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# COMPUTERS IN HEALTH CARE

## REPORT

PREPARED FOR THE

## SUBCOMMITTEE ON SCIENCE, RESEARCH, AND TECHNOLOGY

OF THE

## COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

## NINETY-SIXTH CONGRESS

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# LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND TECHNOLOGY,
*Washington, D.C., December 19, 1978.*

Hon. DON A. FUQUA,
*Chairman, Committee on Science and Technology,*
*U.S. House of Representatives,*
*Washington, D.C.*

DEAR MR. CHAIRMAN: I submit herewith the report, Computers in Health Care. It is based on information collected during the 95th Congress by the Subcommittee on Domestic and International Scientific Planning, Analysis and Cooperation, chaired at that time by James H. Scheuer, of New York.

The report contains an analysis of hearings held in May 1978, and of information gathered by site visits, interviews and study of the available literature.

The report noted that, of the large number of conceivable applications for computers in health care, a select few show promise of considerable public benefit. These few are ones that process medical, rather than merely administrative information, and that can assist in improving the control or prevention of disease. We believe the Nation could save a great deal of money now wasted in medical practices of uncertain value and in diseases that we can learn to prevent. Computers are the natural tools for collecting and processing the data needed for such purposes.

Regrettably, it appears that we may miss some of the opportunity to reduce our health problems because society may fail to assure the development and use of the most promising information processing tools. We must recognize that if the Government does not systematically encourage computer applications promising the most beneficial public impact, private incentives may lead this technology in a different direction.

The report discusses the possibility of satisfying both public aspirations and individual hospital technical and financial needs. It concludes with recommendations for a Government policy toward medical, rather than purely business administration, applications for computers in health care, and outlines the logic for selecting and implementing a practical development strategy.

I commend these thoughts to your attention, to the attention of the members of the Committee on Science and Technology, and to the Members of the House.

Respectfully submitted,

GEORGE E. BROWN, JR., *Chairman,*
*Subcommittee on Science, Research and Technology.*

# CONTENTS


| | Page |
|---|---|
| Letter of transmission | III |
| Special oversight | 1 |
| Findings | 3 |
| Recommendations | 7 |
| Origin and purpose of the investigation | 9 |
| The witnesses | 11 |
| Summary and analysis of the hearings: | |
| Origin of public interest in the subject. Problems and prospects for information technology | 13 |
| Overview of computer applications in health care | 14 |
| Hospital information systems | 16 |
| PROMIS (problem oriented medical information system) | 19 |
| National program and policy considerations | 21 |
| HEW plans for technology management | 27 |
| Needs, opportunities, and prospects for management of computer affairs affecting health care | 28 |

## SPECIAL OVERSIGHT

Research and development is conducted throughout the Federal Government. Most agencies and departments support research and development to further advance those fields of science and technology which are related to their mission.

In the House of Representatives these research and development activities are reviewed individually by a number of standing committees having jurisdiction over the various programs, agencies, and departments. Beginning with the 94th Congress, the rules of the House provide that a continuing review of the entire Federal research and development effort be done. For this purpose the Committee on Science and Technology is charged with the function of special oversight in this area. Rule X, paragraph 3(f) provides that "The Committee on Science and Technology shall have the function of reviewing and studying, on a continuing basis, all laws, programs, and Government activities dealing with or involving nonmilitary research and development." This special oversight function is to be performed in addition to the legislative and direct oversight function of the standing committees.

The review and the recommendations included in this report are made pursuant to this special oversight provision of the House rules.

## FINDINGS

1. Computer applications in health care vary greatly in respects that should affect Government interest in them. They range over the entire span of health care, from purely business and administrative functions, to the direct implementation, management, and recording of patient care. Over this range, there is much variation in their potential to improve the cost, quality or accessibility of health care.

2. Findings in regard to computers in health care resemble, in several important respects, what was earlier observed in regard to computers in education;[1] there are general analogies between the two fields of application:

(a) In both fields, the principal direction of computer applications has been in administration, rather than in the substance, of health care or education per se.

(b) The greater impact potential is in applications dealing directly with the substance of teaching or the substance of health care. It is substantive, rather than administrative, applications that are the more likely to cause significant improvement changes in the field.

(c) Like the rewards to be gained, the difficulties encountered are also greatest in the substantive applications of computers.

(d) Barriers to substantive applications in health care, just as in education, include problems of professional acceptance and economic feasibility. Professional resistance is enhanced by strangeness and the degree to which computers cause a change in methods.

Financial feasibility is hampered by "economic externalities". That is, the principal financial rewards would return to patients or students and society as a whole, rather than to the institutions that adopt computerization. A greater barrier is the poor treatment of capitalization in the hospital industry. Cost reimbursement does not favor slow pay-off investments. Hence many "investments" are made with donations without regard for efficiency.

3. Several characteristics of hospitals provide practical incentives for computerizing information. It is estimated that 25 to 35 percent of hospital operating costs are presently attributable to information processing. However, the present manual methods are primitive, inefficient and, to an unfortunate degree, faulty. There are many delays, errors, and omissions, and the information collection, storage and retrieval methods provide little opportunity to analyze hospital operation for more efficient management.

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[1] "Computers and the Learning Society." Hearings before the Subcommittee on Domestic and International Scientific Planning, Analysis and Cooperation of the Committee on Science and Technology. 95th Cong., 1st sess., Oct. 4, 5, 12, 13, 18 and 27, 1977, (No. 47). See also, "Computers and the Learning Society," report: Committee Print, Serial JJ. U.S. Government Printing Office (1978).



48-086—79——2

4. Business administration and management applications for computer systems in health care services can contribute to efficiencies that may or may not be in the public interest. Some applications can increase the cash flow or the total charges billed by the institution but these do not necessarily benefit patients or taxpayers. The benefit value to the public of any changes in cost, or quantity of service, or volume of patients, is dependent on whether savings are passed on, the total national health care bill is decreased, more people who need care receive it, or the efficacy or safety of care is improved. These public benefits become more probable as computer applications move more toward clinical care, its management, and the recording of data on public health and treatment follow-up.

There is, however, a great deal of valuable epidemiological and treatment information embedded in "administrative" data. Information on disease occurrence and care rendered, useful in tracking the cause and spread of disease, and in evaluating exposure risks and treatment efficacy, can be extracted from administrative data if systems are designed with this purpose in mind.

5. Better means for collecting and analyzing data on medical treatments and their outcomes could be a powerful aid toward improving the cost effectiveness of health care. Billions of health care dollars are spent on treatments whose effects are poorly known. Some of this expenditure is wasted on methods whose efficacy or safety is ultimately repudiated by accumulating evidence. Presently, the collection of evidence is cumbersome, spotty, and characterized by the inefficiency of manual methods. Present medical information systems used in day to day hospital care do not help much in the evaluation of medical practice, but can be improved in that regard. Special systems for collecting and comparing and evaluating data may be needed. There is danger we may miss opportunities to improve cost-effectiveness through neglecting the best applications of computers in medicine.

6. Only a fraction of the largest and most significant benefits to be derived from applications affecting cost and quality of patient care can be captured by hospitals. Cash savings achieved by improving the cost-effectiveness of health care benefit patients and taxpayers more than the institutions whose computer investments contribute to the improvement.

Contributions to epidemiology, environmental health, and disease prevention would have great public, but no private, financial reward. Even local improvements in ordering and monitoring of patient care do not tend to produce cash benefits to the hospital or clinic for use in financing equipment or systems.

Since investment initiatives depend upon clear opportunities for gaining a financial return, it is desirable to identify and promote for computer applications financing options that are satisfactory to institutions as well as the Nation.

7. There is evidence that computer systems *can* be designed and used in such ways that they simultaneously:

(a) Provide an adequate financial return to the investor;

(b) Do not place additional financial burdens on patients or taxpayers; and

(c) Perform data functions that can improve the cost-effectiveness of health care.

Such evidence needs vigorous investigation and qualification.

8. Medical information systems capable of saving money in the operation of a hospital do not do so automatically. Unless a conscious program is followed to write fewer paychecks or buy fewer supplies or services, potential cash savings will not be realized by the hospital. Nonfinancial benefits may also, to some extent, require a "benefit realization program." Indeed, some observers suggest that more than a few of the benefits achieved with installation of a computerized information system are simply the result of management changes stimulated by the planning for a system.

