OUTPATIENT MEDICAL RECORDS FOR A TEACHING HOSPITAL: Beginning the physician-computer dialogue

Charles Safran, M.D., Charles Rury, B.A., David M. Rind, M.D., William C. Taylor, M.D.

From Department of Medicine, Beth Israel Hospital, and the Center for Clinical Computing, Harvard Medical School, Boston, Massachusetts

ABSTRACT

We have developed an outpatient medical record (OMR) system designed to facilitate direct physician interaction with the computer-based medical record. During the first two years the system was in use, staff physicians, residents, and nurse practitioners entered 15,121 active and 1996 inactive problems for 3524 patients, and 12,651 active medications and 1894 discontinued medications for 3430 patients. These clinicians entered 20,321 items on health promotion and disease prevention screening sheets and with the help of automatic updating by the computer an additional 21,897 entries on screening sheets were made for 8686 patients. On the computer, clinicians wrote more than twice as much - - 10.9 words per problem, in contrast to 4.3 words per problem in the paper record ($p < 0.0001$, Student's t). We conclude that clinicians perceived the computer-based problem list to be more valuable than its paper counterpart.

INTRODUCTION

The advantages of computer-based ambulatory records have been known for over a decade [1-15], yet fiscal, technological and social barriers to the widespread adoption of this technology still remain. Computer-based records improve access to information [1,3,4,6,8,9], positively influence physician behavior [4,5], improve the quality of care [2,3,10-16], and provide a needed opportunity for outcome-based research [7,16]. In institutions where computer-based records have been introduced wisely and well, acceptance by clinicians has been high [17,18].

Early studies of physician-computer dialogue -- e.g. for the collection, storage, and retrieval of the results of the physical examination [19] and the medical history [20] -- showed promise. To this day, however, many practice-based systems do not allow clinicians to interact directly with the medical record system, but rather rely on transcription of data forms that are filled out by the clinician, who in turn is given printed reports. This paradigm of physician-computer interaction is derived from two factors. First, many computer-based ambulatory record systems evolved from technology introduced in the 1970's, when computer processing was both limited and expensive and computer terminals were so primitive that they frequently did not even have lower-case characters. Second, and perhaps more important, physicians tend to consider their time too valuable to spend it entering information into a computer. However, direct entry of information by clinicians should help ensure its accuracy, avoid delays in transcription, and provide an opportunity for knowledge-based computer systems to help clinicians provide care.

At the Beth Israel Hospital in Boston, where clinicians look up patient information on computer terminals throughout the hospital over 40,000 times per week [18,21,22], and type, send, and receive over 13,000 pieces of electronic mail each week, we have developed, as part of this system, an outpatient medical record (OMR) system designed to facilitate direct physician interaction with the computer-based medical record. This paper describes the development of the system and its use since its introduction in February, 1989.

SYSTEM DESCRIPTION

In the 1970s the Division of General Medicine and Primary Care in the Department of Medicine at Beth Israel Hospital in Boston established a cooperative practice model, Healthcare Associates, in which faculty, medical residents, nurse practitioners, psychiatrists, social workers, and, more recently, clinical specialists on AIDS all participate in the care of patients [23]. In February of 1989, one fifth of this practice moved to a location outside of the hospital, where it was not possible to transport the hospital's paper medical record. To facilitate communication between the clinicians at this location and those at the hospital, we installed terminals in every office in this new setting and developed programs allowing clinicians to enter, edit, and display problem lists, medication lists, health promotion and disease prevention screening sheets, flow sheets, and progress notes. In addition, we developed reminders to clinicians for influenza vaccination. Since July 1990, terminals have been in use in all the offices, both in the hospital as well as the distant practice site.

0195-4210/91/$5.00

When a clinician gains access to the hospital's clinical computing system in the primary care ambulatory setting, his or her schedule is displayed on the screen. The clinician can select a specific patient and display a summary of the patient's diagnoses, medications, and recent appointments.

Entries on the problem list are typed in full by the clinician. Problems can be entered as active or inactive, and clinicians can write additional comments of any length. Figure 1 shows a typical problem list for a patient with AIDS. To protect patient confidentiality, a clinician can restrict access to the display of a problem to a specific group of providers. Rather than developing a controlled vocabulary and restricting choice, we have tried to give clinicians control over their records. On the basis of a review of over 10,000 routinely entered problems, we devised a categorization for primary care (an extensive dictionary of synonyms, including misspellings) that serves as a basis for management reports and clinical reminders.

