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SUMMARY

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The complexity of medical care has greatly increased during the past **30** years. More technology, more professionals, and more support services are involved in the care of patients than ever before. Today's medical care institutions encounter problems coordinating and communicating massive quantities of data necessary for clinical care. Medical professionals must note and remember increasing amounts of data about each patient from an expanded number of diagnostic tests and therapeutic procedures. Physicians are also faced with the task of memorizing information about new diagnostic tests and treatments, knowledge that must be constantly updated.

Outside the clinical context, other changes have increased data that must be retained about each patient. Third-party payment systems, particularity the Federal programs Medicare and Medicaid, have raised requirements for data to ensure validity of beneficiary claims. Other Federal and State programs for quality review, planning, regulation, and research have brought additional demands for recordkeeping. And the increase in malpractice litigation has created new pressures for careful documentation of clinical treatment. Traditional handwritten medical records have not kept pace with the rising demands placed on them.

The application of computer technology offers a possible solution to these problems. Called medical information systems, this new application promises to change the medical record from a historical document to timely, accurate information that is instantly available to all those involved with patients. Medical information systems can be used to educate and assist medical professionals during clinical care, reducing the need to rely on memory. Potentially, they can increase efficiency and reduce or contain institutional costs. They can provide a way to monitor and evaluate the quality of medical services. They can eliminate duplication of data collection and can provide accurate, accessible data for evaluating and planning medical care services. Finally, they can be used to supply data that have previously been unavailable to researchers and policy makers.

For purposes of this report, a medical information system is defined as a computer-based system that receives data normally recorded about patients, creates and maintains from these data a computerized medical record for every patient, and makes the data available for the following uses: patient care, administrative and business management, monitoring and evaluating medical care services, epidemiological and clinical research, and planning of medical care resources.

No existing medical information system yet provides data for all of these purposes. Those in use were developed through the independent efforts of many investigators and consequently display a diversity of technical approaches and philosophies. For the most part, they are prototypes and vary in goals, costs, and impact.

This variation, as well as the developmental status of the technology, makes assessment of benefits and limitations difficult. Few careful evaluative studies have been conducted to date. However, recent breakthroughs in computer technology can be expected to increase the availability and reduce the costs of medical information systems. Without a Federal policy toward these systems, their diffusion may well proceed indiscriminately and standardization will not be possible. If so, the full potential of medical information systems is not likely to be achieved.

FINDINGS AND CONCLUSIONS

Benefits and Limitations

Institutional Delivery of Patient Care. Evidence indicates that by facilitating communication and reducing errors, medical information systems improve the patient care delivered in medical care institutions. Some errors are reduced because the computer systems help ensure that data about a patient are accurate, available, legible, complete, timely, and organized. Through their mechanisms to check whether orders have been carried out, medical information systems also monitor performance and prevent some errors of omission.

Support of Clinical Decisionmaking and Physician Education. Some medical information systems support clinical decision making by supplying physicians with appropriate medical knowledge and patient data during clinical care, thus reducing their need to rely on memory. By incorporating valid findings of medical research into programs, systems can also facilitate the spread of new medical knowledge and provide continuing medical education. Preliminary studies indicate that errors of omission by physicians are reduced if timely reminders are provided by the computer systems. Further evaluations are needed, however, to confirm whether physicians' performance is changed.

Assessment of the Quality and Utilization of Medical Care Services. Medical information systems can be programed to assess the quality of medical services provided against agreed upon standards for acceptable care. Appropriateness of inpatient facility use can also be monitored. These legally mandated functions could be accomplished without the expense of any additional data collection. Medical information systems have been used for this purpose in only a few experimental programs, each of which has been limited to a small number of clinical conditions.

Malpractice Litigation. Whether medical information systems would increase or decrease malpractice litigation is debatable. Computerized medical records document the conduct of medical therapy. They could eliminate some causes for litigation by reducing errors in patient care. Errors that do occur could be highlighted, however, and lawsuits increased. No evidence is available to support either hypothesis from institutions using medical information systems.

