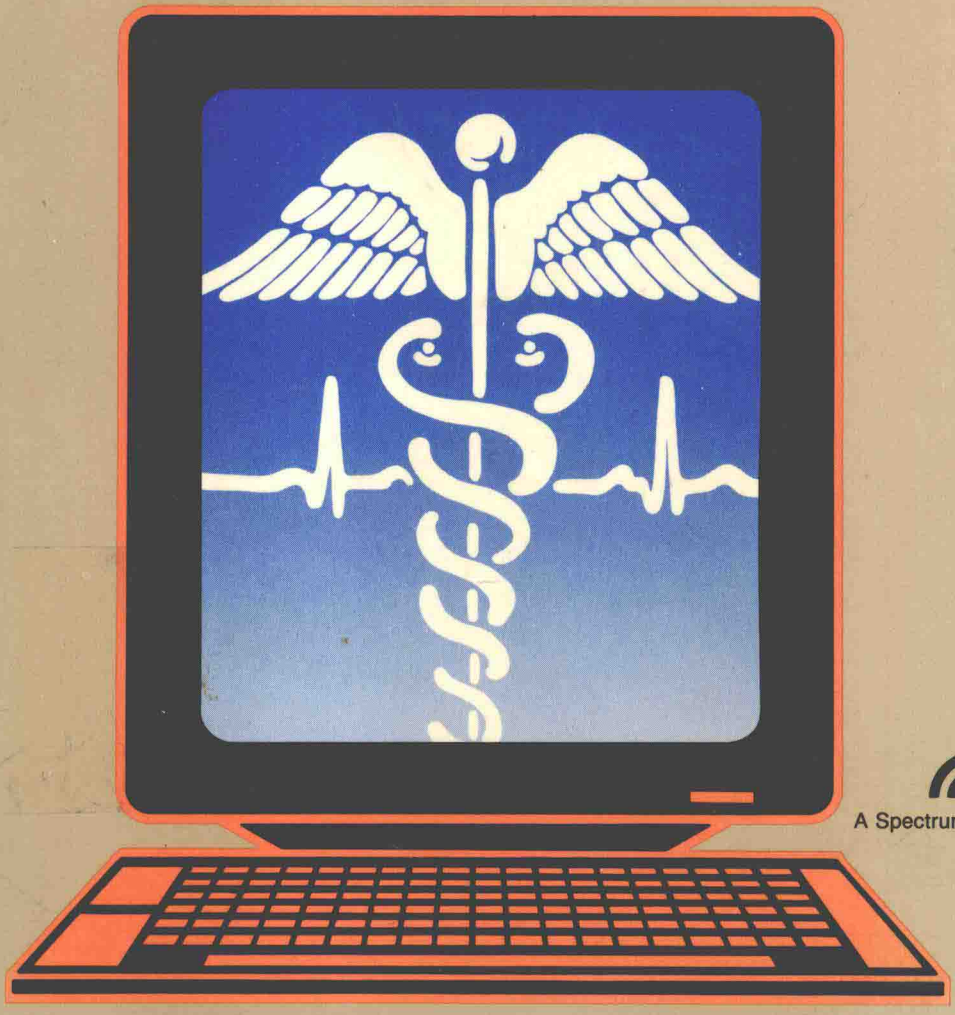
USING COMPUTERS IN THE PRACTICE OF MEDICINE



A Spectrum Book

PROFESSIONAL AND CLINICAL GUIDELINES FOR MANAGING YOUR PRACTICE AND IMPROVING PATIENT CARE

MORTON SOLOMON, M.D.