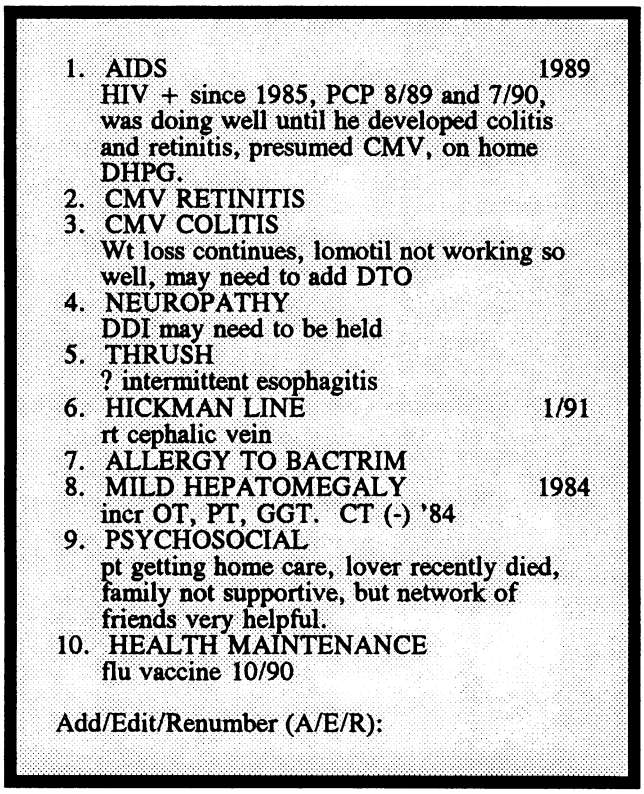

Figure 1. Problem List

Medications can be entered on the medication list by typing the first few letters of either the generic or trade name of the drug. The computer first looks in the hospital formulary for a match. The possible matches are displayed along with possible routes of administration and dosage. If no match can be found, the physician types the medication name. Physicians can print a new prescription or refill an old one simply by typing the letter "p".

Clinicians can elect to view standardized flow sheets for the care of patients with diabetes, hypertension, lipid disorders, HIV infection, and chronic anticoagulation. Alternatively, they can create flow sheets that look into the hospital's laboratory system and combine those data with information they have entered in the OMR system.

Vital signs, weight, vaccination records, cholesterol levels, and the results of cancer screening tests (tests for occult blood and rectal exams; testicular and prostate exams in men; breast exams, mammography, and Pap smears in women) are recorded on screening sheets. Each time the screening sheet is displayed and approximately one month after a patient's visit, the computer automatically updates any new cholesterol levels, mammograms, and Pap smears not previously recorded.

Influenza vaccination is recommended on the schedule displays for any patient who is over the age of 65, has a chronic problem (such as diabetes, chronic obstructive pulmonary disease, or coronary artery disease) on the problem list, has a chronic disease on a discharge summary from any hospitalization since 1984, has had abnormal laboratory values suggestive of chronic disease (elevations in serum creatinine and serum glucose), or has had influenza vaccinations in the past. When a clinician records a vaccination or a patient refusal on the disease prevention screening sheet, this reminder is removed.

Physicians can type progress notes directly into the computer. Each section of a note can be indexed to any problem on the problem list. Such problem-oriented notes can be displayed by date or by problem over time. Notes are printed for the paper medical record.

RESULTS

During the first two years, when the system was in use only in the distant practice site, staff physicians, residents, and nurse practitioners entered 15,121 active and 1996 inactive problems for 3524 patients and entered 12651 active medications and 1894 discontinued medications for 3430 patients. Clinicians also entered 20,321 items on screening sheets while the computer automatically added an additional 21,897 entries. During the first three months of 1991, clinicians also typed 592 progress notes for 383 patients.

In July 1990, the OMR system was introduced practice-wide without any official training sessions. From June to November 1990 after terminals were placed in every office where clinicians see patients, usage increased. The number of times a patient's problem list was retrieved (for display, entry, or editing)

increased by 64% and the number of times a patient's medication list was retrieved (for display, entry, or edit) increased 42%. However, there was considerable variation in use depending on both experience with the system and type of provider (faculty, resident, intern, or nurse). At the distant practice site where clinicians had almost two years of experience with the system, 68% of the 511 patients seen in November 1990 had problem lists and 70% of these patients had medication lists recorded in the computer. For the 2012 patients seen at the hospital-based practice, where clinicians had only three months of experience, only 22% of patients had problems lists and 29% had medication lists in the computer. Overall, 45% of patients who saw a nurse practitioner had a medication list filled out in the computer. Second-year and third-year non-primary care residents were least likely to fill out medication lists on the computer; they did so for only 22% of their patients. Interns, who had received about one hour of instruction in the use of OMR as part of their primary care orientation, completed problem lists on the computer for 39% of their patients, whereas second-year and third-year residents followed by staff physicians were the least likely to fill out problem lists on the computer -- 16% and 29% respectively.

