but also a standardized database for practice monitoring.

We earlier conducted a nonrandomized, controlled, prospective trial performed over an l&month period to investigate the KBMR system [36]. Presentation of a set of alerts and reminders as part of a computer-based medical record resulted in significantly faster and more complete adoption of practice guidelines by a group of clinicians treating patients with HIV infection. The median response times of clinicians to the events prompting 303 alerts in the intervention group and 388 alerts in the control group were 11 and 52 days ($P < 0.0001$), respectively. The median response times of clinicians to the events prompting 432 reminders in the

intervention group and 360 reminders in the control group were 114 and >500 days (P <0.0001), respectively. This study showed that the electronic patient records in routine use could dramatically effect physician behavior in carrying out clinical practice guidelines.

3. Sharing of Clinical Information

Providers within our health care system have always transmitted clinical information to one another through electronic mail [5], but the OMR permits providers to transmit patient-identifiable clinical notes to one another. This is a concept we call *Patient-Centered Communication.*

Clinicians can forward an OMR note to other providers when they are signing a note that they authored. Alternatively, clinicians may choose a note from any patient's OMR record, regardless of the note's author, and forward it to another provider. The sender of the note may optionally attach a free-text comment to the shared note. This comment is not stored in the patient's record but is readable as part of the forwarded note; once read and deleted by the recipient, the attached comments are no longer retrievable. It is important to note that the note itself is not actually transmitted but a pointer to the note's location is sent, ensuring that the recipient is always viewing the most up-to-date version of the note.

When users log on to the system, they are presented with a queue of clinical alerts, notes to be signed, and forwarded notes. The user can read these notes with the attached comments and reply to the sender of the note, forward the note to other providers, view the patient's online record, print the note, or delete the message from his or her queue.

Approximately 1000 *Patient-Centered Communications* are sent each week using the OMR.

During a single week we studied the methods and patterns of communications in one primary care practice using the OMR system [4]. Figure 1 shows

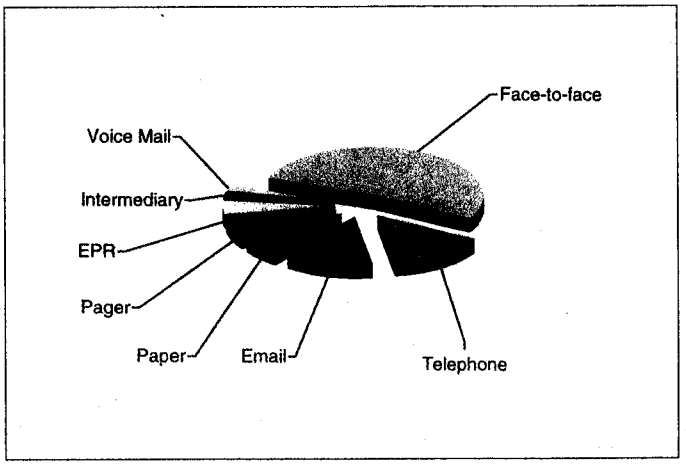

Fig. 1 Modes of clinical communication

that face-to-face communication is still the predominant method for exchange of information between clinicians. However, email and email attached to patient notes are the second most common method.

3.1 Costs and Cost Saving

OMR was developed using research grants. The ongoing maintenance and development budget is provided by the hospital, and covers costs for the OMR specialists (currently 3) and programmers (currently 2).

The actual marginal costs to implement OMR in a practice already connected to CCC are negligible. It costs between $200 and $1800 per user, depending upon the hardware requirements. The archival storage of data from OMR has a cost but it is negligible when compared to the costs of archiving the entire clinical information system.

The savings from OMR can be divided into two areas. One is improved quality of care, arising from better documentation, facilitated communication among providers, and improved adherence to practice guidelines. One could surmise that this could improve the network's ability to obtain managed care contracts and could protect us against malpractice litigation. It is, however, difficult to quantify these savings.

In the clinics where the vast majority of patient information is online, the paper record no longer needs to be retrieved. The cost of retrieval is about $1 per paper record request in the main campus of our institution. This includes retrieving, tracking, delivering, retrieving, and refiling the record. In addition to retrieving a record for a patient visit, the medical record needs to be retrieved for telephone contacts. In the large primary care practice that receives over 20,000 calls per year, the paper records are no longer needed. In addition, we can approximate similar savings in the emergency room where 36,000 patients were treated without retrieving the paper records.