Roles of Medical Care Professionals. Medical information systems reduce or eliminate paperwork at the same time that they make available information needed for optimal job performance. Thus, medical care professionals can make greater use of their knowledge and skills and assume increased responsibilities. However, there is insufficient evidence to conclude that personnel actually perform new duties or that their productivity increases in activities related to patient care.

Health Data Systems. Health data systems are collections of data organized for a variety of purposes including reimbursement of health services, utilization review, assuring quality of care, and planning, monitoring, or evaluating medical care services. Medical information systems could supply these health data systems with data more accurate and more accessible than those currently available. If standard classifications and codes were used and if all data sent to health data systems were already in computerized form, these organizations would be likely to realize substantial cost savings. At present, no medical information system is coordinated with health data systems. Further, health data systems aggregate data from more than one source and could thus take advantage of medical information systems only if widespread adoption occurs.

Planning and Research. Medical information systems could provide planners and medical researchers with data that are not readily available from existing health data systems. The computer systems store a data base that permits detailed analysis. Such analyses are now attained only with the difficulty and expense of special studies. With this kind of data, managers of institutions could predict needs for new supplies, personnel, and facilities. If medical information systems with compatible data bases and standard definitions were widely adopted, they could be used to plan medical services resources, to evaluate the cost and efficacy of medical care, and to conduct clinical and epidemiological research on patients' problems, conditions, and diseases.

Confidentiality of Patient Records. The confidentiality of sensitive medical data could be violated if computer files were infiltrated by unauthorized persons. In addition, computerized records facilitate the availability of detailed data to organizations outside of medical care institutions. At present, each facility using a medical information system has developed its own security precautions to maintain confidentiality. Today computer records are more secure than manual records. However, medical information systems are not in widespread use, and a potential problem does exist.

Factors Influencing Adoption

Acceptability to Medical Care Providers. Medical information systems require medical professionals to record information in a specified manner, and some professionals could resist changing established practices. Persuading physicians to adopt this innovation proved a major hindrance with early systems. More recent experience with the computer systems described in this report indicates that familiarity with a system encourages medical personnel to accept it. Providers who regularly use a system strongly support it, while those who are only occasional users sometimes find fault with it.

Technical Transferability. Prototype medical information systems have been proven technically feasible, but most have not yet been made adaptable to the various conditions of different institutions. In order to realize the benefits of a standardized data base and to market systems economically on a large scale, flexible systems are required. Efforts to make existing medical information systems transferable are now being initiated.

Cost. Medical information systems are an expensive technology. Operating costs for a hospital-based system range from $4 to $9 per patient per day. For systems based in ambulatory care sites, costs range from **$0.50** to $14 per patient visit.

Costs of implementation are high. Costs are, however, likely to decrease in the future, because of lower prices for computer hardware and higher volume, Moreover, a majority of both hospitals and ambulatory care facilities now using medical information systems report overall savings in institutional costs due to their computer systems. At least one study has documented cost savings. In particular, savings are experienced in labor expenses.

General Factors. Rate of adoption of medical information systems will depend on multiple factors applicable to any new technology. New developments in computing hardware and software, Federal policies, and economic incentives and constraints could facilitate or impede adoption. The effect of these factors on medical information systems is not now predictable.

POLICY ALTERNATIVES

At present, the National Center for Health Services Research in the Department of Health, Education, and Welfare supports research on medical information systems through grants and contracts to independent investigators. The commercial computer industry, the major developer of medical information technology in the past, is conducting some new research and directing efforts toward limited marketing of prototype systems.

The Federal Government could continue current policies and allow adoption of medical information systems to be determined in the open marketplace. However, this policy could result in medical information systems being marketed and adopted without additional investment in research to improve certain capabilities. Because capabilities to improve and monitor the quality of medical care and to facilitate research and planning are the least developed and require standardization, these potential benefits for patients and the medical care system might be lost. Computer systems limited to administrative and financial functions could continue to dominate the market. Medical information systems that might be used could also lack high standards of quality or provide inadequate protection for the confidentiality of patient data.