We conducted a chart review for all new patients seen in our practice from September 1 through November 30, 1990. For the 905 new patient visits, 278 charts had either a problem list or a medication sheet in the computer. We randomly reviewed the charts for 446 of the 627 new patient visits in which no information was recorded on the computer. Of the 278 charts with an electronic record, 231 (83%) had electronic problem lists. Of the 446 charts without an electronic record, only 291 (65%) had a problem list (table 1). Clinicians recorded 3.4 problems per patient on the electronic record, compared with 3.9 problems per patient on the paper record ($p = 0.018$, Student's t).

In addition to recording problems, clinicians frequently wrote comments about problems both in the computer and on paper. In the computer, clinicians wrote more than twice as much - - 10.9 words per problem, in contrast to 4.3 words per problem in the paper record ($p < 0.0001$, Student's t). Multivariate analysis shows that younger clinicians tend to write more per problem, and this relationship holds regardless of provider type.

DISCUSSION

We have developed a computer-based medical record system that is easy to use and well accepted by clinicians. In the site outside of the hospital where OMR had been used for almost two years, clinicians kept problem lists and medication lists online for 70% of their patients. Three months after OMR was introduced to the remainder of the practice, clinicians at the hospital practice location kept 22% of their problem lists and 29% of their medication lists online.

Many believe that physicians are too busy and their time is too valuable for them to be responsible for data entry. We would agree that at present it takes more time to type a problem list on the computer than it does to write it (perhaps illegibly) in a paper record. Yet, clinicians wrote more than twice as many words to describe each problem in the computer as they wrote in the paper record. Assuming that each clinician is a good judge of how to spend his or her own time, we conclude that clinicians perceived the computer-based problem list to be more valuable than its paper counterpart. Unlike the paper list, the computer-based problem list can always be read; it never falls out of the chart, and is available at every terminal in the hospital and at home via computer with modem. When patients telephone or come to the emergency room with a problem, their previous problems and medications can be retrieved instantaneously, an advantage that may aid in their care.

Table 1.

Comparison of electronic charting and traditional paper charting for all new visits to a general medical practice, September through November 1990.

	Visits to Healthcare Associates	Charts reviewed	Charts with problem lists	Problems per patient *	Words per problem **
Electronic record	278	278	231	3.4	10.9
Paper record	627	446	291	3.9	4.3

* $p = 0.017$

** $p < 0.0001$

Furthermore, computer-based problem lists are changing the way we chart and practice medicine. The paper-based problem list can be edited only a few times before the increased markings necessitate a new copy (and this is rarely done). The computer-based problem list, on the other hand, invites editing, additions, and deletions. The computer-based problem list becomes a dynamic list of mini-clinical scenarios, which clinicians readily update and annotate because they find it useful.

Our system was designed to provide clinicians with the flexibility to use the words they want in their problem lists. Flexibility has been important to the system's acceptance because of the variability of physician styles. Some members of our faculty use their problem lists to teach [24]. They argue that even the language they use to label patients sends a message to both students and patients. For instance, tension is not necessarily associated with elevated blood pressure. Because of this, some physicians would prefer not to use the term hypertension. Our approach accommodates this small but important variation in practice style. Although we do not force clinicians to use a "controlled vocabulary," we have put their words into a dictionary of synonyms that allows us to provide problem-based reminders, management reports, and to conduct clinical research in ambulatory medicine.

Since our system is integrated into the hospital's clinical information system, clinicians do not need to reenter demographic data, laboratory data, or the results of Pap smears or mammography. In fact, from the same terminals, clinicians can look up test results for either ambulatory or hospitalized patients, send electronic mail, order mammograms and other radiologic procedures, request managed care referrals, conduct literature searches via PaperChase, look up drug information in the online Physicians' Desk Reference, and search for clinical precedents in ClinQuery [25,26]. This powerful workstation environment increases the acceptance and ease of use of our computer-based ambulatory record, and we suspect that without these additional capabilities, OMR would be used less often.

A few clinicians now use the computer for all their notes, indexed by problem. The more proficient typists in our practice prefer this to handwritten or dictated notes. Although we plan to provide the ability to upload the transcript of a dictated note in the near future, this is an expensive feature to incorporate into a system. While the long-term solution may be integrated (not stand-alone) voice entry systems, we need to develop better techniques for rapid entry using a keyboard or mouse [27]. In the near future, we plan to provide tools for rapid entry of physical findings, handle phone messages, follow-up letters to patients, and letters of referral to other clinicians.

We have taken another step toward a paperless record in ambulatory medicine. We have found that physicians are willing to enter information into a computer system when they perceive a benefit to themselves and their patients [28].