9. There is apparent need for better, more credible, and more accessible buyer information on health care computer systems. Managers of clinics and hospitals find it difficult to determine what technology and system design is available, what it can and cannot do, and what the financial realities are. There is also apparent need for a new kind of health care professional, able to advise, plan and manage the purchase, installation, and integration of computer systems in health care institutions.

10. Government efforts to develop, evaluate, or transfer computer technology in health care are fragmented and uncoordinated. They are not integrated or guided by any clear Federal overview, comprehensive strategy, or action plan. Many Federal agencies engage in or support (extramural support is relatively light, and scattered) programs in this field, but the selection criteria they apply are not readily apparent. Their programs are independently conceived and executed. But the limitations or speciality of any one agency's mission requires coordination with other agencies if plans or programs are to have balance and wholeness with respect to long term national or societal priorities.

11. The development and evaluation of computer applications in health services by the National Center for Health Services Research has been greatly constrained by austere funding, limitations in authority, and shifts in that agency's focus of responsibility. The agency has needed most of its remaining computer budget for maintaining a selected portion of its established commitments, leaving little, if any, for new ventures. In addition to budget cuts which have restrained progress, the removal of explicit authority to support development activities has left a serious gap in the line of progress. Current budgeting has been increased, but development authority has not been specifically restored.

12. The lack of an overall policy on computers in health care, even within DHEW, is consistent with a general lack of technology oversight and coordinating management in that Department. A DHEW study cited by the Assistant Secretary for Health reported that the Department had no comprehensive strategy for linking systematically the life stages of technology development, evaluation, transfer, diffusion, utilization, and phase-out. Agencies of DHEW generally decide independently their technology activities. One step taken to improve linkage of agency programs was the creation of an Office of Health Technology, under the Assistant Secretary for Health, to oversee evaluation of technologies and to stimulate and coordinate appropriate actions. This office was specifically required by subsequent legislation, and re-titled as the National Center for Health Care Technology (Public Law 95–623). Much of its attention will be directed toward

discouraging ineffective, unsafe, or unnecessarily costly medical treatment practices. Its future role in stimulating a Department-wide, or Government-wide, strategy for guiding computer applications in health care, or in undertaking positive management initiatives, cannot yet be determined.

13. A major contribution to the utility of computer systems in processing clinical information could be made by improving the ability of machines to recognize and logically process natural language words and phrases. There are serious difficulties in adapting computers to handle information expressed in the customary structure of medical language. Often, many more details must be entered into a machine than would be needed for the information to be "human readable." Such requirements contribute to dissatisfaction of users, especially doctors. They also reflect basic shortcomings in both program logic and machine organization. Advance in either will improve the apparent "intelligence" of the machine system, and will also improve physician acceptance.

14. Computers appear to offer the best hope for counteracting the fragmentation of treatment and records in the care of individual patients. Medical specialization and the organization of clinics and hospitals require the participation of different doctors and departments, in the treatment of a single patient. Episodes may be distributed over the lifetime of the patient. The unitary nature of reactions of the human body to sickness and to treatments, and the importance and relevance of continuity in medical history records, enhances the value of unifying and coordinating present and historic information on each patient. Even small improvements would be desirable.

## RECOMMENDATIONS

1. The Assistant Secretary for Health should assign in his immediate Office, or within the administrative structure embracing the National Centers for Health Care Technology and Health Services Research, responsibility to conduct general oversight, coordination, and planning for managing and transferring the successive stages of health technology being supported by DHEW. There should be one place within DHEW from which its technology support programs can be overseen in the broadest context with respect to each other and to overall national priorities. A secondary center is needed within the relatively isolated National Institutes of Health.

2. The National Center for Health Care Technology (formerly Office of Health Technology) should be given a clear administrative mandate by the Secretary of Health, Education and Welfare, or by the Assistant Secretary for Health, to undertake positive management initatives for the selective promotion of desirable technologies or applications. Such initiatives should complement the more negative watchdog or early warning role that is now clearly expected of this Center. It is recommended that carefully selected aspects of computing technology be considered for promotion.

3. The National Center for Health Services Research and the Center for Health Care Technology should cooperate to initiate development of a national policy to be perfected and implemented by Federal agencies, including NIH, active in the development, evaluation, and use of computer technology in health care.

4. It is recommended that a Government-wide policy or strategy should include the following considerations:

(a) Some computer applications have extraordinary potential for public benefit; others are of little public significance. Therefore, some are more appropriate than others for Federal attention. (See findings 4, 5, 6) Government management and oversight functions should include the identification of criteria for selecting applications for attention and should apply these criteria to Federal planning.

(b) Computer applications receiving Federal support must be compatible with economic realities. Somebody must pay for them. Who? How? There is evidence that "socially-good" systems can be made locally self-supporting without adding to anybody's medical bill. This possibility should be vigorously pursued.

(c) Professional acceptance is a necessary factor for the development and spread of "good" systems. How can doctors be induced to actually use computer terminals? Why have some systems been successful in that while others have not?

(d) What measures of quality or cost improve when a relatively "good" system is installed? Preliminary findings indicate that some expected improvements have derived from unexpected causes. Systematic efforts should be made to identify the true cause of reduced patient stays or other benefits that have followed installation of a computer system.

(e) Development is a serious gap in what could be an integrated federal policy toward computers in health care. How can this be filled?

(f) Late stages of development and evaluation of health care information systems are very expensive. How can the small amount of HEW money available for health care computer technology be used with the greatest leverage? What strategy will obtain the most benefit from the limited funds of NCHSR (National Center for Health Services Research)? What roles should NCHSR, NIH, the Health Care Financing Administration, or the Center for Health Care Technology play? Can industry or other private sector elements be enlisted in cooperative strategies or programs?

5. The Center for Health Care Technology (NCHCT), or Center for Health Services Research, working through NCHCT, should specifically undertake to engage the military departments and the Veterans Administration in devising policy and plans serving broad National interests. In particular, they should consider the unique opportunities afforded by the self-contained health care systems operated by military and veterans agencies. It would be worthwhile, if possible, to develop means for enlisting their cooperation in testing and evaluating computers in health care, or in providing an initial market for desirable products that industry might be induced to develop.

6. The Department of Health, Education, and Welfare should consider strategies that might enable a large scale demonstration and test of a medical information system whose general purposes are similar to the PROMIS system developed at the University of Vermont. Similarities that should be preserved include explicit provisions to reduce:

(a) Problems arising from excessive burdens on a doctor's memory;

(b) Problems of coordination of patient care and the disunity of patient records; and

(c) Problems resulting from a lack of score-keeping and feedback in the evaluation of patient care procedures.

The test system should be designed to fit within a system concept, having defined goals, rules for using the information system to reach those goals, and feedback to correct the logic and procedures in use. There are several existing systems, including "COSTAR" (Harvard Community Health Plan) and "HELP" (Latter Day Saints Hospital, Salt Lake City) in which such an overall design philosophy could be made manifest.

It is recommended that any planning for such a test consider the advantages of acquiring a willing partner for the test site, such as the community of Mobridge, S. Dak. referred to in testimony before the subcommittee.

7. The committee recommends that HEW, and the Congress, when devising health system guidelines or when proposing health care cost containment legislation, take note of the distinction between technology that is designed to save money and technology that is likely to increase costs. Certain applications of computer technology are in the former category. There should be a policy to encourage, not hamper or penalize, investments in capital equipment capable of reducing overall health expenditures. It would be appropriate to include requirements that such equipment demonstrate, on a continuing basis if necessary, that its cost-saving capability is being utilized.

## ORIGIN AND PURPOSE OF THE INVESTIGATION

In the 94th Congress, special oversight responsibility was given to the Committee providing for a continuing review of "all laws, programs, and Government activities dealing with or involving nonmilitary research and development" (House Rule X, paragraph 3(f)). Under this jurisdiction, the subcommittee on Domestic and International Scientific Planning, Analysis and Cooperation (DISPAC) undertook to inquire how computer science might be directed in ways that would benefit the taxpayer and the Nation, and to review federal programs and policy in this area. The investigation included applications in the delivery of educational services, reported separately, and applications in the delivery of health services, the subject of this report.

An extraordinary rise in hospital costs, amounting to 1000 percent, occurred in the past 25 years. In that same period, the health care industry became much more dependent on, and characterized by, the devices and procedures of a sophisticated technology. The subcommittee engaged in a broad oversight review of the national health system, to investigate how technology relates to health care costs, and to consider how this relationship might be modified or directed to stem the upward (cost) trend.

