

The Computer and Medical Care

By

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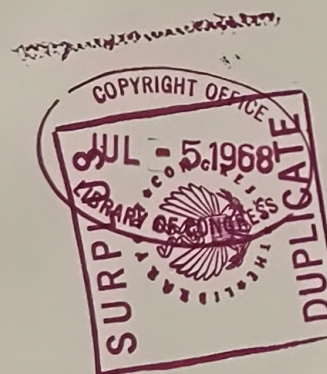
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PREFACE

THIS BOOK is addressed primarily to those persons who are familiar with hospitals. Consequently, more attention will be given to defining data-processing concepts than medical terms.

My purpose is to discuss some specific examples of working systems which utilize computers and electronic techniques for acquiring, processing, and evaluating patient-care data. It would please me more to present a scholarly discussion of the theory of medical data-handling and its rules; unfortunately, no one can yet do this. We must content ourselves with specifics at present.

Because I am a pathologist, with training in anatomic and clinical pathology, many of the examples will be drawn from the fields with which I am most familiar. Most programming and systems examples will be taken from work at the University of Missouri, for the same reason. The Medical Center computer program at the University of Missouri, however, is broadly based, touching all departments of both the School of Medicine and University Hospital. It is our purpose to determine through investigation the proper role of computers in the teaching and practice of medicine. No areas are excluded at the outset. The initial objective has been an attempt to capture in computer-accessible form a major portion of the significant patient record. Probably the most easily attained portions of the record are the data relating to the various laboratories and to diagnoses. This is the reason for their being emphasized here.

The general outline of the book is to consider (1) what data make up the significant patient record; (2) how one can acquire these data; and (3) for what purposes the data are likely to be useful. The fourth part presents in detail some hospital applications which illustrate the capture, processing, and evaluation of patient-care data. Part Five describes the organization of a medical computer-group. In the last part I have yielded to the temptation to try to predict the course future discoveries and uses of computers in medicine will take. This is clearly speculation and must be so appraised.

In this regard, too, let me assure the reader that all the systems and techniques described are offered with cognizance of their shortcomings and their provinciality. No techniques at this time are likely to be universally applicable. Discoveries are made, however, by reacting against what has already been accepted. The techniques and systems developed at the University of Missouri are offered as beginnings only. The reader is encouraged to find fault with our solutions and to improve upon them. I am proud of the performance of my programmers and systems analysts, but so far I am still happiest in believing that our most important discoveries have not yet been made.

The need to develop medical computer groups, the hundred steps necessary to recruit and encourage the initial members of the group at Missouri, and the efforts to provide financing were directly attributable to Vernon E. Wilson, M.D., Dean of the School of Medicine at the University of Missouri, and Director of the University Hospitals. He is truly a remarkable man. Because of the pervasiveness of his viewpoint and fastidious restraint from over-directing his staff, it is impossible for me to say which ideas in this book are his and which are mine. The reader may assume that the good ones are Doctor Wilson's and the poor ones mine.

Much is owed to Fred V. Lucas, M.D., Professor and Chairman of the Department of Pathology at the University of Missouri, by all those who have learned from him. He, too, knows how to encourage his young associates to grow without determining their fates.

I wish to acknowledge the advice and full cooperation of my colleagues in the development, evaluation, and toleration of numerous imperfect systems. They are H. J. Van Peenen, M.D.; Donald A. Senhauser, M.D.; Larry R. Rowland; Joseph Schroeder, and Charles R. Buck, Jr. Programming was performed by many individuals during a four-year period. Especially long-suffering and productive were Marti Ottinger, John Winegar, Camille Ressler, and Judith A. Brewer.

Mrs. Irene Renden undertook to keypunch, edit, index, and process the manuscript text. Despite my hindrance and frequent alterations, she completed this task with good humor and extreme effectiveness. Her editorial corrections and suggestions were distressingly precise and much appreciated.

