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LABORATORY OF MEDICAL INFORMATION SCIENCE

AN ANALYSIS OF AUTOMATED AMBULATORY MEDICAL RECORD SYSTEMS

Volume I: Findings

AAMRS Study Group

Ronald R. Henley, Ph.D.
Principal Investigator

Gio Wiederhold
Project Manager

Technical Report #13(1), June 1975

University of California, San Francisco
San Francisco, California 94143

Final Draft

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AUTOMATED AMBULATORY
MEDICAL RECORD SYSTEMS

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CHAPTER I

EXECUTIVE SUMMARY

Introduction:

This report presents the results of a study carried out at the University of California, San Francisco, by the Office of Medical Information Systems, under the sponsorship of the National Center for Health Services Research, into the state of the art of automated ambulatory medical record systems. The contract was carried out between July 1974 and July 1975 and included visits by a multi-disciplinary team to a selected number of places that operated such automated ambulatory medical record systems (AAMRS's). The major portion of the analysis is hence restricted to sites which in 1974 had operational medical record systems for outpatient data, with a significant amount of medical content, assisting in the process of the delivery of patient care.

The study can be divided into three major phases:

1) A comprehensive survey of sites of automated ambulatory medical record activity. We found approximately 175 such activities during our study.

2) An intensive survey of the 16 sites that appeared to be most advanced and representative, selected through an algorithm described in detail in Section 3B.

3) An analysis and summary of the findings collected from both surveys.

In our study, the term "automated" was largely restricted to systems that used computers to automate the medical record system. In the comprehensive survey, some sites not using computers as part of their automation effort are indicated, but none of these can be viewed as providing the potential for the comprehensive AAMRS's which were to be analyzed. Volume 2 of this report represents the detailed data gathered from the sites that were visited by our study team. The summaries of information, our findings, and our analysis are to be found in this Volume 1. In addition to a large quantity of factual data, the site visit team also collected some valuable insights, which are presented by us in this report in a chapter devoted to the implications of the findings.

Readership:

This report is intended for individuals who contribute to the decision-making process and to the development of medical record systems applied to ambulatory care. A number of closely related areas are also touched upon. Since this field is at the intersection of two sciences, we have attempted to present the material in such a way that it can be read by people with a primarily medical background as well as by those with a technical orientation. The medically-oriented reader will be able to perceive what has been accomplished through the application of technology in this field, how much it has cost, and how well it works. The technical reader may gain increased insight into the acceptance of technology by the medical profession, and into the criteria for the benefits to be achieved in order to gain this acceptance. The evaluations carried out as part of this study included the measurement of both tangible and intangible benefits.

The evaluation methodology for health care delivery systems, as found during our study, is not yet in a very advanced state, and we hope that the presentation of the methodology and the procedures followed will provide some guidance for systems planners who are faced with the need of evaluating the systems that they are considering.

At the very least, the contents of this report can provide a checklist to verify that important services, which can be provided by automated ambulatory medical record systems, have not been forgotten, and that the medical data base considered is adequate to support such services.

The report has been divided into chapters, sections, and subsections, with descriptive titles to make the selection of material easier for the reader. This also implies that some material has been presented redundantly when it forms the basis of more than one topic to be covered.

Significant Findings:

Since the field is still in a state of development, the study team could not expect to find a single right answer, nor to find a single ideal system that would satisfy all possible requirements to be placed on an

AAMRS. The team did find, however, some instances where computer-stored record systems were viable and provided all the services expected according to the design objectives. Such systems were found at a private specialty clinic, at private practices using commercial services, and at sites where training, management, or research benefits provided the incremental justification for the system. An important consideration in the evaluation of benefits and operational effectiveness of an AAMRS is the type of institution using the system and the population served by the system. It was found that where there was a large population base even relatively simple services made a significant difference in the quality and access to medical care. In an environment where the care was provided through a team process of physicians, nurses, and other paramedical personnel, the AAMRS also serves as an important communication tool.

In addition, a number of techniques in the area of automated ambulatory medical record systems have been identified that have the capacity to generate additional benefits if integrated into new systems. Examples of such AAMRS outputs were:

Patient profiles which provide a concise summary of the patient's status, to be used during an encounter for regular or emergency care.

Surveillance reports which advise the provider regarding possible problems and further needs for the medical data base.

Data presentation in flow-sheet format which allows the physician to gain a rapid appreciation of a patient's progress in chronic disease follow-up protocols.

Utilization reports which allow institutions with multiple services to optimize their delivery of health care.

Selective inquiry to generate exception reports, as found in many systems, provides benefits for quality control procedures.

Simplification of the billing process, often in regard to third-party providers, is an important benefit for private practices using AAMRS's.

In all cases, the active participation by medical personnel during the development of the AAMRS was found to be essential if any medical benefits were to be realized.

In the technical area, no single technical approach was found to be superior in all cases to its alternatives: Both large and small computers, both local and remote operations, were successfully used. Communication problems, however, are the predominant cause for lack of system reliability at the sites visited.

In the funding area, it was shown that the sites which have received significant amounts of Federal funding, have not planned as well for financial viability as sites funded from other sources. Complaints were heard from the Federally-funded sites that the indications for the direction of the research and development to be emphasized change faster than the time interval required to bring the previous objective to maturity. The lead times for development of AAMRS's are unbearably long. In fact, most of the sites that were selected for a visit, since they had an important AAMRS in operation, began providing services in 1971--three years before our study team visited them. Even at that point, many of the sites considered that their efforts included a significant development component.

Further Work:

During our study, the team has generated many hypotheses regarding cause-and-effect relationships of aspects of each site visited. It is possible that some of the relationships presented may strike the reader as being trite and obvious. It should be considered, however, that an even larger number of hypotheses were investigated that seem equally obvious, hypotheses which have in fact appeared in print as statements of the "right way to do things," and which either could not be demonstrated as being true, or were actually found to be false. The inclusion of some subjective material in this study leaves the study group open to similar accusations, but the group hopes that the variety of backgrounds of its members and the experience gained during this study have made the statements more restrained.

A great many further conclusions can be drawn from the data presented. Such secondary analyses will require more work, and the group hopes that other researchers will be able to use this data to investigate areas of interest to them. All substantial basic data collected and used is presented in Volume 2, and the members of this study group will gladly assist with interpretation, should this be required.

Gio Wiederhold
July 1975

CHAPTER 2

INTRODUCTION TO THIS REPORT

A. OBJECTIVES FOR THIS STUDY

Introduction:

This study of Automated Ambulatory Medical Record Systems has been carried out in response to a need felt both by the National Center of Health Services Research of the Department of Health, Education, and Welfare, and by the Division of Medical Information Science at the University of California, San Francisco.

Computers have been used for some time to assist in the information management process and in the maintenance of medical records for inpatients, and a number of commercial vendors now operate in the field. A few outpatient services were included in some of these inpatient systems. The use of computers for ambulatory medical records has lagged behind the inpatient area, and was frequently restricted to the analysis of data from limited populations for study purposes; such research was often based in specialty clinics. With increased federal funding for outpatient care a number of reporting systems were developed which had varying degrees of medical content.

These three areas (inpatient services, research, reporting) provide the origin for most of the current systems in operation. A number of projects in this area of Automated Ambulatory Medical Records Systems (AAMRS) have been funded by the Division of Health Care Information Systems and Technology of the Bureau of Health Services Research. Other projects have been supported by the agencies who initiated the reporting requirements as part of the condition for government assistance to health care delivery programs; yet other projects were initiated commercially to relieve the physician from the administrative tasks which distract him from his primary interest. During this study we found AAMRS projects initiated by commercial institutions, by vendors of computer

systems, by interested individuals, and by organizations experimenting with improved methods of health care delivery.

Dissemination of Experience:

The experience gained from these projects has rarely been well-disseminated. Frequently the National Center of Health Services Research is looked upon as an information source in this area, but it has not been able to fulfill this need, since it is mainly aware of the projects which it is actively supporting.

The need for correlated and comprehensive information also exists in the teaching and research programs in information science applied to medicine. Past achievements and directions for further research have to be documented in order to provide guidance to the academic programs. At the University of California, San Francisco, this interest centers in the Division of Medical Information Science of the Department of Ambulatory and Community Medicine. Faculty and graduate students of this division participate actively in the planning, implementation, and evaluation of computer aids to medicine and are excited by the potential applications.

The information presented is intended to be equally useful to researchers and workers within, as well as outside of, the University, and the hope is that dissemination of this report will help the field as a whole.

The dissemination of the reasons for the success and failure of AAMRS projects has been particularly limited. Financial difficulties have caused the discontinuation of some major efforts and inhibited the publication of adequate operational data. Such failures have, in some cases, been due to changes in institutional and governmental support, not to problems with the basic medical or technical methodology. Successful operation has been achieved in some settings due to strong institutional or individual support even when objective benefits are few. The importance of factors external to the project itself has not always been clearly perceived from the outset. As a result, much of the information available regarding rhe reasons for success or failure is on a level which is not far above hearsay or rumor.

Even where objective information exists, it is often of very little value outside of the small cadre of specialists in the area of medical computing. Such information may be either not accessible to the medical profession due to the excessive technological terminology, or forbidding to regular computer professionals due to the mystique of medicine. The lack of objective information also discourages investment by commercial enterprises and their users. Even when information is freely available the risks inherent in new developments are difficult to quantify.

Background:

The importance of automation in ambulatory medical record systems is derived from several parallel trends which together are transforming traditional health care delivery systems. The high cost of care in hospitals has encouraged a move to outpatient care whenever inpatient care is not fully warranted. In order to encourage this trend, insurance coverage is putting more emphasis on outpatient services. As outpatient services become more freely available, the cost barrier to seeking care is being removed. Health maintenance expectations of the populations are increasing in general, and as the percentage of older people in the population increases, the number of individuals afflicted with diseases requiring regular maintenance increases further. One manner in which the health care delivery system can respond to the increase of demand is by resorting to increased use of paramedical personnel.

The desire by younger physicians to avoid the excessive work loads often carried by traditional general practitioners provides another stimulus for redistribution of the health care delivery effort. The emergence of group practice, which provides a better health environment for many physicians today, has an impact on the requirements of medical records. The shortage of physician services in outlying areas generates more pressure to change the health care delivery system.

Increased administrative requirements in health care organizations using prepaid reimbursement methods add to the burden placed upon the traditional record. A greater degree of accountability to the public is

a result of the increasing support of health care out of public funds and the increasing fraction that health care contributes to the Gross National Product. The requirements for Professional Standards Review (PSRO) are an outcome of these needs. Both the development of adequate standards as well as the application of these standards to health care implies an increasing data management load.

There remains of course the need to demonstrate that the considerable expense incurred in the automation of the medical record function has a commensurate payout. The benefits seen from AAMRS's are in the areas of quality improvement, better access to care, quality-adjusted productivity, and cost. All these benefits require considerable attention if they are to be realized through the application of an AAMRS. The measurement of achieved benefits in these areas also requires considerable insight and effort. The fragmentation of the health care delivery system encourages sub-optimization where local benefits are not weighed relative to long-range or broader liabilities, nor vice versa. The approach taken in our study attempts to focus on some of these issues.

Audience:

The audience for this report is expected to range from health care providers who are interested in becoming familiar with alternatives to traditional record systems, to systems designers who want to have access to the experience obtained in the many projects where computer-oriented automation efforts have been applied to medical records. For administrators and funders of such record systems, this report is intended to provide a review of factors which are to be considered in the selection and evaluation of these systems. An attempt has been made to write this report in such a way that extensive familiarity with technical, medical, or economics jargon is not required. Some special terms which occur several times are defined in a glossary (Chapter 8).

Summary:

This study surveys and analyzes the state of the art in automated ambulatory medical record systems. It does not provide a design for the ambulatory medical record systems of the future. It is hoped that it will provide some criteria and a check-list by which new efforts in the area can measure themselves.

It is well known that the interface between computing and medical professionals has been difficult to bridge; therefore, it is worthwhile to list every incremental useful approach in this area. The report shou also provide some standards for the evaluation of proposed systems. The unbridled enthusiasm of computer systems promoters has already aroused suspicions in many members of the medical establishment and we hope that this report will bring some order to the process. From an academic poin of view, we hope that the data in this report will discourage duplicatio of effort and research work and encourage efforts in the areas which hav been inadequately covered in the past.

B. RELATED WORK

Other Areas of Interest to AAMRS Efforts:

Automated ambulatory medical records do not comprise a field that stands by itself. Many other ambulatory or inpatient services have a great deal of relevance to the medical record operation and an analysis of the entire related field is clearly beyond the scope of any single study. The table below lists some of the areas which we consider to be strongly related and provides one or more citations to comprehensive references in each of these areas.

TABLE 2.1 CITATIONS TO RELATED WORK

Automated Patient History	:WAK75, GOU71, BOL72-1
Automated Pharmacy Systems	:KNI73, MAR72
Billing Systems	:BOL72-2, PET72
Clinical Laboratory Systems	:JOH71, BRE71
Disease Registry Services	:TER71, BOY73, WOO71
Evaluation	:KPZ74, MCL71
Immunization Records	:SAU70
HMO Statistics Collection	:LUB72, DAV72
Hospital Information Systems	:BEK72, COL74, BAL74
Legal Aspects of Automated Medicine	:HAV67, CUR69
Management Support Systems	:DON73
Medical Care Review	:PHS73, SAN72, CLA74
Medical Decision Making	:LUS68, GLE73
Multiphasic Screening	:YAR72, PHS70
Real-Time Data Acquisition	:CRO69, WEC71
Technology of Medical Record Systems	:COL72, DEL69

Other Publications:

The full citations appear in our bibliography, which is Chapter 9 of this report. We have also included in the references reports of work that has been carried out in the ambulatory medical records area itself. Especially significant in this area were two studies. One of these is the CAPO project, also sponsored by the National Center for Health Services Research, which studied the introduction and effectiveness of MUMPS services, as provided by Meditech, in private physician offices. A study similar to this one, although not limited to ambulatory medical record

systems, and hence not as detailed, was carried out by Health Care Management Systems (HCMS) of Denver, Colorado, under sponsorship of the Robert Wood Johnson Foundation (GIE74). One product of the HCMS study exceptionally comprehensive bibliography of the entire area of computer applied to health care delivery and research support. In Canada, the Health Computer Information Bureau in Ottawa has the function of a national clearing house to gather and publish comprehensive information about computer use in the Canadian health field. Volume 1 (HEA74) of their publication references more than a hundred activities and include abstracts of many of these. Several projects listed provide ambulatory medical record services.

Journals which publish many of the papers relevant to this area are:

Computer and Biomedical Research (Academic Press)
Methods of Information in Medicine (Schattauer Verlag, Stuttgart,
International Journal of Biomedical Computing (Elseviers)

A number of other medical journals carry occasional papers relevant to AAMRS:

Medical Care
The Journal of Family Practice
The New England Journal of Medicine
The Journal of the AMA
The Annals of Internal Medicine.

Papers on specialty applications of AAMRS's will be found in the appropriate specialty journals, or in computer science publications. Newsworthy items in this area may be found in a number of newsletters:

Computers and Medicine (published by the American Medical Association)
Computer Medicine (published by Girard Assocates, Mt. Arlington, New Jersey)
MCS Newsletter (published by the Medical Computer Services Association, Seattle, Washington)
SCM Newsletter (published by the Society for Computer Medicine, Minneapolis, Minnesota).

A problem with the retrieval of papers in this field is associated w the inconsistent terminology used, so that the indexing of relevant pap is often inadequate. The glossary in Chapter 8 is also intended to def the meanings of terms as used in this report. Even in our small group, differences exist in relating terms to concepts in this field, due to t

variety of backgrounds brought together in this study. The definitions are oriented towards the field of AAMRS, and hence are especially helpful when dealing with material in this area. We have not indicated terms defined in the glossary throughout the text. It may be helpful to glance through Chapter 8 before tackling an area of unfamiliarity in the report.

C. AUTHORS

The members of this study group and their main areas of interest will be summarized briefly in this section.

JOHN V. DERVIN, M.D., is a physician practicing in Santa Rosa, California. He is the Director of the Residency Program of the Sonoma County Family Practice Center. This Center provides facilities for the training of residents in family practice and also trains physician extende and nurse practitioners. During his tour of duty with the U.S. Navy, he was Director of the Family Practice Residency and of the Physicians Assistant Program of the Naval Hospital in Jacksonville, Florida, and a consultant to the Surgeon-General of the Navy. His major interest in this study is the provider interface and the use of AAMRS data.

RONALD R. HENLEY, Ph.D., is the principal investigator for this project He is the Associate Director of the Office of Medical Information Systems at the University of California, San Francisco, and he teaches in the graduate program in Medical Information Science of the Division of Ambulatory and Community Medicine at the University of California, San Francisco. His main area of interest is the design of cost-effective compute systems in health care.

MICHAEL A. JENKIN, M.D., is a private consultant in Minneapolis, Minnesota. He was a resident in surgery at the University of California, San Diego, and was subsequently in charge of the Computer Medicine Sectio in the Office of the Surgeon-General of the Air Force. He is past president and the executive director of the Society of Computer Medicine.

INGEBORG M. KUHN is a Ph.D. candidate at the Graduate School of Business at Stanford University, working in a program in Health Economics and Management Sciences in the Health Sector. Her experience includes the administrative and management aspects of the planning and evaluation of national programs supporting bio-technological research resources and health-care technology. Her main interests include the development of techniques for the evaluation of programs in the health services sector, with special emphasis upon cost-benefit analysis. Her main effort in thi study was devoted to the evaluation of the effectiveness of AAMRS's.

EMMANUEL MESEL, M.D., is the Director of the Clinical Information Systems Group at the University of Alabama in Birmingham. He is an Associate Professor of Information Science and Pediatrics at the Medical Center. His main interests are in those aspects of health services research concerned with the design and implementation and evaluation of information systems for clinical medicine. His current work concerns the development of the disease-specific minimum-data sets for quality of care in an ambulatory care setting, at the Western Health Center in Birmingham. His previous work has been in the design of automatic data analysis systems for a cardiac catherization laboratory, hospital pharmacy automation, and a state-wide Medicaid information system. During this study he concentrated his effort on the health care systems, the effect and the methodology of the AAMRS in the delivery and utilization of health care, and the evaluation required to test the attainment of the objectives.

DIANE RAMSEY-KLEE, Ph.D., is a private consultant in Malibu, California. Her work has involved the development of psychiatric case systems for the United States Navy, at the Reiss-Davis Child Study Center, and at UCLA. Prior to this work she held a number of research appointments in the area of psychology and data analysis. During this study she concentrated on the attitudinal analyses and the development of the economic evaluation protocol.

JONATHAN RODNICK, M.D., is a physician at the Sonoma County Family Practice Center. Part of his training was at the University of Vermont, Burlington, with Dr. Weed, the developer of the problem-oriented medical record. For this study Dr. Rodnick reviewed the medical services provided by the AAMRS's.

GIO WIEDERHOLD, the project manager for this study, is a Ph.D. candidate in the Graduate Program in Medical Information Science at the University of California, San Francisco. Before coming to San Francisco, he managed the design and implementation of medical research support systems at Stanford University, where he is also a Lecturer in the Computer

Science Department. He is preparing the manuscript for a book, to be published by McGraw-Hill, in the area of data base design. Previous activities include the design and management of information retrieval systems and data-processing applications. He directed his efforts toward the technical and data-processing aspects of the management, development, and operation of the AAMRS's reviewed

Dr. Joseph C. Barbaccia of the University of California, San Francisco, helped with the initial selection of the sites; and Dr. Mary Lee Ingbar, then at the Health Policy Program at the University of California, San Francisco, assisted with the definition of data for economic analysis. Gerald . Miller, working with the County of Sonoma, helped with the technical analysis of the Los Angeles System; and Joan Zimmerman, of the University of Missouri, assisted with the listing of MUMPS sites. Voy Wiederhold spent many days tracking down information from various sites and making arrangements for the trips to the sites visited. She also edited reports from the individual sites visited. The production of this report was accomplished by Philomenia Elias, Janice Riedell, Marily Matuna, Susan Yonkers, Tina Walters, Voy Wiederhold, and Martha Zents in San Francisco, and by Shirley Young in Birmingham, Alabama.

D. ACKNOWLEDGEMENT

We wish to thank the National Center for Health Services Research for providing support for this study. Our project officer, Mr. William Anthony, was available and helpful whenever problems arose during this study. Many other members of the Health Care Technology Division of the Center also contributed references and information.

We also wish to thank the staffs at the sites visited, who contributed their insight, their time, and the use of their facilities to show us their approach to the ambulatory medical record problems. The names of the principals of the sites visited can be found in Table 3E1, but at every site many more individuals helped us with the data collection process.

We also thank the many contributors who informed us by letter, telephone, or personally of their work or directed us to other efforts related to the AAMRS area.

CHAPTER 3

METHODS AND PROCEDURES

A OVERVIEW

In this chapter we will outline the methodology followed in order to produce this report and specify in detail the data acquisition procedures used. The final section of this chapter will introduce the individual site visit reports attached as Appendix E to this report. The entire study was broken down into 13 tasks. These tasks included the development of the protocol methodology, the development of interview guides for the site visits, a literature review to bring us up to date on current efforts, the production of a compedium of sites of activity in the ambulatory automated medical records area, the actual visits to the sites including the collection of preparatory material, the interviews at the site, the collection of material from the sites, and the production of individual reports from the sites and finally, the collection of significant findings into this report.

B COLLECTION AND SELECTION OF SITES

Through references from our colleagues and through the literature review, we made an exhaustive list of sites of AAMRS activity. Announcements were placed in a number of journals to invite contributions from sites of AAMRS activity. More than 200 sites were reviewed and about 175 of them are listed in the comprehensive site list, Appendix A of this report. The sites were coded according to four cirteria in this appendix:

Status
Outpatient usage of the system
Medical content of the automated record
Population served

We have also attampted to indicate supplier-user relationships. Codes referred to below are defined in the introduction to Appendix A.

Many of these sites were contacted directly by letter or by telephone in order to ascertain their current status and their suitability for a visit by out team. Criteria for selecting potential sites were developed in order to provide relevance and balance to our study. The principal selection criteria were:

1. No inactive sites were to be visited. This is indicated by code 7 or 8 in the Comprehensive Site List Report.

2. The site had to be mainly active in the ambulatory care area. The list in Appendix A provides a gross estimate of the ratio of outpatient visits to inpatient activity which is part of the system.

3. No sites which had not achieved some degree of production status were to be visited. This meant deletion of sites with status codes 1, 2, or 3.

4. The medical content of the record should be high. We did not wish to review sites where the data is primarily administrative or financial. This was difficult to discern in some cases where the documentation was based on expectations or extrapolation rather than on achieved status. Intention was to eliminate sites where the medical content codes are only O, I, F, or V.

5. We could not visit sites outside of the United States.

From the sites remaining, approximately 30, a further selection was made to provide a representative set of:

A. Ambulatory Care settings, and

B. Systems Support services.

The table following illustrates this classification scheme:

Settings were classified as:

Health Plans, HMO's, Foundations
Hospitals or medical school outpatient services
Corporate or governmental health care systems
Insurance Funds
Clinics and group practices
Neighborhood Services, Ethnic group services
Military

System Support Services were classified as:

MUMPS based systems
Other minicomputer based systems
Systems using commercial timesharing services
Large centralized computing systems

Table 3B1 Classification of Settings and Services

The list of sites to be visited changed throughout our project. Some sites which we had planned to visit discontinued operations or did not yet provide the type of services we were interested in within our time frame. Some sites were added late in the project due to slowness of correspondence between the sites and us.

Appendix B summarizes the principal attributes of the sites visited. We did succeed in the end in visiting at least one site in each category. Several of the sites visited provide an environment which subsumes more than one of these categories. An equal balance was achieved in the selection of computer systems providing these services. The number of sites, however, is not sufficiently large to allow valid statistical conclusions to be drawn based upon the data from the sites gathered. Not only were the sites not selected randomly, but what is more signifi-can, only the best examples of the settings and the technology which we could identify were visited subject ot the constraints listed above.

Due to the selection rules followed, much of the content of this report should not be seen as a comparison between sites, but rather as a description of achievements of projects in actual patient-related health care systems. We expect that the comprehensive site list will be valuable in its own right. Many of the sites, while failing our criteria for a visit, bear watching if one is interested in developments in automated ambulatory care.

C MODEL FOR INQUIRY

A large number of models can be valid for an inquiry of this type. For a study of any single specific site, a model that reflects the state of all the modules of the operation, with all their feedback loops, is in general the most appropriate. In this contract we were faced with visiting a broad spectrum of sites, each of which represents a different system design. Each of these sites has different objectives, uses different methodology to achieve these objectives, and is at a different point in its development cycle.

To minimize problems due to this heterogeneity we have chosen a model for the development of the inquiry protocol that follows an idealized development cycle. This is intended to provide a structure which will not have to be interrupted at various points during the actual interviews due to not yet achieved goals. It is hoped that this model will provide insights that are greater than could be provided by a pure mechanical checklist of the features of the system studied. A reader of a report prepared in this manner will obtain an understanding of the objectives and other preconditions in the site before reading about the details of the operation and the achieved results. The developmental model as perceived by us is sketched in the accompanying figure. Thirteen areas of concern are recognized in this model.

1. Societal Objectives

2. Provider Objectives

3. Definition of Services

4. Enumeration of Tasks to Carry out these Services

5. Process Requirements in Terms of

    A. Data

    B. Computational and Communication Requirements

6. Medical or Health Care Interface

7. The Integration of the Functions Provided Into the Overall Health Care Delivery System.

8. The Distribution of Information Obtained from the System

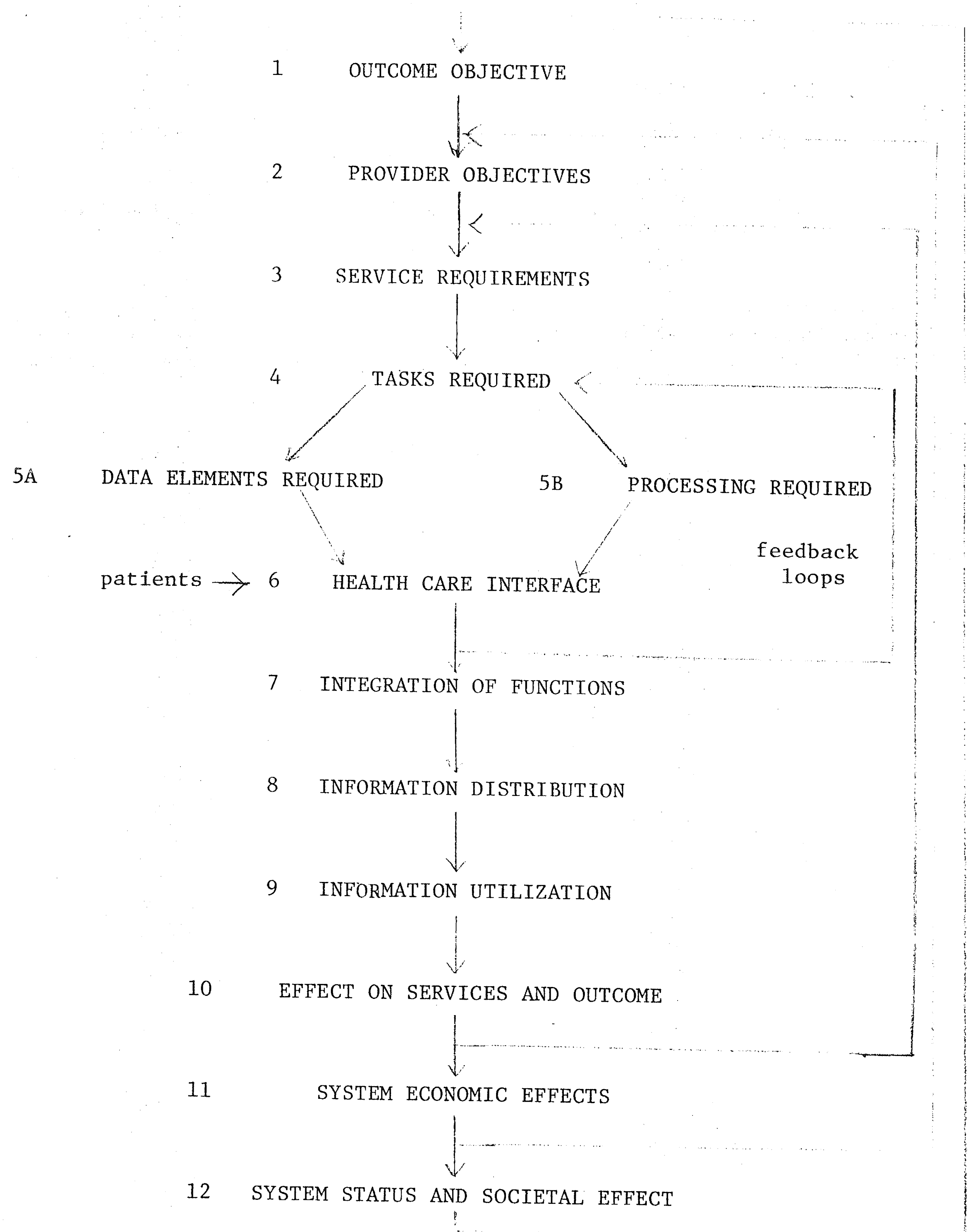
9. The Use and Utility of the Information Provided

10. The Evaluation Provided at the Sites which Completes the System Feedback Loop as Perceived by the Users.

11. An Economic Analysis Provides a Summary View taking all the Measurable Effects of the AAMRS into Account.

12. The Evaluation by our Group of the Features of this Site Completes the Prootcol.

The remainder of this section expands the issues raised in these 12 areas. Section 3D will describe the actual interview guides used for the data collection, and Section 4E describes the interview procedures.



INFORMATION SYSTEM DEVELOPMENT PROTOCOL

Figure 3.1

1. Societal Objectives

The end objectives of improvement in health care delivery have frequently (SAN73) been categorized into three areas:

The quality of health care

The accessibility of health care

The cost effectiveness of health care.

These are valid criteria, and efforts to improve health care are best measured in these terms by the outcome of the projects being considered. Outcome measurements provide indicators of health status, on a before and after basis,or on a treatment and control population. Unfortunately, outcome is extremely difficult to measure in practice, and has been attempted in only a few instances (DAL71, LEA71). Desirable quantities to be measured are related to mortality, morbidity, and the quality of life.

2. Provider Objectives

A provider of health care, in order to develop a charter for his enterprise, will establish some goals. Goals simply may consist of a desire for growth, or they may be related to health care objectives as perceived by a provider. In general there will be a mixture of the two types of goals. The health care field is so complex that the idea of a purely commercial enterprise to carry out the objectives is as far-fetched as is the idea of a wholly idealistic individual.

The provider now may be evaluated by the relevancy of his goals to the societal objectives. Frequently the goals are not stated in terms of a desired objective, but rather in terms of a desired process, which implicitly will lead to some goal. Typical goal statements by providers are the following:

- efficient and effective delivery of health care in a personal and dignified manner (VAL73)
- provide health maintenance and continuity of care (BAR71)
- improved use of personnel resources (BAR69, BAR74)

3. Definition of Services

As soon as objectives are perceived, the inventive provider will hypothesize that new or improved services will be a means to achieve the objective. The distinction between a goal objective and the intention to provide a service frequently requires clarification. When a service is defined, its relation and its effect on the objective provide the criterium for its evaluation.

The adequacy of the service per sé is by itself an objective of system evaluation. In a strongly process-oriented environment, as typically found in active health care delivery organizations, the societal and medical objectives may be so implicit that they are never verbalized, so that the provision of service is perceived as if it were an objective. Statements as such:

- Fast processing of physician orders (BRO71, KOZ73)
- Better management information (BAR71, DAV73) are encountered here.

When services are distinguished from objectives, then services may be specified more definitely:

- Automated interpretation of the EKG (SIM74)
- Maintenance of an easily accessible medical record (GRO73).

4. Enumeration of Tasks

An information service, once defined, can be decomposed into a number of tasks to be carried out. The goal of a system designer is the modularization of a service into manageable tasks. This process is not easily monitored by an external study team. While projects are still in the planning stage, an analysis of whether all tasks required for a service have been considered and are feasible, can be helpful, and will provide an estimate of the magnitude of the cost of the service development.

Typical tasks for a medical record service are the following:

- Determine a patients unit number
- Abstract the medical record for an office visit
- Enter new encounter data
- Obtain verification of input

5. Process Requirements

As soon as the tasks are defined, specific processing requirements can be established. There are two aspects to data processing, as the term implies:

- Data as needed to provide the basis for the information generating processes.

- Computational and communication facilities to carry out the processing of the data.

We have separated these two aspects of data processing into two distinct sections 5A and 5B.

5A Data Elements Required

Any automated system will have data requirements, but AAMRS's are unique in the variety of specialized functions necessary for medical practice, and health care management, which causes a wide diversity of data elements encountered in various settings.

What data is absolutely necessary to all AAMRS? Work supported by the Public Health Service (MUR72, PHS74) has defined a specific minimum data base, but has left open how much data is necessary to fulfill specific medical care functions. It may be necessary to provide an opportunity for wide ranges of individual options in the medical setting.

A number of options are available for recording and entry of various data elements, and the cost of entry, and secondarily storage, plays an important part in the selection of data elements for an AAMRS.

For some administrative and management data the value of a data element can easily be established because the use of energy element is understood. This is less true with medical data and practice or audit oriented data elements.

5B Processing Required

The volume of services provided, the quantity of data to be processed, and the complexity of the processing algorithms define the computational load on a system. Here a thorough analysis prior to development is difficult, and frequently avoided. Where similar systems are operating, base measurements may be available, but extrapolations to increased load requirements require care, because certain utilization parameters will grow logarithmically, others, linearly, and many exponentially, with increasing demand.

The level and the slope of system cost parameters must be identified to judge the cost in hardware for the processing and storage load, both initially and with growth of the system.

An important aspect of processing is the reliability of service. Since development of most sites of AAMRS is ongoing, it is important to have the ability to update processing systems with minimal impact on the users. Frequent accommodation to technological advances will also decrease stability and regularity of services. An adequate understanding and control of the factors that contribute ot that hinder effective system operations is important.

6. The Health Care System Interface

The point where both the major benefits for an ambulatory health care automation project should be realized and where the major problems and difficulties arise is at the interface between the health care seeking public and the health care system. This point of contact between the providers and the patients is where the information services using the data should assist the providers in their task. It is also the point where the data are collected required for the medical feedback loop; and hence it is the point where both costs and frustrations with the system tend to be maximal.

Questions to be asked here concern both the appropriateness of the information delivered, the appropriateness of the data elements collected and the method of collection.

7. Integration of Functions

The tasks which are part of the information system have to appear to the user as a well-functioning, integrated service. Questions to be asked here include:

Is the service complete?
Can it be used in all instances?
Is the patient identification consistent?
Is there any opportunity to collect or produce conflicting statements?
Do the back-up procedures mirror the regular processes?

To understand an operational AAMRS in this manner may be very difficult, since the extent of a computer health care delivery system is difficult to perceive without extremely thorough studies (PET72).

8. Information Distribution

Even when the services to the health care provider are adequate, there are often other areas which require the same information.

How is the information transmitted in those cases?
Is the information adequate; does it contain superfluous material?
Is it appropriate to the receiver?
Are there cases where reasonable privacy requirements are violated?

It is difficult to justify a computer system in medicine for a single purpose, so that barriers to broader use have to be investigated.

9. Information Utilization

The most convincing aspect of the usefulness of information systems is their regular use as part of the day-to-day business of an organization: "The proof of pudding is in the eating." We have to look here not at the work of data collection and system operation but at the involvement of the end-users. Are they aware of its existence? Is its operation vital to their needs? What happens if it does not work for a few minutes, or a few days? Are the users of the information those individuals which were identified in the system design?

When users begin to rely on the data produced, then the reliability becomes of increased importance. The extent of back-up and isolation that the users have found desirable is also of interest here.

The fact that a system is being used is not the final aspect of the system development cycle. The feedback loop has to be closed through the provision of a sensing device which can measure process and outcome of the service, and provide data to the objective setting and service provision machanism.

10. Effects of the System

"The power of information is its ability to effect changes."

If a system has been in existence for a sufficiently long period, then it is proper to attempt to identify how health care delivery has been changed due to its existence:

Are patients receiving better care?
Is the care more comprehensive or more responsive to need?
Is the care easier to obtain?
Are the delays reduced between onset of need and receipt of service?
Is eligibility to receive care verified faster?
Are alternatives available for those not eligible?
Is the cost of the health care delivery system less?
Has the tendency toward increasing cost been controlled?

In developing a model for inquiry into the effects of an AAMRS, it is also necessary to consider the differences in the perspectives of the recipient and the provider of care, the professional and administrative directors of a clinic, and those of a program planner. Daniel Howland (HOW70) draws an interesting parallel between the functional levels of a health system and that of the military establishment which clarifies these differences in perspective and which provides another basis for assessing system effects.

At the lowest or tactical level the decision maker (clinician) functions in "real time" and must rely on resources, including patient records, which are immediately available to treat the individual patient. The process and outcomes of care both diagnostic and therapeutic, are described in patient-specific terms, e.g., observations diagnostic services, treatments, diagnoses, etc.. At the middle or operational level the clinic director works with aggregations of information derived from individual patients and in a remote time frame. Planning at this level may be based on statistical information, but the source data are generated at the lowest level. Optimal choices for groups of patients, e.g., selection of an appointment algorithm which maximizes provider productivity may seem less than optimal to the individual patient (who must wait a long time to see a physician). At the top or strategic level the time frame of the patient encounter is even less significant to the decision maker and choices are based on population statistics. The program planner at this level must assess trends in demand and the level of community resources which will be allocated to health systems. What is common to each level is that the source data comes from the patient-clinician encounter. The ability to ascertain achievement of patient-specific health care objectives results in adaptive action at all levels of functions.

The extent of an evaluation mechanism at the provider site is a measure of the completeness of the cybernetic system.

11. Economic Analysis

The model for the economic analysis of the AAMRS sites is based on the traditional model for a cost-benefit analysis. A cost-benefit analysis is a systematic identification, measurement, and valuation of all costs and benefits over time associated with a project that is designed of achieve specific goals. A detailed description of the rationale and approach to the economic analysis is included as Appendix C.

In the development of the model for the economic analysis, it was recognized that the nature of the data gathering process would severely limit the ability to make a detailed study of the costs and benefits associated with each AAMRS visited. We had to expect that even though some cost data would be obtained, such data would be limited in detail and in scope. Benefit data was expected to consist primarily of subjective assessments of system performance and effectiveness. Accordingly it was decided to limit the time horizon of the cost-benefit analysis to a view of the initial development effort and current operations. Current operations were defined to include routine services and ongoing development. It was considered infeasible for this study to attempt to project the analysis into the future, which would require the solution of difficult problems such as the valuation of potential outcome benefits associated with the effect of an AAMRS on the quality of care.

As indicated above the economic analysis is not a separate activity in the review of the AAMRS, but it is a summary view taking into account every component of the model for inquiry. Accordingly the design for the collection of economic data was directly related to other data being collected. This was accomplished through the use of the same basic classification scheme for collecting data on objectives, evaluation, and benefits. In addition, the collection of organizational, funding and cost data was mapped on to the overall model. It was considered necessary and desireable to have some duplication in some of the data to be collected among the various protocols. This would assume the collection of as complete a set of data as possible, and includes additional organizational information to provide sufficient background information to place the economic information in proper perspective.