Hearings on "Computers in Health Care," held on May 9, 10, and 11, 1978, were a part of that comprehensive study. Related hearings on "Technology and the Cost of Health Care," held September 26, 27, and October 6, 1978, explored broader issues, relevant but not peculiar to computer technology, and are covered in a separate report.

Topics of interest, points of view, and a possible organization of the subject matter were suggested to the witnesses as follows:

*Overview.*—Computer applications in health care appear to vary widely in function, sophistication, barriers to adoption, and possible pay-off to society. An overview of the field, identifying features that characterize and distinguish the various applications, and that affect the degree of public significance, would be useful for selecting issues and devising policy.

*Medically-oriented applications.*—Appear to deserve special attention. Important social welfare advantages seem to be derivable from medical information technology but, like national defense, may lack desirable guidance or support mechanisms in private enterprise. If so, an appraisal of benefits, costs, incentives, and Government action alternatives is in order.

*Government policy and implementation.*—Is there, or should there be, a Government policy to guide Federal actions relating to computers in health care? What are the appropriate policy considerations? What are the options for implementing policy through Federal actions? Is interagency coordination necessary, desirable, or feasible?

## THE WITNESSES

A public hearing on COMPUTERS IN HEALTH CARE was conducted in three sessions on May 9, 10, 11, 1978. This division permitted treatment of related subjects from roughly three different approaches: Overview and organization of the field, emphasis on medical (as opposed to health business administration) applications, and consideration of Government policy and programs.

*Tuesday, May 9, 1978, Washington, D.C.*

### OVERVIEW OF THE FIELD AND ASSESSMENT OF ITS PROBLEMS AND PROSPECTS

Edward N. Brandt, Jr., M.D., Ph.D., Vice President for Health Affairs, University of Texas System, Austin, Texas. Past Dean, Baylor College of Medicine and Baylor Graduate School.

Herbert Sherman, D.D.E., Associate Director for Technology, Center for the Analysis of Health Practices. Harvard School of Public Health, Boston, Massachusetts.

Melville H. Hodge, President, Suntek Research Associates, Saratoga, Calif. Consultant in hospital information systems. Former Chief Executive Officer for development of the first integrated computerized hospital information system (Technicon Medical Information Systems Corp.).

Arnold W. Pratt, M.D., Director, Division of Computer Research and Technology, National Institutes of Health, Bethesda, Md.

*Wednesday, May 10, 1978, New York, N.Y.*

### PROSPECTIVE IMPACTS ON MEDICAL PRACTICE— POLICY IMPLICATIONS

Aran Safir, M.D., Director, Institute of Computer Science, Mount Sinai School of Medicine, New York, N.Y.

Lawrence L. Weed, M.D., Director, PROMIS Laboratory, Department of Medicine, College of Medicine, The University of Vermont, Burlington, Vt.

Henry Cramblett, M.D., dean and vice president for Medical affairs and Ruann E. Pengov, Ph.D., director, Division of Computing Services for Medical Education and Research, College of Medicine, the Ohio State University, Columbus, Ohio.

John C. Beck, M.D., Professor of Medicine, School of Medicine, University of California, San Francisco, Cal., Past President, American Board of Medical Specialties, Past President, American Board of Internal Medicine.

*Thursday, May 11, 1978, Washington, D.C.*



48-086—79——3

Ruth S. Hanft, Deputy Assistant Secretary for Health Policy, Research, and Statistics, Department of Health, Education, and Welfare, Washington, D.C.

H. Phillip Hampton, M.D., Bernard Harrison, Vice President, American Medical Association and George Polli, M.B.A., Assistant Director, A.M.A. Department of Computer Systems in Medicine, Chicago, Ill.

Donald A. B. Lindberg, M.D., Director, Health Care Technology Center, University of Missouri, Columbia, Mo.

Gerald A. Giebink, Director, Health Care Management Systems, Inc., La Jolla, Cal. Review author. Consultant on clinical data processing.

# SUMMARY AND ANALYSIS

## Origin of Public Interest in the Subject—Problems and Prospects for Information Technology

The past 20 years have been marked by much public and private activity to improve the quality and accessibility of health care. This activity was manifested in heavy investment in all aspects of the health care system and assisted by landmark legislation in social welfare reforms. Most recently, however, steeply rising expenditures for hospital care have been a cause for alarm. Concern has shifted to analyzing causes, searching for ways to control costs, while still improving health resources.

A plausible explanation for the steep rise of hospital costs rests on the subsidy effect of health insurance. Cost-plus reimbursement through private insurance policies, as well as Medicare and Medicaid, encourages both unrestrained demand and a rapid expansion and intensification of supply. Patients and health care providers have strong and relatively unbalanced incentives to receive and render the best or the most in medical care. Response to unrestrained demand results in a steady expansion and upgrading of medical services, marked by elaborateness and sophistication.

While doctors, hospitals, and patients tend to equate technological sophistication with quality of medical care, some of the practices which that engenders may be wasteful. There is a regrettable lack of systematic information on the effectiveness of many choices and "standards" in medical practice. And there is often little awareness on the part of doctors or the general public of the detailed costs or the possible consequences of the expenditures involved.

Health care information, if appropriately collected, analyzed, and disseminated, would offer a basis for evaluating health care practices, selecting cost effective use of facilities and manpower, and identifying strategies for preventing disease. Computerized information systems offer a promising approach to solving these national information problems, as well as materially improving efficiency and coordination of services at the local, hospital, level. Witnesses uniformly agreed that suitable design and applications of computer systems in hospitals, clinics, and doctors' offices could assist control of cost elements in several ways. They could provide direct improvements in the cost efficiency of information handling and support improvements in the efficient utilization of facilities (beds, machines, departments, etc.) They can detect and prevent errors or unnecessary duplication in tests or treatment orders. On a somewhat longer range basis, they could provide feedback data for doctors to evaluate treatments, thus affecting the appropriateness and effectiveness of medical decisions and patient management. On a long term basis, cooperative use of accumulated health data could become invaluable in defining the causes and distribution (the epidemiology) of diseases that might then be controlled or prevented.

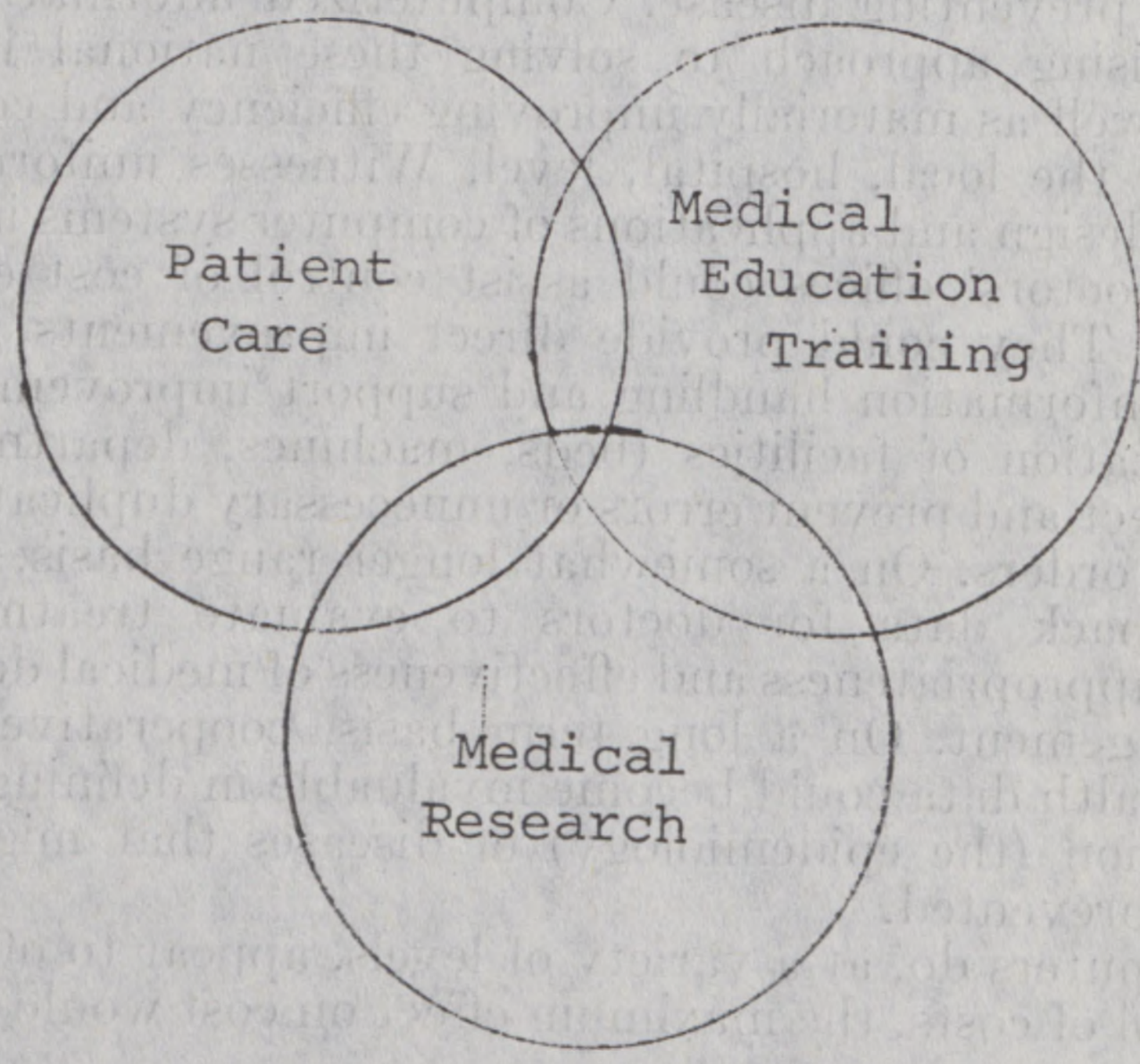
While computers do, at a variety of levels, appear to offer leverage for the control of costs, the maximum effect on cost would be indirect,

