Should the Complete Medical Record Be Computerized in Family Practice?

An Affirmative View

Stephen J. Spann, MD
Oklahoma City, Oklahoma

Technology will play an ever-increasing role in the medical arena as physicians prepare to enter the 21st century. To compete in that arena and to provide high-quality comprehensive, continuous, and coordinated care to patients, physicians must be able to process large and varied amounts of information. Computerization of the medical record is the best way in which the physician can more readily manage and retrieve important information about patients.

The technology to computerize the complete medical record is available and increasingly accessible and affordable.[1] The cost of mass storage, which has heretofore been a major limiting factor in medical record computerization, is decreasing. Two recent developments—the compact disc–read only memory (CD-ROM) and the write once read many optical disc (WORM)—offer gigabyte mass storage capability at affordable prices.[2,3] A growing number of computerized medical record systems have been tried and tested in the ambulatory care setting and are available for purchase.[1,4] The Computer-Stored Ambulatory Record system (COSTAR) was developed by the Laboratory of Computer Science at Massachusetts General Hospital and is the most widely disseminated system of its type.[1] Other available systems include the following:

1. The Medical Record (TMR), developed at Duke University Medical Center[5]
2. The Regenstrief Medical Information System (RMIS), developed at Indiana University Medical Center[6]
3. The Summary Time-Oriented Record (STOR), developed at the University of California Medical Center, San Francisco[7]
4. THERESA, a computerized medical record and decision support system developed by Grady Memorial Hospital in Atlanta[8]

Although the technology is available,[2] a completely paperless electronic medical record (to include electrocardiograms, correspondence, radiographic images, etc) is not necessary or practical at this time. But the electronic paperless office is a future reality, and physicians can and should begin moving their practices in that direction. Currently components of the medical record that can be computerized include reason for encounter, symptoms, signs, diagnostic and therapeutic procedures, test results, diagnoses or problems, and prescribed therapies.

The computerized medical record has several advantages over the manual, paper-based record[1,9]:

1. The computerized record is, physically, more available; it cannot easily be misfiled and can be accessed simultaneously by many individuals. It can be accessed easily from different places, eg, the hospital ward or emergency department, the nursing home, or the physician's home.
2. The computerized record is always legible.
3. Data entered into the computerized record one time can be displayed in a variety of ways. Special reports, flow sheets, trend graphs, patient summaries, and so on can all be produced from one data set. In the paper-based record, the organization of data is fixed; record keeping is usually time oriented and sequential, and frequently the same information must be entered repeatedly. Consider, for example, a prescription for medication. With the standard paper record, the physician may enter this information in the progress note, on the medication list, and on the prescription blank itself. With a computerized record

Submitted, July 3, 1989.

From the Department of Family Medicine, University of Oklahoma College of Medicine, Oklahoma City. Requests for reprints should be addressed to Stephen J. Spann, MD, Department of Family Medicine, University of Oklahoma College of Medicine, 800 NE 15th St, Room 503, Oklahoma City, OK 73104.

system, one entry of this information can accomplish all three of these record functions.

Well-organized patient data can not only save time and money but also influence clinical decisions by presenting a more complete picture of the patient.[9] For example, one study reported that physicians using a computerized record to display previous test results while ordering new tests reduced the number of tests ordered.[10] With a paper-based record system, collecting and compiling information about a patient is often subjective, with the physician jotting notes onto a blank piece of paper. At each patient visit, the physician must thumb through an often extensive volume of data. Because those data are filed in a sequential, time-oriented fashion and cannot be reformatted to address the current problem, key data may be overlooked. With many computerized record systems, the data to be entered into the record are specified, which results in more complete gathering and recording of patient information.[1] These systems also provide the added benefit of allowing the physician to retrieve the information in any sequence, thus avoiding the problem of overlooking a key piece of data.