12. Evaluation

Previous sections have dealt with operational measures for estimating internal system performance. In this section we will address ourselves to utilization measures for assessing the external effects of the information system on the patient, the clinician, the administrator and planner, and on society at large. In the recent past evaluation has centered primarily on process or performance measures in providing health services. Increasingly, evaluation of the quality of health services is focusing simultaneously on both the process and outcomes of care. This is essential because introduction of technological innovations which improve the process of care do not necessarily have a demonstrable impact on end results.

In evaluating the effects of the system normative standards for process and outcomes of care must exist and measures of effectiveness must be agreed upon at each of the functional levels described above. We have attempted to reduce the difficulties in meeting these specifications by dissecting the stated goals of the system developers from those of the system users. A major difficulty was anticipated because detailed system planning and implementation documentation either does not exist or is not available to the review team. However, identification of "top-down" or bottom -up" strategies for design and implementation of information systems allowed us to modify the evaluation criteria in a site-specific fashion.

At the tactical level the most expressive criteria of system effects on the provider are cybernetic (FLA70). How well does the system support the sequential processes of (1) observation and sensing of achievement of desired states, (2) interpretation or analysis of sampled output, and (3) adaptive actions to maintain specified norms or to reach stated objectives. An automated information system seeks to provide the information handling and communications activity of each of the above functions. The hypothesis which is being tested is that an improvement in communication may markedly influence one or more of these functions for the better. Improvement may occur because adequate and appropriate information is conveyed, because information is conveyed in time, because errors in communication are reduced, or because information is collected and stored in a form to permit relevant analyses. Relevant criteria are completeness, timeliness, reliability, and operability. All three of the technical, economic, and human factors have to be accounted for in evaluating system effects. A system may fail because it is unreliable (excessive "down time") or because users avoid, circumvent, or sabotage it. The effects on patient care can easily be confounded. If the system has made no impact on the quality of care, it is important to look for the cause in the appropriate place.

D INTERVIEW GUIDES

Overview:

As discussed in Section C of this Chapter, we used a model of sequential system development to classify the information from the sites. In order to match the expertise in our site visiting groups to these areas, four interview guides were developed. One interview guide was intended for all members of the visiting group and inquires into the objectives and service requirements as well as into the health care interface and the utilization of the information. A second interview guide concentrates on the contents of the medical record. The third interview guide concentrates on the technical aspects of the system including the system tasks and the processing provided, as well as into the organization of the computer service facility. The fourth interview guide provides the data for the economic evaluation. In addition, a questionaire was developed to inquire into the user's attitudes regarding the AAMRS. The four interview guides were used by the members of our group during the site visits and a copy of them was left at the site visited when the visits were completed. We did not consider it advisable to mail the interview guides beforehand,to avoid establishing an excessive conceptual model, which would tend to pattern the answers into a form that could best satisfy our goals and our views of the medical record problem. The four interview guides and the questionaire used were:

1) Descriptions of Objectives,Service Requirements,and Effects (DDSR)

2) Content of the Automated Medical Record (IPCAMR)

3) Technical and Operational Description of the Automated Medical Records System (PTOE)

4) Economic Data Collection (PEAI)

5) Structured Appraisal of the Performance of the AAMRS (PEAA)

Copies of the interview guides and the questionaire in their final form are attached in Volume 2 as Appendix D and should be referred to if this section is analyzed. They are identified by the project file letters given in parenthesis after their title.

There is a great deal of redundency in the interview guides. Some of this redundency is mandated by the structure of the interview model. Objectives expressed by the founders of a system, for instance, will often overlap with the providers objectives. The more specific objectives are generally placed in the latter section of the site reports. Technical investment costs are often closely related or be considered identical to system investment cost. System response time figures may be identical when seen by the provider or by the system designer; sometimes, they may be considerably different since a system designer will consider mainly the technical responsiveness of the computer whereas for the user, the system responsiveness includes the time required to enter the request for the information and the time taken to get all of the information in front of him in a usable form.

The existence of the redundancy in the data collection has helped us in cross-checking for errors of fact and has made us aware of differences in perception and attitudes towards the systems. At times we have had to make an arbitrary classification judgement whether to place a response volunteered at a site in, let's say, the technical versus the medical area.

Description of Interview Guide for Objectives (DDSR):

Founder Objectives (DDSR Section 1)

The goals of the innovator of the system, even when not always explicitly verbalized or articulated provide an important background element, if one wishes to understand the design and the users evaluation of the achievement of the systems described.

In addition to the traditional objectives of

quality,

access, and

cost

we have added a category of management objectives. In many sites no scope for improvement in any of the three primary objective areas listed above exists, until health care delivery can be managed well enough to allow implementation and delivery of system improvements.

We have tried to discount purely technical and commercial objectives. We do find that in nearly every case there is a desire to improve medical care. Better investment opportunities are probably available for business ventures which do not have this concern. The reference data collected in this section provides further background material which is relevant to the system design. Health care delivery in the United States is fragmented to the extent that few institutions can say truly that they are serving the general population or a representative slice of all social strata.

The service environment and the service level to be provided also impact on the design of the systems. The quality of the health care delivered in the institutions visited and to comparable populations outside of these institutions is of necessity a very subjective judgement. Some of us thought that it was important to put the judgement, as subjective it is, on paper since such a judgement is always an implied, but rarely articulated factor in an evaluation of a health care delivery system. Most frequently the judgement is based on the reader's prior knowledge and his model of the health care delivery system. Occasionally, in fact, responses to this question have been suprising. More objective measurements of the health care quality at these institutions cannot be determined during the short time available for the study at the site.

Providers Objectives (DDSR Section 2)

Here we tried to determine what the objectives are at the working level of health care delivery. What is the providers view of what automation can do for him? The degree to which these objectives match the innovator's objectives depend much on the degree of communication between the two parties. Of course, in some instances, the innovator and the provider are one and the same and we can expect a close match between the objectives. In other cases, we have found a gap which is very wide and expectations at the provider level which were not intended to be met by the system designer. In some instances, we have had opportunities to discuss the system with more than one provider, in which case we have tried to merge the data when there is communality, and identify those objectives which are different between the providers. Provider objectives, of course, will also depend greatly on the institutional setting of the provider so that some data relating to this area is collected in the reference information section of this area. The quantitative elements here provide an important basis for the technical evaluation.

The Services Provided (DDSR Section 3)

Here we come to the actual design and implementation of the system. It becomes now impossible to distinguish the intentions and the objectives of the system from the actual implementation. In this section, the attempt is to follow the data flow as viewed by the system user and to list, in general terms, the operational outputs that the provider uses. There may be capabilities and outputs available which are not known or not used, and hence are not considered relevant at this point. Such unused capabilities will be described in the technical interview guide.

The first portion of this section is used to describe the handling of the data entry and overlaps some of the information on the patient encounter in Section 6. The term "as is" in the handling of the entry documents is used to denote the absence of further editing or coding of the data received.

The second portion concerns itself with the use of the data collected into the system, both for individual care as well as for institutional purposes.

The Format of the Medical Record (DDSR Section 6)

This section is designed to establish the actual interface between the physician or other providers, and physician's assistant, nurse, psychiatric or social worker, etc. The format of the medical record was of special interest. Our protocol in this area aimed at an overview of the role of the record in the practice. The record available to the provider can range between extremes of a complete traditional record, to a completely computerized record. Information available to the provider might include: Initial data base, abstract of medical history, and a problem list. Location of the progress record, as well as its availability, was of importance ot us.

The devices and their use at the provider interface are another measure of the AAMRS. The structure and content of the forms used to collect data, where applicable, provides much information regarding the systems approach and comprehensiveness. We have tried in this section to include some typical system output and input forms so that the interface becomes easier to visualize. Since the provider's dependence on the medical record can be a function of the continuity of the patient-provider pair and depends greatly on the institutional setting. Questions relevant to this area are included in this section.

It should be noted that copies of the forms which are presented were reduced in size by 18 to 24%; and since these are copies, the legibility will differ from the quality provided in the originals. At some sites color was a significant factor in the forms design, and we were not able to replicate this aspect in the report.

Information Utilization (DDSR Section 9)

This section is intended to recapitulate the outputs provided by the system and how they are being used. We attempt to note here which outputs are a major benefit of the system and which are mainly a system fall-out, beneficial but not adequate to justify the existence of the system. More critically, we also inquire who depends on the automated system, since even though information may be useful and beneficial, many aspects of medical care can acquire information needed for their function via other means. Related to this aspect is the question of the effect of system unavailability. The answer is, of course, highly affected by the extent to which paper backup records are available. Responsiveness to change should be an important attribute of information systems, and this is why we attempt to inquire from the provider the speed and degree to which changes in the system, which were found necessary or desirable, are being implemented.

Evaluation of the Effects of the Ambulatory Medical Record System on Services and Output (DDSR Section 10)

In this section, we are trying to collect both subjective impressions by the providers of the efficacy of the system, as well as provide indications of some of the evaluation methods which have been applied to test the effect of the system on health care processes and outcome. From a review of the literature, it is obvious that statistically satisfying measures of health care outcome are extremely difficult to obtain. We have attempted to provide also the opportunity for a subjective value judgement in the data collection. We also noted the type of reader would be liable to be interested in the developments and results obtained at this site.

Comments (DDSR Section 12)

This area provides for the visitors to add their evaluation and view of the system.

The most difficult subject to assess is, of course, the effect of the AAMRS system on the quality and access to health care. It is for us impossible within the short time of a visit to provide adequate answers in this area. The most we can do is add some comments which indicate the areas in which we feel that a system has not yet proven itself or which list the areas in which the system seems to be providing adequately the services set by the system objectives. These comments were used to provide input to the scaled estimation of system benefits in the economic analysis of the AAMRS's. This transfer was achieved by a structured interview of the team members after the site visit.

Medical Records (IPCAMR Section 5A):

This interview guide was established for the purpose of identifying the content of the medical record and aimed at a wide range of information which no single site was expected to achieve. The main body of this interview guide follows the physician-patient encounter format for a practice patterned according to the tenets of the problem oriented medical record. The initial section, however, is intended to determine how large the record is, either in terms of memory size required or in terms of parameters collected. Other sections outside of the primary medical concern is the inquiry into the patient identification and the collection of financial and economic information for a patient.

The medical section begins with the establishment of the data base as seen in the every-day practice of ambulatory care. We were interested in every subsection in some general questions, such as: Who collects the data, who records the data, who enters it, is the data entered at each visit, or only at specific visit types, and finally whether and to what extent is the data recorded in a problem oriented fashion. The history of the present illness, the past medical history, the social history, the review of systems, the physical examination , and the objective findings of the past medical history are collected. This is followed by the problem list which might be used to index the findings of the various areas. Plans, specifically diagnostic orders and therapeutic orders, comprise the next two sub-sections. Follow-up data and progress notes complete the problem oriented section of the interview guide. Three other areas are inquired into by this interview process which may be of concern to a practicing physician: patient services management, practive information, and the extent of research oriented data collection.

Description of the Interview Guide for Technical and Operational Evaluation:

Tasks Required (PTOE Section 4)

An important system element, both in terms of the human interaction required and the computer resources involved, is the data entry process. This is the initial task inquired into by the technical interview guide. The verification of data entry as well as the facilities for correcting errors have many technical choices. The reliability problems as perceived from the technical side may be different from the reliability problems looked at from the user point of view in the objective and services interview guide and hence are also inquired into here.

Data storage and updating is another important aspect of medical records. The files required to keep information on an outpatient

We have attempted to present the quantification of file storage in terms of characters. A character can be defined in elementary terms as being respresented by six, seven, or eight bits, each combination representing one character symbol. Sometimes storage is specified in terms of words,the units of manipulation for computers. In most computers, words have a fixed number of characters: two, three, four, five, or even six; so that computer word sizes can vary from 12 to 48 bits. The standardization of the data to character-based quantities has the effect that the same storage device on a different computer can be found to have a slightly different capacity: a computer system which represents characters in six bit units will be able to store more characters than a computer using eight bit units. We consider these differences relatively minor, due to the fact that when smaller character sets are used, i.e., six bits representing a maximum of 64 characters, then frequently special marking or case shifting characters have to be introduced in order to delimit terms or provide formatted printouts. It should be noted that only the seven and eight-bit character sets include the lower case characters.

Another factor which effects storage capacity is the data organization on disks and tapes. If data is maintained in relatively small blocks then the aggregate capacity of storage devices is apt to be less, since some space will be wasted for interblock gaps. Trade-offs between fixed and variable length data organizations can also have a major impact on the effectiveness of data storage devices. These trade-offs are always compromises. The most dense storage algorithms will generally be relatively costly when data has to be retrieved for analysis purposes, and vice versa.

In order to provide the required services, data analysis procedures have to be available. Some of them will deal with individual records, some will deal with selection of groups of patients as subsets from the entire data base, based on criteria of problems or services provided. Appointment scheduling is another selection aspect. Data analysis may require tabulation to generate reports or statistical summaries of all patients or groups of patients. Data may be used for provider scheduling to support a more effective operation of the health care delivery service. Financial management and billing procedures are of primary importance in many environments. The investment required to provide good data analysis procedures is major. We inquire hence also into who wrote the routines and where they are kept and how well can they be shared.

The protection of privacy of data is a major societal concern and requires care in the technical operation of the system. Training, so that both medical and clerical users can use the system effectively, is another area inquired into. The devices with which the computer presents the results are also an important aspect of the service quality provided. More detail of these devices is given in the actual hardware description section which follows.

Processing Required (PTOE Section 5B)

This section of the protocol describes the processing required in terms of the hardware facilities. How the hardware is obtained, what it costs and how well it functions are important aspects. The detailed specification of storage devices and terminals, as well as the designer goals in terms of system responsiveness, provide basic measures for further system development. Since the cost-performance ratio is constantly changing, the equipment investment costs may well be different to-day from the figures quoted.

Many technical choices exist in the operating systems area. To make this section of the report useful to non-technical readers, many of the terms used in this section are included in the glossary. The performance obtained through the system in terms of reliability and response rate is the most important parameter of a system design.

The size of the data processing staff required for system development and maintenance is often the predominant cost factor in ambulatory medical record systems. A high degree of responsiveness to changes is important in the developmental stages of medical record systems. This question refers to the technical aspect of the programming response time. It is obvious that in a practical environment the decision making and the scheduling can take considerably longer. Systems which are intended for distribution require more generalization and more documentation efforts, as well as overall capability and flexibility than systems dedicated to one institution. The degree to which distribution has been achieved or had been intended should corelate with these factors.

Integration of Functions (PTOE Section 7)

This section of the interview guide attempts to place the automated medical record system into the overall health care delivery system picture. Proper integration of functions is critical to success of the automated medical record in any realistic clinical setting. The administrative, the financial and the traditional medical records interfaces provide choices of operational integration for automated systems. The relative place of the automated record and traditional paper record was to be evaluated, as well as any inputs into the automated system other than from clinic encounters. If this system interacts with other automated systems, important benefits may be achieved. This also involves the management of the technological effort, the source of the financial resources, and the determination of priorities for the systems.

Information Distribution (PTOE Section 8)

The last section in the technical interview protocol is oriented towards the distribution of the information which is not used only for individual health care,but which is used in the administrative and clinical management of the facility. We also inquire into the existence of data which are derived from the system and used for research purposes. These aspects may provide a major contribution to the operational benefits obtained from an automated ambulatory medical record system.

Description of Interview Guide for the Economic Information:

The background for this guide is exhaustively described in Appendix C - Economic Evaluation Methodology.

During the first set of site visits, it was soon learned that some parts of the interview guide could not be completed as originally intended and that some parts could not be completed at all. In some cases, the site had not gathered sufficient data for the visit and time constraints prevented the location or development of the data during the visit. Time and accessibility to appropriate personnel was a major factor effecting the ability to fully cover in detail every component of the interview guide.

A major consequence of the limits to the data gathering process was that the original scheme for measuring and valuing intangible benefits had to be dropped (see Section 5E Appendix C, PEAM). A new scoring scheme was developed which consists of the assignment of a score, ranging from -1 to a +3, to be assigned to each intangible benefit based on information obtained from the interview. The criteria for this scoring scheme is presented on the following page.

Provider Intangible Benefits: (Scored on Basis of Interviews - Site should offer their own score as well.)

- \- negative benefit - no measure of magnitude.
- 0 no benefit or not applicable, not considered an objective of the System.
- \+ Some - but more as an indirect or derived benefit. Probably identified through interview process rather than readily visable prior to the interview.
- ++ More than some. Readily visable to user, but not considered a major justification for the system.
- +++ Major benefit and/or major justification for the system.

Societal Intangible Benefits:(Scored by Site Reviewers)

- 0 none or not applicable.
- \+ some and/or not published.
- ++ more than some and published (for training and planning categories. The "and published" need not apply if the benefit is operational and visable.
- +++ Significant impact and published.

Tangible Benefits:

Benefits in cost savings claimed but not quantified, or feasible to quantify were scored according to the same criteria as Providers Intangible Benefits.

The scores for societal intangible benefits represent a composite score of the site visit team. After each site visit, the visit team met to identify and discuss Section 1b or PEAI: Constraints affecting the attainment of provider objectives and the transferability of the AAMRS. Additionally, a concensus score was obtained for societal intangible benefits.

Relationship to Economic Methodology

The following comments will link to the availability or ability to develop the economic information during the interview; these notes refer to the Economic Interview Guide PEAI Section 2.

Section a:

The assignment of weights to provider objectives could not be completed as intended and was dropped as explained above. The procedure for Section a2 constraints affecting the attainment of Provider Objectives and Transferability is also explained above.

Section b:

In general, the organizational environment and operating data was gathered during the coverage of the objectives protocol and supplemented in subsequent interviews for the economic protocol. The information for this section was generally available. The only exception was the identification of the indirect cost rate for the institution.

Section c:

Cost analysis parts 1 (development costs), and parts 3 (operating costs) were completed from data prepared in advance by the site or through interviews with appropriate personnel. In most cases, part 2 (investment costs) could not be completed with respect to any cost detail. The interview for part B identified those elements that would be required for a new user to adopt the system under review, without making specific cost estimates. Parts 4, 5, 6, and 7 were extremely difficult to complete, given the limitations on the interview setting. In most cases, they were completely skipped over during the interview process, and filled in subsequent to the visit to the best extent possible based on recall and information obtained elsewhere. It was decided that part 8 of Section c, which requested salary data and income for health care providers would be skipped entirely and standardized National Income data (BLS74) would be used for the classes of personnel in the development of cost data. This eliminated the need to request the sensitive information from the site.

Section d:

The benefit analysis was the most difficult part of the interview guide to complete since most of the data obtained was subjective opinions of the persons being interviewed, without statistical or financial data backing their impressions. To the extent that some data was available, it was recorded or referenced in the interview guide. Even though the interview covering the tangible and int ngible benefits was difficult, it was clear that the structure of the interview guide aided the process. The major difficulty in completing this part of the guide was to identify an estimate of benefit achievement for provider intangible benefits. For most sites, this was done retrospectively by the site visitors based on information obtained during the interview.

In order to achieve consistency in the data to be recorded for every site, the cost data contained herein was developed according to the following guidelines:

1) Personnel costs - standard salaries were used for the various categories of personnel. Salary information was derived from the 1974-75 Occupational Output Handbook, published by the Bureau of Labour Statistics.

2) Equipment - all purchased equipment was amortized over five years and included in the estimate regardless of the date of acquisition. Cost of equipment purchased or rented was based on data provided by the site or upon estimates of current prevailing prices for comparible equipment.

3) Other costs were added according to the characteristics of the AAMRS; such as costs for encounter forms and data transmission. The allocation of costs between production and routine services was primarily based on information acquired in the technical prorocol.

4) Indirect costs were applied at the consistent rate of 50% of total personnel.

In consideration of the manner in which the cost data was developed, the operating costs reported herein should be considered as representative costs data ot the system reviewed, rather than an exact presentation of costs incurred by the site. The detailed breakdown of our cost estimates were submitted to each site for review and comment and changes were made based on comments received. For the purpose of this report, however, it was considered inappropriate to present the details - accordingly, only totals will be found.

Structured Appraisal of the AAMRS (PEAA):

To complement our evaluation of the operational setting at the site we used a short inquiry instrument which we intended to distribute to actual health care providers at the site to gain an impression of the system benefits and liabilities as seen from the front lines. This questionaire is discussed further in Appendix C as part of the Economic Evaluation methodology. The analysis performed is specified with the results in Section 4L and the responses are presented in Appendix F in Volume 2.

E METHOD OF INQUIRY

Pre-visit Activity:

Once a site was selected, letters were sent to the principal investigator or his equivalent explaining the nature of the project, the site visit anticipated, and the background and interest of the visitors. Frequently telephone contact was made. Each visit was scheduled to take a full day with a team made up of two-three physicians, one-two technical people, and one or two economic analysts.

Frequently the sites provided descriptive material regarding the system, which was augmented with reports from our files, and distributed amoung the study group. This allowed us to make more effective use of the time at the site.

Daily Site Sequence:

The visiting group met in general a few hours in the evening preceeding the visit to discuss assignments and the distributed material. We tried to meet with the site group by 9:30am, and succeeded most of the time.

The plan of the day was established around the previously described model for inquiry. Each site was given an opportunity to g ve an overview briefing and frequently assisted the group by distributing a packet of documents, forms, etc. In order to structure the large amounts of data to be collected, and to assure a comprehensive survey, the set of interview guides were allocated among the survey team for use during the visit. These covered each of the topics described in the Structure of Information Systems Development, as well as some others. Each of the guides is included in its entirety in Appendix D and covers the following topics:

1. Description of Objectives and Service Requirements
2. Technical and Operational Evaluation
3. Content of Automated Medical Records
4. Economic Analysis
5. Structured Appraisal of Performance

It is important to stress that each of the four interview guides was filled out by at least one and usually two of the team members.

The first guide in fact was completed by all or nearly all of the visitors since it contained the most critical material for our conceptual frame-work.

The Structured Appraisal was to be filled out by site personnel. This form was either collected prior to our departure or it could be mailed back to San Francisco. Before leaving, a set of "blank" interview guides was given to each site, but they were available only after the visit was completed in order to avoid leading responses.

Generally, most of the Objectives and Service Requirements guide could be completed during the initial session with parts being verified later in the day. The group then usually broke up into technical, medical, and economic interest parties so that optimal usage was made of site and visit team personnel, and adequate and broad coverage of viewpoints and relevant data could be accumulated.

At many sites the physician members of our group had the opportunity to interact with providers who were using the system, and occasionally they were able to be present during a patient encounter.

The technical members of the staff were generally able to interact with one of the implementors of the system and had only minor problems with data collection. In institutions where the users were not the developers, not all technical questions could be answered and separate inquiries were made later to complete the data. Cost and reliability data were often not documented in the technical area.

All of the interview guides required revisions after the initial site visits and additional data was requested by mail or telephone from some sites so that all areas could be covered equally.

Only about one hour of the visit was available for direct concentration on the economic interview guide. The persons interviewed included administrators, AAMRS users, technical staff and principal investigators. It was usually necessary to interview more than one person to cover the entire guide. In general, administrative personnel provided cost data and the AAMRS staff or users provided benefit data. Organizational data was often obtained as the objective protocols was covered. If background material for a visit was prepared in advance, some cost data was generally included. The scope of our inquiry always resulted in requests for information in addition to that provided.

Integration of the Findings:

After the visit, the findings represented on the guides were collected from the visitors and assimilated into a summary of each site. No attempt was made to make the redundant data collected in the various areas of the protocol uniform. Differences can be due to the perception by the individuals at the sites of the systems used as well as due to the attitudes of the interviewers towards the problems seen. Where we found definitions necessary in our communications we have included them in the glossary (Chapter 8)

Comments collected by the site visitors were transcribed as written into the initial version of the summary to provide a basis for further discussion and evaluation.

Copies of this initial summary were mailed both to the site visited and the site visitors, to be reviewed for accuracy and completeness. Most of the sites contributed constructively to the request for verification and completed data fields which we failed to collect during our visits. The site reports went through two or three complete cycles before verification. The number of revisions for each report and sometimes for individual pages, is noted as the site report sequence number.

Some sites were very slow in responding. While we have tried to include all the last minute comments in the individual site reports, some of the most recent material was not available in time to be integrated into all the analyses leading to the findings presented in this volume. A short summary of the findings at each of these sites is presented in Appendix B of this volume.

The table which follows lists the name and addresses of the principal contacts at the sites, the term used in this report to refer to these sites, the members of the visiting groups, the dates of the visits, and the report code used in Appendix E.

Production of the Final Report:

Data from the sites visited was tabulated, according to the area of their interest by the various members of the study group. Reports or conclusions drawn from the findings were mailed to at least one other member of the study for review, comment and expansion as needed. Where questions arose, other visitors, and occasionally the sites themselves, were contacted for more information.

Final draft copy was prepared after some joint meetings in San Francisco by Ingeborg Kuhn and the project manager, in Birmingham by Dr. Mesel, and in Malibu by Dr. Ramsey-Klee.

The final draft version of the report is due to be further reviewed by the National Center for Health Services Research. We hope that the interest expressed by many of the people contacted during this study will result in a wide dissemination of the data presented, and that most importantly, it will have a positive effect on the ongoing development of health care dělivery systems.

Table 3E1

AUTOMATED MEDICAL RECORD SYSTEMS FOR AMBULATORY CARE

SITES VISITED BY THE STUDY TEAM

Members of the various teams were:

John V. Dervin, MD, Sonoma Count Family Practice Center	D
Ron Henley, PhD, Medical Information Systems, UCSF	H
Mary Lee Ingbar, PhD, formerly Health Policy Program, UCSF	I
Michael A. Jenkin, MD, private consultant	J
Ingeborg Kuhn, Graduate School of Business, Stanford	K
Emmanuel Mesel, MD, University of Alabama at Birmingham	M
Diane Ramsey-Klee, PhD, R-K Research and System Design	R-K
Jonathan Rodnick, MD, Sonoma County Family Practice Center	R
Gio Wiederhold, Medical Information Science, UCSF	W

Site	Term and Report	Date and Visitors
Dr. James Fries Division of Immunology Stanford University Medical Center Stanford, California	Stanford (CDS)	Dec. 4, 1974 D,H,K,M,R,W
Dr. Stephen S. Leavitt Insurance Technology Corporation 2118 Milvia Street Berkeley, California	ITC (CDI)	Dec. 5, 1974 D,K,M,W
Mr. Gene Thompson County of Los Angeles Department of Health Services 313 N. Figueroa Street Los Angeles, California	LA (CDL)	Dec. 6, 1974 K,M,W
Mr. Gonzales East Los Angeles Child and Youth Clinic Los Angeles, California	East LA (CDE)	Dec. 6, 1974 D,H,R-K
Dr. Eugene Laska Rockland State Hospital Orangeburg, New York with users at: Pomona Outpatient Clinic and Connecticut Mental Health Center	Rockland (CDR)	Jan. 6, 1975 D,J,K,M,W
Dr. Shannon Brunjes Section of Medical Computer Sciences Yale University School of Medicine New Haven, Connecticut	Yale (CDY)	Jan. 7, 1975 D,J,K,M,W

(Continued on next page)

Table 3E1

- continued -

Site	Term and Report	Date and Visitors
Dr. G. Octo Barnett Harvard Community Health Plan Kenmore Square Cambridge, Massachusetts	HCHP (CDH)	Jan. 8, 1975 D,I,J,K,M,W
Mr. John Fakan Medical Data Systems Corporation 24541 Beagley Road Olmsted Falls, Ohio	Automed (CDM)	Jan. 9, 1975 D,J,K,M,W
Dr. Schneeweiss Department of Family Practice College of Medicine Medical University of South Carolina Charleston, South Carolina	MUSC (CDC)	Jan. 27, 1975 J,K,M,R,W
Dr. R. V. Penick Appalachia II District Health Dept. Greenville, South Carolina	Greenville (CDG)	Jan. 28, 1975 J,K,M,R,W
Dr. Ed. Hammond Duke University Medical Center Dept. of Community Health Services Durham, North Carolina	Duke (CDD)	Jan. 30, 1975 J,K,M,R,W
Dr. Clement J. MacDonald Regenstrief Institute Indiana University Medical Center Indianapolis, Indiana	Regenstrief (CDF)	Feb. 25, 1975 J,K,M,R,W
Dr. Galen Robbins Cardiovascular Clinic 3300 N.W. 56th Street Oklahoma City, Oklahoma	Cardiovascular (CDO)	Feb. 26, 1975 J,K,M,R,R-K,W
Dr. Carlos Vallbona & Dr. Lynn Evans Casa de Amigos Dept. of Community Medicine Baylor College of Medicine Houston, Texas	Casa (CDA)	Feb. 27, 1975 J,K,M,R,R-K,W
Dr. Alfred E. Garratt Indian Health Service Tucson, Arizona	IHS (CDT)	Feb. 28, 1975 J,K,M,R,R-K,W
Lt. Cmdr. Gay BUMED Computer Project U.S. Naval Air Station Dispensary Brunswick, Maine	NAS (CDB)	Mar. 31, 1975 D,K,M,R-K,W
Dr. Margaret Lyman Pediatric Outpatient Clinic New York, New York	Bellevue (CDN)	Apr. 1, 1975 D,K,M,R-K,W

CHAPTER 4

REVIEW OF SITES VISITED

A. INTRODUCTION

In this chapter we will describe the status of the systems which were visited, by comparing aspects of the systems in a number of functional areas. These comparisons are based upon the material collected during the site interviews. Details of the results obtained from the sites visited can be found in Volume II, Appendix E. A brief introduction and summary for each of these sites is available in this Volume in Appendix B.

The sequence of the areas to be compared follows the general outline of the model for inquiry, beginning with the objectives of the conceptual creator of the system and environmental setting; then the objectives of the provider of the medical services at the site, and background information on the Health Care Organization; then proceeding to the description of services and tasks performed by the system. Included are the actual medical record services provided at the patient/provider encounter, a comparison of the support required for these services, and a comparison of a number of background issues raised in the review of the sites. Outcome and evaluation efforts conclude this chapter.

While all seventeen sites visited differed greatly in objectives and environments, we can see that the number of alternatives in the various areas is often limited to three or four approaches. To a certain extent the small number of approaches found may reflect the selection algorithm used for the determination of the sites visited. Since we have restricted our visits to sites with operational ambulatory medical records, we have excluded sites where very recent medical technology or recent results of computer science are being put into use. The fact that common patterns are emerging does indicate a slowly-developing maturity in this field.

There still remain marked differences of opinion concerning the structure, coding, and content of medical records for delivering "good care." These differences are a consequence of the lack of maturity of the evolving discipline of Medical Information Sciences, and the almost complete lack of scientific formalism, i.e., the development of general theoretical constructs, adequate experimental controls, and randomized trials, in attempting to answer questions rather than relying on conventional wisdom or opinion. It would be extremely easy to interject the individual biases of the members of the review team in reporting the results of current efforts among the sites selected for intensive scrutiny. However, this chapter's presentation of the objective findings of our joint efforts is as free as possible from editorializing and from the "product rating" approach typical of popular consumer publications. In the individual sections, we do attempt to identify parameters which are helpful in explaining the many differences in approach to designing and implementing systems, and in explaining the present status and acceptance of AAMRS projects. To encourage readers to be their own judges of what is most appropriate for their own particular settings, we have deferred our conclusions regarding appropriateness, validity, and effectiveness until the corresponding sections of Chapter 6.

The twelve sections that follow within this chapter will present the findings as listed in the table below:

B. Objective and environmental factors
C. Services provided by the systems
D. Data collected for the automated medical record
E. Medical and management status
F. Technical status
G. Financial status
H. Technological vs. medical orientation
I. Population characteristics
J. Effects of funding
K. Transferability
L. Analysis of responses to the AAMRS attitude questionnaire
M. Evaluation methods and results

B OBJECTIVES AND ENVIRONMENTAL FACTORS

1. Outcome Objectives

In this discussion those parameters which were mentioned by half or more of the conceptual creators of the AAMRS's as being a significant objective for the sites will be reported. Significant omissions will be cited.

Principal Objectives

The intended societal outcome objective was an improvement in the quality of care for all but one of the sites (ELA). The expected increase in the quality of care was in the area of preventive and acute and chronic medicine. This was to accomplished primarily by better communication among personnel and better feedback to providers of care. An improvement in general medical knowledge was expected to be a significant result of the implementation of an AAMRS in a minority of sites.

Cost management was the goal of 8 of the AAMRS's. This was to be achieved by utilization review procedures, an increase of productivity without a change in quality, and better use of resources. Only 2 sites expected to lower the cost of delivery of health care (MUSC, Regenstrief). One site expected preventive care and efficient allocation of resources to impact significantly on cost containment (Greenville).

Access to care can be considered to have two components: the initial access to the provider and the subsequent access to facilities, such as the medical record needed to deliver adequate care. Only 6 of the 10 sites concerned with access to care expected the AAMRS to affect initial access to care. In nearly all of these, this was to be achieved by an increase in visit frequency and contact with appropriate providers. Nine sites expected secondary access to be affected through record availability, decreased delay, better availability of providers, and simplified administrative barriers.

The two most significant factors leading to the formulation of these objectives were administrative direction and a need felt by a medical researcher (12 sites). In half of these groups both factors were concurrent. Only one AAMRS was implemented in response to patient demand (LA). Two were implemented in response to public demand (Casa, IHS). Political pressure was not listed by any of the groups as a significant motive.

Thirteen of the fifteen systems are completely new. Approximately half of these are supplements to an existing manual system, whereas the others are seen as eventual replacements of a manual system.

Reference Information

Half of the systems serve the general population in an area. The other half serve populations that are special in terms of ethnic distribution (minority (8), white (4), mixed (2), social category (8), age distribution (4), diseases presented (3), and geographic distribution (3)).

Most of the service environments were urban (16). Five of these also served suburban populations. Only two served rural populations (IHS, Greenville). Two-thirds of the systems provided primary care. One-third provided secondary care; and three tertiary care.

The existing quality of health care in the institutions with an AAMRS was judged to be average or high in 14 of the 16 sites for which a rating was available. These judgements were provided mainly by the providers of care. As would be expected with implicit ratings, the academic groups rated themselves average-to-high more frequently than did the non-academic groups.

There was an even distribution among AAMRS's between medium-to-high income population groups and low income population groups.

The needs for the population served by the AAMRS's were primarily in the area of primary care (14 of 17 sites), specialty (6 of 15), and tertiary (3 of 15). Services provided matched perception of needs at all sites.

Patients visits were primarily a result of appointments in 10 of the 17 sites for more than 75% of encounters, in four additional sites the visits were a result of appointments in more than 50% of instances. In the remaining three sites patient or physician-initiated appointments were significant for less than 25% of the visits.

2. Provider Objectives

Medical Aspects

In all but one of the AAMRS projects, the providers' chief objective was to improve the delivery of health care by increasing the quality of care provided. This was to be accomplish by improved patient management, increase patient compliance with physicians orders because of greater continuity of care, institution of quality of care review procedures utilizing the data base as a source of information, and for the collection of research information.

All but two of the providers (Stanford, Yale) perceived the AAMRS as a means of improving access to care in contrast to the developers of systems. Less than half of the latter group designed the system to have an important impact on access. In the view of many of the providers, access to care was to be improved primarily by increased record availability, and secondarily by improved patient follow-up and appointment scheduling.

Most of the providers felt that the AAMRS would impact favorably on the cost of health care delivery by improved resource utilization (primary cost factors). Improved utilization and availability of health manpower was the most frequently mentioned factor which would be impacted by the AAMRS. The medical and technical categories of personnel were the target for this improvement. A minority of sites listed changes in patient services, i.e. fewer unnecessary visits, fewer redundant laboratory tests, and better referral, attributable to the AAMRS as likely to result in cost containment or reduction.

In contrast providers were nearly unanimous in stating that the AAMRS was to have a positive effect on management aspects of health care (secondary cost factors). The improvement was expected to be the result of the provision of management with information and analytical tools for utilization review procedures and budgeting and planning; for faster and more accurate processing of patients statements and insurance claims; and for reduction of operating costs resulting from increase productivity of manpower.

Reference Information

The organizations which made the decision to provide automated record services were evenly divided between single units of an institution and the entire institution. About 60% of the sites planned to expand services according to a general plan.

The institutions fell into three main categories.

1.	Clinic (hospital-based/neighborhood)	5
2.	HMO	4
3.	University Medical Center	4

The remainder were a solo general practice, an insurance company, a county health department, and a specialty group practice.

Eight of the seventeen sites were either local, state, or federal government sponsored. Six sites were private, non-profit corporations, and three were organized as private for-profit corporations.

The control over the medical content of the record system is provided by a committee of physicians and technical staff in twelve of the fifteen sites. There was an even distribution of sites with approximately one-third in each of the following categories controlling the technical operation of the system: an in-house staff, a research staff, and a vendor of computer services. The majority of the sites are under the supervision of the institution's administration.

C. SERVICES PROVIDED

Introduction:

This section will deal with the services provided by each record system visited. The primary emphasis will be on the services for the provider, most often a physician, but in several settings other health workers provided health care directly to the patients. The services to the administrator, researcher and patient are also considered. The main analysis regarding services for administration (financial and planning) will be found in Section 4E. The services provided will be broken down into the following areas:

How is the data collected:

- who collects the data
- what kind of forms are used
- what coding method is used
- how easy is entry and correction

How is the data entered:

- what is the entry device
- who enters data
- when is the data available

What is the output of the system:
for the provider such as:

- medical record entries
- flow sheets
- encounter documents
- patient profiles
- lab results
- drug orders
- free text notes

for administrative purposes such as:

- scheduling and visit reminders
- work lists
- practice and patient profiles
- utilization statistics
- program reports
- pharmacy and drug data

for financial purposes such as:

- claim processing
- third party billing
- eligibility determination
- accounts receivable reports

What are the inquiry capabilities for:

medical status
appointments
financial status

What is the format of the medical record:

computer outputs and the traditional record
what is available when the provider sees the patient

How are these information and services provided:

at what sites
for whom
who depends on the output

Data collection and entry is summarized in Table 4C1, and the services provided are summarized in Table 4C2. For those systems with medical content in their AAMRS.

Selective reporting on patient groups and statistical analysis will be covered more thoroughly in Section 4E.