through the improvement of quality and effectiveness (and thus the efficiency) of care, and through assistance toward the prevention of diseases. The potential impact would be expected to increase with the time over which computers were employed; because of the virtual continuum of short and long term goals. The prospects of the longer range goals depend on the distant possibility of sharing data on a broad geographic scale. Unfortunately, these grand potentials for public benefit offer small incentive for investment by individual hospitals. For hospitals, clinics or doctors' offices there has to be a payoff in the short term and which can be captured by the investor—or there must be a subsidy to support the cost of the necessary technology.

Since the greatest potential benefits from the use of computer technology would take some time to develop and would accrue to the public in general, rather than to institutions and private investors, several questions are raised. What incentives are there for doctors, hospitals and clinics to install computerized information systems? Would privately financed systems be the kind likely to yield maximum patient and taxpayer benefits? What role(s) can or should Government play to recognize and promote development and use of maximum-public-benefit systems? Fortunately, according to the witnesses and other available sources (e.g., Policy Implications of Medical Information Systems, Office of Technology Assessment, Congress of the United States, November 1977), there are encouraging answers to these questions.

## Overview of Computer Applications in Health Care

A multitude of applications exist for computerized information technology over the entire span of health care, from the business office of a clinic or hospital, to more medically-related functions in the care of patients, to education for the medical professions, and to health care research. Dr. Ruann Pengov, one of the witnesses, offered a convenient diagram for pictorializing the field of health care in three parts, patient care, medical education, and health research.



The overlap areas of this functional grouping are most strongly related to health and medicine, per se, (as opposed e.g. to resource management or teaching techniques), and tend to share a common data base. This is an area where information technology could be shared. The most medically oriented computer applications reside in the overlap areas and hence would both serve and benefit from interchanges made possible by the interdependence of these three major groups of professionals. In the most extreme case, computer algorithms, or subprograms for doctor/computer decisionmaking in diagnosis and treatment, developed by clinical practice or research, would be readily transferrable in either direction.

It may be anticipated that suitable computer technology might be developed or initiated in the most receptive or feasible area, like clinical research, before attempts are made to transfer it to adjacent areas, like patient care or medical education, where there are temporary barriers to overcome. Thus it appears that a strategy to promote the dissemination of selected applications would prudently consider the most hospitable site for introducing them.

In the hearings, many comments suggested that familiarity derived from contact with computer technology in an academic setting might reduce or eliminate some of the emotional or intellectual barriers to use of the technology by doctors in normal practice. It was also pointed out, however, that getting medical schools or academic medical centers to introduce any technology or train their students in its use may be a circular process that is not well understood. New ideas that are incorporated into training by these centers may spread into general clinical practice; but acceptance by academics is so dependent upon clinical validity that there are questions of how, under what conditions, and by what process new technologies gain acceptance into medical school curricula. Thus, academic centers may prove to be desirable sites from which to promote the spread of computer applications in medicine, but it would be unwise to assume that the process could be easily, or casually, started in academic centers or that other barriers to dissemination could be ignored.

A second entry for computers into medical education is in the area of post-graduate education of physicians. The evolution of specialty training with its attendant process of board certification and periodic recertification as well as the increasing adoption of state relicensing requirements, have formalized the need for continuing, renewing, and periodically assessing the up-to-date knowledge and competence of practicing physicians. One result has been to stimulate the exploration and development of computerized methods either for the training or for the testing burdens created by these growing requirements.[1]

According to Dr. Beck,[2] one of the hearing witnesses, "There is little doubt that computer based simulations currently provide the most promising approach to the measurements of clinical judgement".

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[1] For detailed information, see Computer Technology in Medical Education and Assessment, Congress of the United States, Office of Technology Assessment (April, 1979).

[2] Professor of Medicine, School of Medicine, University of California, San Francisco, immediate past president of the American Board of Medical Specialties. Member of Coordinating Council on Medical Education and chairman of the Coordinating Council's Committee on Continuing Physician Competence. Past chairman of the American Board of Internal Medicine. Testimony before the subcommittee, May 10, 1978.

He notes that "Acceptance by the practicing profession . . . (encounters) a certain amount of resistance . . . which, in a large part, stems from a lack of understanding and fear of its implications. Newer generations of physicians will undoubtedly have greater familiarity with this technology if more substantial training in the information sciences occurs in the undergraduate phase."

There are three types of barriers to the introduction of computer systems in hospitals. One includes the problem of how to finance the technology. The others involve technical feasibility and professional acceptance. Isolated applications exist, particularly in the business office and to some extent elsewhere in a hospital, which are technically feasible and that may be financially appealing to an administrator. But as with computers in banks or other businesses, there is little basis for Government interest in them, except insofar as they might assist or deter development of more socially desirable systems. Several witnesses expressed concern that investments in some systems have led to financial and technical disappointment, expended funds that could have been used for "better" systems, or locked hospitals into technologies incapable of improvement or expansion.

The Office of Technology Assessment has also observed that "capabilities to improve and monitor the quality of patient care and to facilitate research and planning are the least developed" (among medical information systems), and expressed an apprehension that potential benefits for patients and our health care system might be lost if medically-oriented systems are supplanted by a less significant technology.[3] There should be public interest, therefore, in how or whether the most socially desirable information systems can be made feasible, attractive, and economically sound.

## Hospital Information Systems

One promising approach to financing computer systems capable of improving patient care is to include functions that directly save money in the short run, while still embracing the strictly clinical information functions of patient care. Several characteristics of hospitals promote the computerizing of information:

(1) 25–35 percent of hospital costs are traceable to information processing;[4]

(2) Present manual methods are inefficient and ineffective, and

(3) They provide little opportunity to analyze hospital operation for more efficient management.

Since quality of patient care is heavily dependent on the accurate and timely transmission of orders and findings among several hospital departments, it is reasonable to expect quality improvements, as well as cost savings, from methods that improve information handling. The following examples from the introduction to Melville Hodge's recent book[5] illustrate typical hospital problems and the close coupling between quality of care, costs, and information processing.

A man who is unconscious is brought to the emergency room by ambulance. His wife reports he had just been discharged from the

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[3] Policy Implications of Medical Information Systems. Office of Technology Assessment, Congress of the United States, November 1977.

[4] (a) Same reference (see also its refs.). (b) Hospital Financial Management Association, private communication based on 1976 study. (c) The Health Care Financing Administration, DHEW, has consistently employed the range of 27–32 percent as a rule-of-thumb guide to cost share due to information handling.