Although the goals of the OMR project were to produce a paperless medical record, for medical legal reasons we continue to print a permanent hard copy of the record. A paradox of going paperless is that we print more sheets of paper today than we used to in the past. Our medical records department prints more than 367,000 sheets of paper each year for filing in records of ambulatory patients. That is roughly 1000 sheets per day; 71% of this is printouts of laboratory data, 20% is OMR notes, and 9% is operative notes and discharge summaries. The cost for supplies to print this (and thus the potential cost savings) is $20,000. Filing these papers requires about 6000 hours, which is worth $69,000. These documents occupy 187 linear feet of file space. The space that these records consume (and the opportunity cost of this space) is $10,000. The total potential savings is therefore $200,000 per year should we stop the printing. Overall, the total of realized and potential cost savings from not having to manage paper records in our institution is $250,000 per year.

Table 1 Reasons for assessing a patient record and time lapse before re-asking.

Reason for Access	Time until Re-Asking
Providing Clinical Care	6 months
Cross-Coverage or Follow-up	3 months
Precepting/Teaching	3 months
Research	3 months
Administrative/Scheduling/Ancillary Care	1 week
Quality Assurance	1 week
Unsure if this is the Patient	Next access
Other	1 week

3.2 Confidentiality Protections

Since its inception, the CCC system has utilized multiple mechanisms to protect the security and confidentiality of patient information [1; 3; 9]. These protections include passwords that are assigned by the system, access restrictions by user and location, automatic timeouts of terminals, audit trails of changes to data, audit trails of access to data, and a utility that allows any user of the system to easily view who has looked at that user's medical information.

After implementing the OMR, we found that certain confidentiality enhancements were necessary to improve provider and patient comfort with the system [31]. In designing these enhancements, we tried to keep with the existing CCC policy that confidentiality protections should not interfere with necessary access for patient care.

3.2.1 Monitored Notes

Any author of a note on the CCC system may choose to "monitor" access to that note [8]. At the time the note is electronically signed, or at any other time, the author can turn monitoring on or off for a note. If a note is monitored, when someone attempts to read the note, he is warned that access to the note is being monitored and that if he proceeds, an electronic message will be sent to the note's author informing him/her that the reader accessed the note. If the reader chooses to proceed, he/she is asked to type a reason why he/she is looking at the note, and to confirm by entering his password. This reason for access is part of the electronic message that is sent to the author.

Mental health providers monitor notes far more frequently than general internists or other specialists.

3.2.2 Reason for Access

In 1996 after we had dealt with several breaches of confidentiality that seemed to be due in part to staff being unaware of the importance of maintaining confidentiality, we decided to add a question asking every provider the reason why he/she was accessing a patient record the first time that record was accessed [9]. Table 1 shows the possible reasons for access as well as the length of time until that provider is again asked to provide a reason for access. If the provider chooses "Other" as a reason for access, he/she is able to type a free-text reason for accessing the record.

Whenever a provider enters a reason for accessing a record of a patient, a notification of the access and the reason given is sent to the patient's primary care physician who is recorded in the OMR, if such a person is known to the system. Notifications are not sent while a patient is hospitalized or is being seen in the Emergency Department, to cut down on the volume of notifications. Individual physicians can turn off routine notification and request notifications only about specific patients. Providers other than primary care physicians can also choose to be notified about accesses to any specific patient's record. This request for notification is tracked and communicated to the primary care physician just as a record access would be.

3.2.3 Patient and Employee Access to Audit

With the consolidation of care, we increasingly find that employees with access to the clinical computing system and OMR are also our patients. Although we have explicitly studied access patterns and have not been able to detect that employee patient records are accessed more frequently than non-employee records, we perceive that employees are at greatest risk for inadvertent exposure of their health information. In addition to recording the reasons for access to the record, we make available online a display of the audit for each individual employee. This not only allows for self-policing and some reassurance, but is a gentle reminder that any patient can see who has looked at their records.

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