ACKNOWLEDGEMENTS

We would like to thank Drs. Warner V. Slack and Howard L. Bleich their for support of this work. We would also like to thank Drs. Carol Bates, Jeannette Shorey, Robert Shmerling, David Calkins, nurse practitioners, Kathleen Griffin and Doreen Spence, and Ms Sarah Turner and Mr Jack Bradbury for their invaluable help and patience with our OMR system. We would thank Ms. Kathryn Rippel and Mr. Jason Boro for their assistance in reviewing paper medical records and Ms. Emily Boro for her editorial assistance.

BIBLIOGRAPHY

1. Grossman JH. An ambulatory medical record system for patient care and health care management. Methods Inf Med Suppl 1972; 6:375-82.
2. McDonald CJ. Protocol-based computer reminders, the quality of care and the non-perfectibility of man. N Engl J Med 1976; 295:1351-5.
3. McDonald CJ, Murray R, Jeris D, Bharagava B, Seeger J, Blevins L. A computer-based record and clinical monitoring system for ambulatory care. Am J Public Health 1977; 67:240-5.
4. Wilson GA, McDonald CJ, McCabe GP. The effects of immediate access to a computerized medical record on physician test ordering: a controlled clinical trial in the emergency room. Am J Public Health 1982; 72:689-702.
5. McDonald CJ, Hui SL, Smith DM, Tierney WM, Cohen SJ, Weinberger M, McCabe GP. Reminders to physicians from an introspective computer medical record. A two-year randomized trial. Ann Intern Med 1984; 100:130-8.
6. Barnett GO. The application of computer-based medical record systems in ambulatory practice. N Engl J Med 1984; 310:1645-9.
7. McDonald CJ, Tierney WM. Research uses of computer-stored practice records in general medicine. J Gen Intern Med 1986; 1(4 Suppl):S19-24.
8. McDonald CJ. Tierney WM, Computer-stored medical records. Their future role in medical practice. JAMA 1988; 259:3433-40.
9. McDonald CJ, Blevins L, Tierney WM, Martin DK. The Regenstrief medical records. MD Comput 1988; 5(5):34-47.

10. Dambro MR, Kallgren MA. Drug interactions in a clinic using COSTAR. Comput Biol Med 1988;18(1):31-8.
11. Frame PS. Can computerized reminder systems have an impact on preventive services in practice? J Gen Intern Med 1990; 5(5 Suppl):S112-5.
12. Fordham D, McPhee SJ, Bird JA, Rodnick JE, Detmer WM. The Cancer Prevention Reminder System. MD Comput 1990; 7:289-95.
13. Hammond KW, Prather RJ, Date VV, King CA. A provider-interactive medical record system can favorably influence costs and quality of medical care. Comput Biol Med 1990; 20:267-79.
14. Norman LA, Hardin PA. A multipurpose, computer-assisted program to improve ambulatory medical care: a preliminary report. QRB 1990; 16:365-72.
15. Ornstein SM, Garr DR, Jenkins RG, Rust PF, Arnon A. Computer-generated physician and patient reminders. Tools to improve population adherence to selected preventive services. J Fam Pract 1991; 32:82-90.
16. Murray MD, Brater DC, Tierney WM, Hui SL, McDonald CJ. Ibuprofen-associated renal impairment in a large general internal medicine practice. Am J Med Sci 1990; 299:222-9.
17. McDonald CJ, Wilson GA, McCabe GP. Physician response to computer reminders. JAMA 1980; 244:1579-81.
18. Bleich HL, Beckley RF, Horowitz GL, et al. Clinical computing in a teaching hospital. N Engl J Med 1985; 312:756-64.
19. Slack WV, Peckman BM, Van Cura LJ, Carr WF. A Computer-based physical Examination system. JAMA 1967; 200: 224-8.
20. Kiely JM, Juergens JL, Hisey BL, Williams PE. A Computer-Based Medical Record. JAMA 1968; 205:99-104.
21. Safran C, Bleich HL, Slack WV. Role of computing in patient care in two hospitals. MD Comput 1989; 6(3):141-8.
22. Bleich HL, Safran C, Slack WV. Departmental and laboratory computing in two hospitals. MD Comput 1989; 6(3):149-55.
23. Berarducci AA, Delbanco TL, Rabkin MT. The teaching hospital and primary care. Closing down the clinics. N Engl J Med 1975; 292:615-20.
24. Weed LL. Medical records that guide and teach. N Engl J Med 1968; 278:593-600.
25. Safran C, Herrmann F, Rind D, Kowaloff BA, Bleich HL, Slack WV. Computer-based support for clinical decision making. MD Comput 1990; 7: 319-22.
26. Safran C, Porter D, Lightfoot J, Rury CD, Underhill LH, Bleich HL, Slack WV. ClinQuery: a system for online searching of data in a teaching hospital. Ann Intern Med 1989; 111:751-6.
27. Safran C. The mouse-waving principle. MD Comput 1991; 8:4.
28. Slack WV. Assessing the use of computers. MD Comput 1989; 6(4);183-5.