[5] Medical Information Systems, A Resource for Hospitals, Aspen Systems Corp., Germantown, Md. (1977). Mr. Hodge was a witness in the hearing, May 9, 1978.

hospital seven or eight days before. The patient's record is not in the medical records department, and two hours after his admission the chart still cannot be found.

At 8:30 a.m. a patient is escorted to the x-ray department for an upper GI series. She waits 40 minutes before being taken into an examining room. The technician asks when she last ate and discovers she had breakfast that morning. Since the x-rays must be taken on an empty stomach, the procedure must be postponed until the next day.

A physician writes an order for one of his patients to be given an electrocardiogram. Since it is late in the morning, he anticipates the EKG will not be performed until the next day and that the results will not be available until the day after that. He really expects the EKG to be normal and will discharge the patient if that is the case. He realizes he could save the patient one or two days' hospitalization if he ordered the EKG STAT (that is, EXPEDITED) and got the results that afternoon. But there is no medical justification for the STAT order, so he decides to follow the hospital's routine procedures.

In a hospital which employs a computerized medical information system connecting different service departments, there often is no need for a special "STAT" request to get an immediate service reaction. Orders entered into the system are immediately transmitted electronically to the service department. In a well-designed system, such orders also automatically generate appropriate accounting and billing information. Without an electronic information system, such orders are entered on paper, generally at the nurses' station, and may go through several manual transfers to achieve the same result.

David Rogers, President of the Robert Wood Johnson Foundation, has written[6] that the "task of compiling, storing, and transmitting patient information—clinical as well as administrative—is a continuing source of frustration and challenge in a hospital setting, . . . If anything, the situation is even more difficult . . . in ambulatory care settings" (hospital outpatient, clinics, group, and solo practice) "especially those devoted to general, or primary, care." Here "patient data is rarely gathered and organized in a way permitting analysis of the types of problems seen, or how they are being dealt with, or at what cost."

Economic attraction to computer systems is enhanced by the burden of reporting that Government and "3d party" (insurance) payers have imposed on health care providers, requiring the gathering and manipulation of patient and administrative data and statistics in numerous different ways. Indeed, the number of reports required for Government financed patients is now so great that the cost of billing for x-rays and certain other services is said to be greater than the cost of the service, itself.[7] But even without the reporting burdens for insurance payments, the task of communicating among the various services of a hospital is inherently burdensome. If information processing can be made more efficient, a substantial saving in labor is achievable. If beds, nursing personnel and other resources can be utilized more efficiently, further savings can be realized. These savings

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[6] See "Foreword" to Computer Projects in Health Care, by G. A. Giebink and L. L. Hurst. Health Administration Press, Ann Arbor (1975).

[7] Private communication. Dr. Howard Bleich, Beth Israel Hospital, Boston, Oct. 31, 1977.

may be sufficient to pay for a system which enables more precise and reliable medication and monitoring of treatment and provides data for medical auditing. Review of medical data can supply the feedback that doctors might use in raising the average quality (cost effectiveness, not intensity) of quality care. Longer term studies of shared data can reveal regional patterns, identify trends, and assist in the understanding and control of disease occurrence. Thus, short term fiscal savings may support systems with long term benefits derivable from capturing and processing medical data.

Surveys of computer system installations in various health care situations over the past 10 years or so reveal a great variation in financial success or failure. Witnesses such as Gerald Giebink and Melville Hodge, who have been especially interested in the business management aspects of computer installations, were particularly careful to stress what is required for financial success. Both emphasized that installing more efficient equipment does not automatically save money.

Money-saving requires a carefully planned and vigorously executed "benefit realization program," which will lead to the writing of fewer pay checks or the purchasing of fewer supplies or services. The early development of such a plan has been found invaluable for stimulating a systematic critique of how things are being done, what needs to, or profitably can be, changed. One result is, even if automation were not subsequently adopted, some improvement changes are likely to ensue. Another is that both time and direction are made available for absorbing constructively—rather than painfully—the shifts in personnel and their job functions that should result from a good installation. A good installation probably would not "automate the status quo."

The immediate financial soundness of a medical information system depends on the linking of patient medical data, like drug prescription orders, to business and administration functions, like billing and reporting. In addition, of course, efficiency would require that such orders also be linked to the pharmacy, the nurses' station, and the patient's record. Harmoniously linking all the different hospital service departments and their many functions is a formidable but logically desirable task. It is here that one finds the remaining technical and social difficulties.

Many of the technical difficulties are problems in business organization and management. Some are caused by the more intimate interfacing of departments introduced by the mechanization. Others involve changes in methodology required for the improvement and benefit realization previously mentioned. A third, and more troublesome, source of problems is the interaction between people and the machine. It is both necessary and difficult to design this interaction to be facile, so that it is not actually, or perceived as, a handicap. And there is the additional optional challenge to automate some of the traditional human functions in medical decision-making. Naturally, physicians have some reluctance to relinquish any of their authority or responsibility to a computer. In addition, there are serious difficulties in adapting machines to the customary structure of medical language. Despite the difficulties, significant progress is being made, as attested by the number of hospital and ambulatory care services now routinely incorporating some measure of patient care management in their computerized information systems.

To reduce the number of information transfers in the care of patients and the attendant delay and risk of error, it has been found to be important to have both doctors and nurses interact directly with the computer terminals. Existing systems have had varying degrees of success in enlisting this participation of medical personnel. Apparently, it is commonly more difficult to gain full personal participation among the attending physicians than among nurses. Since there are notable exceptions to this experience, where physician acceptance and participation is virtually 100 percent, the barrier is evidently surmountable. This is one of the challenges that could be earmarked for special study and which would benefit from incentive changes that could affect a doctor's motivation. The "PROMIS" development program, discussed in the next section, is one of the several in the nation that explore the problems and benefits of doctor/machine interaction.

## PROMIS (Problem-Oriented Medical Information System)

Under the direction of Dr. Lawrence L. Weed, personnel in the Department of Medicine at the University of Vermont, in Burlington, have been developing and testing, in a clinical setting, a medical information system that emphasizes both the benefits and the difficulties of doctor/machine interactions. It is described here not for its resounding success but for its forthright identification of, and attention to, key problems in decision-making and patient management. Because it "takes the bull by the horns," so to speak, it clarifies, perhaps better than any other known system, principles that are likely to be important in the evaluation of other medical information systems. Its head-on approach may polarize professional reactions, as indeed it seems to have done, but it also provides an explicit recognition and testing of design principles that, if valid, could become accepted as basic.

The PROMIS system was specifically designed to address four general problem areas in the doctor-patient relationship: memory problems, logic problems, coordination problems and audit (feedback or scorekeeping) problems. The problems derive from the crushing burden of information that a doctor should but cannot memorize, from the errors caused by a memory-dependent logic system, from the fragmented nature of patient care due to specialization and patient mobility, and from the fact that doctors have no feedback that tells them the outcome of their decisions.

An overwhelming burden of emerging knowledge forced doctors to specialize, but knowledge growth continues to saturate the memory of even the subspecialist. Specialization requires the attention and coordination of different doctors and departments responsible for the care of a single patient, yet the human body tends to be unitary; ailments, medications, and other treatments affect several body systems at once, all of which may be the provinces of different physicians or hospital departments. Perhaps worst of all—and the objection most generally affirmed by physicians—doctors have little or no feedback from which they can evaluate their effect on patients. As Dr. Safir pointed out, except for a few outstanding cases marked by brilliant success or dismal failure—sometimes death—a doctor may wonder at the end of a year what he has accomplished.

Besides addressing the problems of memory, logic, coordination, and medical audit, PROMIS was devised to fit within a system concept,

having defined goals, rules for using the system to reach those goals, and feedback to correct the logic and procedures in use. When criticizing or evaluating PROMIS, it is important to distinguish between the principles on which it was founded, the problems it was intended to improve, and its actual manifestation in hardware, programs and operating logic. One could anticipate criticism or objections to the details of the model; it seems less likely that the premises or the problem identification could be dismissed. Its developers do not regard PROMIS as "the solution." The solution (of our medical practice problems) rests in the principles Dr. Weed invokes and attempts to implement. PROMIS is regarded as "the tool." It is perhaps still more proper to regard it as "a tool."