Computerized medical records can facilitate and enhance quality-of-care assessment and assurance activities in clinical practice.[1,9] Health care providers are under increasing pressure from third-party payers, patients, and various regulatory agencies to document the quality of the health care services provided.[11,12] Quality-of-care studies can focus either on the process of care or on the outcome of care.[12,13] Process-of-care studies generally compare actual care rendered according to preestablished criteria for standards of care for specific tracer conditions.[14] Retrospective process-of-care studies in medical practices that use paper-based medical records require manual chart audits, which are cumbersome and expensive.[15] Such retrospective process-of-care studies are faster and more accurate with computerized medical records because they can be performed electronically. Information from process-of-care studies can shape practice behavior.[16] For example, studies have shown that feedback from process-of-care audits can alter diagnostic test-ordering patterns and medication-prescribing behaviors.[17,18]

Computerized medical record systems also allow for prospective or concurrent quality-of-care assurance. The computer can be programmed to prompt the physician with certain information when specific conditions are present or absent.[9] In one study a concurrent quality-assurance audit of computerized medical records increased the proportion of those patients with throat cultures positive for β-hemolytic streptococcus who were treated appropriately with antibiotics.[19] Studies have shown that concurrent quality-assurance audit and computer-generated physician reminders improve compliance with the performance of recommended periodic health screening tests and are readily accepted by the user physicians.[20,21]

Computerized record systems can also be used to generate patient reminders for health maintenance activities. These patient reminders have been shown to increase compliance with health maintenance recommendations.[22]

Computerized medical record systems have the potential to enhance outcome-of-care studies.[11,12] To perform outcome-of-care studies in primary care, sensitive outcome measures, such as functional health status, must be followed in a large number of patients over time.[11,23] Instruments to measure functional health status, which are easy to use in day-to-day family practice, are becoming increasingly available.[11,23] Computerized record systems could be programmed to allow patients to complete these instruments directly onto the computer; the computer would then store the data elements and track changes in functional status over time. Ultimately, studies could be done electronically to assess the relationship between process of care and outcomes.

Computerized medical record databases can facilitate research in family practice. For example, a number of studies have documented the variability in medical care across different geographic areas for certain surgical procedures and hospital admission practices.[24] A few studies have shown similar variability in the use of more common treatment options such as tests ordered and medications prescribed, both across specialties[25,26] and within the same specialty,[17] in the outpatient setting. Additional studies are needed to compare variability of medical care within the ambulatory care setting in family practice. These studies could compare the way different family physicians evaluate and treat various problems. Physician behavior could be compared with that of other physicians in their own group practice, with that of physicians in other practices in the same geographic area, and with that of physicians in other geographic areas. Feedback from these studies could improve the process of medical care. Computerized medical record databases have been used successfully to conduct clinical research in several medical specialty areas.[4]

There is a growing interest in developing computer programs to support clinical decision making.[27] A computerized medical record database can function as a clinical decision support system with self-contained, perpetually self-updating knowledge bases. The THERESA medical record system, developed at Grady Memorial Hospital in Atlanta, is one example of such a system.[8] For clinical decision support in family practice, data are needed not only on the sensitivity and specificity of different symptoms, signs, and laboratory tests but also on the predictive value of these cues for specific diseases in the primary care setting. This kind of information and the

large number of cases needed to establish statistical confidence can best be gathered through a structured, computerized medical record system.

A series of objections are typically raised in discussions concerning computerization of the medical record. The cost of computerization is an important concern.[1] There are no well-formulated methods for conducting cost-benefit evaluations of either manual or computer-based medical record systems. Thus, little quantitative information is available about the relative costs and benefits of manual vs automated systems. One study examined the cost of implementing the COSTAR computerized record system at the North San Diego County Health Services Organization.[1] The additional cost of using COSTAR to perform conventional medical record tasks was estimated at $0.87 per encounter. When the costs of the additional functions provided by COSTAR were included in the estimate and then compared with the costs to perform those same functions in a manual record system, however, COSTAR was associated with a saving of $0.72 per encounter.