If Federal action influencing development, standardization, and eventual use of medical information systems is considered appropriate, a range of policy alternatives could be pursued. These alternatives are illustrative and not mutually exclusive. Addressing problems through several mechanisms may be most effective.

- . Establish a central clearinghouse to coordinate developmental projects and provide information to the public about medical information systems.

- ● Provide funding for evaluation of medical information systems in a number of different medical care facilities and locations to determine their effectiveness in terms of relative benefits and costs.

- ● Ensure the availability of medical information systems with specified capabilities and applications by contracting for their design and development.

- . Provide incentives for medical care facilities to adopt medical information systems that improve the quality of patient care and support research and planning.

. Authorize a central organization to develop, validate, and maintain the content of medical knowledge within medical information systems.

● Develop standardized medical data bases, including nomenclature, terms, definitions, classifications, and codes for use in medical information systems.

. Establish guidelines for precise standards to protect confidentiality of patient data within an institution and release of identified data to third parties.

SCOPE OF THE STUDY

There are three boundaries on the kinds of computer systems considered in this report. The first boundary is that this study discusses only those computer systems that electronically store at least part of the individual patient's medical record. The capability to accumulate and retrieve data for each patient is critical for both the process of patient care and research.

A second boundary limits discussion to broad-based systems that could provide information needed by a medical care institution as a whole. Although computer applications such as automated clinical laboratories, pharmacy systems, intensive care monitoring systems, and financial systems can benefit particular areas of clinical care or institutional management, this study excludes computer systems applicable only to such specialized units or functions.

Third, this report assesses only computer systems that can provide information about patients during the clinical care process. This boundary limits consideration to systems meeting two technical requirements. First, the computer itself must be directly linked to both the stored data files and those medical care providers who enter and use the data; such a system is referred to as "on-line." Second, the computer system must process and return data quickly enough to be used; such systems are said to operate in "real -time." However, systems can combine "on-line" and "off-line" methods for entering and displaying data.

This report does not attempt to survey the field and categorize systems by design and capacity. Three advanced systems are described to illustrate potential implications of this new technology for patient care in particular and, more generally, for the whole medical care system. Although an important capability of medical information systems is to provide necessary data for administrative and business needs, implications of medical information systems for these areas are not examined in this study because computer applications performing similar functions are already widely in use.

ORGANIZATION OF THE REPORT

Chapter 2 defines the basic capabilities of medical information systems and gives a historical overview. Major problems that have hindered development are reviewed: variations in medical care, inadequate computer hardware and software, and inadequate commitment of capital for long-term development.

Chapter 3 describes the three medical information systems referred to throughout the report. One system, Technicon's Medical Information System (TMIS), is de-

signed for acute care hospitals. Its use at El Camino Hospital in Mountain View, Calif., is reviewed. Another, the Computer Stored Ambulatory Record (COSTAR) system at the Harvard Community Health Plan in Boston, Mass., is designed for ambulatory care. The third, the Problem-Oriented Medical Information System (PROMIS), can be used in either setting, although the prototype operates in an inpatient facility at the University of Vermont Medical Center.

Chapter 4 discusses the implications of medical information systems for institutional delivery of patient care, clinical decision making and physician education, assessment of the quality and utilization of medical care, malpractice litigation, the roles of medical care professionals, health data collection systems, planning and research, and confidentiality of patient records.

Chapter 5 reviews factors that will influence the use of medical information systems: acceptability to medical care providers, technical transferability, cost, and general factors that influence the use of any new technology.

Chapter 6 summarizes alternative policies for the Federal Government in relation to medical information systems. Possible actions directing development, standardization, and dissemination of the technology to ensure maximum benefit for the medical care system are discussed.