DONALD A. B. LINDBERG

CONTENTS

	<i>Page</i>
<i>Preface</i>	vii

Part One THE NEED

<i>Chapter</i>	
I. MEDICINE'S NEED FOR COMPUTERS	5
Research	5
Teaching	6
Practice	7

Part Two THE DATA

II. THE SIGNIFICANT MEDICAL RECORD	13
Components of the Patient Record	14
Changes in the Patient Record	15
III. DISEASE NOMENCLATURE	18
More About Numbers	22
The Intelligent Inquirer	22

Part Three COLLECTING DATA

IV. CHOICE OF MEDIA	31
V. DATA WHICH CLERICAL PEOPLE CAN ACQUIRE	34
Hospital Systems	34
Patient-Numbering Schemes	34
Data From Physician and Patient	35
Image Processing	41
Psychological Tests and Vital Signs	43
Physiological Monitoring	43
Nurses' Notes	43

Chapter	Page
VI. DATA VOLUNTEERED BY THE COMPUTER	45
Simple Processing of Traditional Hospital Data	46
Automation of Medical Interpretations	46
Implementation of Hospital Administration Decisions	47
Gratuitous Laboratory Studies	48
Indication of Associations	48
Interrogative History	49
Physical Examination	49
Literature Citations	49
Differential Diagnosis	50
Patient Routing	50
VII. LABORATORY DATA SYSTEMS WITHOUT COMPUTERS	51
Prepunched-Card System for Laboratory Data	53
Use of Result Cards	58
Experience With the System	61
Limitations of the System	62
VIII. DATA PROCESSING WITH AN IN-HOSPITAL COMPUTER	63
In-Line and On-Line Computers	63
Orientation of a Hospital System	64
Justification	65
Missouri Computer Laboratory Data-Transmission System	66
Missouri Surgery Information System	77
Other Selected Hospital Computer Applications	88
Systems for Diagnosis	89
Summary	89

Part Four

SPECIFIC APPLICATIONS OF COMPUTERS IN THE HOSPITAL

IX. TECHNICAL ASPECTS OF MISSOURI COMPUTER LABORATORY DATA-TRANSMISSION LIMITS SYSTEM	93
Bacteriology	93
Chemistry	100
Hematology	110
Types of Reports	118

Chapter	Page
X. MISSOURI TEACHING PROGRAMS	120
Laboratory Inquiry Routine	120
SHOW-ME Inquiry Routine	120
CASE Inquiry Routine	121
Statistical Analysis by Computer System	126
Hospital Diagnosis Inquiry Routines	127
Computer Routine CONSIDER	135
Deficiencies and Problems	140
Audiovisual Teaching Materials	141
XI. QUALITY CONTROL IN THE HOSPITAL LABORATORY	143
Basis of Initial Computer Approaches	144
Possible Future Computer Quality Control	149
The Computer System: An Essential Element	150
XII. PATTERN RECOGNITION	151
Definition and Importance	151
How Patterns are Recognized in Medicine	152
Information Science Approaches to Pattern Recognition	161

Part Five

THE HOSPITAL COMPUTER FACILITY

XIII. ORGANIZATION OF A COMPUTER GROUP	167
The Environment	167
Selection of Personnel	168
Training of Programmers	169
Computer Languages	169
Operating Systems	170
Computer Personnel	171

Part Six

THE FUTURE

XIV. THE FUTURE ROLE OF COMPUTERS IN MEDICINE	179
Services to the Physician	179
The Present Problem	181
Apologia	190
References	191
Index	197

he enters information about them into the system.

OTHER SELECTED HOSPITAL COMPUTER APPLICATIONS

Doctor George Williams at the Clinical Center of the National Institutes of Health and Dr. David Seligson at the Yale Medical Center, have attacked the problem of automating the bench-level determinations. Seligson long ago achieved direct digital read-out of laboratory colorimetric analyses (63, 68). This is done by utilizing analog computer circuits within the photometers. The values so elegantly obtained are then reported in an essentially traditional fashion. Williams is presently constructing a specimen transport mechanism and chemical analytic system which will output directly on-line to a digital computer for subsequent peak-picking and calculation of the results (118). Reports will then be printed by the computer system which, because of limitations of its size, cannot include evaluation of considerations such as constitute the Missouri LIMITS system. One would hope that the best aspects of all such programs could ultimately be brought together into a single system.

