The Role of Clinical Information Systems in the Linkage between Health Care Providers and Insurers

NAVA PLISKIN
BEN-GURION UNIVERSITY OF THE NEGEV

ABSTRACT

In an era of exploding medical expenses, the linkage between health care providers and insurers becomes a focus of concern because its improvement is necessary if costs are to be contained. This paper discusses the role of information technology, both in the general context of health care delivery and in the particular context of the linkage between insurers and providers. The observations in this article come from a health maintenance organization whose technology acquisition and management over more than a decade included implementation of a clinical information system. Based on that experience, it is possible to conclude that careful technology management can bring about not only improvements in clinical care and research, but also a more effective administration of the linkage between insurers and providers of medical care.

INTRODUCTION

Application of technology in health care varies [1]. The focus of this paper is on information technology (IT), as opposed to other technologies applied in the medical field. IT refers to technologies that enable development and implementation of medical information systems. Imaging (non-IT) technologies, such as X-ray, CT, or MRI, are beyond the scope of this paper except when there are data transmissions between non-IT technologies and medical information systems.

Efforts to employ computers for managing information in the health care environment span more than three decades [1]. These efforts have yielded three kinds of medical information systems: administrative information systems that support administrators, research information systems that support researchers, and clinical information systems (CLIS) that support clinicians. Most prevalent are data processing systems that have been developed over the years to support health care administration in such functional areas as inventory, purchasing, accounting, or budgeting. Administrative systems of this type are not unique to the medical field. As is true of non-medical enterprises, the motivation for introducing administrative information systems in health care has been the need to cope with growing data processing complexities. Probably the first systems to be computerized were billing and accounting in the linkage between patients, providers, and insurers. Also widely used by doctors are research-oriented information systems such as bibliographic databases, decision support and expert systems, and a wide variety of statistical packages for data analysis. Significantly less prevalent is the use of CLIS for organizing and managing clinical data about patients.

It is important to realize that, in reality, neither medical information systems nor their users can be exclusively classified. First, there is data exchange between medical information systems. For instance, the transport of data from a CLIS to a research-oriented statistical analysis package. Second, there are systems that support more that one kind of user. For instance, membership management systems can be accessed by both clinicians and administrators. Third, some "impure" entities can employ all three types of medical information systems. For instance, health maintenance organizations (HMO) have a dual insurer/provider function. Finally, there are additional players in the medical arena who interact with medical information systems. For instance, patients during a visit at the doctor's office or the government through policies and regulations.

The online CLIS discussed in this paper, implemented by an HMO both in its clinics and in the offices of affiliated private physicians, is also hard to classify. While in the doctor's office clinicians have applied this CLIS to clinical tasks, users who cannot be distinctly classified as either

insurers or providers have applied it to business-oriented and research-oriented tasks. In other words, in this case, the private doctors (providers) and the HMO (insurer/provider) have put the CLIS not only to clinical use. Their experiences provide a unique opportunity for studying the many roles of a CLIS in modern clinical care, and for demonstrating that, when properly designed and implemented, a CLIS can have a significant role in enabling and improving the insurer-provider linkage. On the basis of theoretical background (in the next section) and a detailed case history (in the third section), this paper will discuss (in the last two sections) the system's role in modern medicine on the road to the 21st century.

Theoretical Background

One common feature of both research-oriented and business-oriented medical information systems is that they include a minimal amount of clinical data about patients and that they hardly help to manage the provider-insurer linkage. Traditionally, a paper-based clinical record has been utilized by medical staff members, in ambulatory practice as well as in hospitals, to capture the patient's medical history and to maintain the clinical data essential for continuous quality health care. The paper-based patient record has been used mainly for routine data storage and retrieval during the patient-doctor encounter. It may contain reports from a variety of doctors and nurses, results of laboratory tests, products of imaging procedures, and the like. Such patient records also serve an administrative function when doctors rely on data stored in them to generate information needed in the billing process.