Table 4C1

DATA COLLECTION AND ENTRY

Site	Collection of Medical Data Formsize/Method <values> Collector	Entry Method
Stanford	13 pages with past data, prob.spec. <numeric> MD, labtech	iTT, iCRT
ITC	2 large sheets <marks and notes> claims adj.	fCRT
LA	1 page <identification (flags)> C, MD for flags only	fCRT
ELA	Traditional record is kept.	Abs. to KP
Rockland	1 to 4 pages <selfcoding marks> MD, N, P, C	MS, KP
Yale	16 pages <selfcoding marks, notes> MD, C	KP
HCHP	2 to 6 pages+,dict. <selfcoding marks, notes> MD	iCRT
Automed	Direct to CRT, prob.spec.* <categorized free text> MD, C	fCRT
MUSC	Dictation <free text> MD, C	iCRT
Greenv.	1 to 6 pages <selfcoding marks, values, notes> MD, N, C	fCRT, KP
Duke	1 page, prob.spec.* <selfcoding marks, values> MD, P, C	fCRT
Regens.	1 to 2 page past data,prob.spec.<digits,marks,notes>MD,N,C	MS, iCRT
Cardio.	2 pages, prob.spec.* <selfcoding marks, notes> MD	iCRT
Casa	Traditional record is kept with problem list.	Abs. to KP
IHS	4 pages, prob.spec.* <marks and notes> MD, P, N	KP
NAS	Dictation and iCRT for lab <free text, values> MD, N, P	iCRT
Bellevue	1 to 6 pages+<categorized free text, values> MD, N, C	iTT

Legend for Table 4C1:

+	Form is specific to specialty clinic visited.
prob.spec.	There are problem specific encounter forms.
*	Applies only to selected users or applications.
MD	physician
N	nurse
P	paramedic
C	clerk
iCRT	interactive CRT
fCRT	fill in the blanks CRT
iTT	interactive terminal
tTT	typed entry on terminal
MS	mark sense
KP	key punch

Table 4C2

Provider Services

Site	AMR only	Patient Profile	Encounter Form Avail.	Flow Sheets	On-Line Inquiry	Special Search	Update Cycle
Stanford		-	+	+	+	+	1-
ITC		-	+	+	+	+	1-
Rockland		-	-	+	-	+	3+
Yale		+	+	+	-	+	3+
HCHP	+	+	-	+	+	+	1+
Automed	*	+	-	+	+	+	1-
MUSC		+	-	+	+	+	1+
Greenville		+	*	+	+	+	1-
Duke		*	+	-	+	+	1-
Regenstrief		+	+	+	-	+	3+
Cardiovas.	+	*	-	-	+	+	1-
Casa		+	-	-	-	+	3+
IHS	*	+	+	*	+	+	5
NAS	+	+	-	+	+	+	1+
Bellevue		+	+	-	+	+	3+

Legend:

AMR only : Only automated record available at encounter.
Patient Profile : A summary of patient status is provided.
Encounter Form Avail. : The encounter form used to collect data at the last visit is available.
Flow Sheets : Tabular presentation of visit observations.
On-Line Inquiry : On-line inquiry available in clinic.
Special Search : Special searches (on-line or batch) available.
Update Cycle : Number of days from data acquisition to file updating.

Update cycle : - less than
\+ more than

* This applies to selected users or applications only.

Data Collection:

The data is collected in a variety of ways. Several of the sites visited had more than one way to collect data. Most of the sites depended mainly on input forms. Four had developed multiple forms to enter selected data. At MUSC and NAS, providers dictate nearly all of the information which is subsequently input into the AAMRS. In approximately half the sites, the input form is kept in the traditional record and either constitutes the entire progress note or augments written information in the record.

Data could be entered on the forms by using check marks, numerical entries, or free text. At many of the sites (Rockland, Yale, HCHP, Cardiovascular, and to some extent at Stanford, Greenville, Duke, Regenstrief, and IHS), the forms were designed to be self-coding: Entry is done by marking labeled boxes with a check-mark; later a code corresponding to the box is entered into the computer. At Stanford, Greenville, Duke, Regenstrief, and IHS numeric values are put into these boxes instead of check-marks and then both the box number and the value is entered. This self-coding approach allows entry of data through selection of the relevant boxes by the provider without any further encoding by clerical personnel. When mark-sense sheets are used, then the data can be read automatically into the computer, the optical mark-sense sheet reader assigns the box number from the position of the mark on the sheet.

Some sites had one universal form (such as Stanford, Yale, or Cardiovascular); some had one for each speciality area (such as HCHP); and some had one or more for each type of service or clinic (such as Greenville). Regenstrief had a variable computer generated form, specific for each clinic and previous findings in patients record. The forms varied from one page (such as Duke) to up to 16 pages (Yale).

The following table summarizes how data were collected (many sites use more than one type).

Forms with checkmarks	10 sites
Forms with written free text	11 sites
Forms with numerical entries	5 sites
Dictation entered	5 sites
Direct entry (clerical)	4 sites
Traditional medical record keeping	2 sites

Some of the forms required that some coding be done (such as diagnosis) by the clinician or clerk. Casa de Amigos and East Los Angeles required abstraction of the traditional written encounter by clerical personnel.

In most sites (13 out of 17) a provider (MD, nurse, pharmacist, or paramedical staff) entered at least some of the data on to the forms. Six sites also had clerical personnel enter medical data on the forms. At most sites the patient identification data was entered by clerical personnel; only at Regenstrief was the data-collection form preprinted by the computer with the patient's identification, and at Bellevue the referral note had the patients name preprinted. At most of the sites with on-line operation using CRT devices (not at Stanford and Regenstrief) registration data were entered on the CRT by clerical personnel when the patient came for services; in Bellevue this was done on teletype terminals. Three sites (Automed, MUSC, NAS) had the capacity for the provider to enter data directly into the computer through the terminal. However, this feature was used only selectively; at MUSC on weekends and at NAS for laboratory orders. We did not see direct entry used by physicians at Automed.

Data Entry:

All 17 sites used clerical personnel to enter all or the majority of the data from the forms, from charts, or from dictation into the computer terminal. The predominant data entry device was a CRT-Keyboard terminal. Many sites had more than one type. The following is a summary of the devices used, noting that some sites used more than one type of entry device:

CRT Keyboard	11 sites
Keypunch	5 sites
Mark sense for optical reader	5 sites
Typewriter keyboard	2 sites
Key-to-tape	1 site

A more thorough description of entry methods and machines is provided in Section 4F.

Data Archiving:

When data is collected year in and year out, the volume of data may become intolerable for on-line storage and archiving operations to move inactive data off-line may become necessary. A majority of sites stored the data "forever" (11 out of the 17). In a number of these the systems were not in operation long enough to have built up enough data volume to be overly concerned about storage. Data archiving operations were mainly seen at the centers with long operational history and many patients. There the data are removed usually after a specified period of time since the last visit (two years for Cardiovascular) or after moving from the area (one year at the Naval Air Station). At the Cardiovascular Clinic the problems of archiving are minimized since for many data elements only the current value is kept in the AAMRS's; visit specific data are only kept selectively for patients on jypertension protocols and for some key data. At Bellevue the archiving of the collected data followed a carefully worked out algorithm specific to the type of data element. Data are kept on-line as follows:

Key data (allergy, immunizations)	permanent
Diagnoses	one year
Visit records	six months
Laboratory results	60 days

At MUSC the computer-stored record containing the past medical data is deleted after a three year period when the resident leaves the clinic. The new resident initializes a new record from a review of the past record, and from a new physical exam and history taken from the patient. The quantity of data stored varies widely; this aspect is discussed in other sections of this chapter.

Output of the System:

The output of the systems can be summarized in terms of reports that are commonly prepared as follows:

Reports	Sites
Medical	
Patient profile summarizing his medical status	11
Encounter reports (progress notes)	7
Encounter document (separate parameter for each diagnosis)	3
Flow-sheets (lab,vital signs,immunizations,medical findings)	8
Laboratory results	8
Dictation or free text progress notes	5
Administrative	
Scheduling (patients)	6
Provider work lists	10
Utilization or program reports	14
Practice, disease or treatment profiles	15
Visit reminders	2
Pharmacy labels	2
Reports to outside agencies	9
Financial	
Third party bill preparation (partial)	6
(complete)	4

An indication of the medical reports prepared is given in Table 4C3. The content of the various categories of reports can differ, so that some reports may be subsumed by others.

Table 4C3

MEDICAL OUTPUT OF AAMRS

Site	Status Report	Problem List	Medica-tions	Labora-tory	Immuni-zations	Previous Encounter	Flow Sheets
Stanford	-	-	-	-	-	+	+
ITC	-	+	+	-	-	+	+
LA	-	-	-	-	-	-	-
ELA	-	-	-	-	-	-	-
Rockland	-	+	*	-	-	+	+
Yale	+	*	-	-	-	+	+
HCHP	+	+	+	+	+	+	+
Automed	+	+	-	-	+	+	+
MUSC	+	+	+	+	+	+	+
Greenville	+	-	*	*	+	+	+
Duke	*	*	+	-	-	+	-
Regenstrief	+	-	+	-	-	+	+
Cardiovascular	*	+	+	+	-	+	-
Casa	+	+	+	+	+	+	-
IHS	+	+	+	+	+	+	+
NAS	+	+	-	-	-	+	+
Bellevue	+	+	-	+	+	+	-

* Selectively as to user or function. At Cardiovascular the patient profile is not used during regular visits, and at Duke the profile and problem list was not yet in regular use during our visit.

Patient Profile:

All of the clinical care sites (15) produce in some form a summary of the patient status. The patient profile at Greenville was still being developed and this site is excluded from the analysis in this subsection. The current summary at Greenville provides identification data and an indication of any of the other 131 clinics which might have been visited. We include in this table Stanford, where the encounter form is the flow sheet with past data; ITC, since their entire output ((CRT screens) can be considered similar to a patient profile; and Rockland which produces a patient visit summary listing for each encounter the type of service rendered. At Cardiovascular a summary is used for telephone inquiries and in emergies, but not during regular patient visits. At Duke, when we visited, the patient profile was not yet in regular use. Table 4C4 lists some of the information found on these patient profiles. Sample profiles were obtained from the remaining 14 sites and information regarding data elements present was obtained from these sources. Copies of these sample profiles produced at the sites can be found in the site reports in Appendix E. Often additional data is availablr outside of the patient profile. Table 4C4 restricts itself to data commonly seen on the profile. Where free text is presented any other areas could be noted.

Identification data was of course present on all profiles. But extensive (more than name and number) identification data was included at only seven sites. At Regenstrief and at Bellevue the identification data are printed on a copy for the patient. This provides an incentive for patients to indicate corrections to be made. At Duke, Automed users and Greenville the identification data are displayed during the registration procedure with the same objective of verification and correction. The address and telephone information was considered of limited use at Bellevue, due to the mobility of the population.

Two sites (Casa and Bellevue) included extensive social information (language, household, socio-economic). Automed stressed the use of some social data to establish rapport with the patient.

Data from the last visit was presented for the encounter at 10 sites.

Chief complaint	at 7 sites
Problems treated	at 7 sites
Treatment provided	at 6 sites
Provider name	at 7 sites
Other data coded or free text	at 5 sites

Drug summaries were included at 12 sites.

Names of drugs	at 12 sites
Quantity and frequency	at 10 sites
Renewal data	at 2 sites (HCHP and Regenstrief)

Table 4C4

DATA ELEMENTS PRESENT ON PATIENT PROFILES

	Stanford	[illegible]	Rockland	Yale	[illegible]	Automed	[illegible]	Duke	Regenstrief	Cardiovascular	Casa de Amigos	[illegible]	MAS	Bellevue
Identification	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Extensive		A			A	A					A	A	A	A
Social Information					F	F					A			A
Last Visit - Date	A		A	A		A	A	A	A	A		A	A	A
Data	A									A			A	A
Chief Complaint	M					A				A			A	
Problems				A			A	A		A		A	A	A
Treatment	A		A			A		A				A		A
Provider			A	A			A	A		A		A	A	A
Drugs - Name	A	A		A	A	F	A		A	A	A	A	A	
Quantiry/freq.				A	A	F	A		A	A	A	A	A	
Renewal Date					A				A					
Laboratory Results	A				A				A	A	A	A	A	A
Since last visit					A									
Problem List	M				A	A	A	A		A	A	A	A	A
Date entered	M			A	A	A	A	A		A		A	A	A
Status					A	F				A	A	A	A	
Date resolved	M				F		A				A			
No. of visits				A	A							A	A	
Last visit				A	A							A	A	
Disposition		A	A	A								A		A
Compactness Range in pages	13	9	1	1-9	1-2	1-2	1-4	1	1	1	1-2	3	3	2-4

Legend:

- A in AAMRS
- M Manual only
- F used a free text note

Laboratory results obtained since the last visit were a part of the patient profile at 10 sites.

Problem lists were included at 9 sites. Detail included:

Date entered	9 sites
Status	4 sites
Date resolved	2 sites (MUSC & Casa)
Number of visits	4 sites
Last visit	5 sites

Often the problem list was divided into two levels of problem manifestation:

major/minor	(HCHP)
permanent/temporary	(MUSC)
active/inactive	(Duke, Casa, IHS, NAS)

The divisions can help in the management of problem lists. At MUSC the problem definition could also be changed with a cross reference to the new assignment; at the other sites the physician could only indicate a change of status. One site included similar information in the form of diagnostic codes (Bellevue). The problem list at Yale was implied through a listing of problems seen at encounters, sorted by problem number.

Other data presented at various sites included a free text patient description, past hospitalizations or consultations, health screening data, allergies, blood type, surveillance follow-up to be done, lists of previous encounters, immunizations, and skin tests.

There was a wide variation of compactness of data on the patient profile given to the provider, with four sites providing the information on the equivalent of one typewritten page, seven sites on two pages, and three sites on three pages. Very careful forms design was evident at the Casa with the Health-Illness-Profile. The patient profile at Regenstrief also served as a turn-around document for data entry. The paper forms provided at ITC forced the claims adjuster to match her observations to earlier prognoses and to reassess those recovery prognosis where there was a significant deviation.

Encounter Reports:

Computer generated encounter reports range from a complete history, physical and lab evaluation (at Cardiovascular) to a simple free text progress note (at Automed). These notes are prepared from checkmarked forms (Yale), from a form with checkmarks, numerical values, and free text (at HCHP) or from dictation (at MUSC). Three sites prepared encounter documents specific to the problem encountered: IHS, a user (Victor Straubs, M.D.)of Automed, and Regenstrief. Of the 10 sites with computer generated encounter reports or documents, two (Yale and MUSC) tied all data entered to a problem. Others tie some data to the problem (HCHP, Casa, NAS). Most sites, although they maintain problem lists, do not link specific data or findings to the problem or diagnosis. More discussion regarding this aspect of the record organization is found in Section 4E. At four sites (HCHP, Automed, MUSC and NAS) providers can dictate; the dictation is transcribed into the system and generates free text progress notes. The volume of dictation at HCHP and Automed is small, at Bellevue dictation does not enter the AAMRS and enters the traditional record only after a long delay.

Laboratory Test Orders:

Laboratory tests are ordered directly at NAS by entering commands on a CRT; at Regenstrief they are ordered by checking suggested tests on an encounter form, which is then computer processed. At other sites the computer did not play an active role in ordering laboratory tests. In eight sites lab data, after having been obtained.was entered.

Flow Sheets:

Computer generated flow sheets were used at eight sites. These included history and physical data, lab, vital signs, immunizations, and medications. Examples are Rheumatology parameters (Stanford), Immunizations (HCHP, Automed,IHS, Greenville), and Prenatal data (HCHP, Automed, Greenville). At Stanford graphs of any two selected medical variables could be quickly generated. The ability to generate tabular data depended in principle only on the extent of coding of variables and on the ability to search and analyze this data. Duke and Regenstrief had developed special languages to phrase those retrieval requests, at Stanford and HCHP programs were available which interactively requested from the user the information required to generate those tabulations. Some sites such as Rockland, HCHP, and Duke used computer generated tables extensively for utilization and administrative data.

On-Line Inquiry:

In eleven of the fifteen clinical sites it was possible for the provider to make on-line inquiries into the database. However at only two sites, NAS and MUSC, did the provider actually have a terminal in the examining room. At Automed users and Cardiovascular the terminal was in the providers office, but usually not the examing room. Because the traditional record is not available at NAS, the provider frequently queries the database on-line.

At HCHP a hardcopy document is available to the provider at the time of the patient encounter. Because most of the encounters are patient or physician-initiated appointments, it is not usually necessary to obtain an on-line printout of the patient's summary at registration time. A request to prepare a report can be made for drop-in patient, and terminals are available in the service areas to request more data. Inquiry is also used by physicians at Cardiovascular to deal with telephone calls, and a terminal has been made available for inquiry at the emergency room of the nearby hospital.

Data Base Searches:

All of the clinical sites have database searching capabilities. Eleven sites could search any coded variable and boolean combination. Four sites had more limited search routines. These retrieval capabilities were rarely used at any site during the patient encounter. At MUSC, because of the strong educational component, the residents and physicians in preparing for "grand rounds" presentations, and for peer review, frequently used the database searching capability.

The ability to do searches was the basis for commonly prepared (scheduled or by request) reports for various variables, such as disease profiles (lists of patients with certain diseases or problems), and medication profiles (lists of patients on certain drugs). Indeed a number of sites (such as Stanford, HCHP, Yale, MUSC) did complete coolean searches to generate list of subsets of the population according to a combination of parameters, all those patients over 45 years old, with a blood pressure of less than 150/100, on thiazide medication, and with a potassium less than 3.0. This type of ability was the basis of medical audit which had been started at HCHP, MUSC, and Stanford.

Graphic Output:

Only two sites routinely used the computer to produce graphic output; Stanford used scattergrams and histograms and Rockland used pyramid histograms to compare and present patient populations. We noted that a number of other sites had manually drawn graphs in the reports they presented.

Update Cycle:

In only 4 of the 11 primary care sites new data are entered into the AAMRS files in less than one day. At each of these sites on-line updating is possible, but at two (Duke, Greenville) the systems are so embryonic that it is difficult to evaluate how the system will work when it is more heavily loaded. Most of the other projects utilize an overnight update run, even those sites with on-line connection to the computer system. All sites utilizing dictation have experienced difficulty in remaining current with input even though the stated update cycle is approximately one day. Where batch updating occurs, delays of 3 days or more may occur between acquisition of new data and having this available at a new patient encounter.

D. DATA COLLECTED

Introduction:

The data elements which are collected into the permanent automated medical record are an important measure of the power and cost of a system. In this section, we will present an overview of the content of each AAMRS, and subsequently focus on specific data element types collected at the sites visited.

After two brief overviews more detailed data is presented in largely tabular form.

Identification:

Some identification data is always required, but at sites with a limited population this data did not appear critical. At sites with a large population several data elements were collected specifically to cross-check or improve retrieval probabilities for the record. Some data elements collected with the identification have medical relevance for certain analyses (age, race, height, weight, occupation) and hence overlap the findings in the medical data base.

Medical Content of the AAMRS:

The medical content of each AAMRS is summarized in Table 4D1. The following comments are particularly applicable to the eleven primary care sites, but they also apply to Rockland and ITC in a limited way.

The chief complaint, or the presenting symptom at an encounter, stored almost universally. This is captured in text form much more commonly than it is coded. However, the problem description is much more apt to be coded than to be stored as free text. More than half the sites coded problems, and a few stored both the coded and descriptive versions.

The remaining historical portions of the data base (the details of the history of the present illness, the past medical history, the family and social history, and review of systems) were infrequently stored in the AAMRS. Those sites committed to storage of textual data (Automed, MUSC, NAS, Bellevue) had a far greater potential for storing this type of information than the other sites. Yale, HCHP, Greenville, Regenstrief, Casa, and IHS all had a limited capacity to store significant data in these categories, primarily in coded form.

Table 4D1

MEDICAL CONTENT OF AAMRS

Site	CC	HPI	PMH	FH	SH	ROS	PE	PROB	LAB	MEDS	NOTES	FU
Stanford	C	C	L	L	L	L	L	M	L	L/T	M	-
ITC	C	C	L	-	C	-	L	T	-	T	-	C/T
Rockland	L	L	L	L	L	L	L	C	-	L/T	L	L
Yale	C/T	C/T	L	L	L	C	C/T	C/T	T	T	C/T	C
HCHP	C/T	C/T	T	L/T	C/T	T	C/T	C	C	C	T	C/T
Automed*	T	T	T	T	T	T	C/T	T	T	T	C	C/T
MUSC	T	C/T	T	T	T	T	C/T	C	C	C	T	C/T
Greenville*	C/T	T	L	L	-	L	L	T	T	T	L	C
Duke	-	C*	-	C*	C*	C*	L	-	-	T	T*	C
Regenstrief	-	T	L	-	-	C	C	T	C	T	C	C
Cardiovascular	T	C	-	C	C	M	C	C/T	C	C	T	C
Casa	T	C	L	C	C	-	L	T	C	T	-	C
IHS	T	C	L	-	C	-	L	T	C	C	L	C
NAS	T	T	L	-	-	-	T	T	C	T	T	C
Bellevue	T	T	T	-	T	T	L/T	T	T	T	T	C

Legend:

CC	Chief complaint	PE	Physical examination
HPI	History of present illness	PROB	Problem list
PMH	Past medical history	LAB	Laboratory
FH	Family history	MEDS	Medications prescribed
SH	Social history	NOTES	Progress notes
ROS	Review of systems	FU	Follow-up or disposition

* Used only selectively, according to user or clinic

C Coded — L Limited data in coded form (specific to disease or clinic site)

T Text — M Stored in Manual record

A limited amount of physical examination data was collected and stored in coded form by most of the primary care sites. This was often restricted to vital signs (temperature, pulse, respiration), blood pressure, and weight. Those sites committed to storage of free text can store more details of the physical examination.

The assessment of patients' problems were generally stored in textual form, and several sites coded this information for storage in parallel with the text.

Plans for patient management were generally not stored, with the notable exceptions of laboratory tests ordered and medications prescribed. Approximately half the sites recorded this information in coded form and half as text.

Progress notes were stored primarily by sites committed to free text. Limited storage of this information occurred at the other sites.

Patient follow-up was coded almost universally.

Specific Patient Identification:

Patient identification data was obviously adjusted to satisfy the individual needs of the sites visited. The details are summarized in Table 4D2. Several trends could be seen in regards to information commonly collected: Identification numbers utilized were in general local Unit Numbers (12) or Social Security Numbers (8), with 4 sites utilizing both.

Information commonly gathered was:

- Full Name - (17)
- Address - (14)
- Home Phone - (13)
- Sex - (17)
- Date of Birth or Age - (17)
- Marital Status - (13)
- Race - (14)
- Occupation - (10)

Only one site utilized family identification numbers (Casa). In the military (NAS) the dependents used the social security number of the member of the military services with a prefix. At Greenville the capability to collect multiple numbers for one patient, as used by the various service sites was available, and Los Angeles allowed several names for every individual registered. Soundex codes were used to find patients in large populations. These codes reduced the name of a patient to a simplified code, which is designed to combine spelling features commonly in error. At the Casa this approach has been extended to Spanish surnames (Soundex).

Table 4D2

PATIENT IDENTIFICATION

Patient Identification	Stanford	ITC	LA	ELA	Rockland	Yale	HCHP	Automed	MUSC	Greenville	Duke	Regenstrief	Cardiovascular	Casa	IHS	NAS	Bellevue
ID Number:																	
Social Security	X	X	X				X	X			X				X	X	
Unit number	X		X		X	X	X		X	X		X	X	X	X		X
Sequence number				X													
Family number														X			
Name:																	
Full	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Soundex			X				X			X				X			X
Address	X		X	X	X	X	X	X	X	X	X		X		X	X	X
Phone:																	
Home	X	X	X	X		X	X	X	X	X			X			X	X
Business						X		X	X		X		X				
Sex	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Date of Birth or Age	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Marital Status	X	X	X	X		X	X		X	X	X	X			X	X	
Religion			X		X			X			X				X		X
Race	X		X	X	X		X	X	X	X	X	X	X	X	X		X
Education:																	
Level			X	X	X												
Years							X			X				X			
Occupation:																	
Free text	X	X	X	X	X		X		X		X			X		X	
Coded		X															
Date Collected		X	X	X	X					X	X		X	X		X	X

Financial and Economic Information:

Financial and economic information stored varied greatly from site to site. This data is presented in Table 4D3. Some communality was found at the private practice sites (Automed & Cardiovascular), at the Family Practice Unit at MUSC, and at Duke. The following specific information was entered at these four sites:

Total Bills	- outstanding	- 3 sites
	- aged	- 3 sites
	- year to date	- 3 sites
This Visit	- line itemized	- 3 sites
	- provider	- 4 sites
	- amount	- 4 sites
Billing Detail Retained	- date	- 4 sites
	- diagnosis	- 2 sites
	- provider	- 3 sites
	- line itemized	- 4 sites
	- amount	- 3 sites
Guarantor	- relationship	- 3 sites
Insurance Carriers	- name	- 4 sites
	- type	- 3 sites

A wide variety of information was stored in sporadic fashion by the other sites visited.

County hospital sites at LA, East LA, Greenville, Regenstrief, Casa, and Bellevue stored little economic information and only Bellevue spins off data for patient billing. In general, these sites were characterized by a lack of

No site stored sufficient information to carry out prorating of charges for insurance,or deduction of insurance deductibles in the third-party bills generated. This is a capability of many in-patient systems, but the rules for in-patient coverage seem to be easier to manage. Most private provider sites could generate Medicare and Medicaid bills.

Data Base - History of Present Illness:

History-of-present-illness data was entered at 12 sites. Only at 3 sites are data in the form of free text (Automed, NAS, Bellevue). Some sites (Yale, HCHP) allowed additional free text notes. Table 4D4 summarizes our findings for the sites which provided specific data categories.

Table 4D3

FINANCIAL AND ECONOMIC INFORMATION

Financial and Economic Information	ITC	HCHP	Automed	MUSC	Greenville	Duke	Cardiovascular	Bellevue
Total Bills:								
Outstanding				X		X	X	
Aged				X		X	X	
Year to Date				X		X	X	
This Visit:								
Line Itemized	X			X		X	X	
Provider		X	X	X		X	X	
Amount			X	X		X	X	
Billing Detail:								
Date	X		X	X			X	
Diagnosis						X	X	
Provider	X		X			X	X	
Line Itemized			X	X		X	X	
Amount			X	X			X	
Discount							X	
Date Paid	X						X	
Guarantor:								
Relationship	X			X	X	X		X
Amount	X		X					
Ability to Pay					X			
Insurance Carriers:								
Name	X		X		X	X	X	X
Type	X				X	X	X	X
Code	X		X				X	
Date Insured	X	X						X
Insurance:								
Plan Type						X	X	
3rd Party Bills Prepared			X				X	
Date for Bills Generated	X	X				X		X

Table 4D4

DATA BASE: HISTORY OF PRESENT ILLNESS

History	Stanford	ITC	Rockland	Yale	HCHP	MUSC	Greenville	Duke	Regenstrief	Cardiovascular	Casa	IHS
Free Text (if only free text not included)								M				
Chief Complaint:	X			X	L	X		L	X	X		X
Coded		X	X		X							
Severity	X	X	X				X					
Symptoms:	X	X	X				X					
Coded				X	X					X		
Descriptive	X			X	X	X	X			X		
Detail:	X	X	X	X			X			X		
Location	X	X		X						X		
Onset type		X	L	X								
Quality		X	L	X						X		
Frequency				X								
Active Problems:	M		X					X		X		
Date of Entry	M			X	X	X	X				X	X
Problem Name	M			X	X	X	X				X	X
Problem Code					X	X	X	X			X	X
Severity	M			X							X	
Status				X	X	L					X	
Risk Factors				X	X		X			X	X	X

Legend:

L = limited
M = manual, not entered into AAMRS

Chief Complaint was entered:
- Free Text (5 sites) or Coded (3 sites)

Detail related to the chief complaint was commonly included:
- Severity - 4 sites
- Symptoms - 5 sites

More elaborate detail was less commonly entered as coded:
- Location - 2 sites
- Date of Onset - 2 sites
- Onset Type - 1 site
- Quality - 2 sites
- Frequency - 1 site

Active Problems were entered at 8 sites:
- Free Text (2 sites) or Coded (6 sites)

Detail commonly obtained related to active problems included:
- Date of Entry - 5 sites
- Problem Name - 6 sites
- Problem Code - 5 sites

Less commonly entered data included:
- Date of Onset - 2 sites
- Severity - 1 site
- Status - 3 sites

Risk factors were entered infrequently:
- Smoking - 4 sites
- Alcohol - 3 sites
- Accidents - 2 sites

Past Medical History:

Past medical history is stored to some degree at most sites.

Family history is stored in coded form at 7 sites, and in free text form at 2 sites. Detail collected includes:

Family Detail for:
- Parents - 3 sites
- Grandparents - 1 site (Greenville)
- Siblings - 3 sites
- Any blood relatives - 2 sites, with the relationship indicated.

Specific diseases were collected, without further specification, at 5 sites.

Past diseases are stored at 9 sites. At 8 sites the diseases are coded as a problem list.

- Description of Past Diseases - 7 sites (as free text in 3 sites)
- Date of Onset - 3 sites
- Final Date - 2 sites
- Diagnosis (Coded) - 4 sites

Past hospitalizations are stored at 14 sites. Data is stored free text only at 3 sites. Detail for past hospitalizations includes:

Number - 4 sites
Type of Operation or Illness - 8 sites
Date - 4 sites
Location - 3 sites
Discharge Summary (Abstracted) - 1 site

Previous diagnostic test information (such as PPD, Cholesterol, etc.) is stored at 6 sites. Detail includes:

Name (5 sites) or Code (4 sites)

Immunization information is stored at 8 sites. Detail includes:

Name (6 sites) or Code (7 sites)

Allergies are stored at 7 sites. Medicine allergies stored at all 7 sites (HCHP, Automed, MUSC, Greenville, Casa, IHS, NAS), with detail including:

Name (7 sites) or Code (4 sites)

Environmental agent allergies stored at 5 of these sites. Detail includes:

Name (MUSC, IHS, or INAS) or Code (IHS, NAS)

and 2 sites collected allergies for specific agents:

Pets (HCHP)
Food and Respiratory (Casa)

Current Medications are stored at 14 sites. Detail includes:

Name (14 sites) or Code (10 sites)
Problem Prescribed For - 2 sites
Quantity - 10 sites
Frequency - 10 sites
Dates Filled - 2 sites
Duration - 1 site (HCHP)
Cost - 1 site (ITC)

Past medications are stored at 10 sites. Free-text storage is utilized at 2 sites. Detail collected includes:

Rx - 8 sites
Quantity - 6 sites
Frequency - 6 sites
Patient Compliance - 2 sites
Date - 1 site
Source - 1 site

Diet data is stored at 4 sites only. Detail includes:

Type - 4 sites
Detail - 1 site
Patient Compliance - 1 site

At several sites, special diet orders are entered as medication.

Psychiatric data is stored at 10 sites. One of these (Rockland) is devoted entirely to this specialty. At other sites only limited quantities were collected. Some encoding and free-text storage is used at 2 sites (HCHP, NAS). Detail includes:

General Attitudinal - 5 sites
Detail is stored - 3 sites (ITC, Automed, MUSC)

One site (Bellevue) stated specifically that, in order to protect patients' privacy, they do not store psychiatric data, but do indicate psychiatric visits.

Nutritional data is stored at 4 sites only. Detail includes:

Type of Diet - 2 sites
Descriptive - 1 site
Coded Risks - 2 sites

Bellevue stores categories specific to Pediatric care: Growth & Development, Prenatal History, Birth, and Neonatal.

Data Base - Social History:

Social history was entered at the majority of sites (12). No site stored information as free text alone.

Specific social history detail entered is outlined below in decreasing order of frequency:

Employment - 8
Place of Birth - 5
Size of Household - 5
Number of Children - 5
Level of Education - Type - 5
Primary Language - 5
Ability to Speak English - 4
Census Tract - 4

At 2 sites (Automed and HCHP) social notes regarding patients could be entered as free text.

Data Base - Review of Systems:

Review of systems were <u>not stored</u> at the majority of sites.

When stored (6 sites), a free-text method was used at 3 sites (Yale, HCHP, Bellevue) and specific detail was sparse:

Positive Findings Only - 4 sites (Rockland, Stanford, Regenstrief, Greenville)
Overall Impression - 1 site (Rockland)

Table 4D5

DATA BASE: SOCIAL HISTORY

History	ITC	LA	Rockland	Yale	HCHP	Automed	MUSC	Greenville	Duke	Casa	IHS	Bellevue
Stored as Free Text							X					
Place of Birth		X	X	X				X		X		
Citizenship			X								X	
Employment	X		X	X		X	X	X	X	X		
Income Source	X		X									
Size of Household	X		X	X			X	X				
Number of Children			X	X	X		X				X	
Education Level:												
Type			X		X		X	X		X		
Highest Grade								X				
Primary Language	X		X							X	X	X
Ability to Speak English	X		X		X					X		
Census Tract		X					X	X	X			
Block			X							X		

Data Base - Physical Examination:

Physical examination data was entered at the majority of sites (14). The data was uniformly entered in specific categories. Frequently collected data included:

- Date - 10 sites
- Height - 14 sites
- Weight - 14 sites
- Sex - 7 sites
- Vital Signs - 10 sites

Yale collected considerably more detail; and Stanford, Rockland, and Greenville collected more detail in specialty areas. Risk factors, such as smoking, accidents, and alcohol, were collected infrequently (Yale, HCHP, Cardiovascular).

Objective Findings of Past Medical History:

Objective findings of past medical history were stored at the majority of sites. Detail in this area includes:

- Routine Laboratory - 10 sites
- Special Laboratory - 7 sites
- X-rays - 8 sites
  - X-ray results were reported for chest only at 3 sites, and indicated only as being normal or abnormal at 2 sites
- EKGs - 9 sites
  - EKG results were reported only as normal or abnormal at 5 sites
- EEGs - 3 sites (HCHP, Regenstrief, NAS)
  - EEG results were reported only as normal or abnormal at 2 sites.
- Pulmonary Function Tests - 5 sites
- Renal Function - 3 sites (Stanford, Regenstrief, NAS)
- Gastro-intestinal Function - 2 sites - (Regenstrief, NAS)
- Source of Order - 4 sites

Problem List:

Problem lists were not stored at 7 sites and stored in some detail at 8 sites.

Free text storage of problem names was utilized at only 2 sites (Yale and Automed).

Active problems were entered in detail at 8 sites. Specifics commonly obtained were:

- Date of Onset - 2 sites (ITC and IHS)
- Date of Entry - 9 sites
- Problem Name - 8 sites
- Diagnosis Name - 6 sites
- Severity - 3 sites
- Status - 5 sites

Temporary problems were entered at 2 sites (HCHP and MUSC).

Inactive problems were entered less frequently (at 6 sites), and detail included:

- Date of Onset - 2 sites
- Date of Entry - 6 sites
- Problem Name - 6 sites
- Diagnosis Name - 3 sites
- Final Date - 3 sites

No site stored references to past or successor problems related to a problem definition, although multiple symptoms could be entered with a problem at Automed.

One site (IHS) indicated the location of the encounter site and the identity of the provider initially identifying the problem.

One site (Bellevue) entered diagnoses, not having chosen the problem-oriented record.

Plans - Diagnostic Orders:

Diagnostic orders were:

- Not Stored - 7 sites
- Stored in Free Text - 6 sites (Yale, HCHP, MUSC, Greenville, NAS, and Bellevue)
- Stored in Detail - 4 sites (Duke, Regenstrief, Casa, and IHS)

Order types commonly coded and stored included:

- Routine Laboratory - 4 sites
- X-rays - 3 sites (Duke, Regenstrief, and IHS)
- EKGs - 2 sites (Regenstrief and IHS)

One site only (Regenstrief) stored orders for Special Laboratory, EEG, Pulmonary Functions, and other medical tests.

Plans - Therapeutic Orders:

Therapeutic orders are entered at the vast majority of sites (14). Medications alone are entered at 6 sites. Detail regarding medications includes:

- Name of Medication - 12 sites
- Quantity - 12 sites
- Frequency - 11 sites

One site (Stanford) enters only medications pertinent to Immunology and Rheumatology.

Type of diet can be entered at 5 sites.

Table 4D6

PLANS: THERAPEUTIC ORDERS

Therapeutic Orders	Stanford	ITC	Rockland	Yale	HCHP	Automed	MUSC	Greenville	Duke	Regenstrief	Cardiovascular	Casa	IHS	NAS
Medications:														
Rx	X		X	X	X	X	X	X	X	X	X	X	X	X
Quantity & Frequency			X	X	X	X	X	X	X	X	X	X	X	X
Type of Diet					X			X		X		X	X	
Patient Education								X					X	
Physical Therapy		X		X	X			X						
Occupational Therapy		X												
Activity Orders		X		X				X						
Nursing - Home Care Orders		X			X									

Other orders entered included:

Patient Education - 2 sites (Automed and Tucson)
Physical Therapy - 4 sites (ITC, Yale, HCHP, and Automed)
Occupational Therapy - 1 site (ITC)
Activity Orders - 3 sites (ITC, Yale, Automed)
Nursing, or Home Care Orders - 2 sites (ITC and HCHP)

Information regarding referral is entered at 1 site (IHS).

One site (Bellevue) enters data in free text only.

Follow-Up Data:

Follow-up data is stored at the majority of sites. Information commonly stored includes:

Routine Laboratory - 8 sites
Special Laboratory - 4 sites
X-rays - 7 sites
EKGs - 6 sites
Findings for X-ray and EKG results were stored in free text only at 2 sites
Disposition - 7 sites

Other follow-up data was indicated less frequently:

EEGs - 4 sites
Pulmonary Function Tests - 5 sites
Other Medical Tests - 4 sites
Medications - 5 sites
Re-assessment of Problems - 3 sites
Prognosis - 2 sites (ITC, Bellevue)
One site (ITC) stored data regarding prognosis in some detail:
Recovery Time
Functional Effectiveness
Long-Term Care Requirement

Progress Notes:

Progress notes were not stored as such at 11 sites.

Encounter forms were utilized for data entry at 6 sites:

Acute Illnesses - 5 sites
Chronic Episodes - 6 sites
This data was entered as free text at 1 site (Yale) and coded at 5 sites (ITC, Rockland, Greenville, Regenstrief, and Cardiovascular)

One site (ITC) entered progress notes for all diseases. One site (Automed) permitted entry of any disease, and 2 sites entered specific diseases only:

Psychiatric (Rockland)
Cardiac (Cardiovascular)

Patient Services Management:

Some patient services management information is provided at the majority of sites (14). Commonly provided information included:

Schedule for Patient Visits - 9 sites
No-Show and Cancellation Rates - 7 sites
Medication Schedules - 2 sites
Visit Reminders - 5 sites
Staff Schedules - 3 sites
Chart Review Schedules - 3 sites
Patient Compliance - 3 sites

One site (IHS) provided surveillance reports, family planning, and discharge information.

One site (Greenville) entered transportation services information, and another one site (NAS) entered patient waiting times.

Bellevue analysed the data for their scheduled patients in terms of no-show rates, unexpected drop-in rates, and visits to their emergency clinic.

Practice Information:

Practice information entered included:

First Encounter with the Practice - 12 sites
Encounter Site - 12 sites
Referral Source - 8 sites
Provider at Encounter - 16 sites
Encounter Duration and Frequency - 9 sites
Use of Other Facilities - 11 sites
Audit-oriented Data - 5 sites

Practice information was often cited as an important by-product of an AAMRS. At MUSC the use of practice data was considered a vital component of the educational process for family physicians.