USING COMPUTERS IN THE PRACTICE OF MEDICINE

Professional & Clinical Guidelines for Managing Your Practice and Improving Patient Care

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Dedicated to the memory of Mom and Pop,
William and Bella Solomon,
and to Moise, Wyle, and Susan

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Contents

Introduction

> The most cost-effective technological development during the past 30 years has been the invention and production of information-processing machines. The power and versatility of computers and related devices has increased as dramatically as their unit costs have decreased. The business management of organizations, including those involved in the delivery of medical care, has already been transformed by computer technology. We are now in the early stages of such a transformation in the management of clinical information. Computers are now routinely used in gathering, recording, and distributing data obtained in clinical laboratories. Computer-based records of observations and decisions made by physicians at the bedside or in the office are being used increasingly but are still in an exploratory phase. . . . Medical education should do more to prepare doctors to use information-processing devices.[1]

We are living in the midst of a health boom, and people have a genuine desire to be, look, and feel healthier. They have increased expectations for the efficient delivery of services and a "healthy" way of life. Maintaining good health and preventing illness are becoming more important, and less emphasis is being given to awaiting the occurrence of acute illness. For some patients, the only written communications they receive from their doctors are bills for services. Patients are playing a more active role in their own care and seeking better communications with their physicians and health advisors. Some doctors are beginning to respond more effectively to their patients' needs by seeking and developing new avenues of communication.

The purpose of this book is to present a survey of the ways computer systems can be used by medical and health practitioners. Computers are performing both the clinical and administrative tasks of a medical practice. No one asks whether a computer is useful in professional practice, only how it can be used. This book is designed to answer the question: "What can I do with it?" This book presents a list of ways that computers have been used to assist medical and health professionals in fulfilling their roles.

Medicine has often been considered a "soft" science, but information science and technology may revolutionize the basic reasoning methods in medicine by permitting us to examine medical concepts such as data structure, inference, simulation, and the psychology of diagnosis and therapy. Epidemiologic studies have led to criticism of medicine, and some people doubt that modern medicine promotes health. The decline

in infectious disease has been attributed to higher standards of living rather than to the advances in therapy. Practitioners are often responding to authoritarian rules-of-thumb or other admittedly inadequate bases for a decision. Some critics complain that medicine has not been scientific, only technical.

Information science (informatics) is contributing to a crisis in medicine, especially in medical records and medical decision making, and has exposed the imprecise and uncertain nature of much of medical practice. Handwritten records make measurements of outcome or follow-up laborious, if not impossible. Most practitioners agree that current manual record systems used in doctors' offices are cumbersome and costly. Information science may provide new medical tools, revamp medical education, and transform medicine into a "hard" science.

The essence of medical practice is to collect information about a patient, evaluate it in light of knowledge and experience, and make decisions about actions to be taken. Computers can be applied to medicine to help collect data about a patient's condition by means of automated medical histories, ultrasound, computerized tomography, collecting and organizing laboratory test results, and other monitoring devices; store a patient's medical records; improve communications; and assist in the diagnosis and management of disease. In addition, computers can provide data for review and follow-up of patients and populations at risk; and improve the housekeeping functions of bookkeeping, accounting, budgeting and planning, and scheduling.

Computers have most remarkably contributed (1) tools for medical data collection and analysis; (2) signal analysis (as ECG, EEG) and patient monitoring; (3) information systems for hospitals, clinics, and offices; and (4) control of prosthetic devices such as artificial limbs, organs, or glands. There has been success in the application of computer technology into large clinical laboratories, into radiology and neurology, and in the administrative and fiscal sectors of most hospitals. With the development of microcomputers, more clinicians and allied personnel are becoming involved in using computers for their own needs.

By extending human memory, the computer serves to reinforce the physician's competence and his self-confidence. Computers may contribute to a new paradigm in medicine by making medical knowledge more widely available. Information science may map and systematize medical science, forcing it to be more logical and providing new insights into the organization and consequent effectiveness of modern medicine.

ORGANIZATION

The organization of even a small practice is determined by the need for people to communicate with one another. Rules and procedures help take care of routine tasks and eliminate the need to treat each situation as

unique. Modern information technology can simplify the organization by allowing easier, more direct, and more timely communications between individuals.