Most clinical records today are still paper-based and the majority of medical practitioners are not CLIS users. This apparent lack of CLIS diffusion is surprising for several reasons. First, manual record management is far from ideal, especially for such purposes as chronic care and early detection. Second, the clinical data processing burden can be heavier than the burden faced by other professionals (e.g., accountants, engineers, architects, lawyers, researchers, and managers) who already rely more heavily on IT than do clinicians. Finally, resources have been invested in CLIS technology since the sixties, as evidenced by the many research and development initiatives toward a computerized medical record system [2,3].

The majority of CLIS developed thus far feature interactive data entry of clinical information from a variety of sources into comprehensive storage on magnetic and optical media. Once stored, clinical information can be retrieved easily and quickly through queries and reports. Most CLIS have embedded in them error checking capabilities and have the capacity for automatic production of routine documents such as prescriptions, referrals, and memos [4]. Because medical practitioners are usually inexperienced in using keyboards, some CLIS have relied on other professionals to enter data during the patient-practitioner session [5,6]. In such CLIS, batch data entry is usually left for professional clerks, whose job is to enter the data previously recorded by the doctor either on plain paper in free format, or on structured forms in coded format. The former, free format approach, requires more medically-trained data entry clerks than the latter, coded format form-based approach. However, the trend today is toward real-time data entry by the medical practitioner seeing the patient [7].

Two systems have had a major impact on the CLIS field. COSTAR (computer stored ambulatory record), which was developed between 1968 and 1978 at the laboratory of Computer Science of the Massachusettes General Hospital, featured flexible adaptation to user needs, relied on data entry from specially designed forms, and was eventually transformed from minicomputers (e.g., VAX) to microcomputers [1,6,7]. Implementation of RMRS (Regenstrief medical record system) began in 1972 with 35 patients in the Regenstrief Health Center Diabetes Clinic at Wishard Memorial Hospital [8]. RMRS features automatic generation of memos about clinical events that merit practitioner's attention, and relies on a mixture of data entry methods, matched to meet the needs of the implementing environment. It has been used at three separate hospitals affiliated with Indiana University and at 30 clinics, to manage a total of more than 500,000 clinical records. Common to both COSTAR and RMRS are early development for a minicomputer platform, involvement of academic institutions, and a relatively limited diffusion in health care delivery environments.

The majority of CLIS in use today have not been able to penetrate the patient-physician session, where the actual medical process takes place and where the bulk of medical information is created. Stated differently, most medical processes do not involve online, systematic use of computerized information systems. Studies during the eighties, which have attempted to explain the slow rate of CLIS diffusion, identified the following drawbacks: interference with patient-practitioner interaction, prohibitive cost, slow data entry, inability to adapt to the diversity of the clinical environment, difficulty in consolidating data from multiple sources, and limitations of the data dictionary that result in lack of fit between medical knowledge and its representation within the CLIS [2,6].

More recently, IT costs have come down and performance has drastically improved. Progress in data entry technologies is gradually making input of data easier and faster than ever before. Optical scanning and storage help the CLIS to capture pre-printed textual, graphical, and pictorial documents. Communication technologies enable the transmission and storage of data from diverse sources, including products of

other medical technologies like X-rays and CT scans. Application generation capabilities increase CLIS flexibility and adaptation potential. Advances in artificial intelligence ease the conversion of medical knowledge into CLIS databases. Hence, more business-oriented CLIS initiatives targeted to individual practitioners have been reported [9,10]. It is possible nowadays to acquire, at lower costs, a CLIS that features multi-media, expert systems, and standard record definitions [11,12]. Moreover, users and patients are much readier than before to acknowledge the need for CLIS use in clinical practice [13,14]. Since newly licensed medical practitioners have ample opportunities for IT exposure at home and at school, CLIS avoidance is being replaced by eagerness and enthusiasm. Patients are also becoming more computer literate and many welcome the presence of a CLIS in the clinic even at the cost of some interference in the interaction with the doctor [15,16]. Finally, implementation difficulties related to installation and usage are being dealt with more effectively on the basis of accumulated experience in implementation of information systems outside the medical arena. For instance, there is currently more awareness that the organizational culture presumed during the design of a system must match the actual culture of the implementing organization [17,18].