The cost of a computerized medical record system will depend on practice size, hardware configuration, software specifications, and the amount of programming that must be performed to adapt the software to the particular practice environment.[1] Cost-benefit calculations should consider the costs of installing and operating the system as well as the benefits to the practice, which include the potential decrease in the number of ancillary personnel, improved efficiency in billing and collections, and facilitation of quality-assurance activities. The decreasing costs of computer hardware and the potential for several practices to share a common medical record database through a network will allow computerized medical record systems to become increasingly affordable for the family physician.

The legality of a computerized medical record is a commonly expressed concern.[2] For at least a decade, the courts have had to address the issue of computer-stored records. The type of records (ie, paper-based or computer-based) is less an issue than how the records are used and stored. The courts have used the following three criteria in deciding whether to admit computer-stored records:

1. *Accuracy*. The institution must have safeguards in place to ensure that records are stored correctly with clearly defined procedures for entry and audit (has the information been entered correctly?).
2. *Reliability*. The institution must prove that is uses computer-stored records regularly and relies on them daily for patient care.
3. *Trustworthiness*. The institution must show that the information in the system is secure and cannot be altered.[2]

Other common concerns about computerized medical record systems center on patient acceptance and the potential effect of the system on the physician-patient relationship. Two studies in British general practices examined patients' perceptions of the quality of physician-patient interaction when the physician entered information into a computer terminal in the examining room.[28,29] Neither study found a negative impact. No significant differences were noted in the ease or quality of the interpersonal interactions, in physician attentiveness or rapport, or in patient satisfaction with information received, confidence in treatment received, or expected compliance with therapeutic recommendations.

A final concern about computerized medical record systems is the difficulty in capturing and organizing patients' clinical data in a unified and retrievable format.[9] While clinical and laboratory information gathered in the office setting can be entered on a computer terminal, diagnostic reports ordered during an inpatient admission, an emergency department visit, or a visit to a consultant or results of diagnostic tests performed outside the office may be difficult to capture without completely rekeying the data into the record system. Standards for transferring clinical information among independent systems are being developed by a number of collaborating organizations in an attempt to resolve this problem.[3,9]

In the context of today's so-called information society,[30] family practice *is* information management. Computerization of the medical record can improve information management and enhance patient care. The technology for computerizing the medical record is available, and family physicians are in an ideal position to lead the way in research and development of computerized medical record systems for primary care.

References

1. Barnett GO: The application of computer-based medical record systems in ambulatory practice. N Engl J Med 1985; 310:1643–1650
2. Gardner E: Special selection: Information systems. Mod Healthcare 1988; 18:29–60
3. McDonald CJ: Computers. JAMA 1989; 261:2834–2836
4. Pryor DB, Califf RM, Harrell FE Jr, et al: Clinical data bases: Accomplishments and unrealized potential. Med Care 1985; 23:623–647
5. Stead WW, Hammond WE: Computer-based medical records: The centerpiece of TMR. MD Comput 1988; 5:48–62
6. McDonald CJ, Blevins L, Glazener T, et al: Data base management, feedback, control, and the Regenstrief Medical Record. J Med Syst 1983; 7:111–125
7. Whiting-O'Keefe QE, Simborg DW, Epstein, WV, et al: A computerized summary medical record system can provide more information than the standard medical record. JAMA 1985; 254:1185–1192
8. Walker HK: Grady Memorial's Integrated Database: Improves speed, accuracy and cost containment. Comp Healthcare, March 1989:36–42
9. McDonald CJ, Tierney WM: Computer-stored medical records: Their future role in medical practice. JAMA 1988; 259:3433–3440