During the last thirty years there have been major changes in the content of medical practice as well as the expectations of its practitioners. In the early 1950s an internist with two patients hospitalized with pneumonia was very busy; now the internist must be more "productive" to survive economically. Payment has shifted from the individual patient to the patient's insurance company, prepayment may replace fee-for-service, and the government plays a larger role in financing and regulating medical care.

By the late 1970s, computers in the physician's office were becoming practical because the technology was becoming cheaper and lessons were being learned from some remarkable successes. At the Harvard Community Health Plan, an unusually successful group practice in Boston, Massachussetts, the computer-based record is used in physician–patient interactions. A computer is better than paper for storing and sharing patient information. It is reasonable to expect that the recent advances in communication, information handling, and miniaturization will lead to increased efficiency and quality of the services of the medical and health professional.

New technologies have been classified as *add-on* or *substitute*. An add-on technology makes possible the accomplishment of something that was previously impossible or impractical. The wheel, the printing press, and the automobile are examples. Most of the new medical technologies for acquiring data are add-on. These modern medical technologies often generate additional costs to accomplish something that was not previously possible, but in distinction to the wheel they have apparently not increased productivity and they have not reduced costs either to the society or the consumer. Their value lies in their contribution to the detection and prevention of disease, lessening of disability and pain, or prolonging life.

A *substitute technology* provides a better, more efficient, or more productive way of accomplishing a task. Substitute technology often takes the form of automation and requires fewer workers for the same unit of production or service. The increased productivity (efficiency) usually results from substituting capital investment for labor costs. It can reduce costs for the consumer and increase profits for the provider, but it can also produce unemployment. Current policy does not promote efficiency.[2] The cost/benefit ratio depends upon one's viewpoint and is difficult to determine objectively.

Another question has to do with the compatibility of technological development in the existing social organization. New technologies often require new housing, new technicians and bureaucracies, and new systems of behavior. Medical practice in the United States has not been distinguished heretofore by the rapidity with which it accepts structural

alteration or reorientation of the behavior patterns of its practitioners. It has largely been the physician who decides upon the use of new technologies and they have been notoriously resistant to changes such as computerization. Given the present organization of medical practice, useful computer systems will be developed only if health professionals become more knowledgeable (and demanding) and administrators are persuaded to use computers to provide effective support for clinical activities as well as they do the accounting systems.

Since 1950 there has been a rapid penetration of the "money economy" into all facets of the health-care system. There has been exponential growth in the finances of academic health centers; there is a shift from voluntary to employed physicians in huge teaching hospitals; stipend payments for house staff are reasonable; and philanthropy has declined in meeting the operating deficits and the capital needs of nonprofit hospitals. Medical complexes with annual expenditures in excess of $100 million, as well as those operating on a more modest scale, need strong management to perform their multiple functions of education, research, and service efficiently and effectively.

Three historical stages of office organization have been described: *preindustrial, industrial,* and *information-age.* The first two stages correspond to the guild and industrial models of production.

The operation of a preindustrial office depends largely on the performance of individuals, without much assistance from either systematic organization or machines. Most small-business as well as most medical and professional offices are still in the preindustrial stage. Little attention is paid to systematic flow of work and the productivity of the methods. Although information-handling devices are present (telephones, copiers, and word processors), they are not used to full advantage. Good human relations often develop among the employees; loyalty, mutual respect, and understanding have major roles in holding the organization together. Employees are expected to learn their jobs, to do what is needed, and to ask for help when necessary. Each person does his or her job more or less independently and can have a personal style of work. Preindustrial office organization generally works well as long as the operation is small and fairly simple.