In parallel to these trends, the explosion of medical costs worldwide is forcing providers and insurers alike to lower costs and increase the quality of medical care. A growing recognition of the CLIS potential for planning and control of both cost and quality, as well as an understanding that an effective insurer-provider linkage is critical, are creating a genuine interest in CLIS implementation among insurers and providers.

Case History

The history of a CLIS implementation by MedCo, an Israeli HMO, is reported next. (The actual name of the implementing HMO is withheld at their request). Data collection for this study, performed mainly by the author, included a review of relevant documents, interviews with key figures, and a survey of users.

With close to 700,000 members, MedCo functions in both insurer and provider capacities. As an insurer, MedCo allows insured patients to choose from about 1700 independent physicians. As a provider, MedCo employs about 300 salaried physicians in its own multi-disciplinary regional centers, clinics, and hospitalization facilities. Payment schemes to affiliated providers (e.g., physicians, pharmacies, and labs) can vary according to the type of arrangement contracted and accounts payable are therefore contingent on a diversified set of reports. To facilitate payments to them, providers were required to quarterly submit minimal reports in either handwritten or typewritten form. The reports mailed to MedCo by physicians, for example, included date, a diagnosis code, and a treatment code. MedCo outsourced data processing for accounts payable to an external service bureau, while data entry, i.e., tedious compiling, sorting, counting, and cross referencing reports from providers, was done at MedCo headquarters. The resulting accounts-payable database was of relatively poor quality because the practiced input processes left hardly any resources for auditing other than through minimal sampling of provider reports. Thus, for example, it was practically infeasible to withhold services from non-paying patients or to flag all errors in providers' reports. A new top management team that joined MedCo in the early eighties viewed this situation as a barrier to success and initiated a planning process that eventually led the administrative division to abandon the practice of outsourcing. As a result, an IBM minicomputer was acquired and systems were brought in-house. However, data entry practices remained unchanged and the database at MedCo was neither complete enough to serve for medical quality assurance nor accurate enough for effective planning and control.

While the administrative systems were being upgraded, the medical division was attempting to overcome the lack of charting requirements and formed a committee for developing a standard medical record. Once a consensus was reached, newly affiliated physicians were required to adopt the resulting standard, while veterans were gently encouraged to do so. Within a short period, physician representatives demanded computerization of this standard medical record and a steering committee was formed in response. It maintained regular contact and exchanged ideas with other steering committees which were in charge of planning improvements in various administrative information systems. Eventually, MedCo adopted a revolutionary approach which aimed at responding to both the medical division, which was interested primarily in the quality of medical care, and the administrative division, which was interested primarily in improved auditing channels for effective management and control. Two projects emerged as a result of this unique approach: the CLIS project and the magnetic identification project.

The CLIS project

In 1989, MedCo chose to implement Clicks, an application generator for CLIS. It has been developed, manufactured, marketed, and supported by ROSHTOV SOFTWARE INDUSTRIES, a privately owned company based in Israel. Applications generated with Clicks can be used on standalone microcomputers with full network support and connectivity to minicomputers and mainframes. Clicks applications, in the areas of Primary care, Paediatrics, Gynecology, Orthopedic surgery, Cardiology, Ophthalmology, Dermatology, Physiotherapy, Psychiatry, Ultrasound Gynecology, General surgery, Urology, Delivery room, E.N.T, Gastroenterology, and Neurology, have been installed at hospitals,

HMOs, and private clinics. More than 10% of the physicians in Israel are using Clicks, and installations abroad include the US, UK, France, as well as in as Portugal, Spain, and Turkey.