10. Tierney WM, McDonald CJ, Martin DK, et al: Computerized display of past test results: Effect on outpatient testing. Ann Intern Med 1987; 107:569–574
11. Ellwood PM: A technology of patient experience. N Engl J Med 1988; 318:1549–1556
12. Berwick DM: Toward an applied technology for quality measurement in health care. Med Decis Making 1988; 8:253–258
13. Lohr KN, Yordy KD, Thier SO: Current issues in quality of care. Health Affairs, Spring 1988:5–18
14. Kessner D, Kalk C, James S: Assessing health quality—The case for tracers. N Engl J Med 1973; 288:189–194
15. Palmer RH: The challenges and prospects for quality assessment and assurance in ambulatory care. Inquiry 1988; 25:119–131
16. Eisenberg JM, Williams SV: Cost containment and changing physicians' practice behavior. JAMA 1981; 246:2195–2201
17. Schroeder SA, Kenders K, Cooper JK, Piemme TE: Use of laboratory tests and pharmaceuticals: Variation among physicians and effect of cost audit on subsequent use. JAMA 1973; 225:969–973
18. Gelhbach SH, Wilkinson WE, Hammond WE, et al: Improving drug prescribing in a primary care practice. Med Care 1984; 22:193–201
19. Barnett GO, Winickoff R, Dorsey JL, et al: Quality assurance through automated monitoring and concurrent feedback using a computer-based medical information system. Med Care 1978; 16:962–970
20. McDonald CJ, Hui SL, Smith DM, et al: Reminders to physicians from an introspective computer medical record. Ann Intern Med 1984; 100:130–138
21. Knight BP, O'Malley MS, Fletcher SW: Physician acceptance of a computerized health maintenance prompting program. Am J Prev Med 1987; 3:19–24
22. Larson EB, Olsen E, Cole W, Shortell S: The relationship of health beliefs and a postcard reminder to influenza vaccination. J Fam Pract 1979; 8:1207–1211
23. Greenfield S: The state of outcome research: Are we on target? N Engl J Med 1989; 320:1142–1143
24. Wennberg JE: Dealing with medical practice variations: A proposal for action. Health Affairs 1984; 3:6–32
25. Greenwald HP, Peterson ML, Garrison LP, et al: Interspecialty variation in office-based care. Med Care 1984; 22:14–29
26. Cherkin DC, Rosenblatt RA, Hart LG, et al: The use of medical resources by residency-trained family physicians and general internists: Is there a difference? Med Care 1987; 25:455–469
27. Shortliffe EH: Computer programs to support clinical decision making. JAMA 1987; 258:61–66
28. Brownbridge G, Herzmark GA, Wall TD: Patient reactions to doctors' computer use in general practice consultations. Soc Sci Med 1985; 20:47–52
29. Rethans J, Höppener P, Wolfs G, Diederiks J: Do personal computers make doctors less personal? Br Med J 1988; 296:1446–1448
30. Naisbitt J: Megatrends. New York, Warner Books, 1984

An Opposing View

Jonathan E. Rodnick, MD
San Francisco, California

Computerized medical records have been in existence for over a quarter century.[1] Although conceptualized in 1959, they have yet to become widespread. Probably 50% of family practices currently have some kind of computerized billing, but most likely fewer than 5% do anything more with a computer than administrative tasks. Initially, computerizing the medical record was limited by the high cost of hardware, minimum ability to store data, inflexible software, and a small number of individuals who understood both medicine and the computer. Such limitations, however, are no longer the case. For example, in the last decade there have emerged many computerized medical record systems for office practice that have reached the level of development and application to be considered successful beyond the prototype stage. The four following illustrative systems are all implemented on mini (not micro) computers:

1. COSTAR (**C**omputer **S**tored **A**mbulatory **R**ecord **S**ystem) was developed at Massachusetts General Hospital with the goal of providing a medical record for office-based care. This system has the widest implementation of all computerized medical records.[2,3]

2. RMIS (**R**egenstrief **M**edical **I**nformation **S**ystem) was developed at the University of Indiana, and emphasizes physician reminders to follow rules for medical care. Although not widely implemented, a significant number of studies showing the impact of the computerized medical record have been done on this system.[4–6]

3. TMR (**T**he **M**edical **R**ecord) was developed at Duke University with an emphasis of capturing all the medical data and providing information for longitudinal care and disease epidemiology.[7]

4. STOR (**S**ummary **T**ime-**O**riented **R**ecord) was developed at the University of California, San Francisco, and

Submitted August 14, 1989.