PROMIS is a prototype problem-oriented medical information system that replaces paper records with a programmed computer memory, retrieved and up-dated by medical professionals in the course of their patient care routines. It implements and utilizes a problem-oriented patient record that aims at improving the logic and justification for steps to be taken in diagnosis and treatment. "Problems" range from a patient's stated complaint or symptom to a firm diagnosis. Diagnostic and treatment guidelines use the problem orientation as well as do the treatment records, regardless of what department of medical specialty service executes them. Patient information can be retrieved by problem, by chronology across all problems, by source (such as laboratory or radiology) and in several other modes where appropriate. The organization of data and the logic by which it is entered or used preserves the rationale by which it was generated and thereby facilitates audit and review. These provisions are instrumental in providing for accountability for the actions and decisions of professionals using the system. When, for instance, medication is ordered, it is recorded in such a way that later review indicates the problem for which it was prescribed.

Input-output terminals on the ward, in pharmacy, laboratory, and in radiology and other service departments, make the system a vehicle for communication among physicians, consultants, nurses, technicans, social workers, and others. Simplicity of operating features, such as as finger touches on a TV screen, facilitate using the equipment and encourages physicians to participate directly. Through choices which the user can control, he or she may interact easily and quickly with patient data, with guidance protocols, or with information from the medical literature contained in the 30,000 or so available reference displays.

Criticisms of the system which developed during the public hearings, were primarily apprehensive of the quality or validity of the guidance protocols. Concern was expressed over who would write, or select, the protocols for the system, and how accountability or responsibility for validity of the protocols could be established. In the words of Dr. Safir, "every TV screenfull is an editorial by an unidentified writer . . . you will have to pick certain boards of experts. Who are they; what opinions do they embody; how much room is there in systems like that for the uncommon person (physician) who deviates from the norm?" Similarly, Dr. Beck expressed a concern over influencing doctors to do things the same way. Such a course could perpetuate monolithic errors and penalize creativity if imposed without ingenious provisions for flexibility and personal freedom.

Defending remarks pointed out that such questions were no more cogent for the PROMIS system than for medicine as it is now generally taught and practiced. People with various credentials teach in medical schools, write textbooks, or journal articles. Medical students and graduates are trained by people with varying biases and objectivity. The oral instruction, especially, is virtually unedited. What the PROMIS method makes available is a broader consensus of experts that could be reviewed periodically and updated by a formal oversight process. It also provides for local revision and, at every step, permits departures from the recommendations at the option of the user. In the prototype system, such departures require a "type-in" to be recorded by the user, so that the departures can be evaluated later in terms of resultant patient outcomes. Thus, depending on outcomes, medical audits pinpoint both desirable innovations and erroneous decisions. In Dr. Weed's piquant analogy, if a doctor wishes to ignore the "road map" provided and "drive in the middle of a field," he has the freedom to do so. But, if he does the wrong thing it is not out of ignorance of the best known options; it is because he made a conscious choice of departure.

Dr. Weed's response to various questions and to criticisms both explicit and implied, underscored a common misconception, shared by several questioners. It is not completely logical to judge early models on the basis of medical outcomes. Outcomes are more a measure of the quality and adequacy of contemporary medical knowledge than they are of the guidance system that transmits it. If the system is to be judged on its performance, which is intuitively desirable, one must take care to distinguish performance which is system-dependent from performance that is dependent on outside factors—like knowledge—over which the system initially has little control. Later, especially if the system were large enough to have widespread use, the accumulation of outcome data and the critical review which that enables should lead to modification of medical knowledge and the resultant diagnostic and treatment guidelines, and thus, finally may then appreciably promote the improvement of outcomes.

## National Program and Policy Considerations

The subject of computers in health care covers many different applications. Accordingly, the technology is being developed and adopted by many different public and private centers, over a broad spectrum of conceptions. Some of these developments seem capable of greatly affecting cost and other important qualities of health care, while others do not. But, while development concepts and goals thus could be selected for their potential impact on national welfare, there is reason to question whether, how, and where such selection criteria are operating.

There is at present no evident Federal—or DHEW—policy, planning principle, or strategy guiding the selection, development, or application of the technology. On the other hand, the subcommittee perceives a rationale for selecting what computer topics may be of national significance and what role, if any, the Government should elect.

The subcommittee recommends the following rationale:

Lack of information underlies much questionable, excessive, or wasteful health services. Billions of dollars are spent on tests and

procedures whose efficacy, relative to other available choices, often is not known. Development of a suitable information technology could contribute data for corrective feedback.

In the shorter run, the efficient use of present resources could be improved. Data are needed to establish PSRO norms for appropriate care, classify institutions for cost containment, and improve the efficiency of Medicare. Data are also needed to identify the cost centers in the system so that means can be devised for controlling them. And data are needed on patient mix, demand, and resource utilization for efficient planning for regional needs.

At the hospital level, doctors and administrators have an interest in improving how the patient fares and in moderating costs, but must consider how an investment in technology will clearly pay for itself, either in cash savings in efficiency, in increased cash flow, or in increased charges. The latter would need fastidious justification to establish that it was ultimately in the public interest. On the other hand, systems and uses of technology developed under private initiative can incorporate features that help the taxpayer, but private incentives for doing that are not strong and should not be relied on.

The most important pay-offs for the use of medical information systems are societal and cannot be returned to the private investor. Moreover, the local economic feasibility of systems that would be most beneficial to patient care has not been widely demonstrated and is still in question. It is in the taxpayers' interest to see whether computer systems can be developed that can pay for themselves at the local level while, at the same time, aiming for the most beneficial medical impact.

Abundant evidence indicates that better means for collecting and analyzing data on medical treatments and their outcomes could be a powerful aid toward improving the cost effectiveness of health care. There are frequent claims currently in print—and echoed in the health technology hearings before this subcommittee—that billions of health care dollars are expended for results that are poorly known, or are wasted on treatments that are ineffective or unnecessarily dangerous, debilitating, or costly. At a news conference [8] publicizing a special issue of Science magazine devoted to health issues, Howard Hiatt, Dean of the Harvard School of Public Health, observed that "many current practices in medicine and surgery have not been evaluated. . . . Tonsillectomies are being done less frequently, but one can still seriously question the need for close to a million a year." He urged rigorous evaluation of all medical and surgical procedures on the basis that the cost of not undertaking it will be greater than undertaking it. Similarly, the authors of *The Costs and Benefits of Surgery* [9] observe that many of the 20 million operations performed each year on Americans are of questionable value. Likewise, Dr. Kerr White (Milbank Memorial Fund Quarterly **46** (part 2) 117–125,

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[8] See Victor Cohn, "Health Costs Spur Debate on Who Shall Live, Who Shall Die." The Washington Post, Friday, May 19, 1978, p. A16.

[9] Bunker, John P., Benjamin A. Barnes, Frederick Mosteller, Howard H. Hiatt. Oxford University Press, New York, 1977.

1968) estimates that only 10 to 20 percent of procedures in current medical practice have been proved efficacious by controlled clinical trials. Problems of cost, time delays and the ethical problems of deliberately creating a control (untreated) group account for a general absence of formal trials and enhances the need for alternative means for systematic evaluations. For the vast majority of diseases, Dr. Brandt told the Subcommittee, the outcome or value of treatment remains immersed in ancedotes of limited personal or institutional experience or in statistical forms of no practical use. Dr. Sherman stated his belief that much of the increase in medical cost in the last two decades is due to application of new medical technologies and procedures for which effectiveness has not been adequately demonstrated. He testified that the number of diseases and therapies being monitored is pitifully small, and many less common ones cannot be systematically studied at all because data cannot be gathered over large enough samples.

Lack of information from which to construct appropriate standards leads to disagreement on appropriate care, and wide variation in treatment selections. Among the issues currently under widespread criticism are coronary by-pass surgery, radical mastectomy, tonsillectomy, fetal heart monitoring and various specific applications of C.T. scanning of the chest or abdomen. Because of inadequacies inherent in paper medical records, a national total of 500,000 man-years of experience with coronary by-pass surgery is presently inaccessible to data aggregation and analysis. Radical mastectomy remains the most commonly practiced procedure for breast cancer, although there is no persuasive evidence that it is better than simpler treatments. The frequency of tonsillectomy, hysterectomy, and various other surgeries varies enormously from community to community according to studies,[10] and reflects a lack of definitive data on when to use the procedures. Monitoring the fetal heartbeat has shown to result in a doubling of the number of Caesarian birth procedures, without evidence that this reduces infant mortality or brain damage.