Clicks employs state-of-the-art human interface techniques and features advanced graphic and imaging capabilities. Users of the system may create, capture, store, organize, analyze, retrieve, display, print, graph, chart, and report, vast amounts of clinical information. Data capture into an integrated database is done at the source, during the patient-physician session, exactly when and where data creation transpires. Textual data, pictures, Ultrasound images, X-rays and other diagnostic images may also be imported or scanned into the database from external systems. Information retrieval, which is menu-driven and requires hardly any typing, allows users to easily produce, in both soft and hard copy versions, prescriptions, lab orders, second opinions, referrals, discharge summaries, and reports. For instance, the patient history, diagnosis, past procedures, sensitivities, and chronic medications can be automatically incorporated into a referral. A Clicks application can be designed to alert the user about abnormal test results, sensitivities, etc. It is also possible to create and display online graphs based on patient data and to export data from Clicks to other systems.

The medical division at MedCo was in favor of Clicks for its clear, comprehensive, and readily retrievable electronic medical record. They also valued its potential for responding not only to the needs of multi-disciplinary medical environments in a universal quality-driven manner, but also to progress in medical care. The administrative division approved of Clicks because of its capacity to handle heavy duty and complex data processing. They also envisioned harnessing it to create automatic mechanisms for reporting to MedCo headquarters all information relevant for accounting and auditing.

The first stage of the Clicks project at MedCo targeted family physicians and yielded a unified data set to be recorded during a patient's visit: date, diagnosis, treatments, diagnostic procedures, lab work, and prescriptions. At a later stage, applications were generated for other medical fields in a variety of implementing environments from private practice to MedCo regional centers. Quarterly reports from physicians became an integral part of the Clicks applications and their automatic generation by users for headquarters, either on electromagnetic media or through communication lines, became mandatory. These reports were designed to be more comprehensive than before and include, for instance, several diagnoses or treatments rather than just one of each per visit as well as information about prescriptions and referrals. To facilitate changes in response to progress in medical care, mechanisms for mutual feedback were envisioned during the design phase and have been activated throughout the implementation process. Updates and upgrades of the system have been implemented without disrupting the daily work of each system user and while leaving the database intact. These updates, in the form of auto-update procedures, have been distributed to users on floppy disks.

The magnetic identification project

The rationale for the magnetic card project at MedCo was that automatic member identification by providers who would communicate online with headquarters, prior to provision of service, could contribute to improved administrative control in the accounts payable process. The goal was to make automatic identification mandatory to all providers, not only to Clicks users, without conflict with existing policies and practices. Within fifteen months, starting in January 1992, all patients were issued magnetic identification cards. Implementation then proceeded along two different routes depending on whether they were Clicks users or not.

Clicks terminals were equipped with a magnetic card reader and communication to the headquarters' host computer, by phone line, was enabled. Users were required to alter the health care provision process and validate patient coverage online prior to provision of care. Such validation meant that patient personal data (e.g., name and identification number) were automatically captured through the magnetic card reader and transmitted to headquarters for authorization. Clicks users were thus relieved of the need to enter patient personal data from the keyboard. Also, the link to headquarters facilitated automatic transmission of minimal session information about the date and the major diagnosis and treatment codes to the headquarters' host computer immediately following the patient-provider session.

The use of magnetic identification by the remaining MedCo affiliated physicians, who were not Clicks users, required installation of a dedicated patient identification system. A card reader and a simple data entry device, placed in their offices, were also linked to headquarters via a telephone line. It became mandatory during a session to use the card reader to verify eligibility, prior to provision of care. Moreover, reporting patient visits was no longer paper-based. Instead, providers were required to use the data entry device and the communication line for transmitting the date as well as diagnosis and treatment codes to MedCo's central database immediately after the patient's visit. As a result, even providers without access to Clicks were no longer required to submit quarterly reports, tedious data entry processes at headquarters were eliminated, and the quality of the accounts-payable database improved.