From the Department of Family and Community Medicine, University of California, San Francisco. Requests for reprints should be addressed to Jonathan E. Rodnick, MD, Department of Family and Community Medicine, University of California, San Francisco, Box 0900, San Francisco, CA 94143.

emphasizes flow charts (variables vs time) displaying clinical data.[8]

This list is by no means complete. Other ambulatory medical record systems have been developed in university settings, in private practice, and as part of commercial billing packages. The above systems, however, have had more written about them. Of these four systems, COSTAR and TMR have been used to computerize most of the medical record (not including consultations and some ancillary services, such as electrocardiograms). Both COSTAR and TMR can also be implemented in a modular fashion, so that only portions of the medical record are computerized. Not surprisingly, this method of implementation has turned out to be the most popular. STOR and RMIS were designed from the ground up to be a supplement to the conventional record. More recently, a number of microcomputer record systems, designed for smaller offices and often using a modified database management software, have been developed and marketed both in the United States[9] and abroad.[10–13] With few exceptions, these systems have also been designed to supplement, not replace, the medical record.

With the development of the microcomputer, sophisticated database programs, and networking, the type of technology that was first envisioned a quarter of a century ago has emerged. Despite this availability of technology, the question remains: Why haven't more offices computerized the complete medical record? The following five reasons seem likely:

PROBLEMS WITH COMPUTERIZATION

Data Entry

How can a physician get all the necessary data into a computer in the midst of a busy day of patient care? First, physician entry is neither efficient nor usually acceptable. A few highly motivated physicians can type their own records, but expecting most to do so could lead to 2-hour patient visits. If more than 30 seconds per patient is required to enter data into a computer (in addition to the standard office note), many physicians would probably not be interested, no matter what the returns.

In the long run, data entry may be achieved by voice technology, where speech is broken down digitally by a computer trained to recognize the physician's voice; the computer then prints a note and enters it into the medical record. Unfortunately, voice technology has a high error rate and a small vocabulary (1000 words), requires tedious training, and forces the speaker to have unnatural pauses between each utterance.[14]

Another problem is the diversity of data sources (other than physicians' notes) for a complete computer record. Laboratory tests, x-ray reports, prescriptions, nurses' notes, consultants' notes, hospital discharge summaries, and emergency department reports all need to be entered. Sometimes the data can be captured electronically (if the laboratory has its own computer that can talk to the physician's computer). But what happens if more than one laboratory is used? Different laboratories have different ways to report their results and have different normal value ranges. Each point of data entry requires either costly programming or costly hand-typing.

For those who are already dictating and having their notes transcribed, there will be fewer incremental costs to computerization. To use the medical record for quality assurance, research, and management decisions, however, data must be structured rather than "free text." The structured format allows the computer to analyze data; in contrast, a dictated note has few quantified data. For example, when following patients with congestive heart failure, noting moderate shortness of breath is much less useful than rating predefined signs and symptoms on a graded scale of one to four. Most physicians, however, resist record keeping in a structured format, as doing so takes away some of the finer nuances of patient care that can be better described by language than numbers.

The greatest stumbling block to the successful operation of a computer-stored medical record is devising a means of accurate, efficient, and economical data entry. Limiting the amount of free text, automating transfer of laboratory and x-ray data, and assuring that data entry is performed by individuals with a dedication to accuracy must be high priorities. After studying the issues carefully, physicians in one practice that implemented only the COSTAR patient summary concluded, "The cost of manual data entry is the Achilles' heel of computer-stored medical records."[3]

Storage

Although electronic storage is now relatively inexpensive, it is not free. As with data entry, not keeping all reports in the computer will save both time and money. For example, video images have huge data storage requirements—one megabyte per x-ray film. Digitalized sound for voice messages uses four kilobytes per second. The more data, the more computer time it takes to search records. Furthermore, the decisions as to what data to archive or to discard become more complicated, for all clinical information need not be retained indefinitely.