The experiments of Dr. Ralph Thiers at Duke University Medical Center have shown the value of routine performance of a battery of chemical determinations on each blood specimen obtained (102). This has been possible because of his creation of a ten-channel arrangement of an automatic analyzer which utilizes a single blood sample. This is a major discovery and is especially remarkable in the absence of a good data-processing system to accept and report the results. The success of the experiment makes the need for a good laboratory data-processing system and new

pattern-recognition techniques all the more pressing.

Systems for transmission of physicians' requests for laboratory services exist as working systems at the Children's Hospital in Akron, Ohio and at the Texas Rehabilitation Institute in Houston, Texas (17, 109). In the latter institutions Dr. William Spencer and Dr. Carlos Vallbona utilize a conversational mode of eliciting laboratory orders even without an on-line computer by including the prepunched questions in an IBM 1056 card-reader attached to the IBM 1053 ward-transmitting-units.

Another aspect of processing physicians' orders is that of pharmacy orders. Bolt Beranek and Newman Company, of Cambridge, Massachusetts, has designed an on-line computer system for the Massachusetts General Hospital of Boston (8). Among the many sophisticated accomplishments of this system is an excellent approach to the ordering of medications. The orders are challenged or refused when they exceed predetermined limits with respect to dosage, age of the patient, route of administration, duration of treatment or total dose, or compatibility with other drugs. The physician can overrule the objections. The mode is distinctly conversational, utilizing a Digital Electronics Corporation P.D.P.-1 computer and Model 33 teletype-writers. A special virtue of this system is that the program uses a phonetic approach to word recognition and hence allows for incorrect spelling. This system is working well at a remote location and is gradually being introduced in the hospital.

The last two major areas which have not been mentioned are on-line acceptance of the interrogative medical history and physical examination, and the question of computer-assisted diagnosis. So far as I know, nowhere are the interrogative his-

tory and physical data even nearly completely recorded in computer-sensible form and certainly not on-line to a computer.

Doctors Slack and Hicks, of the University of Wisconsin, have developed and are evaluating a system for eliciting and storing the patient's history with respect to allergic phenomena (90). In this system, multiple-choice questions appear in English on the cathode-ray tube of a LINC computer, and the subject indicates his answer by depressing a number on a keyboard. The program branches to a new line of questions when the subject gives a negative response, or else pursues more detailed questions when the subject gives a positive response or indicates that he does not understand a question. Their initial impression is that the approach seems fruitful and generally acceptable to most literate subjects. Much more computer time is consumed in obtaining this fragment of history than seems desirable, but at present this seems to be the avenue by which computer systems may best be used to aid in history collection. With a time-sharing computer system, many patients could simultaneously use the same computer and thus obviate the objection to the present inefficiency. In any event, the time expended is the patient's, which he would presumably spend freely for elucidation of his complaints. The system should definitely save physician time.

SYSTEMS FOR DIAGNOSIS

Computer-assisted diagnosis is doubtlessly being done in a fragmentary way in many institutions. A great many theoretic-

cal approaches still seem equally defensible. Two papers in particular review these considerations (1, 54). In a few situations, computer diagnostic techniques have been reasonably well integrated into medical practice (15, 16, 20, 62, 65). The systems employed by Dr. Caceres (16) and by the Permanente group (20) have actually employed on-line settings. On the other hand, one is, regrettably, probably justified in concluding that nowhere is there a computer system of diagnosis which is so essential to improved medical practice that an on-line computer system has truly become a requirement.

SUMMARY

Computer processing of medical data has much to offer in rendering data readily available and in assuring the quality of the observations recorded. In order for the computer to perform the editing and monitoring functions it is first necessary that one analyze in detail the essentials of good medical practice and thinking. Such a computer project is heuristic in that it stimulates many subsequent discoveries made through analysis of the elements which are required for the best medical practice. As a consequence of these heavy requirements, no total hospital system exists except for trivial billing functions. There is a need for many hospitals to design computer systems, building on the work of others. Each hospital group will be best advised if it begins to implement a system in the area in which physicians are willing to invest their thoughts in the requisite analyses. It appears that few equipment limitations still remain.