E. Trends in medical services to be provided

F. Trends in technological support for ambulatory medical record systems

G. Trends in financial support for automated record services

H. Interaction between medical and technological development

I. Populations which will benefit most from automated ambulatory record systems

J. Effects of funding on development objectives

K. Factors for transferability and diffusion

L. Interactions between systems and user attitudes

M. Development of measurement tools for evaluation.

Table 4D7

PATIENT SERVICES MANAGEMENT

Patient Services	ITC	ELA	Rockland	Yale	HCHP	Automed	MUSC	Greenville	Duke	Regenstrief	Cardiovascular	IHS	NAS	Bellevue
Schedule of Patient Visits	X			X		X		X		X	X	X	X	X
No-Show and Cancellation Rates		X			X		X	X	X				X	X
Medication Schedules for Patients					X		X							
Visit Reminders for Patients	X				X			X			X			X
Staff Schedules			X									X		X
Chart Review Schedules			X		X		X				X	X		
Patient Compliance Promptness										X	X	X		X

Table 4D8

PRACTICE INFORMATION

Practice Information	Stanford	ITC	LA	ELA	Rockland	Yale	HCHP	Automed	MUSC	Greenville	Duke	Regenstrief	Cardiovascular	Casa	IHS	NAS	Bellevue
First Encounter with this Practice		X			X	X	X	X	X	X	X		X	X		X	X
Encounter Sites		X	X	X	X		X	X		X	X	X		X	X	X	
Referral Source		X			X	X	X			X	X					X	X
Encounter Duration and Frequency		X	X	X	X						X	X	X	X	X		
Use of Other Facilities		X	X	X	X	X	X	X				X	X	X	X		
Audit Oriented Data	X	X				X	X	X*	X		X	X	X	X	X	X	
Providers at Encounter		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

* Selected users or sites only.

E CLINICAL AND MANAGEMENT STATUS OF SITES

Classification of Sites

Because the AAMRS projects surveyed do not constitute a homogeneous group, in this section these projects will be discussed from the following perspectives:

Clinical Perspective

1. Clinical impact of AAMRS
2. Type of care provided
3. Professional orientation
4. Educational goals
5. Surveillance activities
6. Health Services Research

Management Perspective

1. Management impact of AAMRS
2. Types of services
3. Management orientation

Factors pertaining to the direct provider-patient interaction have been discussed in Section 4C (Services Provided). Evaluation methods and results follow below in Section 4M.

1. Clinical impact of AAMRS

Two of the AAMRS projects produced a minor output intended for use by the providers of care (LA, ELA). LA is primarily a patient appointment system at the present time with a miniscule amount of clinical information (flags in I.D. record indicating diabetes, cardiac pacemaker, prosthetic cardiac valve). ELA is essentially a Children and Youth Project reporting system. It produces no output which is put into the traditional manual record. In the discussion that follows, LA and ELA are excluded as insignificant in terms of medical impact at the present time. This is not to say that with further additions and with a re-orientation of purpose that this situation could not be modified.

The group which depends most on the output of the AAMRS are clinicians at only 8 of the 15 sites surveyed. The administrative staff of 5 of the projects are the chief beneficiaries of the AAMRS's. In the two remaining projects, clinical research in training rather than clinical care is the dominant activity.

2. Type of Care Provided

Of the 15 clinical sites, three provide secondary and tertiary care (Stanford, Rockland, Cardiovascular), 11 provide primary care, and one (ITC) is only quasi-medical.

Specialty Care Sites

There is no basic similarity among the three specialty care sites. The Stanford AAMRS is primarily a research project in a rheumatic diseases clinic. The unique feature of this project is the ability to produce computerized consultation reports by matching a new patient with a subset of the nearly 800 patients in the database. The great detail of information collected is achieved through a series of input forms which remains in the manual record as the encounter document. Additional written entries are usually made in the traditional record as well. The technical sophistication of the database system allows considerable flexibility in the types of output which can be provided. The form used is as extensive as the input document developed for the Yale project. The feedback provided by the form, with flowsheets values collected during previous visits, and additional feedback provided by data analyses has affected user motivation positively toward acceptance of this type of input.

The Rockland system as exemplified by the clinics in Pomona, New York, and at the Connecticut Mental Health Center achieves very little of its medical potential as an AAMRS. Those who depend primarily on the output of the system are administrators rather than clinicians. The medical content is rather limited, and this is not likely to change unless the various provider groups recognize the potential of the system. Marketing by the system developers seems to be directed more toward administrative than clinical users. Because the system provides administrators the means to develop and present utilization data as budget justifications for funding requests to the supporting state agencies, it is easy to understand why this project has evolved in a non-clinical direction.

The Cardiovascular project is the only one of the specialty care sites that has the clinician as a primary target. In addition to the 14 terminals at the Clinic, this project maintains a terminal at a nearby hospital enabling clinicians to access data for their hospitalized patients, and to produce hardcopy documents for insertion into the hospital record.

The ITC system belongs in a category by itself since the users of the system are not direct providers of health care. The review team however was very much impressed with the concept of the multi-track system where each track allows the insurance adjustor to follow a significant aspect of the patient's medical, social, psychological, and legal problems resulting from an injury on the job. Technically there are many similarities in the structure of the records kept in the system with those for primary care.

Primary Care

Two of the 11 primary care sites (HCHP, NAS) dispense completely with the traditional record at the patient-physician encounter. One other site (IHS) uses the computer generated record for patient encounters outside the usual clinic setting, i.e. when a patient is seen in the Mobile Health Unit or by a public health nurse. The distinction between the various sites has been discussed in detail in the preceding section which concerns the content and output of the AAMRS.

3. Professional Orientation

Problem-Oriented Record. A commitment to use a problem-oriented record has been made at 4 of the 15 clinical sites. The explicit linkage between problems, subjective and objective data, and problem management is implemented only at Yale and IHS. Even in these sites, clinicians do not make extensive use of this feature. At almost all the other sites a list of patient problems is stored but the explicit linkages to other data are not provided. This would require extensive revision of files at sites using MUMPS software.

Continuity of Care. Only 3 of the 11 primary care sites utilize the team approach to patient care. The three sites that use the AAMRS outputs as the primary patient record are also committed to a one patient-one provider relationship. The implications of such a relationship for the design of an AAMRS will be discussed at greater length in Chapter 6.

4. Educational Goals

At MUSC, Regenstrief, Casa, Bellevue, and Stanford, resident physicians interacted directly with an AAMRS, but only at MUSC was the information system considered an important adjunct to their training. A reasonably balanced practice profile for each trainee at MUSC was achieved by using the AAMRS. Although MUSC is genuinely committed to a problem-oriented record structure as an educational tool, this is achieved by dictation rather than through software sophistication. The capacity of the database to support complex searches is limited by the storage of relatively unstructured free-text, but nonetheless considerable use is made for such educational exercises as grand rounds presentations and for peer review. The database is generally searched for cases of a particular disease or problem and further analysis is done by reading the individual records.

5. Surveillance Activities

Bellevue, IHS, Casa, Greenville, HCHP, and Automed store immunization data in a highly structured format. At IHS this data is scanned periodically to produce lists of children who are due for scheduled immunization as well as lists of delinquent cases. These are used by public health nurses to provide immunizations when visiting outlying communities. Regenstrief produces a unique surveillance report prior to each patient encounter. The report lists recommended procedures or tests based on the patient's current and previous problems, medications, and laboratory test values. IHS is also producing lists of at-risk individuals for certain diseases such as hypertension to maximize the yield of screening efforts.

6. Health Services Research (HSR)

Relatively little research in the area of HSR is currently being done by AAMRS developers and users. At Duke, Regenstrief, and Casa these activities are based in departments of Community Medicine and concern evaluation of health care outcomes. An EMCRO contract at the IHS in Tucson addresses the same issue. Other sites regularly perform utilization review, but this is primarily a management function. Private physicians at the Cardiovascular Clinic are studying the efficacy of a hypertension control protocol in their practice and report encouraging results in reducing the interval between diagnosis of this condition and achieving control of the elevated blood pressure. No controlled studies are currently in progress which evaluates the efficacy of an information system in improving health care quality, but this is apt to be a major aspect of further research in this field.

MANAGEMENT PERSPECTIVE

1. Management Impact of the AAMRS

While none of the AAMRS's provided full scale accounting and financial management services for the management of the user organization, several provided a significant input to the management function. In fact administrative services, such as preparation of utilization reports, patient registration, and medical record accession were in some cases a major objective and justification for the AAMRS (see Section 4B).

The administrative services provided by the AAMRS may be classified into two broad categories:

1. Billing which includes
   a. Accounts receivable,
   b. Statement preparation, and
   c. Preparing of third party claims

2. Management which includes
   a. The collection and report preparation of various types of utilization statistics and
   b. The collection and reporting of other data useful to management such as manpower staffing reports and scheduling.

Of the 16 sites visited (excluding East LA), seven sites provide a significant input to the billing function and ten were providing a significant output of management data.

The types of user organizations that were using the AAMRS for administrative services range from solo practitioners to large group practices, to the large scale public clinics and hospitals. For the smaller organizations, the major administrative function related to billing and claims preparation. For the larger organizations with large patient populations the major services also included the generation of utilization reports for internal management and external budget requests, and data to meet mandatory reporting requirements of supporting agencies.

It is interesting to note that, even though most of the AAMRS's were primarily oriented to the automation of the medical record, the administrative services provided the primary cost justification for the system, either in terms of manpower saving and reduction of lost charges in the billing process (Cardiovascular) or by the development of data in support of budget requests (Rockland - CMHC).

2. Types of Services Provided

The types of administrative services provided may be classified as follows:

Billing

Accounts receivable
Direct patient billing
Third party claims

Management Data

Utilization statistics
Other data

Appointment Scheduling

Patient identification or visit registration

Record accession

Tables 4E1 and 4E2 summarize the types of billing and management services provided by each of the sites, and for management, the major

TABLE 4E1

BILLING SERVICES

SITE	ACCT'S REC	DIRECT INPUT	PATIENT BILLING STATEMENT	3RD PARTY PREPAR'N	CLAIMS ELIGIB'Y
Stanford	0	X	0	0	0
ITC	0	N/A	N/A	0	X
LA	0	0	0	0	X
ELA	0	0	0	X	X
Rockland	0	X	0	0	X
Yale	0	P	0	0	0
HCHP	0	P	0	X	X
Automed	XX	XX	XX	XX	X
MUSC	X	X	X	P	X
Greenville	X	X	0	P	X
Duke	X	X	F	X	X
Regenstrief	0	P	0	0	0
Cardiovascular	X	X	X	X	X
Casa	0	X	0	0	P
IHS	N/A	N/A	N/A	N/A	N/A
NAS	N/A	N/A	N/A	N/A	N/A
Bellevue	0	P	0	0	X

X = Service provided; XX = Major justification for system - primary service
P = Partial or "fall-out" Service
F = Service to be provided in near future
0 = Service provided by other automated services
N/A = Not applicable

TABLE 4E2

MANAGEMENT SERVICES

SITE	UTILIZATION REPORTS INTERNAL USE	OUTSIDE AGENCIES	BUDGET JUSTIF'N	OTHER REPORTS INTERNAL USE	OUTSIDE AGENCIES	BUDGET JUSTIF'N
Stanford	P/O					
ITC	X			X		
LA	P	XX	XX			
ELA		XX	XX	XX	XX	
Rockland	P	XX	XX	P	X	X
Yale	X					
HCHP	X			X		
Automed	P			P		
MUSC	X	X				
Greenville	X	X		X		X
Duke	X			X		
Regenstrief	P	P		P		
Cardiovascular	X			X		
Casa	P	X	X			
IHS	P	X	X		X	X
NAS	P	X	X			
Bellevue	X	X	X	X		

X = Service provided; XX = Major justification for system - primary service
P = Partial or "fall-out" Service
F = Service to be provided in near future
O = Service provided by other automated services
N/A = Not applicable

purpose for which the reports are prepared. As shown in Table 4E3, there are two types of services relating to direct patient billing, data input to the billing process and statement preparation. This distinction is made to separate those sites where the AAMRS is contributing data for the billing process but does not perform the entire function. At several sites this is an important function of the AAMRS because more accurate data is available on services provided and results in significant reductions of lost charges. The third party claims service is also divided into two types, claims preparation and eligibility determination.

Interactive appointment scheduling systems have been incorporated into the AAMRS at six sites (Los Angeles, HCHP, MUSC, Greenville, Cardiovascular, and NAS). At Greenville the system is considered to be a major benefit resulting in clerical time savings, more efficient use of medical personnel, and a reduction in the number of "no-shows".

Patient identification during visit registration is provided at eleven sites. At most of these sites, proper patient registration is considered a significant contribution to management for varying reasons. At Los Angeles, Greenville, and Bellevue, the ability to accurately identify and keep track of individuals in a large patient population is considered a major benefit. At the HCHP and Greenville, a control check is made to assure patient eligibility.

Time savings for clerical personnel in the registration process was reported by Los Angeles, Greenville, Cardiovascular, and NAS. In contrast, at Duke, the time for registration increased after the registration process

TABLE 4E3

SUMMARY OF BILLING AND MANAGEMENT SERVICES

	Number of sites
Billing Services:	
Accounts receivable	6
Direct Patient Billing	
Data Input to the Billing Process	12
Statement Preparation	3
Third Party Claims	
Processing	6
Eligibility determination	11
Management Reports	
Utilization Statistics	
Internal use (for planning and budgeting)	14
Required by outside agencies	9
For budget justification to outside supporting agencies	7
Other Reports	
Internal use	9
Required by outside agencies	2
Budget justification to supporting agencies	3

was automated. This was primarily due to the increased amount of data collected and verified in comparison to the manual process.

The AAMRS is used for record accession at five sites (LA, HCHP, Regenstrief, IHS, and Bellevue). Essentially the service consists of the preparation of appointment lists for retrieval of the traditional record. At Los Angeles and Bellevue this service is viewed as one of the major benefits and justification for the system.

3. Management Orientation

The management orientation of the AAMRS users is best described in terms of their organizational structure and operating objectives. The user organizations may be classified as follows:

Private, solo or group practice, fee-for-service

Automed - Primary and secondary specialty care
Cardiovascular - secondary, specialty care
ITC (quasi) - specialty, employee disability

Private, group practice, HMO - capitation

Yale (CHCP) - Primary Care
HCHP - Primary Care

Public clinics, city, county or state (large patient populations); government support of health service cost.

Los Angeles
Rockland
Greenville
Regenstrief
Bellevue

Public clinics, neighborhood (small to medium size patient population); government support of health service cost.

East LA
Casa

Federal Government, direct operations; free services to patients

IHS
NAS

University - based clinics (small to medium size patient population); health services subsidized and fee-for-service.

Stanford - specialty
MUSC - family practice primary care
DUKE - specialty, and primary care (student, faculty, and employee health)

The management and operating objectives for these types of organizations vary significantly and are primarily influenced by the major source of operating funds and organizational affiliation. The nature of the source of operating funds probably bears the greatest influence upon the particular management style. For the small practice, the physicians constitute management; while larger group practices such as HMO's have a separate management staff.

The private solo and group practices are primarily dependent upon charges to patients for the practice income, whether on a fee-for-service basis or from capitation payments. Thus a primary operating goal is the management and control of services provided and related charges. For the fee-for-service operation, the management will be primarily interested in the proper recording of services performed for direct patient and third party billing. Another feature of this group is that it is generally not a part of a larger organization, and thus does not have external reporting requirements.

For prepaid capitation plans, the management orientation is directed toward a careful overview of the nature and amount of services provided, and the setting of prepayment rates to assure cost recovery. Additionally this group will be interested in having adequate controls to assure that only eligible patients receive services. Thus the extent and nature of data collected is primarily for internal use and determined by the immediate practice management.

In contrast to the private practices, the public clinics are generally affiliated with larger organizations and receive substantial funding support from external sources such as Medicare, Medicaid and other categorial support programs. In these settings the management of the billing function may be less important, in that fees-for-service may represent only a minor fraction of income. Primary operating goals are directed toward producing utilization data to meet reporting requirements of supporting agencies and parent organizations, and to support budget requests for funding.

Federal government operations have heavy bureaucratic levels of management above the user operating unit that impose operating rules and reporting requirements. In these setting, since health services are free, there is no concern for individual patient billing and claims preparation. All emphasis is directed toward meeting bureaucratic requirements.

In concluding this section, we would like to stress that the foregoing discussion covers only operating objectives relating to the administrative services provided by an AAMRS; it does not include operating objectives with respect to patient care and operations management.

F TECHNICAL STATUS OF THE SITES VISITED

Introduction:

The sites visited present a wide variety of equipment, technical methodology and operational sophistication.The broad distribution is partially related to the fact that one of the objectives on the site selection algorithm was indeed to visit a wide variety of sites. In this sense, the summary of the sites visited is not a reflection of the current status of medical record systems development in the United States in general. Chapter 5, which will review a much broader range of sites, can be used to provide some impression of this aspect.

Appendix B in this volume can be used to obtain a gross classification of a number of aspects of the sites. The detailed reports in Appendix E should be read however, to make a fair evaluation of the various technologies and their effect on the health care process. Most of the material for this description is based on the Sections 4 (Tasks) and 5B (Processing) of the detailed interview reports. The attached table summarizes some of the technical aspects of the sites visited.

Computer Equipment:

The computer equipment in the sites visited ranged from medium large commercial computers, frequently shared, to large mini-computer systems. None of the sites we visited had what could be called supercomputers nor did we find any micro-computers used for the AAMRS. Seven of the sites were using large commercial machines. Six of those were manufactured by IBM and one, used by Bellevue Hospital, was a Univac 1108. Nine sites used mini-computers, predominately Digital Equipment Corporation machines (7). One system was based on a Data General Nova and one system used was an IBM System/3. The one computer that did not fall into either category was the Univac 492 used by Medical Data Systems for their Automed system. This system is a real-time oriented, medium size computer. The medical record application was the dominant use in all but three of the systems.

All of the mini and midi-systems were fully devoted to medical support. Only three of the shared systems, Stanford University, Clemson University, which supports Greenville, and Baylor Medical College, which

TABLE 4F1

Site	Computer	service	system language	year origin	outputs	space:total/ per.pat./per visit update cycle MTBF
Stanford	IBM 370/158	shared maxi	timesh. PL/1	73 Res	Stat Indiv	8M/8900/2000 7 days 7
ITC	packaged NOVA	dedicated mini	i.m.p. Ass.+table	73 -	Indiv Rep	.9M/1500/420 1 day 120
LA	IBM 300/50	dedicated maxi	trans. Assembler	68 Reg	Pull Rep	2000M/1000/1000 instant 30
East LA	IBM System 3	dedicated mini	batch RPG/Cobol	71 Gov	Rep	5M/500/160 30 days 240
Rockland	IBM 360/67	shared maxi	rem.btch. PL/1 + Ass.	69 Inpat	Rep QC	700M*/25000/2700 1 day+local 4
Yale	DEC PDP 11/20	dedicated mini	batch FORT	72 Res	Indiv Stat	1500M/.1M/10000 several 15
HCHP	DEC PDP 15	dedicated mini+	timesh. MUMPS	70 Inpat	Indiv RepStat	120M/3300/780 2 days 90
Automed	Univac 492	dedicated midi	trans. Assembler	71 -	Indiv Rep	100M/300/100 1 day 360
MUSC	DEC PDP 15	dedicated mini+	timesh. Mumps	73 Teach	Indiv Rep	31M/4400/1200 1 day 360
Green- ville	IBM 370/158	shared maxi	trans. COBOL+Ass.	74 Gov.&Reg.	Rep	68M/560/730 imm. 5
Duke	DEC PDP 11/45	(shared) mini	timesh. table+Ass.	74 Inpat	Rep Indiv	7M/630/180 imm. 10
Regen- strief	DEC PDP 11/45	shared mini	timesh. BASIC+table	73 -	Indiv	1.7M/760/170 3 days 30
Cardio- vascular	DEC PDP 15	dedicated mini +	timesh . Mumps	71 -	Indiv	29M/2200/580 1 day 90
Casa	IBM 360/50	shared maxi	batch PL/1	71 Res	Res, Indiv	18M/3000/850 2-3 days 60
IHS	IBM 370/135	(shared) maxi-	trans. COBOL/FORT	71	Indiv Rep	110M/9100/2750 3-4 days 40
NAS	DEC PDP-15	shared mini +	timesh. Mumps	71 POMR	Indiv Rep	37M/2300/1500 1 day 25
Bellevue	Univac 1108	shared maxi	trans FORT+Ass.	69 Reg	Pull Indiv	240M/16000/14000*+ several days 1

* estimated

\+ on-line only

Abbreviations used in Table 4F1. For further detail please refer to the text. Many terms are also defined in the glossary.

System:	timesh.:	timesharing
	trans.:	transaction processing
	i.m.p.:	interactive mono processing
	rem.btch.:	remote batch
	FORT:	Fortran
Year:	the year indicated here is based on the first year that regular patient data were kept and used through the AAMRS. At times this data had to be estimated from other data provided.	
Origin:	Res:	research derived system
	Reg:	patient registration derived system
	Gov:	government reporting requirements service based system
	Inpat:	inpatient services derived system
	Teach:	teaching goals based system
Outputs:	Stat:	statistical analysis
	Indiv:	support for individual patient care
	Rep:	reports
	Pull:	pull lists for medical record retrieval
	QC:	quality control
Update cycle:		
	imm:	immediate

supports Casa de Amigos, were not primarily used by Medical Record applications. Nearly all computers were owned by the organizations which provided the service. Only one, at East Los Angeles Child and Youth, was leased from IBM. Of the sites visited, nine were based at universities, four were based on commercial vendors of services, three systems were based on County and State service systems, and in one instance, Cardiovascular Clinic in Oklahoma City, the computer is fully owned and operated by the clinic itself. Of the nine university based systems four (Stanford, Greenville, Casa, and Bellevue) use central large computers and two (HCHP and Duke) are based on central sharing of multiple small computer systems. Regenstrief uses its computer for general ancillary services and the AAMRS's at Yale and MUSC where dedicated to the AAMRS.

Programming Languages:

A wide variety of programming languages are in use. Of the sites visited, four sites use the language or derivatives of the language originally developed at Mass. General Hospital, the MUMPS language. Three sites use languages based on PL/1 or PL/1 itself, and at three of the sites applications were programmed using assembly language. Two of the sites visited were primarily COBOL oriented. Both of these COBOL sites require interface routines written in assembly language for their operation. Two sites use Fortran. One of these sites operates primarily in batch: Yale University. The other site, Bellevue Hospital, had to write many assembly language programs in order to achieve on-line operation. Data analysis routines at IHS in Tucson, which is otherwise a COBOL user, are also written in Fortran. The Child and Youth Clinic in East Los Angeles which only does report generation, uses primarily the report generating language provided by IBM. Some COBOL programs are also in use there. Three sites provide table oriented languages to allow the user to specify system decisions and report output without resorting to procedural statements. One of these sites, Regenstrief Institute, has developed the Care language. The Care language allows a specification of algorithms for patient surveillance and for data base retrieval through the specification of decision rules, which can use named variables from the data base and compare the change of variables specified over time. The underlying system at Regenstrief is written in the BASIC language so that the resulting system could be transportable to a variety of sites.

At Duke, the Gemisch System uses a number of specialized table oriented languages for data collection, data base retrieval, and report generation. These are described in somewhat more detail in the site visit report. Insurance Technology (ITC) provides for its users the ability to interactively request a report from the data files. The interaction protocol that was used in the generation of the report can then be stored permanently, so that the same report type can be generated at later dates.

Operational Systems and Their Origin:

Most of the sites visited used an on-line form of operation. Only three sites were primarily batch oriented, and one site, Rockland, provided remote batch services. The operation provided by Insurance Technology is based on a dedicated single user machine. In the other cases multiple users could share the computer equipment. Seven of the systems were based on a time-sharing approach, and five of the systems used transaction processing to provide on-line entry. All the transaction processing systems are based on standard commercial products available on IBM and Univac machines. Time-sharing systems were provided through the MUMPS system (four cases) and at Stanford, through the ACME system. Both of these systems were designed specifically for medical applications. Two of the PDP-11 based systems used DEC's operating systems to provide time-sharing capabilities.

Only three of the systems visited had their origins in inpatient services: MSIS at Rockland, MUMPS at Massachusetts General Hospital; Gemisch at Duke was used originally in specialty inpatient areas. Two of the systems derive their main impetus from patient registration and record accession requirements: Los Angeles and Bellevue; and two systems received their primary impetus from government reporting requirements, namely East Los Angeles and Greenville. Greenville has in a strong desire to centrally register and cross reference health services. The remaining nine systems were specifically developed to serve outpatient medical records requirements as perceived by the institutions. The storage of data is predominantly on-line in all of the systems visited. The exceptions are the two batch operations at Yale and the Casa de Amigos. The systems which have a longer operating history and a large patient population keep a significant amount of data off-line, in order to provide more economical service. This was particularly true at three institutions, Rockland, Tucson and Bellevue. Large removable disk-packs provided the primary storage capacity in all systems. In the few instances where large disks were not available at the time of the visit, they were expected to arrive within a year.

Data Entry Technology:

The predominant means of data entry was keyboarding on CRT terminals. At two sites, the keyboarding was done on typewriter like terminals. Eight sites used primarily keypunching for data entry, and two sites used primarily mark-sensing for data entry. Two other sites also used significant amounts of mark-sensing. In each case mark-sensing was backed up by other means of data entry. Regenstrief was the only site where the mark-sensing was applied to character recognition. Laboratory findings and objective medical findings at Regenstrief were indicated on special computer pre-printed forms which then can be scanned. Where mark-sense sheets were used, clinicians could enter the data directly on the sheets for further reading, relatively little data entry in this case had to be done by MD's.

Only two sites, East Los Angeles and IHS Tucson, backed up their keypunching with full verification. At all other sites the data quality was controlled by review of the input, frequently immediately on CRT screens. At Duke the data collected were redisplayed in new formats specifically for error checking. Editing or limit checking of the input was done at 12 sites although obviously to greatly varying extent. Where free text is used the only checking possible is in the identification fields and input category codes. One site, NAS, has discontinued entry limit checking due to the large number of false indications of errors. Setting a wide limit range avoids most such problems, but will of course detect fewer errors. Cross checking of one variable against others was not used in general, and audit trails of errors were only maintained at five institutions. At HCHP regular audits are made to monitor data input quality.

Two sites, both of which attempted to implement a largely complete medical record for individual patient care used dictation to a large extent. This dictation was then transcribed direct into the computer using CRT keyboards. This was the means of operation at Charleston and at the Brunswick Naval Air Station. At two other sites, free text was an important component of the automated medical record. These sites were the ones serviced by the Automed system, and Bellevue Hospital in New York. At all other sites, coded data predominated. In general, the coding was carried out using pre-printed forms on which data could be checkmarked by the provider. Four of the sites provided for the entry of free text information in addition to the coded information: the Harvard Community Health Plan, the Greenville Department of Public Health, the Cardiovascular Clinic, and the Indian Health Service in Tucson. The design of forms has been a major effort at many of the institutions. Six of the sites visited have provided very carefully laid-out forms and the forms themselves contribute to the care process, especially at Stanford University, where the form is the major document when patients are being seen, and at the users of ITC, where the completion of the form forces the surveillance pattern of the case worker following the workman's compensation case.

Samples of various encounter forms are provided in the detailed reports. It should be noted that the reproduction of the forms reduces their impact. Color is often an important component. At Stanford, Rockland, and Bellevue the color of the form provides form type discrimination. At other sites, Yale and Regenstrief, a single color is used to provide format guidance. At Regenstrief, forms preprinted for individual provider-patient encounters request data entry for items determined to be relevant for the clinic, the patients past history, and possibly the provider. This has encouraged comprehensive data collection from clinical physicians. A highly comprehensive and extensive general form developed at Yale has not found adequate acceptance among clinical physicians. Simpler forms, tailored to specific clinics. as used by Harvard, Greenville, and Bellevue have been more acceptable. The speciality clinics visited, Stanford and Cardiovascular, were of course already selecting specialized data elements for their input forms.

Users of the Medical Data Systems service, Automed, get only minimal guidance in the utilization of the screen formats provided by the system, so that the file design is largely a matter of the initiative of the physician-users. One of the physicians using the service has used the display and file facilities provided in an ingenious way. He has designed problem specific forms so that he is able to enter relevant data for his patients in a small amount of time and can produce a comprehensive medical record based on the prototype form and patient encounter specific data. Two insitutions, East Los Angeles and Casa de Amigos, rely for data entry into the automated medical record on abstracting from a conventional medical record.

Communication Systems:

The on-line systems all require communication facilities which can add considerably to the total operational cost. One exception is the stand-alone system provided by Insurance Technology Corporation. Here, the single terminal is integrated into the desk which contains the computer hardware itself. Four of the systems visited, Charleston, Duke, Regenstrief and the Cardiovascular Clinic in Oklahoma, minimize their communication cost by having the computer close to the area where the service is being provided so that all the cabling remains in-house. The ten other sites obtain leased lines from the telephone company in order to transmit data from the provider's location to the computer. Only in two instances, Medical Data Systems Corporation and Greenville, is a multi-drop technique used to service more than one provider location from one telephone line. However, the Medi tech services to Brunswick are multiplexed to allow multiple transmissions over each of the three available leased lines. Both at Brunswick and Stanford, backup to the leased lines is provided through dial-up techniques. Mini-computers are used for multiplexing transmission lines at Tucson and New York. At Tucson, a system installed at the Health Station in Sells provides both some in-patient care services as well as multiplexing to the computer center in Tucson of a number of terminal lines. At Belleuve, New York, a portion of the development effort has gone into the programming of a PDP-8 and a PDP-11 to multiplex 16 terminals each, for data transmission to the computer center of the University in the Bronx.

Communication problems were regarded in several instances as one of the major detriments to reliability; specifically, Brunswick was suffering from irregular telephone service to Cambridge, and Bellevue in New York had just undergone the disaster of the fire at the Manhattan Telephone Company Substation, so that only one of the two leased lines to the Bronx was operative. Data communications in Houston had been so troublesome that on-line operation of an intelligent terminal, the Four-Phase, had to be discontinued, and other services which could have been provided using the Baylor tele-processing system were also not considered viable. None of the systems, when visited used local,intelligent terminal type facilities to provide computer buffered back-up of data transmission.

File Storage Utilization:

The amount of file storage in use for the various systems varies a great deal. When analyzing how much data are being stored, we have to consider the variables which will affect the data quantity needed. The primary factor of these is of course the number of patients on whom records are being kept and the number of annual visits that the patients make to the facility. Different aging criteria exist in many of the facilities. We found, however, that in general, visit data was being cummulatively collected. Only at the Cardiovascular Clinic was the system designed to remove data from earlier visits that had been invalidated or superseded by more recent data. The age of the system is of course also a factor because we expect data storage requirements to rise asymptotically to some level per patient over time. Then,finally, the degree to which an attempt is made to provide a total medical record or to collect data for subsequent analysis has a major effect on the collected data volume.

The largest amount of collected data exists at the multi-state information system in Rockland. The total data quantity available is approximately 7,500M* characters. We estimate, however, that the data

*M stands for one million

relavant to the two outpatient user sites we visited does not exceed 700M characters. Larger than this quantity is the amount of data collected at Yale, 1,500M characters. The large quantity there is probably due to the desire to collect very complete data, the fact that batch processing is used so that there are no on-line data storage costs, and the fact that Fortran is used to keep the files, which are probably not very dense. This may also be the case at Bellevue which has 240M characters on-line. At Los Angeles County 200M characters are available. Here the data covers, however, an extremely large population. The smallest amount of data used on-line is in the systems provided by Insurance Technology Corporation. At the site that we visited, only 900,000 characters were used to provide the surveillance record for 600 patients.

If we look at the storage requirements per patient, we find that the largest quantity used is at Yale with a hundred thousand characters storage per patient, followed by Rockland with 25,000 characters per patient. A considerable amount of information also has been collected at the Indian Health Service with 9,100 characters per patient over the history of the system, and at Stanford with 8,900 characters per patient. The high number at Stanford is probably a reflection of the fact that for analysis many data are stored in multiple files so that there is a great deal of data redundancy. Bellevue Hospital in New York seems to use 16,000 characters for recent patients which may be attributed to the use of free text and about 2,000 characters for all patients for registration and key data. The Medical University of South Carolina at Charleston has 4,400 characters per patient.

All the remaining systems are storing 3,000 to 1,000 characters per patient. The four systems which store even fewer data are East Los Angeles, with 500 characters per patient which is due to the fact that they only collect data required for federal reporting; Automed uses only 300 characters per patient which is probably due to the fact that most physicians only collect billing data; Greenville, with 560 characters per patient due to the fact that they have a large portion of their patients identified but not active in the system, and Duke, with 630 characters per patient. At Duke, the major factor may be the Gemisch System, which allows very compact data storage. Many variables in the Gemisch System can be stored within three bits per value.

The picture does not change greatly if we estimate the character of storage used per visit. We now see a range of 1,500 to 100 characters per visit. Exceptions are Yale, Bellevue, the Indian Health Service, Rockland, and Stanford, which store respectively, 10,000, 6,000, 2,700 and 2,000 characters per patient visit. The ease with which storage is available seems to be a contributing factor. Except for Yale, which stores data off-line, all the big collectors use large computer centers, on which large disk files have been available for a long time, so that the cost of on-line storage has been relatively low.

Terminals:

The number of terminals provided at the on-line sites ranges from 64 to 1; the largest quantities, 64 in Los Angeles, 35 at Bellevue in New York, and 27 at Greenville, are supported by large computer systems. The MUMPS system at the Medical University of South Carolina supports 26, the one at Harvard 20, the one at Brunswick 18, and the one in Oklahoma, 12 terminals. It should be noted that the terminal activity at the Medical University of South Carolina is quite low, and that at Brunswick only 13 terminals of the 18 will be active at any one time due to the limited number of ports which have been obtained for this service. The IBM 370/135 used by the Indian Health Service supports 18 terminals. In some of large shared systems, the sum of the terminals available to the medical record application may comprise only a small portion of the total system load.

Year of Service:

The sites that were visited were in different stages of their development cycle. Six of the sites began providing significant services in the outpatient area in 1974, one in 1972, two each in 1969 and 1974 and one, Los Angeles County has been providing scheduling services in the outpatient area since 1968. This last system is only a very limited medical record application. The difference in age reflects less on technology and programming languages used,or similar aspects,than might be suspected. No mini-systems were established, however, before 1970, but since then both mini and large systems have continued to be implemented. Since 1971, no systems based on Fortran have begun service.

On the other hand, in 1973 and 1974, two systems, Regenstrief with the Care Language, and Duke, with the Gemisch System, have implemented new table-oriented languages. The intention of this approach is to remove most of the procedural specifications from the programming systems. Throughout the period of development seen at the sites visited, systems have been based on on-line access through time-sharing or transaction processing. Only in 1971 and 1972 were batch systems initiated.

Status of the Systems:

At most of the sites visited production requirements dominated development requirements in terms of computer services used. Stanford was the one exception from this picture which may be attributed to the fact that direct patient care is done using the manual forms rather than using computer output. At Yale, development activities were becoming predominant due to the discontinuation of the service to the local HMO. At two sites, Harvard Community Health Plan with the Laboratory of Computer Science, and at Duke University continuing system development was a major effort, but was carried out on separate computer systems. At Greenville, Regenstrief, IHS, Bellevue and Rockland, development activities still comprise a major portion of the computer system effort. For some other sites, development is currently negligible. Specifically, Brunswick, due to lack of interested management and resources, and at the Cardiovascular Clinic in Oklahoma, Casa de Amigos in Houston, East Los Angeles, and Insurance Technology, the systems are adequately stable so that current development is minimal.

When the total technical development effort is considered then we find that Stanford, Rockland, Yale, Duke, Regenstrief, and IHS have a substantial faction of their total resources devoted to development.

Of the sites that we visited, four can be said to have attempted to implement totally automated medical records. We consider that a system is total if all the paper routinely used in health care delivery is computer processed. Graphical data as X-rays, EKG-tracings, and old source documents, as referral letters, are excluded. The four total sites according to this definition are the Harvard Community Health Plan, the Medical University of South Carolina at Charleston, the Cardiovascular Clinic in Oklahoma City, and the Brunswick Naval Air Station.

Two of these sites, the Brunswick and MUSC depend largely upon dictation and hence provide little analyzable data. The system at Oklahoma City does not have data analysis as one of its objectives, so that the system at the Harvard Community Health Plan is unique in being a relatively total medical information system with much of the data in coded form. Much more coded data is collected at the Immunology Clinic at Stanford. Here however the intent is to provide very comprehensive information in a single speciality rather than a total automated ambulatory medical record system. One user of the Automed system, Dr. Straub, is also very close to having a fully automated system. However, here again, the analysis capability of the data collected is less than would be desirable from a research standpoint. The capability for automated data analysis was also prominent at Yale and at the IHS operation at Tucson. At Tucson, the intent, however, is not to replace the paper medical record on the sites but to provide a comprehensive medical record that can be shared between the sites.

Utilisation reports are provided by most AAMRS's. Statistical analysis of the collected data has been carried out to the greatest extent at Stanford but data analysis is a regular service at the Harvard Community Health Plan, Yale University, MUSC and the Casa de Amigos.

At twelve sites individual patient-care usage of the medical record systems can be considered predominant: ITC, Yale, HCHP, Automed, MUSC, Regenstrief, Cardiovascular, Casa, IHS, NAS, and Bellevue. At four of these sites, Automed, Cardiovascular, Regenstrief, and Bellevue, little use of the collected data has been made yet outside of this primary area. This is due either to lack of need, newness of the system, or lack of funding for this purpose.

If one wishes to look at the system to judge the extent that they have attained production status, we find that there are eight systems which are now primarily production operations: ITC, Los Angeles, East Los Angeles, Rockland, Automed, Cardiovascular, IHS, NAS, and Bellevue. A large amount of development is still taking place at Harvard Community Health Plan, MUSC, Duke, and Greenville and IHS. At MUSC, development is currently somewhat inhibited due to personnel changes, but it is expected that this will change soon. Regenstrief and Casa, even though they both provide production services, have major development and evaluation components in their systems whereas Stanford and Yale are primarily oriented towards research.

If we correlate these areas: completeness of record and production status we find production services in the full range of total medical records to simple registration and reporting systems. Among the systems that we visited which were in the development stage, most of them had more ambitious plans, although the system at Yale is the only one which is currently developing approaches to a total automated ambulatory medical system. All other sites had more specific and limited objectives.

Computer Reliability:

The reliability of the computers was not an actual major concern at most of the sites visited. However, the figures on reliability were still not always as low as might be considered desireable. The mean-time-between-failures (MTBF) ranged in our sample from 1 day to 1 year. The mean-time-between-failures for all computer systems together was 87 days. If we separate the mini- and the maxi-computers, we find a range for the maxi-computers from 1 to 60 days between failures. The high number, 60 days, at Baylor, is actually in an environment where failures are not apt to effect the users operation, since the system services are provided strictly through batch processing. In such an environment minor failures would not be counted into the operational reliability figures which we were trying to obtain. Including this system, the mean-time-between-failure in maxi-systems is 21 days. If we look at mini-computers, we find a range from 10 to 360 days. The low numbers in fact, 10 and 15, were at institutions which are doing a significant amount of development work on the basic computer systems, which would typically impact system reliability. The mean-time-between-failure for all the mini-computer systems was 21 days. The one midi-system that provides the Automed services, was rated at one failure per year, and has not been included in either of the two above categories. All users which were providing production services had developed backup means to protect the users from failure. In serious failure cases, however, up to one day's data would have to be re-entered at most of the sites visited.