On the horizon are optical drives with laser reading devices and cartridges that can hold 650 megabytes (compared with current hard disks storing 20 to 100 megabytes). Also under testing are wallet-sized optical memory cards that look like credit cards and can contain an indi-

vidual patient's complete medical history. These innovations, however, are all in the future. The development of software that uses this technology effectively, as well as widespread implementation of these systems, will probably lag years behind the new hardware, just as it has done for the past 25 years.

The Display

Aside from entering the data into the computer and storing it, how can it be retrieved most usefully? When dealing with a lifetime of data for a chronically ill patient, it is easy to get overwhelmed by 50 or more blood pressure readings in a chart. How should the complete blood counts and sequential multiple analysis results or all the past medications be displayed? Clearly the data displays need to be flexible. For example, intensive care unit data should be displayed on a minute-by-minute or hour-by-hour time frame. Office data can be displayed in a month-by-month or year-to-year format. The needs of each provider, whether they be family physician, nephrologist, or obstetrician, are different. Few automated record systems allow flexibility to tailor displays. Data for a complete medical record can be overwhelming; a supplement makes highlighting key attributes or results easier.

The hazards of video display terminals are currently being debated. Whether these hazards are due to radiation, electromagnetism, or poor ergonomics, working with a computer all day has lost its appeal. With a fully computerized medical record, avoiding regular "interactions" with a computer is difficult. Paper documents, because they are familiar and offer ease for both input and output, are preferred by most physicians. Paper can be used to capture as well as display information. Indeed, the four systems mentioned at the beginning of this article all use paper turnaround documents. With the use of paper documents, there is less need and justification for computerizing all the medical information.

Software

The ideal computerized medical record software program has yet to be written. Software should be modular, so that one can add components as needed, such as registration, billing, and a patient's summary first, and later pharmacy or laboratory reports. An additional problem is that as hardware is upgraded, the medical record applications written for the old hardware need costly programming and conversion to be useful in new settings.

Few standards have been determined for data definition and transmission. For example, to computerize the complete medical record, it is necessary to discriminate between ACE a test and Ace a bandage. To decrease data-entry cost, laboratory and x-ray reports must be captured electronically. To capture them, current programs must be written almost from scratch, as there are no agreed upon standards for data definition and format. Imagine the number of meetings and papers needed to get agreement on the International Classification of Health Problems in Primary Care (ICHPPC) or on ICD-9-CM. The point has just been reached at which there is some agreement on how to transmit electronic billing data. Without the monetary and administrative force that brought this about, there may still be a debate over whether the laboratory results should include both the time drawn and the time reported.

Last, much of the new advances in medical informatics, such as national databases (ie, the National Library of Medicine's MEDLINE), or expert systems, such as the AMA's differential diagnosis program (DXplain), are not part of the current medical record systems. For many physicians decision-making systems or those that provide easy access to the medical literature have higher priority than do complete medical record systems.

Cost

The cost of hardware, less now than anyone thought it would be 25 years ago, is not the most significant cost in computerizing medical records. Initial hardware costs probably range from $5,000 to $10,000 per physician for the equipment necessary to maintain a complete computer medical record. Other costs are to be considered, however. First is programming. Even with a commercial system, modification to a physician's particular needs will be necessary. Training staff, retrospectively entering old medical records, hardware upkeep, space, and increased personnel needed to run the system all create added costs. Even if all notes (free text) were entered, the traditional chart would need to be maintained for correspondence consultation, electrocardiograms, etc. In family practice centers attached to hospitals, the hospitals may be required to keep the archival record, so the costs savings from decreased filing and paper storage would not be realized. Estimates of the ongoing costs for the COSTAR computerized medical record run from a low of $1.65 per patient encounter (for the addition of a patient summary)[3] to a high of over $5.00 per patient encounter (for the complete computerized medical record).[15]