It is noteworthy that following the implementation of the magnetic card project, the amount of clinical information that can be accessed from MedCo's headquarters depends on the level of automation of the provider. MedCo has full

access to clinical data generated at its clinics and regional centers. MedCo has sufficient (though not full) access to data generated by Clicks users outside the networked environment, who automatically submit soft-copy rich quarterly reports in addition to after-the-session transmission of date and diagnosis/treatment codes. Finally, MedCo's only has minimal access to data from the rest of providers (non-Clicks users) who communicate to headquarters only a very limited amount of information after each session.

DISCUSSION

The Clicks implementation project at MedCo is still in progress, with applications for additional medical specialties being generated and enhancements being added. Use of the system has already spread to all MedCo clinics and other facilities, as well as to most offices of independent physicians affiliated with MedCo. Newly affiliated physicians are required to use Clicks while veteran doctors have been given incentives to do so. Because the project has been unique and unprecedented, not only in terms of variety of medical applications and the number of users, but also because the richness of the implementing environment, it is possible to use it as a basis for discussion.

The main benefit to the providers in this case is in the utilization of state-of-the-art technology for conducting and managing all aspects of the medical process. In a preliminary survey of Clicks users, most acknowledged the advantages of an online, comprehensive, accurate, and well-organized patient chart. They highly valued the easy storage, entry, display, sorting, retrieval, and analysis of data. Surveyed users further confirmed that costs associated with a paper-oriented environment, such as dictation, filing, and correspondence with administrative counterparts (to deal with audits and insurance reimbursements) have been drastically reduced. Although the main use of the system has been clinical in nature, broader uses have been mentioned as well. For instance, taking advantage of the online access to side effects of drugs in combination with immediate retrieval of cross referenced information were mentioned by many respondents as one such broader use.

Some of the intangible benefits to both MedCo and its affiliated practitioners, emanate from the vast amounts of data that have been accumulating in the databases of the providers and the insurer. The possibilities for statistical analysis, processing, and reporting have enriched medical processes and opened new opportunities for research based on the information in the medical records. Also, those in charge of preventive medicine could, for example, gain new insights by listing all the patients who missed an annual checkup, or by selectively calculating the relationship between the number of hospitalization days and the type of procedures and medications used. Thus, the ability to evaluate interrelations between the various elements that make up the medical process, or to know the time and place where money is spent, has allowed MedCo management to achieve more effective and more efficient medical services. Such information has become available online and not only by hindsight through post factum analysis. Hence, timely efforts to improve the quality of the medical process and worthy enhancements of administrative decision making have been made possible with the implementation of Clicks. In other words, the high standards of patient charting within an electronic patient record and the resulting feedback channels, have raised the quality of medical care while, at the same time, contributing to the simplification of administrative tasks performed by insurer and providers alike.

Perhaps the most tangible benefits to the insurer, in this case, were cost savings due to increased data accuracy as evident, for example, by the more effective screening of patients with respect to their eligibility for health care delivery services. At this time, actual figures have not been made public because of the possible ramifications to the maintenance of the delicate balance between providers and insurers. Another cost-cutting result of both the Clicks and magnetic card projects has been the elimination of the tedious data entry that was putting a burden on the process of accounts payable.

Because the feedback channels embedded in the Clicks implementation at MedCo have been designed to work in a two-way mode between provider and insurer, control and medical auditing measures could be incorporated into the basic unit of the work environment. For example, supplementary medical information and the most recent treatment procedures, as well as new regulatory requirements and administrative regulations can now be communicated directly, online, and within the proper context of the medical process. Legal and ethical aspects have been given special attention and data access restrictions can be enforced at all system levels. Thus, for MedCo, technology has had a direct positive impact on the two-way information flow in the linkage between the insurer and the providers.