The mean-time-to-repair was generally given as a few minutes with in-house personnel restarting the system without doing any actual repair, to a few hours when a service call was required. Rarely have systems been unavailable for more than one day. Software changes were rarely indicated as a major reason for system problems. Only at Bellevue Hospital, where the entire communications system was built in-house do software changes affect operational reliability at times.

Protection of Privacy:

The protection of privacy provided for the medical record data was quite limited at the sites visited, although generally considered to be adequate. Even where facilities for extensive privacy protection were available, they were frequently not used. For instance, no one using the Stanford system has made use of cryptographic encoding of data.

Two sites report access violations or attempts to gain unauthorized access. Meditech, in their services, reports attempts to use a file which does not belong to the user to the central computer operations in Cambridge, whereas the system provided by Clemson University at Greenville reports violations to the Director of the Public Health Department. Clemson has also provided password encoding which is such that systems personnel can not gain access to the system. The passwords at Duke were also protected, and those at Automed could easily be changed by the user so that the systems staff did not have convenient access to the data in the users files.

Rockland had studied the legal aspects of access to the psychiatric data and a statute in New York State, based on this research, prohibits data from being shared among institutions and from subpoena to the service center, although the normal legal access to data at the individual sites exists.

The contraints of physical access to the terminals, the knowledge of passwords, and the system operations were in general considered adequate to provide the necessary protection. Data which might be considered particularly sensitive were not entered at Bellevue. Except in the cases mentioned, systems personnel at the computer sites could access user files with minimal efforts.

Training:

The amount of training provided to the users was generally minimal. Frequently little documentation was available, and even when it was available it was not oriented towards needs of the user. We will cite some of the positive examples: Stanford had some user-oriented documentation which helped a user set up the data base system, but no end user documentation for the rotating interns in the clinic other than a familiarization sheet for the entire clinic. ITC provides hand-on training for its user and has a consultant available on call. Rockland provided new installation with a professional training team, which is subsequently available on the telephone for advice. As part of the training program in Charleston, concern existed to improve the documentation for the physicians there. At Duke, discussion of computer system use forms part of the weekly meeting of physicians and residents. A HELP function was available in the computer system at Bellevue so that someone who had enough knowledge to evoke the Help function could get detailed instructions on how to enter data. This information was mainly oriented towards clerical use.

In most instances clerical users were trained using on-the-job training methods and in some instances low turnover was cited as a reason for the high expertise of clerical staff regarding the computer operation.

G FINANCIAL STATUS

Development Effort:

The length of the initial development period ranged from one to seven years and total expenditures for the initial development period ranged from $100,000 to $10,000,000. The distribution of development costs per year, exclusive of equipment purchases, were as follows: (data available for only 15 sites)

Up	to	$100,000	3	sites
$100,000	to	$300,000	8	"
$300,000	to	$500,000	2	"
Over		$500,000	2	"

It should be noted that the estimates for the development effort are rough estimates made by the site representative or derived from other data provided by the site representatives. Accordingly, the figures should be considered only as a gross indicator or approximation of funds devoted to development.

For all but one site visited, there is continuing ongoing development, and the percentage of the operating budget for development efforts ranged from 9% to 76%. The distribution of the current development effort, in terms of percent of current expenditures follows: (data available for only 12 of the 15 sites)

56% - 76%	4	sites
22% - 38%	5	"
under 20%	2	"

Even though our criteria for selection of sites to be visited was that the system was operational, it is clear that there is still a considerable amount of effort being devoted to further development of the systems. The technical status of the development effort has already been discussed. Table 4G1 presents a list of sites showing funds allocated to development, the initial development period, average size of patient population and current number of patients visits per year to the AAMRS user.

Table 4G1

4G2

DEVELOPMENT COSTS

	Patient		Initial Development		Ongoing Development	
Site	Visits*	Pop.*	Period+	Amount*	Amount*	% of Total AAMRS Expend.
Stanford	4	.9	2	$ 100	$ 61	75%
LA	2,000	2,000	5	4,400	200	9
Rockland ***	**	300	7	10,000	557	56
Yale	150	15	3	1,000	214	68
HCHP	155	36	5	2,500	154	29
Automed	**	**	4	1,000	**	**
MUSC	25	7	4	1,000	57	22
Greenville	94	47	2	400	197	38
Duke	40	11	2	550	80	33
Regenstrief	10	2	1	236	169	76
Cardiovascular	26	12	1	230	17	18
Casa	21	6	4	745	**	**
IHS	40	12	3	450	347	38
NAS	20	16	3	500	0	0
Bellevue	70	50	6	300	222	36

* Patient data and dollars are in 1,000's. + In years.

** Data not available.

*** Development period included initial and continuing deveopment after operations began.

Financial Independence:

Another indicator of the status in the development cycle with respect to funding is the extent to which the AAMRS has achieved financial independence. The following factors can be considered as indicators of financial independence:

Dependence upon external support - primarily federal grant funds,

User support: from user charges, or by direct funding by the user,

Total cost justification resulting from operational cost savings for individual users or the total system,

AAMRS services being sold by private for-profit organizations,

Dependent upon direct appropriation from parent organization, and

Future development efforts requires external support.

Table 4G2 presents a listing of the sites with their respective indicators of financial independence. It is interesting to note that of the six sites that have a major source of support from external sources, only one is also deriving some support from user charges. All of the other sites with major external support, also derive some direct support from the user, but in most cases the support is minor and is associated with the support of user personnel interacting with the AAMRS, such as data entry, medical record, and other clerical personnel. Except for HCHP, none of the five sites with major outside funding and some direct user support, is deriving user support for systems development or computing services support.

Four sites can be considered as totally cost justified, one is the entire system acquired by a private group practice, and the others are justified by the individual user sites. Two of the systems are being sold by private for-profit organizations, and the cost justification is based upon the fact that the users are willing to pay the market price.

Table 4G2

INDICATORS OF FINANCIAL INDEPENDENCE

1 Total cost justification: total system.
2 Total cost justification: individual users.
3 AAMRS services being sold by private for profit organizations.
4 User support: user charges.
5 User support: direct support.
6 Dependence upon external support - currently have support.
7 Future development efforts require external support.
8 Dependent upon direct appropriation from parent organization.

Site	1	2	3	4	5	6	7	8
Stanford				X		Xm	X	
ITC		X	X	Xm				
LA								Xm
Rockland		X		Xm	X	X	X	
Yale					X	Xm	X	
HCHP					X	Xm	X	
Automed		X	X	Xm				
MUSC					X	Xm	X	Xm
Greenville				Xm	X		X	
Duke			X		Xm	Xm	X	
Regenstrief								Xm
Cardiovascular	X				Xm			
Casa					X	Xm	X	
IHS								Xm
NAS					X			Xm
Bellevue					X	Xm	X	

(Xm = a major source of support greater than 40%.)

In general, it can be said that further development efforts will require external funding support. The exceptions are the private for-profit corporations, the private speciality group practice, and the direct Federal operations. For these sites continued development will be supported by internal funds, or direct Federal appropriations.

Benefit Achievement:

The extent to which a user or parent organizations will support the AAMRS is influenced by the benefits realized from the system. Tables 4G3a and b present the measures of benefit achievement for each site. Benefits may be realized from the operational aspects of health care (process) as well as the affect of the AAMRS on the ultimate health status of the individual patients (outcomes). From an operational point of view the user's management or parent organization will look to benefits actually being realized as justification for support of the system's operational costs, rather than projected benefits to be realized upon the attainment of outcome objectives. That is, in order to justify the current operating costs, the user will look to process measures, rather than outcome measures. Accordingly, the benefit analysis presented in Table 4G3 is primarily based upon process measures, as outlined in the economic analysis interview guide. If any information was available on outcome benefits realized it was incorporated into the measures of benefit achievement. The criteria for assigning the measures of benefit achievement for the benefit categories is explained in the table and discussed in Section 3D.

Table 4G3a

MEASURES OF BENEFIT ACHIEVEMENT
Tangibles

	$ Estimate	Systems Costs	Health Manpower	Cost of Health Care	Financial	Operations
Stanford	12,400		$	$		
ITC - user		+++	+++		+++	
LA		+	+++			++
Rockland:						
Pomona	150,000		+		$	
Connecticut	300,000	+		++	$	++
Yale			+			
HCHP	54,000	$	++	++	++	+++
Automed		+	++		+++	+++
MUSC				+	+	+
Greenville		+	++	+	+	+
Duke		+		+	++	+
Regenstrief		+	++			
Cardiovascular	70,000	$	$ ++	+	+++	$
Casa - user	5,000		+			$
IHS	240,000	$	$			$
NAS		++	+++	+++		++
Bellevue		+	+	+		+

Legend:

Tangible:

+	Minor
++	Moderate
+++	Significant
$	Quantified

Table 4G3b

MEASURES OF BENEFIT ACHIEVEMENT

	Provider Intangibles			Societal Intangibles				
	Quality	Access	Manage-ment	Tech-nical	Quality Meth.	Re-search	Train-ing	Plan-ning
Stanford	++	+	+		+	+++	++	
ITC- user	++	++	+++	++	+			+
LA	+	++	++					+
Rockland - total				+	+	++	+	++
Pomona	0	+	+++					
Connecticut	++	++	+++					
Yale	+	0	-	+		+		+
HCHP	++	+++	++	+	+	+	+	+
Automed	++	+	++	+	+			
MUSC	++		+		+		++	
Greenville	++	+++	++	++		+	+	++
Duke	+	0	++	++	0	++		
Regenstrief	++	0	0	++	++	++	++	
Cardiovascular	++		++	+	++	+		
Casa - user	++	0	++	+	+	++	+	++
IHS	+++	++	+	+	++	++		++
NAS	+++	++	+	++	+	++	+	+
Bellevue	+	+++	++	+				+

Legend:

Provider Intangibles:

- \- Negative benefit
- 0 No benefit, but explicit objective
- \+ Some but more indirect or derived; not readily visible to user
- ++ Moderate, readily visible to user, but not a major justification of the AAMRS
- +++ Major benefit, major system justification

Societal Intangibles:

- 0 No benefit, but explicit objective
- \+ Some, and/or not published
- ++ Moderate and published (for training and planning; "published" need not apply if benefit is operational and visible)
- +++ Significant impact and published

Using the cost and benefit data for each site, a cost-benefit status measure was developed as an indicator of the extent to which the benefits realized to date are contributing to the attainment of developer and provider objectives. The basic concept behind the cost-benefit status measure is that if all objectives and expected benefits were realized a conservative estimate of the value of the system would be its cost. The justification for this concept is that the decision to automate the medical record was based on the assumption that certain benefits were to be realized, and that the realization of these benefits would justify the cost of the system. For the purpose of this analysis the cost of the system is defined as the annual operating costs, which includes the amortization of equipment purchased during the development period.

In recognition of the fact that nearly every site was still involved with some aspect of development, the cost-benefit status reflects the relationships between annual operating costs and benefits realized at the time of our visit. (The looseness of the cost and benefit data collected for each site, particularly initial development costs, makes this the only reasonable approach. A more sophisticated analysis would require more precise data.) The cost-benefit status for the sites is contained in Table 4G4. The cost-benefit status shows the extent to which the operating budget is justified by the three main benefit categories, tangible, provider intangible and societal intangible, on an individual and cumulative basis. A detailed description of the methodology used for arriving at the benefit status is described in Appendix C. In order to place the cost-benefit status in proper perspective, Table 4G4, also shows the status of the site with respect to routine operations, development efforts, and level of objective attainment.

Table 4G4

COST BENEFIT STATUS MEASURES

WITH LEVEL OF OBJECTIVE ACHIEVEMENT AND STATUS OF OPERATIONS

Site	Cost-Benefit Status Measure					LOA	Status of Operations Production		Development		
	T	P	T+P	S	T+P+S		E	R	Hi. Ea.	Con. Add.	Tr.
Stanford	.15	.18	.33	.34	.67	++	←	x	←	x	x
ITC**	.60	.23	.83	.04	.87	++++		x			x
LA	.20	.22	.43	.10	.52	+		x		x	
Rockland*	.13	.27	.40	.19	.59	++++		x		x	x
Pomona**	1.74	.18	1.92		1.92						
Connecticut**	2.89	.31	3.20		3.20						
Yale	.02	0	.02	.20	.22	+	x		x		
HCHP	.40	.31	.71	.07	.78	+++		x		x	
Automed*	.67	.06	.73	.03	.76	+++		x		x	x
MUSC	.07	.20	.27	.20	.47	++	←	x	←	x	x
Greenville	.10	.31	.41	.20	.61	+	x			x	
Duke	.10	.10	.20	.18	.38	+	x		x		x
Regenstrief	.03	.11	.14	.27	.41	+	x		x		
Cardiovascular	.95	.40	1.35	.04	1.39	++++		x		x	
Casa**	.13	.18	.31	.23	.54	++	x →		x ←→	x	
IHS	.24	.33	.57	.23	.80	+++		x		x	x
NAS	.25	.27	.52	.14	.66	+++		x			
Bellevue	.07	.33	.40	.10	.50	++		x		x	

Legend:

* Vendor
** User
← Transition

T = Tangible Benefits
P = Provider Intangible Benefits
S = Societal Intangible Benefits

LOA = Level of Objective Achievement
See Table 4M2, Section 4M.

E = Early
R = Routine

Hi. Ea. = High level of development at stage of implementation
Con.Add. = Continuing additional development
Tr. = Transfer to other sites or users

H TECHNOLOGICAL VS. MEDICAL ORIENTATION

In Sections C,D,E, and F we have summarized observations recorded at each site and have compared sites along a single dimension emphasizing similarities and significant exceptions. In this section we seek to relate those factors of medical and technological importance that have been blended at each of the sites and have led to varying degrees of clinical and administrative utility and user acceptance. We have attempted to relate the mix of experience in terms of medical (practicing physician), medical systems (physician-computernik), technical (programming and engineering competence), and computer science background of the team of developers at each of the AAMRS projects to enable the reader to understand the wide variance of the current status, acceptance, and future likelihood of cost-effective operations.

Some of the more critical factors taken into consideration from the clinical and managerial viewpoints and from the technical viewpoint are presented in Table 4H1 and are discussed briefly below. We defer until Section 6H a discussion of the appropriate application of recent science, i.e., whether physics or engineering is more appropriate for building bridges.

Features worthy of special mention at each of the sites follow below:

Stanford: Source data is collected on a flowsheet which remains in the chart as the encounter record. The acceptance of the system by other

TABLE 4H1

TECHNOLOGICAL VS. MEDICAL ORIENTATION

Site	Devel (1)	Support (2)	User Accept (3)	Med Obj (4)	Admin Obj (5)	User Doc (6)	Trans Pot (7)	Recent Innov (8)	Non-Sub (9)
Stanford	M+CS		+	+	N/A	+	⊕	+	
ITC	M+T		+	+	+	+	⊕	+	+
LA	T		+	N/A	+				
ELA	T	M	+	N/A	+	+	+		
Rockland	T	M	+		+	+	⊕		+
Yale	MS	T						+	
HCHP	MS+M	T	+	+	+		+	+	
Automed	T	M	+	+(vs)	+	+	⊕	+	+
MUSC	M	T(C)	+	+			+	+	
Greenville	M+CS		+	Dev	+		+	+	
Duke	MS	T		Dev	Dev		⊕	+	
Regenstrief	MS	T	+	+	Dev	+	+	+	
Cardiovascular	M	T(C)	+	+	+		+	+	+
Casa	MS	T	+	+			+	+	
IHS	T	M	+	+	+	+	+	+	
NAS	M	T(C)	+	+	+	+	+	+	
Bellevue	M+CS		+	+	+	+		+	

(1) Developer of system: M = Medical; MS = Medical System; T = Technical; CS = Computer Science
(2) Supporting Staff: same symbols as for developer; (C) = Commercial vendor
(3) User acceptance: + = acceptable
(4) Medical objectives achieved: + = achieved; N/A = not applicable; Dev = system still in developmental state.
(5) Administrative objectives achieved: same symbols as in (4).
(6) User documentation: + = System documented for user.
(7) Transfer potential: + = transferable; circle indicates transfer to another project, or services expanded to other physical sites.
(8) Recent innovation: + = significant achievement (see individual site descriptions in text.
(9) Non-subsidized operations: + = User pays for all services.

users (resident physicians in training) has been high because of the leadership role provided by the system developer. The time-oriented data base concept has been adopted at the University of Alabama in Birmingham to establish a data base on home-dialysis patients and by the Rand Corporation, to establish a clinical data base for drug trials. Medically useful new data has resulted from this project, i.e., the natural history of lupus erythematosis and other similar diseases, by computer manipulation of this deep database. The file structure is a schema + tabular file. Files are inverted and compressed for fast searching and economical storage.

<u>ITC</u>: This is a stand-alone system. It utilizes a unique "multi-track system" for comprehensive care of disabled workers. In the design phase there was heavy clinical and psychological input to the design of the system. This is the only system where the major user is not a clinician. The developers have clearly demonstrated the impact of the system on health care outcomes (reduced disability), and have demonstrated cost effectiveness (reduced dollar reserves) as well. The file structure used is a fixed tabular file with pointers.

<u>LA</u>: The major impact of this system has been on access to care achieved by improving the access of the provider to the medical record at the patient encounter. This is a very large system predicated on a huge urban population, and will be difficult to transfer elsewhere because of this factor.

ELA: This is a typical Children and Youth Project type of data system designed by the Systems Development Project in the Health Sciences Center of the School of Public Health at the University of Minnesota. The dedicated small computer system at ELA produces reports for administrative purposes only.

Rockland: The ambulatory medical system is an offshoot of an existing psychiatric inpatient research system. The ambulatory system is evolving primarily as an administrative system rather than as a clinical system. Data is captured using carefully designed self-encoding forms. The acceptability of the system has been proven by its adoption by other state government agencies. The developers have been extremely sensitive to the issues of privacy and confidentiality. This system was operational very early relative to other sites visited, which explains the technological directions in which the project has evolved. The project is an early user of the IBM data base software (IMS Precursor).

Yale: This project seeks to test the validity of clinical event coding using self encoding forms. This concept remains to be verified. The system uses Fortran files.

HCHP: This is the first civilian system to dispense with the traditional record. The system is based on hardware no longer cost competitive. It is integrated with the administrative aspect of an HMO. Self-encoding encounter forms are utilized. The system files are hierchical without a schema.

Automed: The system is quite flexible and uses a "file drawer" system design to attract a private practitioner. One of the users (Dr. Victor Straubs) has been effective in stimulating new directions for expanding services. The system uses labeled variable-length records with indexes.

MUSC: The developers consider this information system vital for training. It is well integrated with the financial aspects of practice, and with the training of the residents in Family Practice.

Greenville: This is an innovative administrative umbrella for intergrating services for a number of public agencies. It is still in a developmental state, and the medical services interfaces are not yet well integrated. The file utilizes a schema with hierarchical and network structure. Also used is a modern commercial data base software product produced by the Cullinane Corporation.

Duke: The system uses innovative software: a file structure with a tabular file and a hierarchical schema. This is one of the few projects to be linked directly to a department with health services research activities. It is still in the developmental stage and is difficult to evaluate.

Regenstrief: The system uses the Care language for surveillance and inquiry, and also incorporates a database management system for analysis of data on a small dedicated machine. The encounter forms are both disease and patient-specific thus achieving a very high density of information on a single page. This department also has a health services research orientation and is conducting controlled experiments to measure the effect of information systems on health care outcomes.

Cardiovascular: The clinical system is completely integrated with the financial aspect of the practice. The group is experimenting with alternative modes of providing health services for patients with hypertension. They utilize a well designed self-encoding physical examination form. The computer system also provides services to the in-house laboratory. This is one of the few systems with a direct link to its inpatient service (a terminal in the emergency room of the local hospital). The group uses no traditional record. The computer assisted history taking system was unique among the sites visited.

Casa: This is a project with a strong health services research orientation. It is evaluating the effect of technology on health care delivery, and has discarded modules which are found to be ineffective cost-wise. Modules retained have been shown to be cost effective.

IHS: This project makes services available at multiple sites on the Papago Indian reservation. The traditional record is replaced with output from the computer system in non-clinic settings. Extensive use of paramedical personnel is an important feature of this site. It has a long history of tracking the immunization status of its population and active follow up to insure adequate immunization. It is currently developing methods for identifying at-risk populations for screening programs.

NAS: This was the first system to dispense with the traditional record. There is an obligatory physician/computer interaction, but despite this there is satisfactory user acceptance. The system transmits physicians' orders directly to both the laboratory and the pharmacy thus eliminating transcription of information on paper forms. Even after the original system developer retired from the armed services to go into private practice, the system has continued to operate routinely, and is being funded by operational funds of the Bureau of Medicine, US Navy. This system is to be replaced by a not-yet defined or implemented supersystem for all the three services (TRIMIS).

Bellevue: This is another Children and Youth Project, but in contrast to the ELA project, this one produces output for the clinical provider as well as generating reports for administrators. In the emergency room the patient profile frequently serves as the only record available when the provider sees the patient. The system has allowed the integration of multiple services in what is frequently a difficult clinical setting, a university hospital outpatient department serving a large inner core urban population.

I. POPULATION CHARACTERISTICS

Introduction:

Another criterion for classifying the sites visited is the type of population served. Since there are now a number of Federally-sponsored programs which address themselves to specific populations (aged, indigent, child and youth, etc.), the categorical grants to these populations have caused changes in the health care delivery system serving these populations. Frequently, additional record-keeping is required due to the specifications of the supporting grant and sometimes also due to the team approach to health care used to deliver this care in an effective manner, which requires increased communication between the providers at these institutions. Table 4I1 provides a summary of some of the major characteristics of the types of population served. The population at some other of the sites visited was self-selected due to the category of service provided, since the sites provided secondary or tertiary specialty care and hence did not attract a typical population. These factors can determine the characteristics of the medical record, its content, and its use in aiding routine delivery of care. Table 4J3 provides quantitative population data.

Indigent Populations:

Five of the sites visited were government-subsidized and government-administered programs, primarily designed to support the provision of primary care services to minority groups. The largest of these, serving Los Angeles County, supports the registration of two million visits per year for a primarily low-income, chicano and black population. This system also serves some specialty interests: diabetics and patients with various cardiac prosthetic devices are flagged in the records so that appropriate care can be delivered during the encounter. Los Angeles County has, also, a separate institution serving a young (newborn to nineteen years), Spanish-speaking population in East Los Angeles, which accounts for about 32,000 visits per year. Another pediatric population service visited was at Bellevue Hospital in lower Manhattan. Here again, an indigent population is served, supported by categorical grants which are now administered through New York City's Health and Hospitals Corporation. The Bellevue Clinic sees 40,000 patients per year in the scheduled clinic, but also provides records in pediatric emergency, which serves 30,000 visits per year.

Table 4I1

POPULATION CHARACTERISTICS

Site	Area	Pop.	Age	Eth. Fac.	Prim./Sec./Ter.	Appoint. Percent.	Specialty
INDIGENT POPULATIONS							
Public Support:							
LA	urban	large	-	S	PST	60	all
East LA	urban	limited	p	S	P	80	pediatric
Bellevue	urban	large	p	S	P	80	pediatric
Greenville	mixed	large	-	-	PS	40	some
Regenstrief	urban	small	-	-	P	50	diabetic, medicine
IHS	rural	medium	-	I	P	-	all
Pomona & Conn. (Rockland)	u/s	ea.lim.	s	S	P	80	psychiatric
Casa	urban	limited	-	S	P	50	-
NON-INDIGENT POPULATIONS							
Fee-for-Service:							
Users of Automed (most)	u/s	small-lim	-	-	PS	80	several
Cardiovascular	u/s	medium	s	-	S	90	cardiovascular
Fee-for-Service with Educational Support:							
Duke	u/s	lim.-med.	g	-	P	40	-
MUSC	u/s	limited	f	-	P	80	-
Stanford	u/s	small	s	-	ST	100	immunology, other
Capitation:							
CHCP (Yale)	urban	limited	w	-	PS	90	several
HCHP(some indig)	urban	lim-large	y	-	PS	80	all
Employment Related Support:							
NAS	u/s	medium	wr	-	P	70	some
Users of ITC	u/s	small	w	-	ST	-	trauma

LEGEND:

Population:

- large — greater than 40,000
- medium — 10,000 to 40,000
- limited — 10,000 to 4,000
- small — less than 4,000

Ethnic Factor:

- S — Spanish speaking
- I — American Indian
- \- — No problems indicated related to ethnicity of population.

Age:

- \- — population mix
- p — pediatric
- w — working population
- y — young working population
- r — retired
- f — families only
- s — specialty causes some age discrimination

Other Federally-subsidized and -administered projects serve a primarily low-to-middle-income population in Indianapolis, Indiana, at Marion County Hospital, although access is also provided for city and county officials and employees. The AAMRS at this site, which is provided by Regenstrief Institute, supports currently the diabetic and one medical clinic, with about 10,000 visits per year. Harris County Hospital provides services at various neighborhood clinics in Houston. One of these clinics, Casa de Amigos in the primarily Spanish-speaking downtown area, is supported by the Baylor College of Medicine. This clinic provides 21,000 patient visits per year. Another site supported by Federal categorical grants is totally dedicated to the American Indian population on the Papago reservation in Arizona, and is administered by the Indian Health Service. In contrast to the previous services directed toward urban populations, this system serves a mobile rural population scattered over some 4,300 square miles. The 12,000 Indians on the reservation account for about 40,000 visits per year.

The Public Health Department in Greenville, South Carolina, addresses the needs of a rural, suburban, and urban indigent population in the Appalachia II district, with a population of about 450,000. The institution is the regional public health center and is associated with 131 clinics providing services; most of these are neighborhood- and hospital-based. The population served is largely black, and at the time of our visit, about 60,000 visits were recorded per year. Since this system was still in an early stage of development, the eventual population base and activity are difficult to establish.

A population group selected because of their health problem, which for a long time has been treated by some state-funded health care services, is the population requiring psychiatric care. This segment of the population is served by the users of the Rockland State Information System (MSIS). The system was observed in operation at two different sites. One was the Pomona Mental Health Center in the predominantly white Rockland County suburbs north of New York City, and the second was located in New Haven, Connecticut and served primarily a large white, Spanish-speaking group. The needs of both populations are for continuing primary mental health care on outpatient basis. The MSIS system supports the 60,000 patient visits per year for the Connecticut population, and the 200,000 visits per year for the Rockland County population, as well as many other sites.

All of these systems have in common, to a greater or lesser extent, some features associated with institutional health care: There is a large population in need of better access to care; there are often social problems with delivering the care; the rate of no-shows gives concern to those providers anxious to provide continuity of care to the population. There is the need to serve drop-in patients and emergency patients well, and, due to the size and the mobility of the population, it is often difficult to retrieve the medical record in time. Relatively minor improvements to the health care management system at these institutions may result, when aggregated, in significant benefits.

Non-Indigent Populations:

There are several ways in which the non-indigent population supports its health care needs. We visited various examples, but did not exhaust the possibilities now available for health care funding. The traditional means of payment for ambulatory health care is fee-for-service, and we visited both a primary and a secondary health care provider in this category. At three other sites, the basis of operation was fee-for-service, but the computer system was justified at those sites due to its educational or research benefits. Details of these sites are found in Table 4I1. The provision of services by capitation payments, often supported as part of an employment benefit, provides another means of payment for health care. We visited two such HMO sites. Employment-related support of health care is also provided for the military and in workman's compensation cases.

The private practitioners who used the Automed system were primarily concerned with the billing and financial aspects. This generates the major benefit obtained by the use of the automated system, although some physicians are using the system for their primary medical record as well. At the Cardiovascular Clinic, the system is integrated into all operations of the group practice and both maintains specialty-oriented medical record and carries out all accounting functions.

The Community Health Science Department at Duke University operates a clinic which serves as the pilot vehicle for the GEMISCH computer system, developed in the Department. The clinic functions serve primarily students, university or outside employee-group patients through contracts for physical exams prior to employment, and sees also some primary care patients. Forty-thousand visits per year occur in this clinic, but the nature of the population may diminish the potential benefits to be gained due to the health standard and the turnover of much of its population. It is the intention to use other clinics to test further the ambulatory aspects of the system. At the Medical University of South Carolina, the Family Residency Program takes in a mixed population oriented towards the training needs of the Department. The population is made up entirely of family units, generates about 25,000 visits per year, and is selected for its potential benefits to the training program. At Stanford University, the Immunology Clinic sees a highly-selected specialty population requiring secondary and tertiary care. Here the benefits of the AAMRS are related to the ability to gain a better understanding of the disease, the application of the experience gained to new, incoming patients, and the dissemination of the experience through research publications.

Sites where the patient population is encouraged to seek effective preventive care in order to reduce total health care costs, and where the fee-for-service system has been abandoned, were two of the places that we visited. These were at the Community Health Care Plan in Connecticut (served by Yale University) and at the Harvard Community Health Plan (served by the Laboratory of Computer Science of Massachusetts General Hospital). Comprehensive in-house, primary and secondary care with follow-up for incipient problems, and some degree of utilization control are the care components used to minimize hospitalization costs. Adequate patient service utilization records, as well as records that assist in the provision of continuity of care in the group health care setting, can generate important benefits to be obtained from an AAMRS. The capitation fee is often employment-related, so that the population tends to be selected primarily from the middle and lower-middle classes. Harvard Community Health Plan also operates a subsidiary clinic that is primarily oriented towards an indigent population. Wholly supported through their employment, the NAS Military Dispensary in Brunswick, Maine, provides health services for members of the military. This includes military personnel, their dependents, and a significant percentage of retired personnel. Since all retired military personnel have access to the health care system, the population distribution is not typical of a private practice, and the availability of free health care in the military has made the population more dependent on the health care delivery system than those groups which are paying for their own medical care. Recent changes in the military draft laws create medical staffing problems for the military health care delivery system so that now alternative methods of providing health care (through community physicians) are being investigated.

Another employment-related health care service support is provided by the workman's insurance companies. Here the concerns also are broader, although they do not include the whole person, but all aspects of a trauma incident. A broader view is taken since the benefits of effective health care are potentially reduced morbidity and, hence, reduced payouts for the employment compensation funds and reduced requirements for financial reserves. The system at the user of ITC, which we visited, serves about 1200 cases per year, with an average of 3.5 contacts per case.

Summary:

We do note that the type of population served and the matter of payment for services rendered plays an important part in the goal setting and benefit achievement of the sites visited. These relationships will be further discussed in Chapter 6.

J FUNDING AND COSTS

Development Support:

Most of the AAMRS development was performed with one major source of support. Sixteen sites had one primary source of support and three sites had two. The major sources of support were about evenly divided between funds generated internally within the developer's organization and funds derived from external sources such as foundations and federal grants. The major sources of support and sites with the support follow:

Internal:	Direct Appropriation	Los Angeles, Cardiovascular IHS, NAS, MUSC (partial)
	Private Investment	AUTOMED, ITC (partial)
	Private Foundation	Regenstrief
External:	Federal Grants or Contracts	Stanford, Rockland, Yale, HCHP, Casa, Bellevue, MUSC (partial), Duke (partial)
	Research and Development Service Contracts	Greenville
	Foundation Grant Support	Duke (partial)
	Government Funds (non Federal)	ITC (partial)

In general, detailed estimates of the cost of the development effort were not available. This was primarily due to the difficulties associated with differentiating between development and routine operations as system features became operational. Table 4J1 presents rough estimates of initial development costs, period covered, and source of support. If an estimate of development costs was not provided during the site visit, the development costs were derived from other cost data provided by the site.

Table 4J1

ESTIMATED INITIAL DEVELOPMENT EFFORT AND MAJOR SOURCE OF SUPPORT

	Total	Equipment Purchase	Period (years)	Primary Source of Support
	(Amounts in 1000's)			
Public:				
Los Angeles	$ 4,400	*	5	Internal-Direct Appropriation
Rockland	10,000	350	7	External-Federal Grant Funds
Greenville	400	180	2	External-R&D Service Contracts
Bellevue	3,000	125	6	External-Federal Grant Funds
Private:				
ITC	*	*		Internal-Private Investment External-Direct State Support
Automed	1,000	650	4	Internal-Private Investment
Cardiovascular	230	194	1	Internal-Direct Appropriation
University Affiliated:				
Regenstrief	236	110	1	Internal-Private Foundation
Casa	745	0	4	External-Federal Grant Funds
Yale	1,000	120	3	External-Federal Grant Funds
HCHP	2,500	544	5	External-Federal Grant Funds
Stanford	100	minor	2	External-Federal Grant Funds
MUSC	1,000	225	4	Internal-Direct Appropriation External-Federal Grant Funds
Duke	550	95	2	External-Federal Grant Funds External-Foundation Support
Federal Government Direct Operations:				
IHS	450	0	3	Internal-Direct Appropriation
NAS	500	0	3	Internal-Direct Appropriation

Notes:

Initial development is loosely defined as the period prior to the beginning of a substantial amount of routine services. Many sites have continued a substantial development effort along with ongoing routine operations.

Equipment purchases represents amount spent to acquire equipment during the development period. Additional purchases may have been made after routine operations were instituted. (e.g. Cardiovascular acquired an additional $71,000 of equipment in a subsequent period.) For Automed equipment purchases includes building construction.

AAMRS developers classified by type of organizational financial support.

* Insufficient data available to estimate.

Operating Costs:

The major sources of funds for operating costs are similar to the source of development funds, except that more sites were deriving operating funds from more than one source,and user charges is a major additional type of support. The operating costs of AAMRS developers were for both routine production and on-going development. Table 4J2 presents a summary of operating costs for the sites visited and primary sources of support.

Cost of Patient Care:

In general the AAMRS sites were at stages where the cost of the AAMRS has had no or little direct influence on the charges for patient services. The exception is at Stanford, where an extra explicit fee has been established for AAMRS services. At HCHP, it is estimated that the automated medical record costs less than a comparable manual system. However, since the HCHP has always had some aspect of automation with its medical records, this cost difference is not an explicit savings that has a direct effect upon the capitation rates for health care.

As AAMRS users consider whether or not to support and implement an AAMRS,one factor that will receive careful attention is an allocation of the AAMRS cost per patient or per patient visit. This will be especially true for the HMO type organization where health care is provided at fixed rates regardless of the amount of services provided. It will also be an important factor in situations where the AAMRS services are obtained from a vendor (service bureau). Table 4J3 presents the cost of the AAMRS at the sites visited, per patient per year for the average patient population on the system, and the cost per patient visit based on the average number of patient visits per year. Data is presented for routine production costs as well as current total operating costs, which includes ongoing development.

Table 4J2

OPERATING COSTS

AAMRS Sites (developers/users)

	Amount (in 1,000's)			
	Prod. $	Devel. $	Total $	Primary Source of Support
Public				
Los Angeles	2,000	200	2,200	I-Direct Appropriations
Rockland-total (developer)	443	557	1,000	I-User Charges (40%) I-Direct Appropriation (22%) E-Federal Grants (38%)
Pomona (user)	90		90	I-Direct Appropriations
CMHC (user)	108		108	I-Direct Appropriations
Greenville	323	197	520	I-User Charges (40%) E-User Direct Support (20%) E-Service Contracts
Bellevue	394	222	616	I-Direct Appropriations (38%) E-Federal Grant (62%)
Private				
ITC (user)	60		60	I-Direct Appropriation
Automed (developer)			300	I-User Charges I-Private Investment
Cardiovascular	75	18	93	I-Direct Appropriation
University Affiliated				
Regenstrief	53	169	222	I-Private Foundation (93%) E-Federal Grant (7%)
CASA (User)	48		48	I-Direct Support (33%) E-Federal Grant (63%)
Yale	100	214	314	E-Federal Grant (major)
HCHP	378	154	532	I-User Charges (9%) I-User Direct Support (24%) E-Federal Grant (67%)
Stanford (developer)	20	61	81	E-Federal Grant (54%) E-Computer facility (36%) I-User Charges,& Direct App.(10%)
MUSC	208	57	265	I-Direct Appropriation (47%) I-User Direct Support (6%) E-Federal Grants (47%)
Duke	186	59	245	I-User Direct Support (34%) E-Federal Grant (30%) E- Private Foundation (27%)
Federal Government Direct Operations				
IHS	487	533	1,020	I-Direct Appropriation (100%)
NAS	233		233	I-Direct Appropriation (100%)

Legend: E = External Sources I = Internal Sources

Table 4J3

AAMRS COST SUMMARY

Site	Average AAMRS Patient Population	AAMRS Cost per Patient Rout. Prod.	AAMRS Cost per Patient Total Oper.	Average Patient Visits per Year	AAMRS Cost per Patient Visit Rout. Prod.	AAMRS Cost per Patient Visit Total Oper.
Stanford	900	22	42	4,000	5	10
ITC (user)	1,200	50	50	4,200	14	14
Los Angeles	2,000,000	1	1	550,000	4	4
Rockland	300,000	1	3	*	*	*
Pomona (user)	9,000	10	10	200,000	.50	.50
Connecticut (user)	19,000	6	6	60,000	2	2
Yale	15,000	7	21	33,000	3	10
HCHP	36,000	11	15	155,000	2	3
Automed (user)	5,700	2	2	9,000	1	1
MUSC	7,000	23	29	25,000	6	8
Greenville	46,700	7	11	93,500	3	6
Duke	11,000	17	22	40,000	5	6
Regenstrief	2,200	24	101	10,000	5	22
Cardiovascular	12,000	6	8	26,000	3	4
Casa	6,000	8	*	21,000	2	*
IHS **	12,000	41	74	40,000	12	22
NAS	15,770	15	15	20,000	12	12
Bellevue	50,000	8	12	70,000	6	9

* Data not available.

** The IHS estimates the cost per patient, for a total service operation using a different computer than the one currently used, to be $1 per patient per month.

The cost data on Table 4J3 can be summarized as follows:

	Number of Sites			
	Cost per Patient		Cost per Patient Visit	
$ Range	Routine Production	Total Operations	Routine Production	Total Operations
0 - 5	3	3	12	7
6 - 10	7	3	2	5
11 - 20	3	3	3	2
21 - 30	3	4		2
41 - 50	2	2		
71 - 80		1		
Over 100		1		
	18	17	17	16 *

*Totals vary due to lack of data for every site.

K. TRANSFERABILITY

Introduction:

A number of considerations figure as factors in the transferability of any system. Many of these are quite subjective and will be discussed in Section 6 of this report. Some of the more objective factors include:

System Design and Documentation
Communality of Environment and Objectives
A History of Effective Operation.

We restrict our observations to the ambulatory medical record system aspects; some systems visited have seen transfers from research or in-patient surroundings. Nearly half of the sites have at least the potential for offering their services by means of remote terminals to the interested user. Table 4K1 lists some basic aspects of transferability at the sites visited.

The intention of eventual transfer determines the initial system design and the level of documentation provided. We will discuss such issues in the subsections below.

Hardware System Considerations:

The mode of expected transfer of the results of the system development can have a considerable effect on the system design; we distinguish between the distribution of concepts, the distribution of services through terminals, and the distribution of systems through duplicatable hardware and software.

If the transfer of concepts and ideas is of paramount importance, then the use of a powerful basic system may be desirable, so that methodology and effects can be demonstrated with minimum effort, and so that publishable results become available within a reasonable time span.