The foregoing is a small token of the available examples, too numerous to list, to support the general allegation that individual clinicians lack good information on treatment and outcomes, and seldom have data on probabilities and costs. David Cullen and co-authors, in a study of the critically ill [11] observed that doctors expect virtually unlimited resources to be mobilized for these patients, yet remain unaware of the statistical results of their efforts. Such considerations prompted the Office of Technology Assessment to report on the general need for Assessing the Efficacy and Safety of Medical Technologies,[12] and led the Congress to include provisions for assessment and evaluation in the new Health Services Research, Health Statistics, and Health Care Technology Act of 1978.

New technologies and their cumulative costs have been expanding with explosive force in the past 25 years. There have also been some

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[10] See for instance, Bunker, et al., "Costs and Benefits of Surgery."

[11] D. S. Cullen, L. C. Ferrara, B. A. Briggs, P. F. Walker, and J. Gilbert; New England Journal of Medicine, April 29, 1976, p. 282. Survival, Hospitalization Charges and Follow-up Results in Critically Ill Patients.

[12] Assessing the Efficacy and Safety of Medical Technologies, Office of Technology Assessment, Congress of the United States, September 1978.

dramatic improvements in selected capabilities in medicine, but it is not evident that the overall effectiveness of medical practice has changed enough to match the generally increased costs. Lewis Thomas suggests that, until we can dramatically cure or prevent more disorders, we shall be stuck with what he has termed "half-way technologies." These may be helpful, but not decisive, and tend to require systematic assessment to determine their qualifications and restrictions. At present, for lack of adequate information on who did what to whom, and what the outcomes were, doctors often cannot distinguish who probably will or will not benefit from a given procedure, cannot decisively evaluate treatments that may be effective, and cannot choose reliably among alternative procedures, or decide when to stop. What can be done in this period, Thomas says, is "identify the areas of health care in which the spending of money represents outright waste, and then eliminate them. There are discrete examples all over the place".

Testimony received in the health technology oversight hearings of this subcommittee, consistent with the foregoing reference, indicated a regrettable lack of information to supply dotors' general need for corrective feedback. In considering what measures could improve the situation, it is difficult to escape the conviction that better means for scorekeeping would rest on a computer technology that deals explicitly with clinical information. Dean Hiatt, in a medical essay [13] on the coronary by-pass debate writes "we need improved methods for collecting, aggregating and analyzing clinical data. Computers spew out minute details concerning the charges incurred by each patient in most hospitals, but in most places little or nothing concerning the medical problems that led to the hospitalization, the details of in-hospital care, or the long-term outcome of therapy." Dr. Brandt, expressing a similar view in his testimony, proposed that the great challenge in medical science is the creation of clinically pertinent data to define the course of disease and quantify prognosis under chosen treatments.

Some improvements in the knowledge base or the systems to acquire it would take a long time to develop; others are much less futuristic. An intermediate goal could be the collection of information for determining what health care practices the Nation will pay for, so that health care might eventually be paid for in terms of output, rather than input, units. Longer range goals would certainly include efforts to eliminate or shift costs through prevention or postponement of disease and disability, and could profitably include explorations into new ways of making patient care decisions less dependent on human memory, specialization, and the attendant fragmentation of care.

The existence of exceptionally important applications for computer technology where there is high societal incentive but low economic incentives at the local level indicates that a selective federal role is appropriate. This recognition prompted the Office of Technology Assessment to observe that needed capabilities to monitor the quality of medical care and facilitate planning in the health system might be lost in information systems determined only by the open market place. In its report on medical information systems,[14] the OTA stated

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[13] Howard H. Hiatt. Lessons of the Coronary By-Pass Debate, New England, Journal of Medicine, Dec. 29; 1978, pp. 1462–1464.

[14] "Policy Implications for Medical Information Systems," Office of Technology Assessment, Congress of the United States, November 1977.

that "without a Federal policy toward these systems, their diffusion may well proceed indiscriminately. If so, the full potential of these systems is not likely to be achieved."

The inference is reasonable that, if there were a Federal policy, it would clearly distinguish and emphasize computer applications most needful and deserving of public support. The pockets of development or research support that exist in the Federal structure do not appear to be guided by any such clear criteria. Furthermore, there is no integration, coordination or even overview awareness of all the parts of what constitutes the present Federal activity.

Development programs to advance computer services for patient care in their own hospitals are under way in the National Institutes of Health, the Veterans Administration, and the military medical departments. Extramural grant and contract funding emanates primarily from the National Center for Health Services Research (NCHSR) and, to a lesser extent, from the National Library of Medicine and the Division of Research Resources of NIH. Until recently, the Bureau of Health Manpower also sponsored independent investigators. All the Federal programs are independent operations, generally not concerned with each others' activities. As a result, there is duplication and overlap, technical gaps, discontinuities in funding, no progression or handover of projects to other agencies when that would be advantageous, and little opportunity for exchange of knowledge gained from parallel or relevant experience. No one overseer exists, even within DHEW, or even within NIH, to ascertain what the total effect is, what its overall progress and prospects are, or to judge whether, as a balanced whole, it adequately satisfies long term national or societal priorities.

To the extent possible for a single agency, and under exceedingly limiting circumstances, NCHSR has been a principal source of Government support for extramural development of medical information systems and allied projects.[15] Its portfolio of contracts and grants has included a spectrum of research development, demonstration and evaluation programs of computers in health care delivery, but it has been grievously constrained by austere funding, limitation of its authority, and a shifting focus of responsibility. In the period between 1974 and 1979, budget cuts and cost inflation combined to reduce its contract sponsorship more than 50 percent. Development activities were officially proscribed and evaluation programs became almost too expensive to consider. The result is a very small program portfolio with a serious gap in the area of development.

It may not be surprising that under these discouraging circumstances, NCHSR has not assumed a unifying leadership role. Dr. Safir remarked in his statement to the subcommittee that NCHSR is the logical place for such leadership to originate. But he observed that they have not developed a holistic approach to their computer studies, insuring continuity, filling gaps in the transfer process, seeking maximum public payoff, and encouraging an integrated, coordinated effort among the several other Federal agencies.

The sharply falling budget for NCHSR virtually cut off consideration of new programs; because of inherently long development time,

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[15] The Division of Research Facilities and Resources at NIH was once an important source of extramural funding. Its Computer Study Section, recently abolished, served as proposal evaluation center. Now, proposals are sent to whatever Institute of NIH is responsible for the disease category most relevant to the proposal. No testimony was offered in the hearing on NIH extramural programs.

the agency has needed all of its shrinking resource base for maintaining a selected portion of its established commitments. This austerity, combined with the elimination of a substantial grant program under the Bureau of Health Manpower [16] not only curtailed much of the Federal program in extramural computer studies, but also may cause the loss of a pool of established investigators. The situation leaves new investigators almost no hope of finding Federal support. Some improvement in the situation can be anticipated in a now somewhat larger NCHSR budget and a conscious and renewed emphasis on its commitment to computer technology.

The emphasis was given legislative support in Public Law 95–623 (derived from Senate and House bills S. 2466/H.R. 12584), changing the authority to support computer research to a requirement. Recent reorganization within the Public Health Service, placing the National Center for Health Services Research (NCHSR) and The National Center for Health Statistics (NCHS) closer to the authority of the Assistant Secretary for Health, was intended to enhance the importance of how Congress and the Administration perceives the Centers and thereby to induce more generous appropriations. The arrangement could also facilitate or promote a greater degree of HEW oversight and interdivision coordination.

There is a substantial overlap among the technology activities of the various divisions of DHEW. Differences in mission between NCHSR and the parts of NIH supporting computer applications do not, and should not, guarantee exclusive differences in their computer research programs. Indeed, many of the projects of the Division of Computer Research and Technology, the Division of Research Resources, the National Library of Medicine and The National Center for Health Services Research are similar, or of a character not exclusive to the agency in which they reside. The overlap allows one agency to fill gaps left by another, and could, but generally does not, allow for transfer or progressive handover from one agency to another. The National Library of Medicine has initiated a new program in information engineering whose ultimate goal is more efficient prevention, diagnosis, therapy, and care. This is well within the mission of all of the agencies named, but only NCHSR has a clear jurisdiction over, and active program for, promoting the last stages of technology transfer to commercial reality. Transfer from NIH to another HEW agency is possible but not an established process. Without routine interagency coordination, transfer is less likely, and gaps and duplications are more likely. Administrative oversight, with authority of, or delegated by, the Assistant Secretary for Health could assist in reducing these risks.