IT management at MedCo and, in particular, the history of computerizing clinical records and member identification, are consistent with the IS literature in many respects. The criticality of top management support and involvement was reflected by the roles played by the chief executive officer and the chief technology officer. The new chief executive officer was instrumental in effecting a major shift in IS policy and practice by recognizing the potential benefit of technology, by encouraging the formation of steering committees, and by taking part in major decisions. The importance of the attitudes of IT management is also evident from the case study. MedCo's chief technology officer was a devout

supporter of the projects and actively participated both in their planning and implementation.

The events described in the case study are also consistent with more general managerial theories and, in particular, with modern trends toward total quality management and reengineering. In order to achieve quality improvements in the clinical environment and in the administrative systems, the health care delivery process during a session was redesigned to harness the power of technology for managing clinical records and for automatic patient identification. However, in order to minimize user resistance, the redesigned process remained similar enough to the old process.

The Clicks implementation at MedCo has been both intraorganizational and interorganizational. The implementation at MedCo's own clinics and regional centers can be viewed as internal. However, what makes this implementation unique is the interorganizational implementation at the offices of independent private doctors. Practically, MedCo did not provide one technological solution for itself (as insurer/provider) and another for its affiliated independent physicians (as providers). Rather, the technological solution covered both parties as well as the linkage between them. This approach broadened the range of benefits and beneficiaries from the implementation. Normally, the benefits of a CLIS implementation are clinical and the beneficiaries are providers. In this case, however, the interorganizational data transfer, from the offices of independent doctors to MedCo's administrative systems, facilitated auditing and cost control in addition to more to-be-expected clinical benefits. Thus, both providers and insurer reaped administrative benefits. Moreover, both parties were able to take advantage of the system's potential for clinical quality assurance and research. Another value added was the improved quality of the linkage between providers and insurers. Thus, the CLIS implementation at MedCo demonstrates how, in reality, it was impossible to completely separate either insurer from provider or medical from administrative systems. The goals that triggered the IT strategy at MedCo, were neither purely medical nor purely administrative. Better management of patient records, highly accurate databases, medical quality assurance, and a more controlled process of accounts receivable, were both medical and administrative concerns.

CONCLUSION

Although this paper is about a CLIS application in the clinical environment in the 1990s, it is possible to draw conclusions of relevance about IT management in any organization toward the 21st century. First, this case highlights the inclusion of technology in the strategic vision of an organization [19]. At MedCo, top management viewed technology as a strategic asset that can support both quality improvement and cost reduction. It is clear from the case study that while technology is necessary, it is by no means sufficient. A critical success factor, as evident from the MedCo experience, is top management vision, initiative, support, and involvement.

MedCo's top management realized that information technology can be harnessed to handle effectively the persistent growth in membership, the significant increases in the number and heterogeneity of physicians employed, and the frequent changes in medical practice. At the same time, they realized that MedCo's long standing management and control mechanisms had to change. In fact, the rationale for the Clicks project was threefold. The clinical motivation was to improve the quality of daily medical practice by enabling orderly information recording and retrieval. The research-oriented motivation was to improve the study of quality assurance based on a more comprehensive database. Finally, the administrative motivation was to improve control of the accounts payable process by incorporating data entry at the source and by eliminating tedious data entry from providers' reports.

The strategic thinking at MedCo was followed by operational steps. Steering committees, for instance, were effectively employed in matching of need with the solution. MedCo was looking for a CLIS that would match, to a large extent, existing clinical processes. Furthermore, they required that the CLIS would not conflict significantly with management policies while, at the same time, helping to monitor the implementation of these policies. This approach was adopted also throughout the implementation. The professional team in charge of the implementation maintained continuous contact with users of all kind and responded promptly whenever the system seemed to clash with assumptions, beliefs, and processes that were essential to MedCo's survival.