If the transfer of service is intended to be by the use of the same shared computer through additional terminals, then an economical and reliable system of adequate capacity becomes the primary concern.

If the transfer of service is intended to take place by copying the entire system, then a small system, which is affordable by many health care delivery institutions, might be the design goal.

Table 4K1

TRANSFER INTENT AND ACHIEVEMENT OF AAMRS'S

Site	Transfer Intent Method:Scope	Method:Scope
Large Shared Computer Systems		
Rockland	T : RN	S : N
Automed	T : Rn	
IHS	T : ILn	C
Greenville	T : Ir	C
Stanford	T : ILn	C
LA	T : I	
Casa	B : l	C
Bellevue	T : il	
Distributable Shared Systems		
Duke	S : N	T : i
MUSC	S : R	C through training
HCHP	T : i	S : n
Regenstrief	C	S : n
Yale	C	BT : l
NAS	S : n	(C through Meditech)
Small Dedicated System		
Cardiovascular	S : -	(C through Meditech)
ITC	S : Rn	
ELA	S : -	(C from Minnesota)

Legend:

Transfer Method:
- T Terminal services
- B Batch services
- S System transfer
- C Concepts

Transfer Scope (does not include transfer of concepts):
- I In-house achieved
- i in-house potential
- L Local achieved
- l local potential
- R Regional achieved
- r regional potential
- N National achieved
- n national potential
- \- no transfer intended

Another alternative is the generation of a standard program that can be installed on commonly available computers. We will discuss the sites visited with this background in mind.

Large Shared Systems:

Six of the sites are implemented on relatively large-scale IBM computers: three on the 360 series and three on the newer 370 equipment. All of the 370's and the 360's are currently being shared in such a way as to make the addition of more terminals and users a plausible possibility. Only Rockland State currently provides the majority of services to outside users. Rockland has also exported the entire MSIS system to other sites using compatible IBM equipment. We were not able to visit Hawaii to inspect the MSIS operation there.

The system under development by the Indian Health Service is intended for use by other IHS locations; experimental use has been made via satellite link to a reservation in Alaska. Extensive use might require multiple systems. AAMRS developers at Greenville, a relatively recent service, developed the system from concepts developed at other AAMRS sites. In particular they found the concepts developed at the Indian Health Service and by HCMS in Denver, Colorado, of interest to them. Greenville is planning to extend its services to more clinics in its region. The Stanford Immunology Clinic plans to share the services with other centers of immunology research throughout the country in order to establish a more powerful data base. The system, used with other data-base-defining specifications, is also in use by other clinics at Stanford and at the University of California in San Francisco. The Stanford system, both the older version and recent developments there, depend on large local software packages and will require major support efforts even if transferred to compatible hardware.

The registration system at Los Angeles County has expanded to County clinics beyond the County General Hospital, and may become a basis for a more comprehensive system. The Casa de Amigos is an important testbed for innovations sponsored by Baylor Medical College. The batch application programs could be easily transferred.

Two other large sites use Univac equipment. Bellevue uses an 1108 at a Medical Computer Center of New York University. It is the major user of the

Center and its commitment was instrumental in the establishment of the Center. Other users of the Center and the transaction processing system include Rockefeller University in New York. None of the other clinics at Bellevue have yet adopted the AAMRS.

The Automed system uses a medium size computer made by Univac, the 492, which, with its software, is specifically intended for real-time transaction processing. Medical Data Systems Corp. has made extensive modification based on an earlier implementation of a regional hospital information system at the Danderyd Hospital (Stockholm). Automed intends to support itself completely by the sale of its ambulatory record and billing services to private physicians, group practices, and clinics.

The direct transfer of large systems, such as Stanford's, to smaller and possibly more cost-effective machines is inhibited by the substantial reliance upon system support functions. The operating and support systems on the large machines are often larger in terms of program size than the application programs.

Distributable Shared Systems:

Six sites have systems implemented on smaller scale Digital Equipment Corporation PDP computers: three on the 15 series, and three on 11's. For practical purposes, the three 15's and one of the 11's (Yale) are dedicated to the ambulatory medical record application. All six of the sites currently have remote terminal operation, although at Yale this facility is used only in-house. The systems at Duke and Regenstrief also provide in-patient services within their institutions.

The system at Duke is intended for distribution to other sites; it is now used at three other sites (not visited by us), but only one of them has an ambulatory record application. The exported systems are supported by the Division of Information Sciences through Health Care Systems, Inc., as vendor. The design of Duke's Gemisch system, with its tabular structure, is intended to simplify transferability by allowing process-independent specifications of the system requirements. A users' group is in existence to share programs and experience with Gemisch.

The system at MUSC currently serves serveral other family practice residencies in the state, and further expansion of this service is being planned. Additionally, private practice services are provided as a pilot to graduates; this aspect is still in the stage of evaluation.

The HCHP Kenmore facility now uses the system provided by the Laboratory of Computer Science at MGH; a plan to provide the same services to the HCHP's newer and currently smaller Cambridge facility is under consideration. The system at HCHP provides a model for a fully-automated medical record and is hence the source and standard for many current AAMRS efforts.

The system at Regenstrief is currently being implemented primarily to serve local needs. Many innovations are being developed. Even though the implementation emphasis is local, both the use of the BASIC language and the development of a specification-oriented language (CARE) are intended to simplify transfer of the system and its applications.

At the Yale University Section of Medical Computer Sciences, the emphasis is on the testing of the concept of the clinical event. The system is being developed with the intention that it be used by other health care providers while still being maintained by SMCS personnel. The batch operation can be transferred relatively easily although most sites will require services more comprehensive in scope than those that have been developed for CHCP.

The software developed to serve the NAS at Brunswick can be provided through Meditech at other military sites. Private practice use would require a more comprehensive set of services, including financial records. The new plans for an integrated tri-service system, sponsored by the Air Force, will discourage transfer within the military establishment.

Small Dedicated Systems:

The system which has been developed at the Cardiovascular Clinic is, in terms of its operation, a small, dedicated system, although it is based on the same hardware and software that support larger institutions, such as MUSC and NAS. Also, it is classified as a small, dedicated system due to the absence of requirements for ongoing technical involvement, which is partially possible since no performance barriers are being approached. This system provides a fully automated medical record, satisfying the needs of this specialty clinic. The applications were not developed with the intent to be transferred, but they are used as a model by the original vendor of the system, Meditech, for other prospective AAMRS users.

ITC is a commercial vendor, whose system is used by a number of workman's compensation insurance companies in the western United States. This company is also wholly dependent for its income on sales and leases of this system. National distribution is contingent on sufficient sales in a geographic area to warrant an expanded service organization.

The system at East Los Angeles follows the specification of the Child and Youth categorical funding program administered by the Health Sciences Center at the School of Public Health of the University of Minnesota. The entire system should technically be distributable to other sites.

General Considerations:

The suitability of a system in another setting is contingent on a proper institutional match. Both the goals of the institution as well as the patient care interface will have to be compatible to some extent to make a transferred system work without major new development costs. Items considered in this evaluation are listed in Table 4K2.

Input/Output Devices:

Transferability is generally restricted to similar devices for the capture and presentation of data. A system that uses narrative text data entry is intrinsically different from one that uses highly-structured data. Hence it is not yet possible to combine attractive input features of one system with desirable medical record features of another system to obtain a better new system, without a major effort, and in the process create another system de novo. Due to the variety and importance of data entry choices, data entry is of paramount concern to a user contemplating adoption of a system. Table 4K2 lists the interface characteristics of the input devices seen.

Languages:

Higher level languages are used at many sites with the intent to improve transferability. As indicated earlier, large systems, even if they use higher level languages, remain difficult to move to a new

Table 4K2

TRANSFER CONSIDERATIONS

Site	Technically easy to transfer	Situationally flexible	Operational experience	Input device interface	Documentation	Language	Low cost entry	Low operational cost potential	High level service potential	Management benefits
	1	2	3	4	5	6	7	8	9	10
Stanford		+	+	mh	+	LS	+		+	
ITC	+		+	H		S				AP
LA			+	H		LSS				AS
East LA	+		+	B		S		+		A
Rockland	+	S	+	R	+	S	+	+	D	AP
Yale	+			B			+	+	D	P
HCHP	+	H	+	m		LSS			+	ABSP
Automed	+	+	+	H		S	+		D	BA
MUSC	+		+	m		LSS			D	TB
Greenville				HB	+	S			D	ASP
Duke	+	+		H		LS	+	+	D	BAS
Regenstrief	+	+		Bm		L	+	+	D	AS
Cardiovascular	+	S	+	h		LSS		+	+	BSA
Casa	+	+	+	B		L	+			P
IHS	+		+	Bmh	+	S			+	PSA
NAS	+	M	+	m	+	LSS			+	A
Bellevue			+	s		LSS	Local		D	SA

LEGEND FOR TABLE 4K2

column

2 Situationally Flexible:

- H Applies primarily to HMO environment.
- M Applies primarily to military environment.
- S Applies primarily to same medical specialty.

4 Input Device:

- s Slow speed serial, terminal or teletype (110 to 150 baud).
- m Medium speed serial, CRT or terminal (300 to 600 baud).
- h High speed serial, CRT or printer (1200 to 2000 baud).
- H High speed, direct or synchronous transmission, CRT pages or buffered printer (2400 to 9600 baud).
- B Batch operation, with card input or mark-sense sheet input.
- R Remote batch entry, with memory, printer, card reader, etc.

6 Language Category:

- L Language programs may move without the system.
- LS Language moves with system only.
- LSS Language programs can be moved to similar system.
- S System moves, language not used by users; services used directly.

9 High Level Medical Service Potential:

- D Developmental, potential for intensive service not yet proven.

10 Management Benefits

- A Administrative data
- B Billing
- P Planning
- S Patient management services
- T Training

environment due to the demand they place on operating system facilities, libraries, and sometimes also on input/output hardware. Table 4K2 also indicates the languages in terms of transfer potential of programs and systems to other sites.

We attempted to distinguish sites where application programs might be moved separately, without a major redesigning of the application, and sites where the existence of a similar system is a prerequisite. Typical of this last category are the MUMPS-based systems. In other instances it is always the entire system which has to move.

The feasibility of such a move is of course related to the cost of the new system, a subject addressed in another subsection of this section.

Documentation:

One of the more important considerations is the amount of care and effort spent on documentation and training. Any transfer potential presented in other sections may hinge on the availability of documentation.

All of the sites visited had some type of training or demonstration capability, particularly for clerical personnel. None, however, with the exception of the two purely commercial service-bureau-type enterprises (Medical Data Systems, ITC), had documentation or formalized procedures to the extent that they represented a serious interest in transferability. Three systems seen, those at the Medical University of South Carolina, at the Cardiovascular Clinic (Oklahoma City), and at the Naval Air Station in Brunswick, were derived from a commercial timesharing service (Meditech) and therefore have at least part of their systems training available through that enterprise.

The actual availability of system documentation has been emphasized mostly in the larger systems: Stanford, Rockland, Greenville, IHS, and at the NAS. This may be related to the need for a basis for internal communication.

Publications describing the developed systems has come from a variety of institutions--Stanford, ITC, Rockland, HCHP, Duke, Regenstrief, Casa, and NAS--and probably reflects somewhat the goals of transfer of concepts.

Documentation oriented to the end-user--the physician, the nurse or paramedic, or the clerk at the CRT--was generally weak. A lack of need in this area was often attributed to a low rate of personnel turnover. Bellevue has developed computer-based aids to help their clerical staff with the use of system functions.

Cost:

A very important consideration in any discussion of transferability is cost. Costs will vary depending on the type of service to be acquired. A user of a service-bureau-type operation will have a small initial investment, since there are no large expenditures for equipment acquisition, and ongoing operational costs will be based on utilization. On the other hand, the acquisition of a total independent system will involve initial investment costs for equipment purchases and for system development to adapt the system to the new site, and relatively lower ongoing operational costs. Regardless of the mode of equipment or service acquisition, operational costs will include some aspects of ongoing development.

The use of rented equipment for an independent system would make costs more comparable to a service-bureau-type service: lower initial investment, with higher ongoing operational costs.

The operational cost figures for each of the systems are discussed in detail in Section 4G and will not be dealt with further at this point. One must keep in mind, however, that in addition to the cost of routine services, the new user might be expected to contribute to the support of ongoing development at the original site, and also must take into consideration his initial investment costs.

The rough cost classifications given in Table 4K2 are based on the material in the detailed site visit reports.

Benefits:

Transfer of a system is desirable only if the potential for obtaining benefits in the new setting is sufficiently high. In order to complete this table, we have summarized data from Sections 4E and 6E and placed it in the table.

Medical benefits are considered to exist, based on present usage, or are indicated as developmental where medical services are in pilot operation, although they have not yet proven their cost-effectiveness per se.

Management benefits are grouped into general categories, based on the usage of the information now produced at the sites visited.

It should be understood that both the cost and the benefit classifications are based on an integration of data involving many factors, so that the estimates may not be applicable to other specific sites and environments.

L ANALYSIS OF RESPONSES TO THE AAMRS ATTITUDE QUESTIONNAIRE

In Section G of Appendix C the rationale for the development of an attitude questionnaire to measure the value or worth in which a user holds his automated medical record system (AMRS) is presented. The objective in developing this measuring instrument was to provide a way to compare all AMRS sites visited on the basis of the value or worth that the individuals interviewed placed on their AMR system. No valuation of benefits in monetary terms is required in this approach to measuring benefits; rather it represents an attempt to quantify a user's preference for the AMRS over the previous manual medical record system and his willingness to pay for the services provided by the AMRS in his institution or his willingness to give up other services if necessary in order to retain the AMRS.

The actual attitude scale that was constructed consists of 20 statements reflecting a range of positive and negative user attitudes toward his own AMRS. The attitude scale itself is reproduced at the end of Appendix C, along with the covering sheet that explains the purpose of the questionnaire. AMRS users at each site visited were asked to respond to each of the 20 statements in the questionnaire using the following 5-point attitude scale: Strongly Agree, Agree, Neutral Opinion, Disagree, Strongly Disagree. In the analysis of the questionnaire returns, the response scale was assigned weights from +2 to -2 in the following manner:

Strongly Agree	+2
Agree	+1
Neutral Opinion	0
Disagree	-1
Strongly Disagree	-2

If a user selects "Strongly Agree" as his response to all 20 statements, his summated score on the attitude scale would be +40. Conversely, if he selects "Strongly Disagree" as his response to all 20 statements, his summated score would be -40. Thus, the range of possible scores for an individual on this attitude scale is -40 to +40. The weights assigned to Statements 3, 6, 10, 14, and 18 were reversed since these statements reflect negative rather than positive attitudes toward the AMRS.

Eight of the sites visited cooperated in responding to the AMRS Attitude Questionnaire. Another site, HCHP and its sister plan, the Cambridge Community Health Plan preferred to develop its own version of the attitude questionnaire to help it evaluate its AMRS and to define areas for further development. The questionnaire results from this variant are not included here, but are available from the system developer. It should be noted that at the eight responding sites, we attempted to survey as a broad range of informed opinion as possible. At some sites we obtained responses from medical students, residents, and faculty physicians. At others we obtained responses from public health nurses, "line" physicians, and "staff" physicians. Some questionnaires were answered immediately and returned to us personally, others were returned by mail. In all cases, the respondent remained anonymous.

The number of users at each institution responding to the standard questionnaire varied greatly, from a low of two individuals to a high of 28 respondents. At the site that used its own questionnaire, 99 providers responded to the evaluation. The number of users responding to the standard attitude questionnaire at each of the eight reporting institutions is provided below, in order by number of respondents:

Reporting Institution	Number of Respondents
Casa de Amigos Community Clinic, Houston, Texas	2
County of Los Angeles Department of Health Services, Los Angeles, California	2
Stanford University Medical Center, Division of Immunology, Stanford, California	2
Bellevue Hospital Pediatric Department, New York City	3
Regenstrief Institute, Indianapolis, Indiana	3
Indian Health Service, Sells Service Unit, Sells, Arizona	5
Brunswick Naval Air Station Dispensary, Brunswick, Maine	13
Medical University of South Carolina, Charleston, South Carolina	28
TOTAL N =	58

The extreme variation in the number of individuals responding to the standard questionnaire at each reporting institution raised some concern about the validity of the statistical analysis of the responses. Furthermore, in a few cases respondents left certain items unanswered despite the fact that they were urged to respond to every item by the following direction. Please express an opinion on each statement even if you have never thought about this subject before in just this way. Instances of missing responses were handled by substituting the arithmetic mean of that individual's responses to all other items in the questionnaire that he had answered. There were other concerns about reporting the attitude questionnaire analysis results in view of the fact that approximately half of the sites visited did not choose to respond to the standard questionnaire. Nevertheless, at the reporting institutions where it was possible to intensively interview only a few people, these individuals were knowledgeable about the AMRS and used the system's services primarily as medical practitioners but also as managers in several cases. Therefore, although the N's may be small for certain of the institutions responding to the attitude questionnaire, there is the reassurance that their responses represent an informed opinion.

In the aggregate the overall response to the standard questionnaire by 58 respondents reveals a slight positive attitude across the country toward automation of the medical record at this stage in the development and implementation of this technology. This finding is shown graphically in Figure 4L1

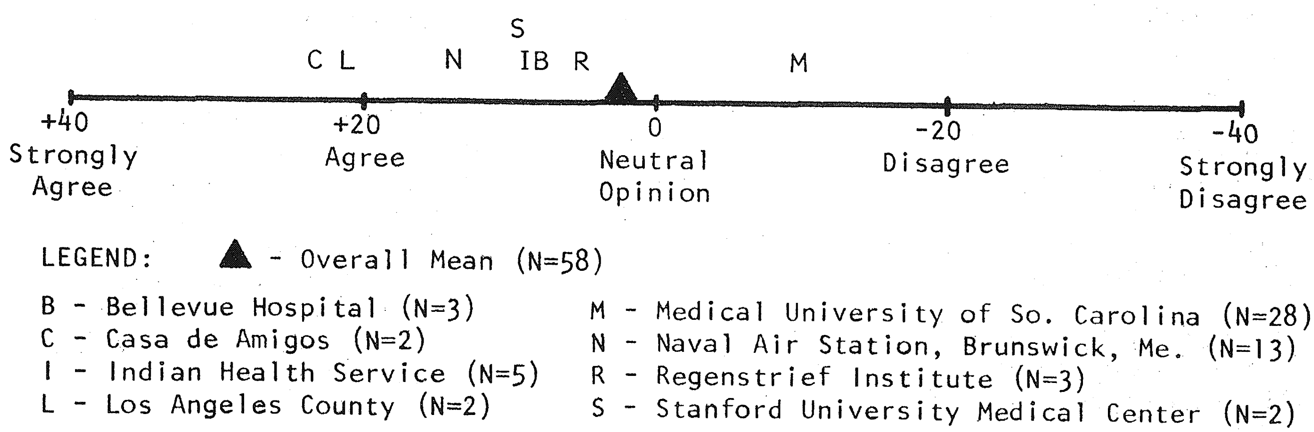


Figure 4L1 Overall Mean Response of Eight Institutions to the Standard Attitude Questionnaire.

From this figure it can be observed that seven of the responding institutions agreed that the AMRS in their setting had yielded positive benefits. Only one institution exhibited a negative attitude overall, and this negativism is a reflection of certain problems at this site related to a lag of several months in data entry and an annoying slowdown when the system is heavily utilized. These problems are being remedied, and a later poll of the user population, when system development and implementation is farther along, probably would reflect a more accepting and favorable attitude. However, because 28 users (26 of them medical users) from this institution responded to the questionnaire, their current frustration with the performance of their system markedly influenced the calculation of the overall mean response. If this institution were to be omitted from the analysis, the overall mean response would shift from 2.2 to 13.2. Nevertheless, elimination of these 28 cases does not seem to be justified on the basis of their being negative. It is quite conceivable that the institutions that did not respond to the questionnaire were unwilling to expose the negative reactions of their user populations at this particular period in their system development and implementation, or that they were unwilling to risk being compared to other AMRS sites on the basis of an attitude questionnaire. Other sections of this report have provided ample evidence of the wide divergence among AMRS sites in their objectives, patient population and load, services provided, content of the medical record, system features, funding and staffing levels, and stage of system development and implementation. All of these factors indicate that it is inappropriate to make a direct comparison among institutions. However, the results of the questionnaire analysis, if interpreted with caution and with an understanding of the limitations of the measuring instrument and the statistical problems encountered in the analysis, do provide a provisional picture of user acceptance of automated medical record system technology in the mid-1970's.

If the individual questionnaire statements are analyzed in a fashion similar to the overall response to the questionnaire, additional insights are to be gained. The same provisos discussed in the analysis and interpretation of the overall response to the questionnaire also apply to the analysis and interpretation of the responses to individual items. Appendix F portrays the mean responses of the eight institutions returning completed questionnaires to each of the 20 statements contained in the attitude questionnaire.

For Statement 1 all but one responding institution expressed agreement to strong agreement that medical record information is more accessible and available more quickly with the AMRS. The one dissenting institutional opinion is a reflection of this institution's discontent with the temporary data input bottleneck in its AMRS. Generally, it appears that AMRS's are meeting the goal of providing more accessible and more current medical record information.

Most of the individuals responding to Statement 2 agreed that as a result of the AMRS, they are able to do a better job. The individuals who agreed tended also to hold a positive overall attitude toward their AMRS.

The distribution of responses to Statement 3 is quite visibly platykurtic, probably indicating more than anything else a wide divergence in expectations about the advent of an AMRS. If one's expectations for the performance of the AMRS are unrealistically high initially, then most likely the system will fall short of these expectations, particularly in the early stages of system development and implementation. If one is skeptical about the expected performance of the AMRS, then one is likely to be pleasantly surprised as the system takes shape and form. The responses to this statement appear to mirror the course of user acceptance for most technological innovations in health care delivery, and suggest that at this point in time, at least for most of the institutions responding, that system refinement and improvement is required to raise the level of user acceptance. This interpretation certainly coincides with the subjective impressions carried away by the site visitors.

The analysis of responses to Statement 4 is particularly revealing. Institutions where the traditional paper record has been replaced by the AMRS or where access to the traditional paper record is complicated by problems of multiple users, ambiguous patient identification, and a slow manual system of filing and retrieving records tended to agree that they could never go back to using the old manual medical record system now that they have been using the AMRS. At institutions where the AMRS supplements the traditional manual medical record or where providers expect to move on to other health care delivery settings in which traditional record keeping practices are followed tended to disagree with Statement 4. In the final analysis, all providers can always use the traditional method of keeping medical records because that is what they learned to do in medical school. The interesting observation is that given the alternative of an AMRS that replaces or outperforms the manual record keeping system, some users would prefer never to return to "the good old days" and ways.

The majority opinion in response to Statement 5 is that the AMR system catches more human errors than the old manual system did. But there are those institutions that disagree or have a neutral opinion. Error detection is a 2-way street, and errors generated or propagated by the AMRS might only be caught by users as they review a patient's record and come across obvious errors or omissions in data entry. These encounters are disconcerting to providers and diminish their confidence in the integrity of the system. Perhaps there is a lesson to be learned here regarding the importance of incorporating error detection and error correction mechanisms in the system design.

Responses to Statement 6 probably reveal one of the more interesting findings resulting from this questionnaire analysis. All eight responding institutions disagreed with the statement that the AMRS should never have been implemented at their institution, seven of the institutions tending toward an opinion of strong disagreement. Even the users at the one institution showing the most negative overall attitude toward their AMRS did not agree on the average that their AMRS should never have been implemented. This finding appears to substantiate the interpretation offered earlier that the frustration and negativism at this institution relate primarily to current problems of system implementation and not to the long-range view held by users of the potential of their AMRS.

On first inspection it appears that most responding institutions gave their AMRS poor marks with regard to system reliability as shown in the analysis of Statement 7. Only three institutions agreed slightly that users never had to wait for necessary patient record information because the AMR system was down. All five of the other responding institutions reported varying degrees of disagreement with this statement. In retrospect, however, the statement probably was worded too strongly. A less adamant phrasing might have been, "I *rarely* have to wait for necessary patient record information because the AMR system is down." To this latter statement users might have felt more comfortable in responding in the affirmative, which also would have raised the value of the overall mean response. More objective data gathered in the course of the site visits indicate that system downtime is rarely a problem. Another real possibility is that responses to this statement indicate user dissatisfaction with degradation of system response time when the system is heavily loaded. This periodic condition was reported at several of the sites visited and corresponds to human habits of work productivity that tend to peak mid-morning and early afternoon for clerical activities and for medical providers when they see their patients. Queuing of users at AMRS terminals was not indicated as a real problem in the data gathered at the site interviews.

Responses to Statement 8 probably best of all reflect the current user attitude toward the state of the art in AMRS development and implementation. All responding institutions expressed positive opinions varying from slight agreement to stronger agreement that in general they like their AMRS better than the old system of medical record keeping, but that there are some problems that need correction. It appears that it is the resolution of the problems needing correction wherein lies the future utility and acceptance of automated medical record systems.

Statement 9 poses a difficult choise to the AMR system user, and the questionnaire responses reflect this dilemma. If there were budget cuts at a user's institution, what other services that he needs would a user be willing to give up before losing the AMRS? Without being confronted, for example, with a real approach-approach conflict such as having to choose between an automated clinical laboratory and an automated medical record system, most respondents appear to have dealt with this statement in terms of their own perception of what the alternate valuable services might be that they would have to give up in order to retain the AMRS. Two institutions straddled the fence on this issue. Two institutions opted in favor of other needed services; but surprisingly, four institutions held out for their AMRS over other needed services.

All but one of the eight responding institutions expressed disagreement to strong disagreement with Statement 10: The AMR system has "goofed up" patient records more times than I care to remember. The institution tending to agree with this statement is the one at which current problems with the AMRS have tested the patience of medical users.

Analysis of the responses to Statement 11 reveals that six of the eight responding institutions agreed in varying amounts that the quality of patient care had been improved as a result of the AMRS. One institution held a neutral opinion with regard to this statement; and the institution reporting an overall negative attitude toward its AMRS tended to disagree that quality of patient care had been improved.

From the analysis of responses to Statement 12, it is clear that most users agree that from an administrative point of view, their AMRS provides timely data for making management decisions that were not available with the manual system. Only two of the eight institutions responding to the questionnaire maintained a neutral position on this issue. Most of the 58 respondents were medical practitioners, so it is of interest to learn that they perceive a benefit from their AMRS for management and administration.

With regard to the improvement of patient scheduling and staffing patterns since the advent of the AMRS (Statement 13), four of the eight responding institutions exhibited varying levels of agreement that improvement had occurred. The other four institutions tended to disagree. Whatever impact an AMRS might have had on patient scheduling and staffing patterns probably is a function of whether or not improvement in these two areas was an objective to be attained by the system. In some of the AMRS implementations, this objective was secondary to other system goals.

Statement 14 is inherently ambiguous in that the first half of it expresses a negative attitude (the AMR system doesn't benefit me very much personally,) while the second half of it expresses a positive attitude (but I can see how it can be a boon to other users). Most respondents arrived at their judgment about this statement by responding principally to the first part of the statement, that is, most users tended to disagree that the AMR system does not benefit them very much personally. The institution reporting an overall negative attitude toward its AMRS tended to agree that they received few personal benefits from the system. The two users responding from the institution shown at -1 on the attitude scale probably were responding principally to the second half of Statement 14. Part of the objectives for the AMRS at this institution is to provide information primarily for clinical research activities and secondarily for training activities and quality review procedures. Therefore, it seems likely that these two respondents were agreeing that the system could be a boon to other users, but possibly also that they receive little personal benefit from the AMRS. Because of the ambiguous nature of Statement 14, a proper interpretation of responses is difficult, and the results probably should be ignored. Any readministration of this questionnaire should either delete this item or replace it. A possible replacement might be the following: Other users of the AMRS at this institution appear to benefit more from its use than I do.

It appears that in Statement 15 the respondents' attitudes with regard to the level of patient satisfaction since the AMRS was introduced reflect a cautious subjective judgment on their part. Four institutions tended to disagree slightly that patient satisfaction was running higher. One institution held a neutral opinion on this issue; and three institutions agreed with the statement in varying amounts. In the absence of objective measures of patient satisfaction with their care that can be attributed directly to the introduction of the AMRS, any response to Statement 15 must necessarily be based on a user's subjective impressions.

Most responding institutions agreed in varying amounts that they were able to get more done in a day with their AMRS (Statement 16). One institution maintained a neutral position with regard to this statement; and the institution reporting an overall negative attitude toward its AMRS tended to disagree that they got more done in a day. Responses to this statement probably indirectly reflect the stage of implementation of each institution's AMRS. In the early phases of system implementation, before the bugs are worked out and while individuals are learning how to use the system efficiently, the presence of the system can interfere with a user's daily productivity. As system performance stabilizes and user proficiency increases, the system should help the user perform more effectively, assuming a good system design initially. The institutions reporting agreement with Statement 16 probably have lived with their AMRS longer and most likely have learned to work with it more efficiently.

Responses to Statement 17 reveal one of the most significant findings to result from the questionnaire analysis. Most of the responding institutions are in agreement to strong agreement that the medical records produced by their AMRS's are more amenable to peer review and better meet PSRO requirements. Even the institution reporting an overall negative attitude toward its AMRS agreed with Statement 17, once again lending support to the view that users at this institution believe that their AMRS has the potential for improving medical record practices. One institution maintained a neutral opinion with regard to quality assurance benefits resulting from its AMRS; and one institution tended to disagree that quality assurance was promoted by its AMRS. However, the overall mean response to Statement 17 shows a definite positive attitude with regard to this benefit. It appears that one of the major contributions of automated medical record systems is to provide for a more complete, up-to-date medical record; to facilitate peer review mechanisms; and thus to better meet PSRO requirements.

Six of the eight responding institutions agreed to some degree that the confidentiality of the patient's record is more vulnerable in the AMRS than it was in the old manual system; however, two institutions exhibited disagreement with this statement (Statement 18). It is interesting to speculate about what features of the AMRS contribute to the attitude that patient record confidentiality is more vulnerable in an automated system. Perhaps it is the fact that patient data are displayed on the video screens of terminals, that unauthorized persons can access patient data via a terminal or special telephone number, and that patient data are stored in computer memory accessible to computer operations personnel. A number of the sites visited have attempted to deal with this problem by employing physically closed and/or locked areas and by requiring user identification and passwords to gain access to the system. In most instances the protection of data provided is considered to be adequate but only loosely utilized. Protection of the privacy of patient data seems to be an area where all AMR systems show room for improvement. On the other hand, the vulnerability of the traditional paper medical record to unauthorized access also can be criticized. It generally is assumed that the patient's paper record is either well protected in the files of the medical records room or safe in the custody of the patient's health care provider. This protection of privacy of the paper record is not always the case, however. It may be that the opportunities to gain illicit access to patient record data in automated medical record systems are more visible, and consequently, users are more conscious of the vulnerability of the system to violations of privacy than they are to opportunities to compromise the privacy of data contained in the paper record.

It is encouraging to observe in the responses to Statement 19 that most institutions are cost conscious. Four of the responding institutions disagreed in varying degrees that regardless of what their AMRS costs to operate, it was needed to handle their patient load efficiently. Three other institutions adopted a neutral opinion on this statement. One institution agreed slightly with Statement 19, probably because funding decisions for this particular AMRS are made at a higher level in the military organizational structure. At the operational level, the major concern is with efficient handling of the patient load. One respondent who selected "Agree" for his response to Statement 19 qualified it this way: "Actually, I *do* care what it costs; nothing in life is absolutely supreme *regardless* of the costs." That observation probably speaks for all other AMRS users as well.

The interpretation of responses to Statement 20 requires some reflection. "If the AMR system were to be taken out, I would be willing to pay a reasonable fee to get it back in service." For the medical resident or health care provider who has only experienced the AMRS as a freely provided service, his natural reaction would be to object to having to pay for the service, particularly if the system were operating at a marginal level of performance. However, medical practitioners that operate in a profit-making setting, such as a group practice that subscribes to the AMRS service, may well be willing to pay a reasonable fee to insure the continuity of the service since the economic benefits of the system may well exceed the costs. From the point of view of the administrator of an ambulatory health care delivery facility, the value of the AMRS may well be worth the allocation of a line item in his annual budget in order to insure the continued benefits from the use of the

AMRS. Therefore, how an individual might have responded to Statement 20 depends on which of these roles he is playing in the delivery of health care. Two institutions obviously highly value their AMRS and would be willing to pay a reasonable fee to maintain its availability. Two institutions have a neutral attitude about this question; and four other institutions object in varying degrees to the possibility of having to pay (somehow) for a service they either have regarded as "free" and/or as not meeting their expectations.

While all of the above interpretations of responses to individual questionnaire statements are speculative and are offered only as tentative observations, one cannot escape the conclusion that AMRS's seem to be offering identifiable benefits despite their current limitations. The summary picture that emerges seems to be, "Don't take my AMRS away; but don't ask me to pay for it yet either. And as long as there are features of the system that I think need improvement, I will continue to withhold my wholehearted support for the system."

It can be concluded that in general automated medical record systems are viewed as affording distinct benefits to users, and in most aspects of the performance of an AMRS, the automated system is preferred to a manual record system. These conclusions have been drawn from an analysis of the responses of 58 informed respondents, an N large enough to lend credibility to the results.

M EVALUATION METHODS AND RESULTS

Summary :

Quality: The stated outcome objectives of the great majority of sites visited was to improve the quality of care provided to the population served by the system. Of the 14 sites claiming an increase in the quality of care (presumably a result of AAMRS implementation) only 6 have objective outcomes data to support this contention and one additional site could provide process data showing an increase in quality. An additional 7 sites claimed an increase in the quality of care, but this could be supported by subjective or implicit process measures only.

Access: Of the 11 sites claiming an increase in access to care after implementing the AAMRS, only 6, about half, could support this claim with objective data, and an additional site based this claim on subjective measures. However, 7 of the 10 sites where increased access was one of the developer's outcomes objective, had explicit measures of improved access.

Cost: While 12 sites claimed the control or reduction of costs, 9 had cost control as a stated objective. The nature of the data used to evaluate cost factors varied greatly, and in many cases subjective estimates of tangible measures were used. With respect to primary costs (health manpower and cost of patient services), 10 sites claimed improvement, but only 4 were evaluating data with objective measures. However, for secondary costs (management functions, such as billing) all but one of the 8 sites claiming improvement had explicit measures to indicate the level of achievement. The primary costs savings claimed generally related to savings of provider time in the review of the medical record, or clerical time involved in direct patient interaction for registration or record accession. Secondary costs savings related mainly to the reduction of lost charges and the elimination of clerical personnel associated with billing.

These observations are summarized in Table 4M1, Evaluation Methods and Results.

Measures Used:

Quality: In order to identify factors which might correlate with the degree of sophistication of the evaluation of the quality of care, those sites that employed either objective or subjective evaluation of health care outcomes were compared for the following characteristics:

1. The type of evaluation methods (objective or subjective).
2. The site team's own subjective estimate of the level of sophistication of the evaluation methodology.
3. The degree of goal attainment for implementing the AAMRS.
4. The type of funding for the project.
5. The inclusion of an evaluation plan in the original proposal.
6. The presence of health services research activity at the site.
7. The level of community health orientation of the project.

Table 4M2 represents the consensus of opinion of the panel of consultants who reviewed each site. The following tentative conclusions may be drawn:

TABLE 4M1

EVALUATION METHODS AND RESULTS**

Site	Quality (Q)					Access (A)			Cost (C)				
		Process		Outcomes						Primary		Secondary	
	↑Q	I	E	I	E	↑A	I	E	↓C	I	E	I	E
Stanford	+*	x							+	x			
ITC	+*		x		x	+*	x		+*				x
LA	*					+*	x	x	+*				
ELA									*				
Rockland	*					+*		x	+				x
Yale	+*	x								x			
HCHP	+*	x	x		x	+	x		+*	x			x
Automed	+*	x		x		+	x		+*	x			x
MUSC	+*	x				<>							
Greenville	+*	x	x			+*		x	+*	x			x
Duke	+*	x				*			*				x
Regenstrief	+*	x	x		x	+*			+*	x			
Cardiovascular	+*	x	x		x	(+)	x		+	x	x		x
Casa	+*	x		x		<>*		x	+		x		x
IHS	+*	x	x	x	x	+*		x	+		x		x
NAS	+*				x	+*		x	+	x	x	x	
Bellevue	+*	x				+*		x	*				

I = implicit or subjective measures
E = explicit or objective measures
↑ = increased; ↓= decreased or controlled
+ = yes
* = stated objective of system developer

** Note: For this draft the source for this table is only Section 10 of the individual site reports, which reports on activities related to evaluation of the sites. This material has not been integrated or reconciled with other data in the site reports.

TABLE 4M2

EVALUATION OF QUALITY OF CARE

Sites Using Outcomes Measures

Site	Eval'n Rating (1)	Type/ Extent (2)	Project Completion (3)	Funding (4)	Eval'n Plan (5)	HSR (6)	CHO (7)
ITC	1+	E/2+	4+	Private	+		
HCHP	1+	E/2+	3+	Federal			+A
Automed	1+	I/1+	3+	Private			+
Regenstrief	2+	E/2+	1+	Philantropic Philantropic	+	+	+A
Cardiovascular	2+	E/2+	4+	Private			
Casa	1+	I/1+	2+	Federal	+	+	+A
IHS	2+	E/3+	3+	Federal	+	+	+A
NAS	1+	E/1+	3+	Federal			

Sites Not Using Outcomes Measures

Site	Eval'n Rating (1)	Type/ Extent (2)	Project Completion (3)	Funding (4)	Eval'n Plan (5)	HSR (6)	CHO (7)
Stanford	1+	-	2+	Federal			A
LA	0	-	1+	Local			
East LA	0	-	1+	Federal			
Rockland	1+	-	4+	State/Federal			+
Yale	0	-	1+	Federal			+
MUSC	0	-	2+	State/Federal			+(A)
Greenville	0	-	1+	State			+
Duke	0	-	1+	Philantropic		+	+A
Bellevue	0	-	2+	Federal			A

(1) Rating of evaluation activities at site by review team.
(2) I = Implicit, E = Explicit, Extent = amount of evaluation activity.
(3) Level of objective achievement
(4) Type of funding
(5) Evaluation plan included in initial project plan
(6) Health services research activities
(7) Community health orientation; A = academic affiliation

1. There was a positive correlation between the reviewer's implicit estimate of the level of evaluation methodology and the employment of either implicit or explicit outcomes measures.

2. The more nearly the complete the implementation of the system was, the more likely was the site to employ explicit outcomes measures. However, there was a considerable overlap between the two groups.

3. Only one site with an expressed interest in health services research did not employ explicit outcomes measures in evaluating quality; and it was in the very early stages of implementation.

4. The degree of community health orientation did not appear to affect the use of objective measures.

Considerable variation was observed in the methodology of outcomes measurement. At one site (IHS) the developers of the AAMRS also had a contract with the National Center for Health Services Research for an EMCRO program. This contract had been in progress for more than a year at the time of the site visit and the level of surveillance of outcomes for a variety of disease conditions was quite impressive. At the other extreme, several sites had selected a single tracer condition for which outcomes measures were available. The use of hypertension as a tracer condition appears to be quite common among the various sites because of the very convenient quantitative outcomes measure in this condition. Another use of the information system is to identify high risk individuals within a population, and to institute intensive screening and followup procedures for the high risk individuals (IHS).