Oversight, from a level near the top in HEW, could also inject a management component derived from a less parochial mission orientation. It should be possible, without being heavy handed, to link agency perceptions and decisions with considerations that are more National or more health-care-systemwide.

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[16] Authorized by the Comprehensive Health Manpower Training Act, this program has had only slight relationship to "health manpower" but has supported a substantial reservoir of skill in the medical application of computer technology. No appropriations are anticipated after 1978.

## HEW PLANS FOR TECHNOLOGY MANAGEMENT

In testimony before the Senate Subcommittee on Human Resources, on the occasion of hearings on renewal authorizations for NCHSR and NCHS, Dr. Julius Richmond, the Assistant Secretary for Health, observed that HEW had no comprehensive strategy for linking systematically the life stages of technology development, evaluation, transfer, diffusion, utilization, and phase-out. Agencies of HEW generally decide independently their technology activities and engage themselves on selected segments or stages of technology development or transfer. Action agencies, like the Health Services Administration, or the Health Care Financing Administration, need technical information for guiding their actions, and would benefit from links to agencies like NCHSR and NIH that produce knowledge.

In 1977, the Office of the Assistant Secretary for Planning and Evaluation, in collaboration with the Office of the Assistant Secretary for Health, conducted a preliminary study of management needs and opportunities at DHEW. With authorization from the Secretary, changes were initiated to provide managerial leadership and coordination from a high level in the Department. Shifting the organizational position of NCHSR and NCHS, alluded to earlier, was one of the changes in what was intended to become a continuing study and modification of how technology is managed at DHEW. A parallel step was the creation of an Office of Health Technology also within the Office of the Assistant Secretary for Health. This new office was to catalyze formation of Department policies on technology management, monitor DHEW agencies' management of technologies to identify gaps and opportunities, and serve as a focal point for liaison with other Federal agencies and outside parties.

In her statement to the Subcommittee, Ms. Ruth Hanft, Deputy Assistant Secretary for Health Policy, Research and Statistics, indicated the Department's intention to have the new Office "direct, systematize, and coordinate Departmental health technology management." She indicated that it was expected to function as the Department's lead agency for health technology management. To carry out this function it would:

(a) Identify deficiencies in the Department's health technology policy and propose improvements;

(b) Coordinate and facilitate collaboration with Federal agencies and;

(c) Supply a managerial approach to priority selection, technology assessment, and information exchange.

These functions would include overseeing the development of the Secretary's decision documents relating technology findings to reimbursement, regulation and Department initiatives.

The statement submitted for a subsequent hearing on health technology [17] by Dr. Richmond, who headed a delegation of HEW administrators, addressed new functions of the Office of Health Care Technology [18] recently mandated by law. His testimony indicates

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[17] See the testimony of Julius B. Richmond, Assistant Secretary for Health, DHEW in the hearing record of October 6, 1978, "Technology and the Cost of Health Care." Subcommittee on Domestic and International Scientific, Planning, Analysis, and Cooperation. Committee on Science and Technology.

[18] Under The Health Services Research, Health Statistics and Health Care Technology Act of 1978 (Public Law 95–623) derived from bills S. 2466 and H.R. 12584, the Office of Health Technology became the National Center for Health Care Technology, with functions including demonstrations, evaluations, and epidemiology.

no conflict between the functions described by Ms. Hanft and those presented by the new legislation. The new Office would promote technology assessment and assist in the formulation of utilization and reimbursement policy, as well as stimulate the internal coordination and steering of technology development. In his words, "The Office (of Health Care Technology) will act as a catalyst for policy development related to technology management, as well as functioning as a liaison to outside organizations, collaborating with other Federal agencies, and monitoring activities in the business and academic areas." For all health oriented agencies, "The Office of Health (Care) Technology should provide a forum for mutual information exchange on health technology activities, for airing individual agency perspectives on particular issues, for identifying critical needs and important opportunities in this area, and for seeking agreement on useful common approaches to problems and appropriate priorities."

## NEEDS, OPPORTUNITIES AND PROSPECTS FOR MANAGEMENT OF COMPUTER AFFAIRS AFFECTING HEALTH CARE

From the testimony received, it appears that DHEW intended for the Office of Health Care Technology to embrace technology policy development and broad management oversight, as well as the evaluation and assessment obligations now specified by law. Since assessment of the manifold impacts of computers on health care is a natural prerequisite for policy development and implementation, there is no logical incompatibility in these functions. There are grounds for concern, however, over the balance between them that might be struck within a realistically modest budget (assessments are very expensive) and over the particular nature, scope, and variety of the management activities that might be elected.

Much support for legislating technology assessment derives from the fact that technology is a major contributor to the cost of health care. Most of the incentives for customers of health care technology favor improving quality of care with little regard for cost. Assessments and evaluations to be performed under the new law will be directed toward curbing excessive and inappropriate practices and toward throttling the development and spread of technologies that are of questionable efficacy or are unreasonably costly for the benefits they can produce. Thus the Center for Health Care Technology has been promoted as a pivotal component and source of initiative for an early warning system. One should hope, however, that affirmative opportunities will not be overlooked. Computer applications seem to be particularly deserving of careful discrimination to identify those whose promotion and positive guidance would be clearly in the Nation's interest. To insure such promotion and provide such guidance is a complex and delicate management task. There are many barriers to overcome and many opportunities that would be missed if nobody undertook the responsibility to devise and implement a comprehensive strategy to get the "best" computer systems developed and applied to the most socially needful problems. Consequently, it is the subcommittee's hope that the Center for Health Care Technology will rec-

ognize and implement what appears to be a unique opportunity to support, cajole, stimulate and assist appropriate HEW actions in the orchestration of a comprehensive management policy and action program.

Illustrative material for deriving health care computer policy, reducing problems, or selecting opportunities for technology management or oversight, is offered in the following list of topics:

Some computer applications have extraordinary potential for public benefit; others are of little or no public significance. Therefore, some are more appropriate than others for Federal attention. Important management and oversight functions include the identification of selection criteria and their application to Federal planning.

Applications having national social value must meet economic realities. Somebody must pay for them. Who? How? There is evidence "socially good" systems can be made locally self-supportive without adding to anybody's medical bill. This possibility should be pursued.

There are numerous special questions to be addressed to facilitate development and spread of "good" systems. One is professional acceptance. How can doctors be induced to actually use computer terminals? Why have some systems been successsful in that? Also, what measures of quality or cost improve when a relatively "good" system is installed? Preliminary findings have often been surprising; some expected improvements have derived from unexpected causes. After installation of a computer system, what has been the true cause of reduced patient stays or other observed benefits?

The National Center for Health Services Research (NCHSR) and other HEW supporters of health care computer technology have miniscule budgets. Evaluation of information systems is very expensive. So are the later stages of development. What strategy will harvest the most benefit from NCHSR's limited funds? What roles should NCHSR, NIH, the Health Care Financing Administration, or the Center for Health Care Technology play? Can industry and other private sector elements be enlisted to cooperate to the advantage of all?

Development is a serious gap in what could be an integrated federal policy toward computers in health care. How can this be filled?

The National Center for Health Care Technology (NCHCT), NIH, and NCHSR are all in the Public Health Service (PHS) under the Assistant Secretary for Health. Health Planning and Evaluation (P. & E.) is under another Assistant Secretary. Even more importantly, reimbursement for Medicare and Medicaid is under control of the Health Care Financing Administration (HCFA), independent of and of equal rank with PHS. How can NCHCT or NCHSR engage the cooperation of HCFA to encourage acceptance of systems and applications identified as cost-saving? Will NCHCT mediate cooperation between P. & E. or

HCFA and NCHSR? Will NCHSR ask for NCHCT help in this task? Will NCHCT perceive the need or opportunity without prodding from NCHSR and, in effect, itself be the prodder?

It is particularly difficult to engage agencies like the military departments or Veterans Administration in a national strategy that is not obviously in their mission. In addition to poverty of available mechanisms, these agencies have relatively limited interests, tailored by their specialized missions. They do, however, have control of self-contained health care delivery systems. It would be difficult, but probably worthwhile, to develop means for enlisting their cooperation in the testing and evaluation of certain aspects of computers in medicine, or in the provision of a guaranteed initial market for products which industry might then be induced to develop.

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