Another dimension of thoughtful matching is demonstrated by the adaptation of the system, during implementation, to the diverse environment at MedCo. While private affiliated physicians have been using a stand-alone configuration on a one-to-one basis, the implementation within the network environments (e.g., regional centers) has allowed access from any Clicks work station, whether local or remote, by any authorized user. Connectivity with administrative or research-oriented medical information systems, as well as with non-IT medical technologies has been also incorporated into the implementation. In particular, authorized administrators have been able to obtain, online, those fractions of the database relevant to performing accounting and auditing jobs.

One lesson is particularly relevant to IT management in health care environments. Because of the interdependence between many kinds of entities involved in medical care, it is important to plan for bridges between them. MedCo was

looking for a system that would enable data import from other systems and data export to other systems via communication or electromagnetic media to facilitate data transmission to and from equipment in labs, hospitals, and organizations providing scanning and imaging services. Transporting medical information through these channels can contribute greatly to the quality of medical care, research, and administration.

Assuming that the trend toward CLIS and data capture at the source will continue, the challenge will be to secure cooperation of the individual health care provider (e.g., the practicing doctor). In this respect, the important thing to remember and learn from the MedCo experience is that Clicks was perceived at MedCo just like any other management-induced change.

First, synergy between the daily practice and the implemented system has been promoted. Although MedCo was willing to redesign and somewhat modify the clinical work process, the basics remained unchanged and only a relatively narrow gap existed between the old and new processes. Second, the incentive scheme built into the implementation was remarkably similar to the one used earlier to implement the standard medical record. In both cases, incentives were designed to encourage the medical staff to change the way they worked. For instance, both the standard medical record and Clicks were made mandatory for physicians who wanted to become MedCo-affiliated. Those who were in practice for MedCo already were advised, but not forced, to adopt the sought changes. In particular, to encourage the adoption of Clicks, veteran practitioners were given administrative and financial incentives. In addition to those incentives, the CLIS itself provided users with tangible benefits. They were relieved of the tedious billing reports and their interaction with the insurer was significantly simplified. Third, integration with other processes and systems was pre-planned. Although the Clicks project at MedCo was geared to support clinical health care delivery, it interacted heavily with administrative systems. At a very early stage, bridges to the membership identification and to accounts payable systems were envisioned and planned for.

The above conclusions about IT management, both in general and at health care organizations in particular, are based on a case study. A case study is perhaps the best way to initiate implementation research. However, other research methods are called for to gain more insight. For example, a preliminary survey that was conducted for the present case study compared users to non-users and found that non-users felt that they record patient data more accurately and more completely than other users. Without more in-depth work studies it is impossible to draw any valuable conclusions because a survey reflects the subjective judgement of users, as opposed to facts. Similarly, responding users were younger and worked longer hours for MedCo. It may very well be that these findings are a reflection of non-response bias. Through in-depth interviews it might be possible to verify and explain such differences and find out whether, for example, MedCo's incentive scheme might have been the cause of such differences.

The evaluation of benefits and costs, with particular emphasis on clinical or economic intangibles, is perhaps of greatest importance. This paper has only scratched the surface in dealing with such issues as effectiveness, efficiency, and quality assurance. For instance, what is the role of technology in quality assurance? How can one insure the quality of technology applications? Finally, since health care is becoming more and more a government concern, it is recommended that future research examine whether government, through policies, regulations, and incentives, can bring about effective utilization of technology by providers and insurers.