However, the steady increase in the volume of work and the growing need for more reports on which to base decisions make preindustrial manual methods too slow and expensive. It is ineffective for handling either a large volume of transactions or complex procedures requiring the coordination of a variety of data sources. Information on ledger cards can be current but not easily summarized. Recapping is laborious and costly, and the chance for error increases with each writing. If the workload increases or if business conditions get more complex, as with new reporting requirements or changes in insurance codes, people are asked to work harder or more employees are hired. Without the benefit of ad-

ditional systems or technology, however, efficiency and morale often break down. Although the preindustrial model of office organization can be effective for some small operations, direct conversion to information-age methods is fairly easy.

One solution to the problem of keeping pace with the large volume of data was to apply mass production principles of work simplification, specialization, and time-and-motion efficiency to the clerical work force (the work emanates from large armies of clerks). For instance, the production-line approach has been used for handling the large volume of transactions required for processing health insurance claims. This industrial model of office organization is based on an endeavor to maximize efficiency and output. (To create an assembly line the flow of work is analyzed, discrete tasks are isolated, and the work is measured in some way. Jobs are simple, repetitive, and unsatisfying. Jobs, transactions, technologies, and even personal interactions must be standardized. Responsibility becomes fragmented, a bureaucracy develops, and paper proliferates.) Many errors arise in a production-line process and tend to remain uncorrected and compounded. Because a given item can take weeks to flow through the pipeline, it is often difficult to answer providers' inquiries and harder to take corrective action. Effective people do not want to stay in boring jobs; people who do stay often lack interest in their work.

The *information-age* office exploits new technology of automatic processing to attain a high level of efficiency and a return to people-centered work. Instead of executing a small number of steps repeatedly for a large number of accounts, one individual handles all customer-related activities for a much smaller number of accounts. In the medical practice setting, the clerk or professional continues to work directly with the patient. The machine assists by performing the background processing. Productivity is not measured by hours of work or number of items processed; it is judged by how well the patients are served.

It was the research of Robert S. Ledley that established a rational basis for the application of the computer to medicine.[3] Ledley provided a mathematical basis for computerized medical diagnosis, medical record processing, special biomedical data processing methods, and automated pattern recognition. Lee B. Lusted explored the practical needs of scientists in employing the computer in diagnostic calculations and revealed ways that computers could serve physicians.[4]

The electrocardiogram was the first physiologic signal to be processed and analyzed by digital computer by Hubert Pipberger in 1957. Smith, Caceres, and Pipberger explored the cardiologic field in such areas as electrocardiography, arrhythmia, and cardiac diagnosis. H. Warner introduced the computer into congenital cardiac diagnosis.

X-ray diagnosis was enhanced by techniques of image reconstruction (IRC) which derived from developments in radioastronomy. In 1971,

Bates and Peterson developed procedures for reconstructed tomography. The CT scanner (Computer Assisted Tomography) was introduced by Hounsfield in 1972.

MUMPS (Massachusetts General Hospital Utility Multi-Programming System) was specifically designed and developed to address data management and information processing problems in the delivery of health care. It makes the manipulation of text easier so that any piece of data may be inspected for format or for content; its hierarchical file structure is tailored for the medical record with its many different levels of importance and detail; and it is a high-level language with its syntax and concepts oriented towards the kind of problems that it was designed to solve rather than a particular computer.

At least half of all group practices now use automated billing services, and some collect data for administrative use. Automated consulting services have had their greatest use in the interpretation of electrocardiograms but acceptance remains limited. The automation of clinical laboratory equipment has created small and effective devices that can accurately perform common clinical tests, improving the efficiency and convenience of the ordering physician, but are threatening to both technicians and pathologists.

Professionals are increasingly meeting the computer terminal whenever they want information. Information may be internal, generated by the practice itself, or external, coming from outside the practice in the form of paper or electronic messages from telephone or other networks, such as assistance in a personal knowledge-base system, accessing scholarly literature, a stimulus to active learning, and informal communications. Computer literacy will be necessary for survival in medicine, and some physicians will go for computer mastery. The computer promises to have profound effects on medical practice and the future of medical care.