A rare controlled experiment is currently in progress at the Regenstrief Institute to measure the impact of the information system. Preliminary findings indicate that the number of diagnostic procedures ordered of physicians who receive "surveillance reports" was significantly greater than that ordered by physicians who had to rely on their own store of knowledge of the patient's condition and the specific disease process.

Access: The change in the access to care has been evaluated through measurement of factors relating to patients (10 sites) primarily. Objective measurements were obtained by counting the number of patient initiated appointments, the number of missed appointments, the availability of the medical record at the time of the patient visit, and by measuring the appointment waiting time. Improved follow-up particularly for missing immunizations was also cited as evidence of improved access.

Cost Factors: The cost factors affecting health care delivery have been evaluated primarily through the factors relating to the health care providers and administrators. There are few objective data on the evaluation of health manpower utilization.

Evaluation of management aspects of health care (secondary cost factors) are much more plentiful. These data relate primarily to the availability of information for manpower and facility planning, and the availability of information for facility operations through better financial management relating to the speed and accuracy of billing and claims preparation.

CHAPTER 5

REVIEW OF SITES NOT VISITED

A. INTRODUCTION

This chapter discusses some of the more interesting findings in our comprehensive survey of sites of activity in the area of Automated Ambulatory Medical Record Systems. Many of the sites mentioned here cannot be considered to have operating AAMRS's. However, in a field which is developing as rapidly as this area is, it is important to complement the findings from the limited sites reported in detail in Chapter 4, with some relevant information from the larger set of sites.

The sites discussed in Chapter 5 are listed in Appendix A of this report. We hope that we will reflect accurately on their activities. We have not had direct contact with many of these sites so that much of the information is from a review of the literature. Some of the data is abstracted from other reports, and any view we obtained is apt to be based on an incomplete understanding of current efforts. Where we have references in the bibliography for this report, an entry is made in Appendix A. Even though the evaluation of automated ambulatory medical records is not a formal, continuing activity at the University of California, we would appreciate feedback regarding any errors or omissions found by the readers so that we may keep our reference files as up-to-date as possible. The sections following correspond in title and intent with the sections of the previous chapter.

B. OBJECTIVES AND ENVIRONMENT

We see again both in commercial, as well as in service or research efforts a genuine desire to improve the quality of medical care. Many of the projects encountered have addressed themselves to specific environments. The current trend toward health maintenance organizations and group practices has given an impetus for many organizations to address the data management problems in this specific area. Meditech, using the experience generated at the Laboratory of Computer Science of Massachusetts General Hospital of course is one of the principal suppliers to this field. Other companies in this area are Compas of San Antonio, Texas and

Systemedics in Princeton, N.J. The Group Health Co-op of Pudget Sound, Washington and the Medical Care Group in St. Louis, Missouri are developing their own systems.

The requirements for medical care review, often combined with reimbursement incentives, has stimulated other system developments. An early organization in this field was the San Joaquin Foundation for Medical Care in Stockton, California. The Medical Care Foundation in Sacramento is developing broad approaches based on these ideas. Utah is developing support for state-wide PSRO activities. Dikewood Corporation, a commercial vendor in this field, provides services to the New Mexico Foundation for Medical Care and the Multnomah Foundation in Portland, Oregon. The depth of the medical data in these systems is often quite limited, and to date the computerized data has not been used as a source for individual patient care.

A system where quality control and individual patient care objectives are combined has been developed at the Jefferson County Health Department's Western Health Center in Birmingham, Alabama. A similar system, with objectives which include health care research data collection, is serving the Columbia Medical Plan in Baltimore, Maryland. John Hopkins University is sponsoring some of these efforts. At Duke University, the Medical Center provides data collection to test prognosis of the effect of treatment choices. Another research oriented objective can be found at Tufts New England Medical Center in Boston where the data base is used to develop and prove hypotheses in the area of the diagnostic and therapeutic process.

C. SERVICES

A wide variety of services is becoming available in the ambulatory medical care area. A traditional service available is billing of patients and third-party payers, which is provided by a number of companies. In some instances the services are augmented by other aids to health care delivery. An example of this are the correspondence aids provided by Edelman Systems Inc. in Baton Rouge, Louisiana, for the generation of routine medical correspondence based on simple phrase selection by the physicians. Other services seen in conjunction with billing-oriented systems are practice evaluation and medical history taking or processing. The interpretation of electrocardiograms, provided mainly to hospital-based operations, is an example of another component of comprehensive health care delivery. Such a system is provided by CEIS of Denver. The dissemination of this service will be studied seperately by the National Center for Health Services Research.

Patient registration and appointment scheduling is an important problem in most hospital-based outpatient clinics. Systems like this are available at UCLA, where the Soundex codes were developed by Russell, in order to improve the matching of the patient by name to his record. Scheduling services of considerable sophistication have also been developed at Boston Children's Hospital and at the Lahey Clinic in Boston. At the Lahey Clinic, the system takes into consideration some of the medical information on the patient in order to determine the visit interval. Comprehensive scheduling of treatments and medications is available for inpatients and outpatients at the Texas Institute for Rehabilitation and Research in Houston. Clinic scheduling is also provided at the University of Texas in Dallas. Scheduling for ambulatory care has also been an objective of the HCMS system in the Denver area. Practice analysis services, utilized by a family practice unit, are provided by Health Care Systems of Minneapolis.

The integration of the many categorical programs available for indigent populations is the objective of a number of systems. We visited such an application in Greenville, but we find similar concerns at Case Western Reserve Medical Center in Cleveland, Ohio, at Roosevelt Hospital in New York, Purdue University, Indiana, and at the Center for Community Health at Columbia University in New York. The latter three of these institutions direct their attention specifically to the pediatric area, as does the Bellevue project which we visited.

D. DATA COLLECTED

In general the systems listed in Appendix A collect fewer medical data than the systems which we visited. While we indicate in the Appendix A approximately which categories of data are being collected at the site, it is not feasible within this chapter to discuss the collection of data elements in detail. There have been a number of large scale efforts addressing the collection of selected data elements. One of these was the University of Alabama-Medicaid Information System which collected physician, institutional, laboratory and drug dispensing information on a statewide basis to produce individual patient medical profiles for Medicaid recipients. On a batch mode basis drug dispensing data are being collected by Health Application Systems and their subsidiary, Paid Prescriptions, in a number of states. California Health Data Corporation, which provides now mainly accreditation services to hospitals, is also developing services in this area. The state of Colorado and Florida also have systems in operation which collect data for reimbursement and service verification. Health Care Management Systems operates a more comprehensive system which includes scheduling of patient appointments in the Denver, Colorado area.

There are a large number of systems which deal primarily with specifically selected populations. We will discuss some of them in Section I of this Chapter. Medical research of course is thoroughly dependent on collected data. We mentioned earlier the Columbia Medical Plan, but there is a plethora of clinical data collection systems in operation, most of which, however, are not set up to provide information for continuing individual medical care. The problem of collecting, verifying, and storing for research, large quantities of data without incurring excessive costs in personnel and equipment has not yet been solved anywhere. An alternative to centralized computer storage of records for individual patient care is suggested by the Medical Passport Foundation of Deland, Florida. The concept of a portable medical record, as developed by them, has many attractive aspects and a low system overhead. In order to make the maintenance of the data easier, the Medical Passport Foundation is now implementing a computer system. The military services have required military personnel and dependents to carry their medical record from one service station to the next. While some problems, primarily with sensitive psychiatric data, have been noted, on the whole this approach has been satisfactory. With the current trend to free access to data the differential impact on the content of a portable medical record may be minor.

E. MEDICAL DEVELOPMENTS

An important development in medical methodology which is felt by many to hold the key to more usable medical records is the problem-oriented medical record developed and promoted by Weed at the University of Vermont. The intention is to apply his automated record soon to an out-patient environment, and it will be interesting to see how a computerized comprehensive problem oriented medical record interacts with the outpatient care environment.Some suppliers of history taking systems in the out-patient care area are computerizing some of their services and thus entering the medical record area. Pelam Inc. of Chicago is one of these companies, and Patient Care Systems, in Darien, Connecticut, the designers of the Rocom forms, is another potential vendor. On a much larger scale, the problems of growth from multiphasic screening at the Kaiser-Permanente Health Plan in Northern California to a pilot comprehensive medical records system indicate some of the difficulties that have to be overcome if one is to develop an effective system for a large population.

In some cases, medical data is added on to existing financial systems. Searle Medi-Data was developing an automated history system at the Charlotte Medical Clinic; this clinic now uses the Edelman System. The latter system is being expanded by the Diagnostic Clinic in Shreveport, Louisiana to include more medical data. The introduction of technical aids to medicine has been studied by the CAPO project managed by Bolt, Beranek and Newman of Cambridge, Massachussets. Family Health Associates, with Dr. Morrison, the initiator of the ambulatory medical record system at the NAS in New Brunswick, has been one of the participants in this evaluation. It has not been demonstrated that the off-the-shelf system as provided by Meditech had an adequate cost/benefit ratio for a solo or small group private practice, but a number of areas were identified which may, together, yield sufficient savings to pay for a small scale computer service. No actual medical record data were stored.

A number of speciality area applications are providing services to the ambulatory medical record area which should be included in a comprehensive system approach. Some of such services are the ENT-workup reporting systems at the University of Illinois, Cook County Hospital, the EEG reporting system at the University of Michigan, and the Radiology reporting systems developed at Missouri. A beehive of activity is at the University of Utah in Salt Lake City, where a number of projects are being developed by Dr. Homer Warner at the Latter-Day Saints Hospital, which may eventually enter routine out-patient care systems. Multiphasic screening is being offered now commercially by their associated venture, Medlab Computer Services, Inc., of that city.

A number of hospitals are attempting to transfer their inpatient experience to their outpatient services as they realize that outpatient care accounts for an increasing share of health care delivery. The Bishop Clarkson Hospital in Omaha, Nebraska, is developing services for the community physicians which use the hospital for their patients. El Camino Hospital in Mountain View, California, which uses the Technicon system for its inpatient care, uses this system also to register outpatients and collect laboratory test and billing data for these services. No long term medical record is maintained by this system. Grady Hospital in Atlanta, Georgia is maintaining surveillance records for family planning, and St. Joseph's Hospital in Milwaukee is using its Burroughs system to develop outpatient oriented services, as is St. Peter's Hospital in Albany, New York. Guys Hospital in London, England is attempting to bridge the formidable gap in the English National Health Service between the specialists and the general practitioners through the use of a shared record system.

F. TECHNICAL DEVELOPMENTS

Many new technological areas are being attacked both by medically oriented researchers as well as by commercial vendors. We will list some interesting developments, but the reader should consider that these do not now form integrated parts of ambulatory medical record systems.

Telecommunications:

The delivery of health care to ambulatory patients in remote areas is considered a problem which is amenable to technical solutions. Both NASA efforts using satellite communications between consultants in central facilities and remote Mobile Health Units in Indian Reservations and in Alaska, as well as the Telemedicine Project at the School of Engineering of the University of California in Los Angeles, and at the University of Arizona, address themselves to these problems.

Data Entry:

Entry of medical record data is done mainly via forms and keyboarding. Outpatients at El Camino Hospital have their laboratory orders entered by light-pen selection on CRT screens, and similarly the Illinois Eye and Ear Infirmary is planning to use selection on CRT-like plasma display panels for their entry of data into the medical record. A CRT selection system was developed for the pharmacy at the University of California in San Francisco and experiments are in progress to evaluate the use of touchscreens, joysticks and keypads in conjunction with this selection. The experience may affect the methodology for the TRIMIS system being developed by the US Air Force. Touch systems are used in inpatient care at the University of Vermont by Dr. Weed.

Data Presentation:

Improved presentation of data for clinical judgement is also being developed at the University of California of Los Angeles by Dr. Carol Newton, using graphics techniques. These services are being currently evaluated by the Cooper Clinic in Camden, New Jersey.

Storage Techniques:

Alternate storage means for the medical records are being applied at Framingham Union Hospital in the Radiology area where intermediate records are held on audio storage devices. Video storage systems for medical records have been installed by Trans-A-File of Cupertino and are also being developed by Teknekron of Berkeley in conjunction with the Insurance Technology System which we reviewed. Automatic tracking of manual medical records is a concern for a number of technical projects. Shaw & Co. of Cherry Hill, New Jersey and Ames (the developers of the colorcoded medical record jacket system) of Somerville, Massachusetts are both applying new technology in this area. The prospect of storing medical record information in a distributed systems is being investigated at the University of Waterloo.

Data Base Structure:

The Illinois Eye and Ear Infirmary is implementing a distributed system using mini computers. It is the intention that one of these minis will be used only to manage the data base, using a relational data base system.

Linguistic Analysis:

The ability to analyze free text automatically remains an issue of interest to computer scientists in the medical area. The Stanford MYCIN project allows free data entry of text to the antibiotic therapy analysis program. Major efforts in the pathology area have been carried out by Pratt at NIH and Lamson at UCLA. The Necker Hospital in Paris provides free text analysis in the area of objective data, while in the Netherlands, at Leiden, data are collected in free-text form with the expectation that analysis of these data will eventually be possible.

Operating Systems :

An important aspect of technical developments in medical record systems remains the operating systems software required to use the systems effectively. The Laboratory of Computer Science at Massachusetts General Hospital, as well as a number of commercial vendors, are active in this area. We visited some of the sites of activity in this area, as described in the previous chapter. We are equally sure that we must have missed many software efforts, specifically those which are not yet related to an operational system.

G. FINANCIAL TRENDS

It is not possible to get an adequate impression of the financial status of sites which we did not actually visit. We do notice however that a number of efforts have been discontinued, either definitely or temporarily, which may indicate that the prospects for the recovery of the investment expense were poor. In academic institutions this occurred frequently when grant funding was terminated.

H. TECHNICAL VERSUS MEDICAL ORIENTATION

The proper balance of medical versus technical orientation may have been the reason why many promising projects have failed to achieve operational status. Biomedical Communication Systems, Inc. of Minneapolis, Minnesota has developed comprehensive system designs for introduction of automation into a number of health care delivery environments, including ambulatory care in Vancouver, British Columbia. The institutional and technical barriers, however, to implementation of a new, systemized approach to health care delivery have not yet been overcome. On the other hand, strongly technologically oriented efforts, like the support for astronauts at the Goddard Space Flight Center, the use of Cybernet services at Georgetown University, and the technical capabilities of Bolt, Beranek and Newman in the CAPO project have not been sufficient to overcome the problems of medical acceptance and economics. In Belgium the Centrall Laboratorium, which provides regional laboratory services for private physicians is engaged in a project to automate the medical records for its users, starting from the laboratory data base. It will be interesting to follow this development.

In some instances, the use of technology has been an aid in the development of systems which subsequently could stand on their own without the use of computers. An example exists in the development of protocols for screening and triage. At Beth Isreal in Boston, the protocols which have been developed using computers, are not managed manually. On the other hand the super position of an inappropriate computer system on top of a good paper and people system at Fort Belvoir was a failure. The experience however is a model for newer developments at the Veterans Administration Hospital in San Francisco and the Veterans Administration Hospital in Palo Alto.

Other work where technology is used to gain an understanding of the medical care process, rather than provide immediate patient benefits is at Tufts New England Medical Center where data from patients are being used to generate a model of the diagnostic and therapeutic process. Another effort in this area is found in Pittsburgh. More specific models, at Mt. Sinai and Rutgers in glaucoma and at Stanford University in antibiotic therapy, may enter patient service sooner.

I. POPULATIONS SERVED

Because of the availability of categorical funding a number of the systems that we reviewed are addressed to specific populations. An example of this is the Indian Health Service System in Tuscon. Services to a similar population are also provided at the Rosebud Reservation at South Dakota in a project supported by Control Data Corporation. The area of psychiatric patient support has given rise to many system developments, partially because of the reimbursement pattern which requires reporting of treatments provided and outcomes. Examples of such systems exist at the Institute for Living at Hartford, Connecticut, one of the pioneers in this field; at the Langley Porter Institute in San Francisco; and at the Missouri Institute of Psychiatry, and in Orange County. New services in this area assist in coping with the drug problem. There are many projects which maintain records for people in drug rehabilitation programs; Creative Socio-Medics of New York and San Francisco provides commercial services in this area.

Patients in specific disease groups are being serviced by narrowly focused systems. Here, as much of the medical content of the record as appropriate to the disease may be collected and used to supplement or replace the traditional record. Examples of such systems are found in the Diabetes Clinic at the University of Texas in Houston, which uses a fully computer-stored medical record for this disease category; and in the University Hospital at Case-Western Reserve, Cleveland, Ohio. Programs to implement TB surveillance have been produced by Arthur D. Little, sponsored by the Center for Disease Control in Atlanta.

Such programs are operative in the states of Virginia, Pennsylvania, and at three urban centers. Arthur D. Little is planning to develop similar services in the area of hypertension control programs. An effort to study appropriatness of TB drug regimens has been carried out at the University of Arizona, and the Indian Health Service in Tucson has also addressed this patient population. Surveillance and follow-up of handicapped children is the objective of the system at the University of Oregon Medical School in Portland. This is a population where successful long term follow-up can make an important difference throughout the life-time of these children. At the University of North Carolina, in the Dental School, programs for the matching of patients and providers and joint optimization of the schedules are in operation.

There has been a lack of integration of the numerous Children and Youth Project reporting systems into the mainstream of pediatric patient care. These systems have great potential for conversion to care-oriented AAMRS's, but relatively few programs, such as the Bellevue system, which we visited, and the University of Virginia system in Charlottesville are currently closing the loop back to the provider.

J. SOURCES OF SUPPORT

The development of a new, automated ambulatory record system requires a major investment of time, effort, and money. While some ongoing inpatient operations may be able to add on outpatient services incrementally, as discussed earlier, it is difficult ot privately fund an effort de novo.

We have seen in the above summary that the sources for the support of many systems are based on categorical grants to service specific populations classified as to need, medical problems presented, or environment. Only sporadic support has been made available for services in private offices which still are responsible for a large proportion of the delivered health care in this country. Commercial services like Automed (which we visited) have systems available to provide services to physicians. A considerable effort in the private offices is required to bring these efforts beyond the routine financial managements stage. Many financially oriented systems are designed in such a way that the addition of medical record services requires modifications or augmentations of the basic systems.

In a few instances private practices have supported their own system development or system adaptations. We visited an outstanding instance of such an effort, the Cardiovascular Clinic in Oklahoma City, which developed their system from Meditech's offerings. Dr. Budran at the Troy Family Practice has collected, coded, entered and analyzed for practice management purposes patient medical information on a small computer leased from IBM. The Diagnostic Clinic in Shreveport is expanding the Edelman System to include Medical Records. The limited scale of these efforts relative to the investment effort required to see these projects to completion will limit developments coming out of the private provider area.

Support by vendors of computer systems is of relatively minor importance. Control Data Corporation supports currently the development of the Indian Health Management System on the Rosebud Sioux Indian Reservation in South Dakota. Honeywell Corporation has aquired the REACH hospital system developed by National Data Corporation and is now marketing it under the name VITAL. No major efforts in this area seem to be sponsored currently by IBM, a corporation which previously has invested substantial efforts in various health care delivery system areas.

Economic pressures, as well as restriction imposed due to financial accountability, make it difficult to support development of systems by most public health care delivery institutions. The U.S. Public Health Service Hospital in Baltimore, Maryland has been involved in the development of a number of small scale automated medical record system developments. However, none of them have reached operational status to the extent that health care delivery was significantly impacted.

The military establishment is under pressure to revamp its health care delivery system because of the expiration of the doctor draft. A major project for all three services (TRIMIS) is sponsored by the Department of Defense and managed by the Air Force in Montgomery, Alabama. Earlier efforts at triage of patients to clinics have been carried out for the U.S. Army at Fort Belvoir in Virginia.

The funding by the department of Health, Education and Welfare for new project development in the area of automated ambulatory medical record systems is limited while the National Center for Health Services REsearch evaluates the status of currently operational systems. They have recently supported the Physicians Association of Clackamas County in their efforts to develop criteria for system selection and implementation. Funding by the National Institutes of Health is limited to the collection of data for medical research or the exploration of new concepts in medical diagnosis or treatment. The health service oriented area of HEW has funded mainly registry and reporting services for its programs; some of these have been expanded into more comprehensive services.

In Europe and Japan, the predominance of Government supported health care services has provided the impetus for the development of systems that produce management or epidemiological information. A well known example is the system at Danderyd in Stockholm County which provided the initial system development for the Automed software used by Medical Data Systems C orporation. In England, studies in the Devon-Exeter region, in East Anglia, and at Livingston New Town provided base data on health services to regional populations. In Germany, the Kassenarztliche Bundesvereinigungen are the reimbursement agents for private physician services in Germany's union or employment oriented Health Care Support. About a dozen regional computer systems are operational, covering most of the population, and a central data bank is under discussion. Plans to use this system to share critical medical data among the providers both within the regions as well as throughout the Federal Republic are being evaluated.

K. TRANSFERABILITY

Before systems can be effectively transferred, potential purchasers will want to have the chance to see and evaluate existing operational sites. It is hence not surprising that transfers rarely take place until several years of demonstrated system of operation. A system widely transferred is the Meditech service, MIIS, which is based on the MUMPS system, developed at the Laboratory of Computer Science (LCS) of Massachusetts General Hospital. Meditech operates a subsidiary center in Phoenix, Arizona, which serves, among others, the Arizona Health Plan with an ambulatory medical record. The outpatient department of UCLA uses the MIIS service for patient scheduling and the Physicians Association of Clackamas county is considering the use of this service. On the East Coast the Wiscasset Health Center and the Penobscot Bay Medical Center are new HMO's starting to use automated medical records. MUMPS based services are also provided by other vendors, but have not been utilized in the ambulatory medical record area as far as we could determine. The MUMPS service provided by LCS to the Kenmore Center of the Harvard Community Health Plan, which we visited, is under consideration for transfer to their Cambridge Center. The psychiatric record system developed at the Rockland Research Center has also been transferred to other sites. This transfer is in addition to the many service locations concentrated in the northeastern quadrant of the United States which are served by Rockland directly. One independent user of the Rockland System is the University of Alabama in Birmingham. The Gemisch system developed at Duke University is used also at the

University if Chicago and by Health Quest in the Washington area for the ambulatory care services. The Automed system provides services for all of its customers in the adjoining states from its location near Cleveland only. A contract for the development of clinical patient data base support system is being executed at Rand Corporation. The intention of this system is to serve the clinical research centers recently funded by HEW. The system designers have visited a number of earlier sites of activity and state that they are adopting a number of concepts from the Stanford system. We would expect that applications of this system will impact the ambulatory medical records area.

L. ATTITUDES

During our search for AAMRS sites we have had the opportunity to discuss with numerous individuals their progress in the development of automated ambulatory medical record systems.

The attitudes which we perceived in our collection of sites ranges through the full spectrum of human emotion. It would be inappropriate to reference the specific sites where we heard strong opinions, since the feelings conveyed are both individual and often temporal. At sites where systems have been tried and subsequently abandoned, the feeling is frequently that the support was discontinued before effectiveness or benefits could be adequately demonstrated. At a number of sites, medical personnel felt that they had not received a fair and honest treatment by the technical promoters of the systems. On the other hand, technical developers tend to complain of inadequate understanding and cite constantly changing specifications and expectations from the medical community. It is obvious that a broad gap has to be bridged. In new projects, which are currently under development, there is universal enthusiasm both among the technical and medical personnel. There we find often an extrapolation of benefits and acceptance of the new endeavor which has not been critically evaluated. The rapid advances of technology provide convincing arguments for workers in the field that past failures are no reflection on the eventual capabilities of ambulatory medical record systems.

M. EVALUATION METHODS

The sophistication of the evaluation activities at many sites appears to be limited. We found during our inquiries a great deal of interest in the data and the criteria which we were using in this evaluation of medical care technology. Four sites involved in the evaluation of ambulatory medical care records should be mentioned. Both Northeastern University in Boston and Northwestern University in Chicago, Illinois are studying the benefits of automation; the former in the area of manpower deployment and the second in the area of health care outcomes. Other evaluations are based at the Lincoln Community Health Center in Chapel Hill, North Carolina, and at the Walter and Elizabeth Hall Institute of Medical Research in Victoria, Australia. Less formal evaluation methods are of course an integral part of any of thedesign efforts in the development of medical record systems. Since the cost of these systems tends to be proportional to the quantity of data collected and stored, the value of data elements is judged critically by any implementer. Development of disease - specific minimum basic data sets for quality assurance by the Clinical Information Systems group at the University of Alabama is a current effort directed toward parsimonious data collected.

CHAPTER 6

IMPLICATIONS OF THE FINDINGS

A. INTRODUCTION

In this Chapter, we will try to analyze the trends and the causes for relative success or relative failure of a number of aspects of the automated ambulatory medical record systems surveyed. A problem with the assessment of trends is that each of the sites visited or described in the literature is apt to be at a different stage in its development. The most developed sites, the pioneers in this field, have borne a great burden while acquiring organizational, medical, and technological expertise. More recent systems have used to varying degrees the experience accumulated from the earlier sites. These users may have suffered less pain, but have also collected less experience with the operational aspects of their systems. Many of the most recent systems have not yet been able to establish the validity of their approaches.

This Chapter should be read with great care because it presents, of necessity, a rather subjective view of the activities in the area of Ambulatory Medical Record Systems. We felt, however, that this material should not be withheld from publication, since it may present a more comprehensive view than a listing of mere data can convey. The fact that our study team had a multi-disciplinary background, and was made up of members of a variety of institutions, should temper somewhat the subjectivity of this material.

The twelve areas discussed below are synchronous with the descriptions from the visited sites presented in Chapters 4 and 5. They are summarized in the table below:

B. Validity of objectives and importance of environmental factors
C. Benefits of the services provided to medical and institutional personnel
D. Assessment of the value of medical data elements to be included in ambulatory medical records

E. Trends in medical services to be provided

F. Trends in technological support for ambulatory medical record systems

G. Trends in financial support for automated record services

H. Interaction between medical and technological development

I. Populations which will benefit most from automated ambulatory record systems

J. Effects of funding on development objectives

K. Factors for transferability and diffusion

L. Interactions between systems and user attitudes

M. Development of measurement tools for evaluation.

B. VALIDITY OF OBJECTIVES AND IMPORTANCE OF ENVIRONMENTAL FACTORS

Introduction:

We cannot disagree with the stated goals of most system developers and provider groups that the basic goals: improve quality and access, and reduce costs, are available. Since there are few well controlled studies on the effect of information systems on care quality or access and since it is nearly impossible to arrive at accurate developmental and operating costs of many sites, it is difficult to evaluate how valid objectives are. We have to assume that the founders and providers of the services recognized a valid need in their surroundings and are attempting to achieve gains in a balanced manner. The fact that often many collaborators are required to implement new systems to aid health care delivery should provide some checks and balances.

We tended to discount purely technological factors as for instance "a total automated medical record" but instead looked for the benefits and liabilities of such an approach. Only at sites where technological achievements were clearly stated as major objectives did we include these factors. This should not be taken as an indictment on our part of technology, but rather as an indication of our belief that the right technology at the right place will be beneficial.

Often the solution to care management or to care funding problems had to be attacked before thought could be given to the basic objectives of health care systems stated above. In large institutional settings dependent on government funding administrative requirements these secondary coat factors may take precedence over medical goals.

Environmental factors such as population groups served, the socio-economic status of patients, and the needs for primary or specialized care exerted an effect on the relative valuation of the three nominal goals, but did not effect the actual achievement of the objectives.

Environmental Factors:

The protocol was designed to identify significant environmental factors at the AAMRS's. The factors consisisted of:

Population served (ethnic, disease, age)
Service environment (urban, rural)
Social status of patients
Health care needs (primary, secondary, tertiary care)

We found that environmental factors had a minor effect on ability of the site to attain its goals for the AAMRS. It became clear after our visits to the various sites that attainment of stated goals for and AAMRS was greatly dependent on the ability of the AAMRS designer and the providers using the AAMRS to effect changes in the institution as a whole.

In several sites, e.g. Cardiovascular Clinic, HCHP, Automed users, ITC, control over the various aspects of the site was such that all goals could be accomodated. These sites were particularly able to demonstrate an ability to affect secondary cost factors.

Other sites, such as Bellevue, Casa, Regenstrief, Duke, Greenville, MUSC, operated an AAMRS superimposed on traditional university-based systems. These sites were relatively ineffective in obtaining a gain in cost containment, because of their relative inability to directly effect these areas. For example, substantial use of an automated record could not be realized a gain by reduction in record room personnel. From our vantage point the most important environmental factors were the relationships of designers and providers involved with the AAMRS to their institution as a whole.

Quality of Care:

Improvement in quality of care was a goal of all designers and all but one provider of an AAMRS. This goal was to be accomplished by such measures as improved patient management, increased compliances, institution of quality of care review procedures, and better communications between, and feedback to, providers of care.

Evaluation of the quality of care is discussed extensively in Section 6M. Subjectively we found that quality concerns were a real, but rarely a primary motivation for an AAMRS. We found that in more than half of institutions visited the quality of care had been positively affected, and at others the quality of care had not changed significantly.

Indirect factors, as the frustration of a physician with system shortcomings may affect care at times, but also occurs due to non-automated happenings.To reduce subjectiveness in this area, it can be stated that quality of care evaluation in terms of outcome criteria is needed. Process criteria are most commonly utilized for care evaluation and most of the sites we visited utilized this method.

A comprehensive record, with a good indication of problems, complete recent medication and laboratory data, items for surveillance, and improved following were the major elements of improved quality of care to be provided by an AAMRS. The most vivid improvement in this area was achieved at sites, i.e. Bellevue, where the traditional record is not reliably available, and when available, is not complete. After institution of the AAMRS, the record was available and a great gain in both quality of care and access to care had been achieved.

Other gains in quality of care, after introduction of AAMRS, were less vivid, and taken alone, did not justify the systems. The validity of quality of care as an objective could be questioned in sites where no plan for an evaluation was included as part of the design of AAMRS. Further it is of interest that the majority of sites considered the existing quality of care in their institution as high, and therefore gains in quality might reasonably be more difficult to achieve.

Access to Care:

Improvement in access to care was an objective shared by many of the sites. There is clearly overlap in goals in the area of quality of care and access to care. Environmental factors had obvious critical effect on the attainment and relevance of stated goals.

A number of systems were instituted with incomplete understanding of the fundamentals of practice management. A case in point is the institution of automated appointment system. Many were established in centers serving minority and indigent populations. Goals of the automated appointment system were decreased waiting time for patients, with resultant increased patient satisfaction and compliance. Most sites visited had previously utilized a block appointment system, (i.e. all patients were scheduled at the beginning of clinic). Most automated systems were then geared to 15 minute blocks. Uniformly, the managers of the systems believed that they had not previously had an appointment system, where in fact they had had a block appointment system which makes maximum utilization of provider time, with the trade-off of patient delay. Fifteen minute block systems were instituted with little understanding that a trade off had been accomplished, (LAN71) (i.e. less patient delay for poorer utilization of providers). Most of these sites experienced no-show (pt. neither keeping, nor canceling an appointment) rates*of approximately 50% with a wide variation due to weather, traffic patterns, etc. The no-show rate was attributed, in part, to the existing appointment or non-appointment system, a factor which has, to our knowledge, never been documented. Factors documented (HOF69) as having influence on no-show rates, i.e. who makes the appointments, who refers the patient, and the time interval between making appointment, and visit, were not indicated as considered. Most of the sites indicating decreased patient waiting time as an outcome objective, also listed better utilization of physician manpower as a goal. Introduction of a 15 minute block appointment system, into a setting of 50% no-show, makes better physician utilization less attainable. Automated appointment systems in settings that had previously utilized manual systems with little patient delay, and also had low no-show rates, 2-5%, had different expectations for the systems. In general, automation in these settings was seen as a minor benefit of the AAMRS with a gain mainly due to the easing of clerical work load, and little direct effect on access to care.

On the positive side, sites listing "greater availability of the medical record" as an outcome goal, were uniformly successful. Many of these sites were again centers serving indigents and minorities. The traditional record was, for the most part, available approximately 50% of the time, and when available, was incomplete (eg. 40% of lab tests were not entered within 6 months). One of the sites (IHS) indicated improved patient follow-ups as an objective, and was successful in attaining this goal through the use of Public Health Nurses. This seems to be an effective method of achieving the goal of better access in an ethnic and indigent population. Centers in urban areas had neither the resources nor the patient management methods to utilize outreach effectively, and access is determined by availability of an appropriate provider with adequate data when health care is sought.

Cost Containment:

Cost containment was a stated goal of the majority of AAMRS designers and providers. Designers and providers both expected savings in the area of improved utilization of health manpower. Other factors indicated were fewer unnecessary visits, fewer redundant lab tests, and better referral. Providers expected significant savings in the area of recording cost factors. In the HMO systems reduced hospitalization is an important outcome. Environmental factors were clearly critical in attainment of cost containment goals. Many of the sites had little or no control over either primary or secondary cost factors. For instance, savings expected from replacement of manual record methods could not be realized as cited in the introduction to this section. We were unable to identify significant true cost savings at any sites by better utilization of providers due to the AAMRS.The most obvious cost savings were achieved at sites with close integration of medical, business, and administrative areas. Cardiovascular Clinic was able to demonstrate cost savings primarily in the area of secondary cost factors, and had significant control in this area to readily realize these gains.

C. UTILITY OF THE SERVICES

D. UTILITY OF THE DATA

Introduction:

Since the services and the data are joint elements providing the medical benefits of an AAMRS, both analyses are combined into this section.

The services provided by an AAMRS at the provider/patient encounter are conceptually similar to those provided by the traditional record systems. The benefit of computer use is mainly the ability to present data in an orderly and legible fashion, possibly with some emphasis drawn to critical information. To provide this service in a traditional environment would require a great deal of clerical effort, as well as a certain basic medical experience by the personnel, so that automation is often an economic prerequisite to such services. On the other hand, many personal touches and individual habits of flagging of items of interest are lost when the medical record is automated.

In our discussion regarding utility of the data gathered at and reported to the encounter, we must point out that, clearly, all of the data could be considered useful at some point, by someone, for some problem. To have economic utility, data must contribute to better patient care and management, and at the same time its collection and storage must not unduly burden the system.

Little objective evidence has been gathered regarding the effect of medical record content on quality of patient care. Medical students are often urged to get "complete histories and physicals," but completeness is nebulous if the time factor is not specified. The effect of these "complete" evaluations on quality of care is questioned by the work of Fessel and Van Brunt (FES72).

We know little about the cost/benefit of data gathering. At what point is the presumed improvement in patient care resulting from the availability of more data offset by the demand for provider time? Time taken to resolve numerous trivial problems may well lead to the neglect of more important problems in other patients. At what point can providers no longer handle the large volume of data that they are expected to gather or pursue, and must abandon the system?

In our visits to the various AAMRS sites, we observed a wide variety of approaches to source collection. However, some common threads did appear: At most sites, basic data, which were obtained before the provider saw the patient, were available at the first visit. These basic data may be limited to identification information, but prior to an initial visit a patient history or multiphasic test may have been taken. At each encounter, the provider recorded specific data, which were available at subsequent visits; and specific data was scrutinized on a regular basis by computers at several sites, and surveillance information returned to the provider. These common threads then took several forms: initial data base, abstract of past medical data (patient profile), encounter data, and surveillance. In the absence of objective evidence to substantiate the economic utility of data, criteria for evaluation are of necessity subjective. One of our particular biases is related to our background as family physicians involved in a broad spectrum of patient care in a busy practice setting.

Data Base:

A number of authorities have approached the problem of determining what is an adequate data base. Voluminous though the discussion has been, little objective evidence exists to help bring light to this area. Optimum cost, time, and yield have not been established for a complete data base. Even in multiphasic screening, much controversy remains (WAK71). Savings in provider time with automated data base availability at the first visit have been documented in the CAPO project (BOL72-1).

We will not attempt to add further confusion to this area by defining our ideal data base. The defined data base will be different for different practices, specialties, and groups, and for different patients of different ages. What is important for one doctor or patient, may not be important for another individual. In our survey we looked for all conceivable entries into the data base, and did not draw any general conclusions whether or not the specific entry was important or appropriate for that practice.

The content of the data base presented to the provider was perhaps not as critical as the format. Sites which printed detailed, multipage data bases with patient replies to all inquiries were uniformly unable to gain provider acceptance. The next level of sophistication consists of the return of pertinent negatives and positives only. Branching type questionnaires are aimed at cutting back the number of trivial or false positive replies.

A more logical approach (WIR75) would seem to us to include data elements aimed at definable objectives. For instance, a data base aimed at decreasing mortality from selected, high probability causes could be designed with relatively few data elements. Additional elements might be included if the system aimed at morbidity, disability, time lost from work or school, and preventive care compliance in areas with proven results.

The real problem comes when we aim at disease during a review-of-systems. At the Family Practice Center in Santa Rosa, experience has shown that the average pre-printed, patient-completed history produces 19 to 20 positive replies that require further provider follow-up, which only infrequently leads to any demonstrable benefit to the patient.

If an extensive data base is to be gathered, it is essential that this information be presented to the provider in abstract form. Pertinent positives and negatives will offer more than enough endurance testing of the provider.

Abstract of Medical Information (Patient Profile):

Abstracts of medical information including current medications and recent visit data seem a particularly valuable output of an AAMRS. Providers at all institutions considered them of some value. We are aware of no specific published studies relating to the value of abstracts in contributing to improvements in quality of care or in utilization of provider time. However, studies relating to the value of the initial data base in better utilizing provider time are probably equally applicable to abstracts of data from a series of encounters (BOL72-1).

No studies that we are aware of have addressed quantitatively the problem of just what data is most useful in an abstract, and what is unnecessary. We have considered a methodology for such a study: varying amounts of information to be provided in the abstract, and traditional records sealed; or completely computerized records to be programmed to indicate the need for additional information beyond the abstract. Such an experiment will require a controlled test with a site which has a similar patient and provider population, and a similar mode of operation to allow proper evaluation.

Abstracts of medical information are clearly most useful in a setting where the traditional record is not reliably available (Bellevue). Even during our brief visit there, the usefulness of the abstract was demonstrated, resulting both in improved quality of care and savings in costs due to avoidance of redundant laboratory tests.

Encounter Form:

The free text progress note has constituted the traditional encounter document for medical practice. In our visits, a number of different encounter documents were utilized, varying from the traditional form to multi-page highly coded entry documents.

The dilemma presented here is between written free text methods and coded forms. Free text allows the provider great leeway in describing the encounter, but offers poor retrievability or requires expensive coding by clerical personnel. Coded forms offer excellent retrievability but to a questionable extent impinge on provider time and diligence (BAR69-3).

We feel that a compromise is in order and suggest:

brief (one-page) encounter documents
in problem-oriented fashion
with some coded information.

When information is to be coded, the provider should be offered some relief from his labors: A check list of laboratory codes could serve as the order slip and should also generate the information that he wishes to be able to use for surveillance and to analyze in the population served. The format most approaching our ideal was that used at IHS, but this form requires clerical labor in encoding some of the data.