A CASE REPORT

A group from the Department of Family and Community Medicine at the University of Arizona has recently published an article entitled "An Unsuccessful Experience With Computerized Medical Records in an Academic Medical Center.[15] In the report they explained how they

wanted to computerize all the medical records in the family practice center, which had about 20,000 patient visits a year. There was careful planning, and the medical records system, COSTAR, had been previously pilot-tested in a satellite clinic. They used data entry forms so that almost all information was recorded in coded form, ie, checkmark or circled. They also entered laboratory and x-ray reports and consultation notes. The COSTAR record could be accessed through one of 13 computer terminals located in the family practice center. No attempt was made to enter prior medical data. After 4 months it became apparent that the patient care revenue could not cover the cost of operating the system, and the COSTAR system was terminated. The lessons learned were the following:

1. A large volume of data was generated in this teaching practice. The data entry quickly fell behind, and there was no trained backup staff. The long lags meant that physicians could not rely on the system to have all the patients' data.
2. Up to 15% of the records had data entry errors. Fortunately, only 4% of these errors were estimated to be serious. These errors were attributable to poor handwriting by the physicians. Seeking clarification of unclear notes required time and further delayed data entry.
3. With an adequate number of personnel for data entry (twice the number that they had planned), the cost to operate the system would consume 17% of the average $29 office fee.
4. The computer was frustratingly slow during peak periods. On numerous occasions physicians abandoned attempts to retrieve data. The computer's storage capacity turned out to be inadequate, and the computer needed upgrading long before it was planned or budgeted.
5. Additional programming was needed to customize the record for the family practice center. Programmers with a knowledge of the system were rare.
6. The Medicare administration refused to accept computer-generated records as evidence of a direct physician-patient contact because the notes were not handwritten! Medicare's refusal to pay would have resulted in over $90,000 per year of lost revenue.
7. There was a lack of institutional financial commitment. The institution expected that ongoing operational costs would not exceed that for paper records, which was obviously not the case.

EVALUATION OF COMPUTER MEDICAL RECORD SYSTEMS

To decide what should be in the computerized medical record, one must look at what has been successfully done in other settings. Does having a computerized medical record reduce laboratory tests, decrease ordering of inappropriate medications, improve quality through better audits and feedback, decrease visit time, or improve patient outcomes? Not surprisingly, automated record systems have rarely been evaluated.[16] Haynes and Walker[17] reviewed 135 studies published up through 1986 that described computer applications for medical care. Only 10% were randomized trials. All reported a positive effect on the process of care, but only a few studies documented minor improvements in patient outcome.

The best data so far deal with the effect of reminders from the computer to the physician about needed patient care. For example, reminders for cancer screening, such as sigmoidoscopy and mammography, have led to a significant increase in use of these procedures.[18] In another example, RMIS has 1490 rules; when one is not followed, the computer prints a suggestion. These systems have substantially increased physicians' adherence to a broad range of outpatient protocols, including increasing by 150% to 400% the use of pneumococcal and influenza vaccine, Papanicolaou smears, and occult blood testing.[5]

Another computer record function that has shown significant impact is computer drug-drug interaction screening to reduce adverse drug reactions.[19] The display of past test results in an easily readable format reduces the number of new laboratory tests ordered[6] and helps physicians better predict future clinical events.[8] In the United Kingdom (where physicians do not do office billing), microcomputers have been in wide use for patient recall, repeat prescriptions, and monitoring immunizations.[13,20,21]

In the short run, it is unlikely that an automated medical record will have much impact on patient outcome. Process of care, however, is probably improved by organizing patient data, by displaying past results, and by reminding about needed care.