REFERENCES

1. Schoenbaum S.C. and Barnett, G.O., 1992, "Automated Ambulatory Medical Records System", *International Journal of Technology Assessment in Health Care,* Vol. 8, No. 4, pp. 598-609.
2. McDonald, C.J. and Tierney, W.M., 1988, "Computer-Stored Medical Records: Their Future Role in Medical Practice", *JAMA,* Vol. 259, No. 6, pp. 3433-3439.
3. Salenius, S.A., Margolese-Malin, L., Tepper, J.E., Rosenman, J.J., Varia, M., and Hodge, L., 1992, "An Electronic Record System with Direct Data-Entry and Research Capabilities", *International Journal of Radiation Oncology, Biology, Physics,* Vol 24, No. 2, pp. 369-376.
4. Dick, R.S. and Steen, E.G. (Editors), 1991, *The Computer-Based Patient Record,* National Academy Press, Washington, DC.
5. Warshawsky, S.S., Pliskin, J.S., Sharon, A., Binztok, M., and Margolis, C.Z., 1993, "Physician Use of a Computerized Medical Record System During the Patient Encounter: A Descriptive Study", *Proceedings of MIE 93,* Jerusalem, Israel, pp. 611-613.
6. Barnett, G.O., 1984, "The Application of Computer-Based Medical-Record Systems in Ambulatory Practice", *The New England Journal of Medicine,* Vol. 310, No. 25, pp. 1643-1650.
7. Peterson, H.E. and Schneider, W. (Editors), 1986, *Human-Computer Communications in Health Care,* Elsevier Academic Publishers, Amsterdam, Holland.
8. McDonald, C.J., Tierney, W.M., Overhage, J.M., Martin, D.K., and Wilson, G.A., 1992, "The Regenstrief Medical Record System: 20 Years of Experience in

Hospitals, Clinics, and Neighborhood Health Centers", *Clinical Computing*, Vol. 9, No. 4, pp. 206-217.
9. Greens, R.A. and Shortliffe, E.H., 1990, "Medical Informatics, An Emerging Academic Discipline and Institutional Priority", *JAMA*, Vol. 263, No. 2, pp. 1114-1120.
10. Shortliffe, E.H. and Detmer, D.E., 1991, "Patient Records and Computers", *Annals of Internal Medicine*, Vol. 115, No. 12, pp. 979-981.
11. Arnold, U., and Peter, G., 1993, "A Computer-Based Distributed Multimedia Patient Record: Use of New Technologies for Computer-Based Medical Records", *Proceedings of MIE 93*, Jerusalem, Israel, pp. 585-590.
12. Bradbury, A.R., 1991, "Computerized Medical Record: Defining A Standard without the Computer, *Medical Informatics*, Vol 16, No. 3, pp. 279-286.
13. Shortliffe, E.H., 1991, "Medical Informatics and Clinical Decision Making: The Science and the Pragmatics", *Medical Decision Making*, 11 (Supplement), S2-S14.
14. Ball, M.J., and Collen, M.F. (Editors), 1992, *Aspects of the Computer-Based Patient Record*, Springer, New York, NY.
15. Fitter, M., 1986, "Evaluation of Computers in Primary Health Care, the Effect on Doctor-Patient Communication, in Peterson, H.E. and Schneider, W. (Editors), *Human-Computer Communications in Health Care*, Elsevier Academic Publishers, Amsterdam, Holland, pp. 67-79.
16. Brownsbridge, G., Herzmark, G.A., and Wall, T.D., 1985, "Patient Reactions to Doctors' Computer Use in General Practice Consultation", *Social Science and Medicine*, Vol. 20, No. 1, pp. 47-52.
17. Romm, T., Pliskin, N., Weber, Y., and Lee, A.S., 1991, "Identifying Organizational Culture Clash in MIS Implementation: When is it Worth the Effort?", *Information & Management*, Vol. 21, 99-109.
18. Pliskin, N., Romm, T., Lee, A.S., and Weber, Y., 1993, "Presumed versus Actual Organizational Culture: Managerial Implications for Implementation of Information Systems", *The Computer Journal*, Vol. 36, No. 2, 143-152.
19. Walton, R.E., 1991, *Up and Running - Integrating Information Technology and the Organization*, HBS Press, Boston, MA.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the invaluable contributions of Dr. Alon Zucker and Mr. Hanan Shachaf of ROSHTOV, and Dr. Lea Friedman, Ms. Ayelet Cohen-Israeli, and Mr. Roni Ben-Zion of Ben-Gurion University.