The most important reason to computerize is that the boss wants it. While it is common to expect to save time and money with a computer, the most valid reason is to take advantage of new opportunities and to have the time to do what is not now getting done. A computerized office is a more enjoyable place to work because of decreased drudgery and less personnel turnover. It is one way of answering the question of how to practice.

Computer applications in medical and office practice are flourishing. Different types of practices require different approaches. One specialist may place emphasis on the production of reports to referring physicians; another may emphasize connections to laboratory equipment. Options must be tailored for the specific practice. Scientific conferences on the subject have increased, products are offered at industrial fairs, and a market of considerable activity is predicted. Advancement in hardware and software systems has made the task of system selection difficult and frustrating.

This book begins with some guidelines on how you can make sure that the equipment you buy will meet your immediate needs and permit growth over the next few years. The second section deals with the use of computers in managing a professional practice. A presentation on the use of computers in patient care follows, with sections on collecting, storing, and analyzing patient data. The final section presents the ways the computer has been used in special circumstances to solve specific problems.

To be most effective, computers must directly interact with medicine and must become part of the process of medical decision making. This book is meant to be a guide to what is being done to use the computer to assist medical and health providers. It is an attempt to present the results of computer science and engineering to medical and health practitioners. Methods and techniques have not been described here, and the specific technical methods can be obtained from the bibliographic sources. Inevitably in this field soon after remarkable things are accomplished, new applications are suggested. There is an apparent need for research and development in image processing, large-scale data bases, artificial intelligence, human engineering, the logistics of the distribution of information, and perhaps a specific medical computer science.

Computers have influenced business, schools, and government and they are changing the way medicine is practiced. Computerized axial tomography, ultrasonography, radionuclide imaging and evoked potential measurements are now routinely used. The greatest values the computer offers are improved data management and the potential for improving the management of patients and the resources of the practice. This book is intended to provide specific information on useful applications.

PURCHASING AND INSTALLING A SYSTEM

> Buying a computer can be likened to acquiring an automobile. The purchaser has to have a basic knowledge of the applications so that the decision can be made as to whether to acquire a dune buggy, sports car, family car, jeep, pickup, or tractor. A further analogy is the similarity between computer salesmen and used car salesmen.[1]

It is the buyer's responsibility to make sure that the equipment he buys will meet his immediate needs and permit growth over the next few years. Deciding what to buy involves assessment of the available resources, what is important, and what is available. The hardware is the largest single expense and sets a constraint on the system, and the selection of the manufacturer is a major decision.

It is the salesperson's job to try to persuade customers that their system answers all the customers' needs. One of the first things that a salesperson does is "qualify" the customer. All customers are not created or treated equally. An evaluation is made about the seriousness of the customer—how likely he or she is to buy a system. Sales techniques include emphasizing the company's reputation and experience, rather than explaining the details of the system; creating a warm friendly atmosphere to discourage tough questions; and giving incomplete replies to inquiries. Don't expect a salesperson to devote an afternoon to teaching you the fundamentals of computing or answer open-ended questions, such as "What can a computer do for me?" *Do* expect an answer to a specific question that relates to your needs.

The customer purchases the equipment with the hope that new developments won't make the selections obsolete before it arrives. Or the purchase is postponed indefinitely because of rumors of new equipment a few months away. The purchase of a computer is a major consideration for a professional practice, and it is often investigated in a superficial way. Maximal benefit may not come from a system purchased from a high-pressure computer salesperson who reports that you can save "all" this money because the computer will do "all" the tedious work. The buyer brings along an enthusiasm and optimism. To buy the equipment and then see what you want to do with it may not be the best approach. Without some background, one can be taken in by the marketing wiles and brochuremanship of the manufacturers and the sales departments. Dissatisfaction is more likely if the selection is made on a general and superficial basis. Computers are sexy and it is easy to want to be seduced. Professional practices are a hot market, and large profits are being made selling computer systems at inflated prices to uninformed buyers.