SUMMARY

The goal of replacing the entire paper chart with an electronic record may be a subtle barrier to the spread of computer-stored medical records. The focus on needing to replace the current paper chart draws attention away from the benefits of having parts of the record stored in a computer retrieval form. Furthermore, the focus on total computerization implies a large initial and ongoing dollar commitment to replace the record completely. This commitment is unacceptable to most practices.[22]

No doubt, there are advantages of computerizing key patient data. Only key data should be computerized, however, not all data. Patient summaries containing the patient's demographics, medical problems, allergies, health

maintenance status, and recent laboratory results can be used to generate needed prevention reminders as well as to do research (such as postmarketing drug surveillance) and management (such as being able to compare the utilization of various laboratory tests by physicians). Computer searches of these data can also be used to create patient target groups and to produce individualized labels and letters to contact patients.[23]

The computer medical record should complement, not replace, the traditional office record. The computer then can be used for a subset of the full record to take advantage of its unique power of retrieval and analysis. As a supplement to the record, the computer can be implemented in a modular step-by-step fashion rather than all at once with its attendant costs. This approach implies that the goal is more effective care of patients rather than a fascination with high technology.

References

1. Stead WW: A quarter-century of computer-based medical records. MD Comput 1989; 6:75–81
2. Barnett GO: The application of computer-based medical record systems in ambulatory practice. N Engl J Med 1984; 310:1643–1650
3. Goroll AH, Goodson JD, Piggins JL, et al: Evolution of computer-based supplement to the office medial record. J Ambul Care Manage 1985; 8:39–65
4. McDonald CJ, Blevins L, Tierney, WM, et al: The Regenstrief Medical Record. MD Comput 1988; 5:34–47
5. McDonald CJ, Hui SI, Smith DM, et al: Reminders to physicians from an introspective computer medical record. Ann Intern Med 1984; 100:130–138
6. Tierney WM, McDonald CJ, Martin DK, et al: Computerized display of past test results: Effect on outpatient testing. Ann Intern Med 1987; 107:569–574
7. Stead WW, Hammond WE: Computer-based, medical records: The centerpiece of TMR. MD Comput 1988; 5:48–62
8. Whiting-O'Keefe QE, Simborg DW, Epstein WV, et al: Computerized summary medical record can provide more information than the standard medical record. JAMA 1985; 254:1185–1192
9. The Fifth Annual Medical Software Buyer's Guide. MD Comput 1988; 5:18–151
10. Chan DH, Donnan SPB, Chan N, Chow G: Microcomputer-based computerized record system for a general practice teaching clinic. J Fam Pract 1987; 24:537–541
11. Bridges-Webb C: Computer summary for general practice medical records: MEDSUM. J Fam Pract 1986; 23:389–392
12. Jones B: Microcomputers for general practitioners' scheme. Aust Fam Physician 1988; 17:366–369
13. Kelly SD: The impact of a microcomputer on a general practice immunization clinic. Practitioner 1988; 232:197–201
14. McDonald CJ: Medical information systems of the future. MD Comput 1989; 6:82–87
15. Dambro MR, Weiss BD, McClure CL, et al: An unsuccessful experience with computerized records in an academic medical center. J Med Educ 1988; 63:617–623
16. Kuhn IM, Weiderhold G, Rodnick JE, et al: Automated Ambulatory Medical Record Systems in the US, In Blum BT (ed): Information Systems for Patient Care. New York, Springer-Verlag 1984, 199–217
17. Haynes RB, Walker CJ: Computer aided quality assurance. A critical appraisal. Arch Intern Med 1987; 147:1297–1301
18. McPhee SJ, Bird JA, Jenkins C, et al: Promoting cancer screening: A randomized, controlled trial of three interventions. Arch Intern Med, in press
19. Davidson KW, Kahn A, Price RD: Reduction of adverse drug reactions by computerized drug interaction screening. J Fam Pract 1987; 25:371–375
20. Donald JB: On line prescribing by computer. Br Med J 1986; 292: 937–939
21. Hargrave L, Hutchinson A, Cavill A, et al: Computerized family practitioner committee records—A data base for general practitioners. J R Coll Gen Pract 1988; 38:22–23
22. McDonald CJ, Tierney WM: Computer stored medical records: Their future role in medical practice. JAMA 1988; 259:3433–3440
23. Block B, Brennan JA: Automated health surveillance. Fam Med 1988; 20:377–380