No studies exist, that we are aware of, that document the effectiveness of improved data collection by means of encounter forms on quality of care improvement versus the increased costs of medical care. Several sites encode the encounter data without requiring coded encounter forms from the providers. Casa is an example of this format, where providers enter free text progress notes, which are later abstracted by record-room technicians for entry into a coded format.

Sites using multi-page encounter documents (Stanford, Yale, HCHP, and Cardiovascular) did not require that providers indicate each data category at each visit; only new findings or changes had to be indicated. Acceptance was a function of motivation; at Stanford, where the users were designers of the system, enthusiasm for the system was high, while at HCHP, acceptance of the system by busy clinicians was modest. Cardiovascular was another instance where the users had designed the system to their specific needs and were enthusiastic about it.

One site (Regenstrief) has produced a most innovative combination of the abstract of medical information, and the encounter form, and further evaluation of the acceptance of the approach will be very interesting. In practices with mainly acute presenting complaints, the selective hand printing of values for findings may not be applicable.

Two sites (MUSC, NAS) had potential for allowing direct (CRT-keyboard) entry of encounter data by the providers. At these sites the providers we surveyed rarely used this option: at MUSC only a few residents on low load weekends entered encounter data, and at NAS entry was made only for laboratory orders. At all other times, providers at these sites relied on dictation for entry.

The differences in provider acceptance of abstracts of medical information (patient profiles) and of encounter forms are of interest. Several elements of this contrast are evident. The content of data in the patient profiles is much more uniform between various sites, than is the format of the encounter forms. The format of patient profiles is often quite concise (one page), with information elements appearing in the same place each time. Encounter forms are often multiple-paged. Where distinct forms for various encounter types were used, they did not have the same format. Finally, the coded entry forms for the recording of the encounter forces the provider to actively "change his ways."

In a research-oriented environment, the desired extent of data collection encumbers the actual care process with burdens that would not be tolerated in private practice.

A possible difficulty at many sites was in the changing or correction of a mistake in data already entered. At some sites the entire or major portions of the encounter document had to be re-entered. Monitoring for errors was carried out by the highest level medical personnel at several sites. System improvements based on rational trade-offs between cost of errors remaining uncorrected in the data base, the cost of correction, and choice of error-correcting feedback loops at multiple specified levels, seem to be needed.

Type of Entry:

Physicians certainly type slower than they can write; it is not surprising that no system functioned well with direct typing of data by physicians into the keyboard of a CRT: check-lists on forms and dictation were the predominant means of data collection. Often only the minimum number of elements which avoided rejection by the system were entered. Data entry by CRT selection, relatively successfully employed in inpatient settings at El Camino Hospital by Technicon, by Weed in Vermont, and by the Honeywell REACH-VITAL System, was not used at any of the sites visited. A console with a touch matrix and paper overlays is part of the Searle system at St. Peter's Hospital outpatient service, but only clerical or nursing personnel use is foreseen.

The difference may occur because in an inpatient setting, the physician, in writing up the patient record, uses a long and thorough format which is relatively standardized for all types of illness, whereas in the outpatient setting the note is usually brief and with variable content. Thus, with a menu-type selection, the outpatient provider might have to spend considerable time finding the right heading or area to record his data, and the format required will be the same for a minor complaint or a major one. In the outpatient setting, flexibility, care, and quickness of entering data are important attributes, as the provider usually averages seeing about 4 patients per hour. This does not leave much time for recording data. It is doubtful, at this time, that any direct machine interface can permit as rapid recording of data as a scribbled note or a few sentences on a pocket dictaphone. The result of these constraints is that most sites have come to rely on one of two methods for entering data: forms (with checkmarks, numerical entries, or written free text) or dictation; and no alternatives have been proven in an ambulatory setting.

Tabular Data Representation:

The traditional as well as the problem-oriented record, and computerized revisions of this record, place limits on the amount of information that can be reviewed conveniently. Flow-sheet-type computer-generated reports for various medical parameters summarize larger amounts of data. The format of a flow sheet will depend on its purpose and the information to be presented (SCH74-2). Other outputs may be in the form of histograms, tables, or graphs. Many of the flow sheets seen were very poorly formatted, and inhibited scanning for exceptions or trends by not being rigorously columnar. Some presentations extended routinely over many pages and contained much repeated text to identify the variables. Only one site (Stanford) used graphical computer output, scattergraphs or histograms, to a significant extent. Graphs were also seen in reports from the Connecticut Mental Health Center, generated by the Rockland system.

Some sites (Duke, Stanford, MUSC) were able to generate simple histograms that displayed utilization-type data. For instance, one axis might be age by 5-year intervals, the other the number of visits per year in

5-year intervals. This kind of format was obviously particularly useful for managerial tasks. By using as a search parameter an item such as cholesterol, many descriptive parameters of the patient population could also be displayed. This kind of presentation could well be useful to medical researchers, but does not in general aid the practitioner for individual cases. Comparison of a group of patients, selected to be similar to a new incoming patient, was used at Stanford to prognose results of alternative treatment modalities.

For patient care the most useful format of presentation is a well-formatted flow sheet with various parameters displayed over time. Examples were rheumatology data at Stanford, and family planning data at Greenville. Diabetes and hypertension monitoring protocols from sites not visited also used flow sheet presentation for their data. The capability of these flow sheets is limited by the number of coded variables and the programmers' ingenuity in formatting. Particularly with chronic medical diseases, such as hypertension, diabetes, congenital heart failure, and arthritis, this format offers many advantages. Pediatric preventive care and family planning are also amenable because the same parameters are being followed for a long time.

Surveillance:

Several of the sites utilized the computer in active surveillance of the health care process. By surveillance, we mean the computer's indicating to the provider what data is needed but not yet collected. At Regenstrief a powerful surveillance system was established in the diabetic clinic; it was individualized for each patient, and was geared toward monitoring potential complications of his illness and the medications he was taking. A controlled study has demonstrated the value of this surveillance in effecting provider compliance to advice-rules, in regard to the ordering of monitored lab tests. Even in this setting, however, inexperienced providers (medical students and residents), apparently unaware of the study results, were unimpressed with the value of this system. IHS utilized surveillance of preventive care to provide worklists for community health personnel.

There is little question about the value of pediatric preventive (well-child) care, but the cost-effectiveness in adult preventive care of being able to modify the course of potential disease has not been proven. Thus, even though this is a neat service, the additional costs of many tests may not be justified. The ability to do patient surveillance depends on the ability to do searches on data entered in a structured manner. This requirement has also a cost factor, which may have to be partially allocated to surveillance costs.

Prevention of illness is frequently not given a high priority, especially when a provider is constantly dealing with more acute and pressing problems. These surveillance systems produce the reminders needed, in a timely and well-thought-out fashion. We would predict that surveillance will gain greater utilization in automated systems in the future if the health care delivery system adjusts to greater acceptance of paramedical personnel.

Appointment Scheduling or Registration:

Scheduling systems seen by us are subjectively reported as saving time, making more efficient use of medical personnel, and, when in use for patient reminders, being able to significantly reduce the number of no-shows. Appointment registration was also used at Regenstrief, Cardiovascular, Bellevue, and NAS, and was under consideration at HCHP. At Greenville, where it was stated that 131 clinics were connected to the central appointment registration system, each clinic was programmed according to individual providers' preferences in terms of how long per appointment, how many nursing patients per period, how many add-ons, etc. It offered another advantage in that if a patient needed an appointment at more than one clinic, the system would attempt to get all necessary appointments on the same day. Similar choices were available at Bellevue and Cardiovascular. In a setting with a large number of clinics and/or providers, this kind of service can save clerical time, assure well-booked clinics to make the best use of providers, and decrease patients' waiting time (HOF69). It also can make it easier and simpler for patients to get appointments, and can improve the percentage of appointments kept by patients. This is especially true in a county or federal setting. In a smaller office with efficient secretarial help and with a low no-show rate, a computerized patient scheduling would not hold the same advantages.

E MEDICAL AND MANAGEMENT STATUS AND TRENDS

Current Status:

The quest for data concerning ambulatory care encounters reflects the dearth of knowledge about even the most elementary measures of performance of the health care delivery system. Although huge investments have been made in biomedical research, comparatively little has been spent in the study of the factors responsible for the quantity, distribution, and quality of health services. Automated medical record systems may be viewed as a possible mechanism to systematically acquire knowledge about the actual operation of the system. Using this view we see that data are to be aggregated in meaningful ways as input into the decision-making processes that occur at all levels of the health care delivery system, from the tactical or patient care level through the strategic or planning level.

In contrast to hospital inpatient care in the United States, there is little homogeneity in settings in which ambulatory care is provided (MUR73). Prepaid group practices in health centers with registered populations account at this time for something less than 5% of total annual patient visits to physicians. Hospital clinics and emergency rooms (in all categories of federal and non-federal institutions) account for approximately 20% of total visits; this number has been rising steeply in recent years. The great majority of visits - more than 75% - occur in the offices of physicians practicing alone or in small partnerships and groups.

Minimum Standards:

Many physicians keep very limited medical records on their patients. They rely on their memory, their accumulated experience in the local health care setting, and perhaps on data provided by the patients themselves. Most need little data to manage their practice from a business point of view. The only information they are required to provide to others routinely is the information required for insurance claims forms for some, but not all, of their patients. The effect is that the average independent physician does not have the same motivation as an HMO or hospital-clinic to analyze his practice and participate in health information systems, although some have argued that there would be substantial benefits (SEH74).

In the absence of a universal health insurance system covering all ambulatory services, there is no simple way to build a composite picture of ambulatory medical services. The concept developed by the Conference on Ambulatory Medical Records (MUR73, PHS74) of a minimum basic data set, with uniform definitions and classification, recognizes the fact that there is no single pattern of ambulatory care services. The internal and external requirements for data from different settings will dictate the design of different types of information systems and the use of different methods. The overriding need is to introduce comparability in data collection in all settings, starting with the most important and useful elements of data.

The intent of the minimum basic data set, Murnaghan explains, is not to restructure the medical record, but to encourage the incorporation of certain basic data in the record so that they will be available for reporting and analysis as needed by the health care provider himself or external agencies. The participants at the Conference on Ambulatory Medical Care Records identified five broad categories for intensive study:

1. Patient care
2. Management
3. Planning
4. Evaluation
5. Research

The fifteen elements of the minimum basic data set are grouped into registration and encounter data:

Registration Data
- Person identification
- Residence (including zip code)
- Date of birth
- Sex
- Marital status
- Race

Encounter Data
- Facility identification
- Provider identification
- Person identification
- Source(s) of payment
- Date
- Patient's purpose, reason, symptom, or complaint
- Physician's diagnosis or problem designation
- Diagnostic, therapeutic, or management procedures
- Disposition of patient

The participants at the Conference also recognized that as part of a more comprehensive system, encounter data could be consolidated to provide useful patient summaries or profiles. They also stated that a traditional, well kept medical record contains much more clinical detail than is necessary for the purposes of a minimum basic data set, and at the same time, it may be missing certain universally needed items, like source of payment, address, and other facts that are frequently recorded on a one-time basis by the office staff when the patient registers, enrolls, or presents himself for treatment.

In other sections of this report the relationship between medical record contents and evaluation is discussed (Chapter 6 M and Chapter 7). It remains to be demonstrated whether or not parsimony and simplicity in recording medical data is consistent with delivering high quality care. Fessel and Van Brunt (FES72) report that there is no positive relationship between the structure and content of hospital records and the outcomes for the patients with several common conditions. Until such a definite relationship can be demonstrated in ambulatory care, the conventional wisdom of numerous practicing physicians who record data frugally ought to be regarded with tolerance, especially by the academic community.

All of the fifteen data elements recommended for inclusion in the minimum basic data set are stored by most of the AAMRS projects reviewed. Moreover, patients profiles are produced by all of the operational AAMRS projects involved in primary care. At several sites this patient profile replaces the traditional medical record at the time of the patient encounter (HCHP, Cardiovascular, NAS).

Classification:

A wide spectrum of data acquisition practices has been observed among medical practitioners and a classification scheme has been suggested (WIR75).

At the lowest level (Level I) the medical record consists of an index card which is devoid of medical data entirely and serves only as a cash accounting and administrative system. Because the form and content of medical records is not regulated, there is no legal proscription to the use of this type of medical record for ambulatory care in most states.

Level II represents the more common manilla-folder-bound, source-oriented record. The entries usually record one or two lines of unstructured and uncoded items, ranging variously from the chief complaint to the historical, physical examination, laboratory, diagnostic and therapeutic data.

Level III is similar to level II, but because of third-party claims, the clerical staff abstracts and codes the data for filing insurance claims. Some physicians have found it convenient to keep duplicate copies of these claims as their functional records. It has also been proposed (MES75) that computer processing of claims data to produce a "skeletal" medical record and summary, inclusive of medical data, could provide automated ambulatory medical records for the entire Medicaid population.

At Level IV not only the basic minimum data set as described by the Conference on Ambulatory Care Data is recorded, but health surveillance information, other structured medical data, and medical text augment the contents of the records.

Most of the AAMRS projects reviewed can be classified as Level IV, but some are probably operating at level III. Table 6E1 ranks sites according to the number of characters in the computer file per patient. Those sites with less than 1000 characters stored per patient are probably operating at level III whereas those above 2000 are probably operating at level IV.

Even though some sites operate essentially on level III, it is very clear that this is dependent on maintenance of continuity between the patient and the physician. The physician can only function with the computer-generated patient profile adequately without resorting to the traditional medical record only if continuity is maintained. It is also interesting to note that sites that have dispensed with the traditional record also maintain a one-patient one-provider relationship (HCHP, Cardiovascular, NAS) even though they have a deeper data base available.

Structure:

There is considerable variation among sites in the amount of structuring of data for storage in computer files of the medical record systems. At one extreme all information entered into the Yale system is coded to produce a three-dimensional matrix of "clinical events". At the other extreme are sites that store large amounts of free text (MUSC, NAS, Bellevue). Despite the elegance of the concept at Yale, it is very clear that the mechanism devised for capturing data is not yet satisfactory and that user acceptance has been quite low. While capturing an average of five "clinical events" per encounter, the sixteen page encounter document was stored in the traditional record in compliance with legal advice.

Those sites employing extensive structuring of data enjoy the greatest flexibility in producing reports from special database searches. However, because of the shallowness of most databases, the evaluations of the quality of care delivered are rather limited. Most of the information retrieved is for the purpose of practice management, health surveillance, and analysis of care process in relationship to diagnostic impressions. Most systems enable management to report extensively on on personnel, facilities, and equipment utilized in providing health care. These parameters relate importantly to the financial consequences of providing health services (HCHP). Those clinics which acquire health surveillance data, e.g., immunization records, have the ability to identify populations at risk, to initiate and plan further patient contacts, and to demonstrate the achievement of their health surveillance objectives within their service group (IHS). Several projects have analyzed the appropriateness of prescriptions in relation to specific medical problems (MUSC, Yale, IHS).

The Weed concept of the problem-oriented record, despite lip-service by a number of projects, has not had a major impact on the development and use of an AAMRS. Even those AAMRS that allow the entry of linkages between medications and problems find that providers rarely fill in the data field that specifies the linkage.

Summary:

From the provider's viewpoint, it has yet to be proven that automated record systems are superior to paper systems for delivery of ambulatory care. The power inherent in an AAMRS is the use of potentially inexpensive technology for management, planning, evaluation, and research functions in addition to the patient care function. Although some providers are perceptive of the need for performing these functions, most are probably not aware of these needs or are unable to see how data for these functions will affect them in an immediate and positive way. Clearly the benefits as perceived by physicians will be more in keeping with their individual environments and experiences--a much narrower focus than the objectives identified by system developers.

TABLE 6E1

SITES RANKED BY RECORD SIZE

Site	Characters/ Patient* (Thousands)	Characters/ Encounter	Remarks
Yale	100	10.0	Offline
Rockland	25	2.7	
Bellevue	16.0	6.0	Free text stored; probably a minimum estimate.
IHS	9.1	2.75	Operational 1969
Stanford	8.9	2.0	
MUSC	4.4	1.2	Free text stored
HCHP	3.3	.13	No traditional record at patient encounter.
Casa	3.0	.85	Offline
NAS	2.3	1.5	Free text stored. No traditional record.
Cardiovascular	2.2	.58	Computerized history not stored
ITC	1.5	.42	
LA	1.0	1.0	
Regenstrief	.76	.17	Disease and patient-specific encounter form
Duke	.63	.18	
Greenville	.56**	.73	Developmental system
ELA	.5	.16	Used for reports to funding agency primarily.
Automed	.3	.1	Most users not storing medical records.

* Except where indicated, this represents the number of characters stored online divided by patients in the file.

** Number of patients served by system is used as the denominator.

F TECHNICAL STATUS AND TREND

Introduction:

As discussed in Chapter 4, there are still many technological choices of methods for ambulatory medical records support and no definite pattern is yet established. While a trend to mini-computers can be perceived, the large storage requirements associated with automated ambulatory medical records have placed a relatively high lower limit on the total system size for ambulatory medical record systems.

The ideal systems in ambulatory care would be strongly linked with laboratory, and pharmacy and billing systems. We find, however, that this has only been accomplished where these services are provided by the same or by closely associated organizations. No adequate automated networks seem to be operational now, which could provide linkages between independent systems providing such services so that we find that these systems have to share the same computer if they are to be able to totally use the same data base.At times we find data manually transcribed between computers. Only at Yale did we see identification data communicated automatically between two systems, using punched cards. Intensive research in computer networks, now being pursued by computer scientists, may help in the breakdown of this barrier.

When surveying the quality of consultation provided by University based computer scientists we find unfortunately that the more ivy-league type institutions with the "best" scientific departments seem not to interact well with the health care delivery system. We heard one statement from a computer science student to the affect that the technical and operational problems of an AAMRS are on a level which is not addressed at all by the training he receives. Very competent and relevant support was found to be provided at Clemson University to the Appalachia District Health Department in Greenville. Here the fact that both the health care institution and the University are state supported may be a contributing factor to the productive cooperation.

It is not yet clear whether total medical record systems will provide acceptable and economic service. All but one (HCHP) of the systems which expect to be the container of all medical record data, are heavily dependent on dictation and free text, which reduces the potential benefits of such a system, due to the limited capability for analysis of free text now available. We will discuss some selected aspects of technical issues in the remainder of this section.

The Binding Time in System Design:

An important issue in the design of information systems is the binding time. This concept refers to the point in the implementation cycle where decisions of system or data specification and format are made that will affect all further operations in the development and use of the system or the storage and accessability to the data (WEG68,CRE70). If we choose an early binding time, that is, the system design, the data layout, and the file content is specified early, then we increase our capability of providing a system of the greatest efficiency. A system which is fully defined at an early time is, however, apt to be extremely inflexible when requirements of the services provided or information needs change.

Early binding in the programming area tends to be associated with the use of assembly languages and fixed data structures. Late binding allows the respecification of system outputs, data elements, and analysis procedures. In the programming area later binding is associated with the use of compilers or interpreters. Interpreters allow the binding time to be deferred to the point of actual execution of the data-processing algorithm. Delayed binding for data structures can imply the use of data base management systems, which use descriptions of data elements external to the programs to provide greater flexibility of data collection, storage, and analysis. A considerable cost can be associated with late binding. The decision of binding times for programs and data structures should be considered in any data processing system design. The deferred binding in programming through the use of interpreters has only limited

Table 6F1

BINDING TIME

	No. Sites	Design	Definition	Implementation	Set-up	Execution
MUMPS-Based	4	S	D			FP
Stanford	1	S		FD		P
Table Driven	3	S	D	F	P	
Automed	1	S		P	D	F
MIS-Based	2	S	F	DP		
Non-Interactive	3	S	F	DP		
Terminal-Oriented	2	SD		FP		
East LA	1	F	SD	P		

early ——————→ late

Legend:

System Aspects:
- S Structure of medical record
- D Data base structure
- F Data element format
- P Programs

Site Classification:

MUMPS:	HCHP, MUSC, Cardiovascular, NAS
Table-driven:	ITC (limited), Duke, Regenstrief
MIS-based:	Rockland, Greenville
Non-interactive:	Yale, Casa, IHS
Terminal-Oriented:	LA, Bellevue

benefits when the data structures are bound early so that little flexibility exists for change in this area. Similarly, very flexible data structures are not easily utilized in systems which have bound the processing algorithms rigidly to a particular system design. During our visits we found all of the four possible combinations of early and late binding applied to processes and to data structures. It should be emphasized that the classification of a concept such as binding time for complex projects will be subjective. We considered four areas where the concept of binding can be applied.

S: The formalization of the structure of the automated medical record.

D: The design of the data base structure needed to implement the desired AAMRS capabilities.

F: The definition of the format and range for the data elements needed.

P: The establishment of the analysis algorithm programmed to provide the AAMRS services.

The binding times employed at the sites visited are presented on a five level scale between conceptualization to production in Table 6F1. Another aspect of the binding problem is the issue of structured versus narrative data itself. In a system, like many of the ones visited, where the data are highly structured the collection process is more inhibited, by limited choices of data elements and their values. (MAR73) A system which contains narrative or free text data, or uses data directly from dictation as the contents of the medical record, provides much less constraint on the data collection process. However, we must realize that we cannot analyze data directly in free text form. Any analysis to generate new information will have to include a process of encoding and pattern recognition if free form data are to be used. While such developments are the subject of many investigations in computer science, we have not yet found operational systems in medical records which can perform this task effectively. In fact, it has been argued that this can never be done although work in this area is continuing (EID71,LAM67,PRA69). Relatively simple approaches in a limited domain (anti-microbial therapy) are in fact able to use free English conversation. (SHO75) The deferral of binding to the data analysis stage in either case provides data collection benefits at the cost of data analysis benefits. For individual patient care, however, the use of unstructured data may be adequate, because the physician is used to providing the intellectual processing which includes activities analogous to the binding of data for analysis and synthesis purposes.

Hardware Systems:

It has been exhaustively demonstrated that hardware costs are going down while system costs are going up. (AFI74) The examples cited to prove this generally give a list of prices of CPU's of equivalent computing power. The cost of the mini-computer systems at the sites visited are,however, discomforting since they are much larger than the computer prices one tends to see advertized in the press. A total system, before it becomes effective, needs not only processing power, but also considerable amounts of disk storage, communication devices, and software systems which all combine to raise its cost substantially. We do, however, indeed expect the cost of all the hardware elements to diminish in the future; and we also expect that AAMRS's will be able to benefit from these reduced costs, albeit with some time lag. To make this possible AAMRS system developments should take future directions into account and attempt to develop systems based on a general and flexible structure at the hardware interface level.

Storage:

Interesting concepts in storage technology are still evolving. The frequency of access for various elements in the medical record is not equal (FRI74-1) and file systems based on single level storage technology are not easily optimized (GIR71). Large data storage devices are becoming common, but often inadequately slow for high frequency usage, such as dictionaries, schemas (see below), indexes, and other file elements unrelated to a patient's individual record.The replacement of rotating disks, especially for limited quantities of frequently used data, by electronic technology seems to be a foregone conclusion. The storage of material for display only, where no further analysis of the content is required, by video techniques can reduce the data entry burden and can still share many of the communication benefits of automated systems.

Display:

When we think about automated information systems, we visualize a user in front of a video terminal. We have seen only incidental instances of direct use by physicians of data displayed on CRT screens. At nearly every encounter, paper documents, either kept in permanent files or printed for the occasion, were the predominant means of data display. The cost of printing, both in terms of the actual print effort, the storage, the transportation effort to get the printed output to the provider, and in terms of the supply cost, is large. It seems that an investment in high level display technology might be experimentally warranted in order to obtain a more adequate answer to a totally soft output of the automated ambulatory medical record.

Networks:

With the reduction in cost of storage and processing devices, which has not been matched by equivalent reductions in communication costs for low band-width data, the concept of a distributed system is becoming more attractive. Work in this area is proceeding at the University of Illinois (MCC74) and other sites are planning development efforts in this direction. Distributed processing and data storage sites may give individual segments of the health care delivery system the control over the data they desire. It may make them more independent of communication failures and of management decisions at large, multi-purpose computer centers. The storage of data locally can provide an important increment to the quality of the data stored, since local control and feedback loops can identify and correct errors earlier, and restrict the responsibility for data quality to a manageable domain.

Software System Design:

The software system issues are best discussed in terms of three areas: the compilers and translators for the application program, the operating systems which direct the execution of the programs, and the file systems which manage the data bases.

Languages:

Current issues in medical applications tend to be less concerned about the traditional issues of higher level language design.(WAS75) The choice of implementation of these languages by compilers versus interpreters is still a matter of discussion, but can probably be rationally analyzed in most situations. (BAR70,WEI72) The increased computational overhead for interpretive execution of programs seems to be of minimal concern with the improvement of cost/performance in hardware. Only when many users share a system or when complex analyses are to be done does this problem raise concern. Examples of complex analyses which might better not be carried out interpretively are the analyses of image data and some of the applications of artificial intelligence techniques. In both these instances many data elements have to be processed in order to produce single results. If considerably faster storage techniques become predominant, then the ratio of CPU speed versus disk file speed, which now favors the interpretive approach,might become less. The problem of adequate documentation of higher level languages, however, is still an issue, and the most compact and expressive languages for writing statements, for instance APL, do not compare favorably in this aspect with some of the traditional and wordy languages, for instance, COBOL. An alternative to procedural languages was found at two sites we visited, Duke and Regenstrief. The tabular languages used there are based on the expectation that the underlying structure of the system will be able to carry out complex decisions based on many simply specified conditions. Predecessors of this approach are found in report generator languages, as used in East LA; and interactive acquisition of decision tables for future report generation is a feature of the ITC system. Developments at the University of California, San Francisco (Henley in SCM74, LEB74) use a CRT-selection approach to generate the code for the decision tree implementing interactive terminal applications in medicine.

Operating Systems:

When we look at the operating systems used at the sites, we find in general that time-sharing was more flexible. It provided more capability for a provider to carry on a continuing conversation with the computer system if needed. It could prompt him and suggest interactively further paths to follow or other data to be collected. A transaction processing approach is more passive. It does provide a great deal of efficiency for the on-line entry of data and for the retrieval of well defined units of information. In sites where batch processing was used, factors which led to this decision seemed to depend entirely on the availability and the need for communication facilities and not on basic problems with interactive processing.

Data Base Support:

Much current effort in computer science is in the area of data base design. Some of the work is based on prior commercial and scientific experience. Issues raised here commonly include two concepts in the area of data base management.

One of these concepts is the use of a separate data description which allows more formalized access to data by separating the processing programs from an intimate knowledge of the internal structure of the file. This provides more flexibility to and allows delayed binding of the file contents and the constructive application of hindsight.In recent commercial developments such a description is referred to as a schema.

The second concept is concerned with the layout of the data files themselves. Two structures are commonly found in the medical application area. A hierarchical structure models effectively the conceptual layout of medical data from the providers point of view. (BHA74,DAV70,GRE69) The hierarchy established begins at the patient identification level and then may go down through levels of visits, problems seen, treatments provided for the problems, etc. A tabular design, also referred to nowadays as a relational data base, will tend to lay out many parallel files with records identified with a patient name for identification data, patient name and visit date for visit data, etc. (COD70)

Table 6F2

DATA BASE STRUCTURE

		Schema or External Structure		
		none	tabular	hierarchical
File Structure	tabular	ITC Yale LA IHS East LA	Stanford-TOD Ill. Eye & Ear 1) Rand Corp. 2)	Duke-GEMISCH
	hierarchical	HCHP Cardiovascular	Rockland	Greenville Regenstrief
	bins	MUSC * NAS *	Automed	Bellevue

* the MUMPS hierarchy is used mainly for access.

1) see MAN75 2) see GRO74

As indicated earlier, a number of sites use the automated medical record system mainly as a depository for free text recorded from the patient encounter. The file can then be considered as a number of containers or bins, but even there differences in structure are evident.

Analyses of data structure choices seem to indicate that for the specific individual patient encounter the hierarchical file will provide advantages in terms of minimum cost access; on the other hand, files on the relational approach provide advantages when processing involves analysis across patients problems or treatment types.(MAN75,STO75,WIE75)

If such analyses do not occur frequently, then the increased cost associated with the hierarchical file design for these processes may be of little importance. At one site (Regenstrief) we find in fact that data for analysis is copied from the main patient file to a data base system which provides schema facilities. Similar copying for analysis by statistical packages is carried out at most facilities which have research interests. Classification of some of the systems seen in terms of these concepts is given in Table 6F2.

Issues of file design are often argued on the basis of the amount of redundancy in the data stored. This applies both to redundancy between the manual and the automated system as well as to redundancy within the automated system. Total elimination of redundancy seems technically desirable since it would require minimal storage and cause the least update problems. On the other hand, redundant information can considerably simplify retrieval, since extra data elements can be placed together with frequently related data items. Furthermore, seemingly identical data elements in medicine, when obtained by different methods or observed by different providers, may have valid differences and should be kept.

It was obvious after our visits that those people which were routinely storing a majority of their data off-line, were under considerably less pressure to economize and evaluate the benefit of data elements to be kept on the system. These institutions tend to have larger files of medical data on the average than the ones who kept all data on-line. The greater selectivity associated with on-line storage, and probably the greater quality of those data which are kept available and are used more frequently, cause us to assign a greater potential value to these data than sheer volume would indicate. Separate data bases, on the same equipment, will not easily be combinable for joint health services research purposes, due to differences in definition semantics, and local habits of even the most conscientious investigators.

We have already discussed data quality issues of local versus remote systems. These and other problems of scale should be carefully followed. No particular system design is independent of scale effects, and many systems are bound to fail if put under the stress of a major expansion. While there are many technological factors which point to increasing efficiencies in large operations, there are equally important human as well as technical factors which tend towards the opposite direction.

Data Entry and Reliability:

A number of available data-output and -entry techniques were not used at any of the sites that were visited. One of them is the use of computer generated microfilm to ease voluminous reporting requirements, and the other is the use of touch screens to enable fast data entry and make terminal interaction more acceptable to physicians. The hardware and technical demands of this last type of data entry may have been the barrier to attempts to use this technique for outpatient care, whereas it has been accepted by a number of institutions and vendors. Technicon at El Camino and other sites (BAT73), Spectra Medical Systems, the Reach-Vital system of Honeywell, and the PROMIS system by Dr. Weed in Vermont consider this the most acceptable alternative for hospital use of computers.

A number of sites used mark-sensing for data entry, although the superiority of this approach over keypunching has not been demonstrated. Rockland users in fact, relied suprisingly much on keypunching, although much experience and thought has gone into the use of mark-sense forms at Rockland. One site (Regenstrief) used recognition of hand formed characters successfully; broad user acceptance may still have to be demonstrated. The overall system is carefully worked out and involves the use of a turn-around document so that much data can be entered with a minimum of effort. Turn-around documents for care planning are used at Cook County Hospital in Chicago.(STE75)

More sophisticated character recognition, such as used in the air-line ticket and credit card industry, was nowhere used. Some hospital systems (AMES) are experimenting with bar code scanning, based on the same principle now used at automated super markets.

A system, operated by the University of Alabama at Birmingham, has been successful with touch tone telephone entry of claims for provider offices (MES75). Voice answer back provided the feedback for verification of correct receipt of the data.

Voice recognition combined with voice response is yet more into the future, experimental applications are now under test, also in the super market area. The size of the vocabulary and speaker specific factors are development problems in this data entry method. If these are solvable for the variety of goods and personnel at a Safeway store, then health care applications are sure to follow.

The reliability problem of computer systems, once one of the biggest barriers to medical computation, seems to be adequately under control now. Most problems found during the visits were related to communication problems rather than to problems with the computer or disk hardware. Disks, however, were rated as yet giving more problems than the processors, and most sites have backup procedures for disk failures.

The rapid development of economic CRT terminals has also contributed to system reliability. Recent printing devices were also considered reliable whereas printers developed more than 5 years ago were generally stated to give problems.

An explanation why the computer reliability was not of much concern in many of the sites visited was the fact that many of the sites were effectively decoupled from the effects of computer failures. The greatest amount of decoupling of course exists in those sites which run a purely batch operation, but in many other situations, paper documentation and paper data entry methods or dictation provided independence from the vagaries of computer operation and the patient care delivery operation. The greatest reliance on computer availablity existed at the Naval Air Station in Brunswick. Here, the medical record is kept entirely on the computer and not printed until the patient registers for his appointment. Only summaries printed at that time and more data are available to the physician through the CRT terminal in his office during the encounter.

Patient summaries are printed in preparation for appointments at Bellevue in New York, Indian Health Service and Harvard Community Health Plan. On-line inquiries into the system for telephone call responses or for unscheduled visits may be made by users of the Insurance Technology Corporation system, the Automed System (mainly for billing information), and at the Cardiovascular Clinic. On-line registration which could be affected by computer availability is made by Los Angeles County, Harvard Community Health Plan, Duke University and at Bellevue. At all of these sites the capability exists to register patients even in the absence of computer services.

G STATUS AND TRENDS - FUNDING

Potential for Financial Viability:

A major factor in the future success and acceptance of AAMRS is the likelihood of financial independence. Regardless of technical achievement and impact upon health care, a system must have a source of operating funds to remain viable. Until recently, technological innovation was generously supported with government funds, and the cost of routine services from advanced technology was added to the cost of health care. It should be noted that most of the technological advancements in health care have been involved with the advancement of science, rather than with a reduction in cost through the substitution of equipment for labor.

The Federal government now has taken a new position with respect to the support of technology: the emphasis of Federal support is being shifted from the support of new advances to the evaluation of the social and economic effects of existing technology. This shift in government support will have a major effect upon the financial viability of current and future AAMRSs.

As indicated in section 4G, most of the sites visited will be dependent upon external funding support for continued development efforts. In view of the current emphasis of Federal support, this appears to be a dangerous situation, particularly where the system user and developer are different organizations,and the user does not have a heavy financial investment in the system. That is,if a user currently has a financial investment in the system through equipment acquisition, personnel support or payment of service charges, some assessment has already been made by management as to whether or not the benefits are worth the cost. If a user who is not actively supporting the AAMRS is subsequently asked to contribute to system support, a potential user may conclude that the benefits are not worth the cost. Accordingly, it appears reasonable to conclude that the potential of future financial viability for the AAMRS may depend heavily upon the extent of the user's financial involvement. A summary of the factors that may effect the potential financial viability of the AAMRS follows:

Extent of user support of system cost;
Extent of user full knowledge of system cost;
Potential for user charges;
Identified cost savings;
Existence of system features that contribute to measurable;
Tangible benefits;
Extent of user management support;
Status of recharges:
plans for recharges,
the extent to which current recharges are
recovering costs (production and development); and
The existence of lack of a general financial plan.

Table 6G1 presents a list of the sites visited and the factors that may affect the future financial viability applicable to the site.

Table 6G1

FACTORS AFFECTING FUTURE FINANCIAL VIABILITY

Site	SGS	LFP	UFN	UFL	UCI	UCL	UCP	USL
Stanford	X	X			X	X		
ITC					X			
LA		X	X					X
Rockland	X				X	X		
Yale	X	X	X	X			X	X
HCHP	X			X			X	X
Automed					X			
MUSC	X		X	X			X	X
Greenville					X			
Duke	X		X					X
Regenstrief		X	X	X			X	
Cardiovascular								X
Casa	X	X	X	X			X	
IHS			X					
NAS			X					
Bellevue	X	X	X				X	X

Legend:

SGS Substantial grant support.

LFP Limited financial planning.

UFN Users don't know what system costs (users are not the developers).

UFL Users have relatively limited to no financial investment in the AAMRS.

UCI User charges are imposed for AAMRS services.

UCL User charges apparently not recovering full costs.

UCP Site is suitable for user charges.

USL Users are providing some direct financial support (other than user charges, e.g. terminals, salary support of user personnel involved in AAMRS activities).

Potential for New AAMRS:

The conversion of the traditional medical record from a manual base to an automated version requires the expenditure of resources. The costs of pilot projects in this area have most often been underwritten by the federal government, but significant investments have also been made by the private sector. Many of these record systems have different capabilities and costs, and it is difficult to determine the optimal system for a given site. Furthermore, data reporting requirements for ambulatory care have yet to be completely formalized. A prospective investor in an AAMRS will want to make a rational selection of a system from those currently available. To do so requires a matching of user needs (both present and projected future needs) with the solutions offered by the various systems.

a. Private Practitioners and Small Groups

The solo practitioner's perspective presents fewer difficulties in a benefit-cost analysis than the governmental frame of reference. The private physician has direct control over the way in which he decides to operate an office, including the record svstem. He may tend to look at benefits in a way which eliminates the intangible benefits or remote effects of evaluation and research. Management functions are most often related to the financial status of the practice including cash flow, claims preparation, and ability to answer inquiries from patients about billing. He may also find benefits in patient care areas most closely related to his productivity--including the ability to perform quick record searches in response to phone inquiries about medications. His analysis would therefore include the costs of his present system and a look at available computer systems that were either competitive in price with a manual system or included so many benefits for practice that price became less of a consideration (i.e. increase in benefits outweighed increases in costs, thus giving a more favorable benefit-cost ratio).

b. HMOs

The HMO viewpoint will be much different. The management functions of such organizations are not as concerned with billing for individual services, as with rates of growth of enrollment, attrition and its causes, productivity of individual providers, hospitalization rates, number of tests and x-ray examinations ordered, referral and revisit rates, etc. The problem appears to be how to keep patients satisfied without over-utilization of services. At this level of organization the record system can function as a data base for management, and the scope of services and patient volume begins to allow economies of scale. Management is obliged to provide reports that are cumbersome to generate from paper record systems, but rather easily done with automated systems. Planning functions in the HMO can also utilize an automated record system as a data base for future projections including decisions about numbers and kinds of new staff required, expansion of facilities, etc.

c. Government

Assignment of values to benefits at the regional, state, and federal levels will reveal a differing set of priorities. The ability of governments to influence the health care delivery system is closely tied to reimbursement for services and to financing of health services research. A question to be answered concerns the optimal strategies for allocating resources. The federal government has an obligation to monitor the expenditure of public revenues for health services and to concern itself with the appropriateness, effectiveness, and costs of these services. A portion of this obligation requires the utilization of data found in the medical record. Currently, providers of services utilize independent data reporting forms to bill third-party carriers. These reporting forms are viewed as a benefit by insurers (and also the federal government), but they represent a cost or disbenefit to providers, since personnel time is required for providing this data.

Medical record reporting systems have potential for planning at regional and federal levels. There is little data about the frequency of presenting complaints or problems in the population, the costs and frequencies of common treatment modalities, outcomes or further utilization of the system by treatment modality, et. Perceived benefits of record systems in this area are related to resource development, allocation, utilization, and effectiveness.

H PROPER BALANCE: MEDICAL VS. TECHNICAL

Introduction:

The proper balance between medical and technical support and innovation in the area of computers in medicine is a subject of discussion at many institutions which are training or beginning to train professionals with this specialization. This problem is also faced by implementors of automated ambulatory medical methods systems, as it is by any application of technology to the health care sciences. Institutions concerned with the educational ramification of proper balance in this area include Rutgers University in New Jersey, the University of Utah, the State University of New York at the Downstate Medical Center, and the University of California in San Francisco (COL74).

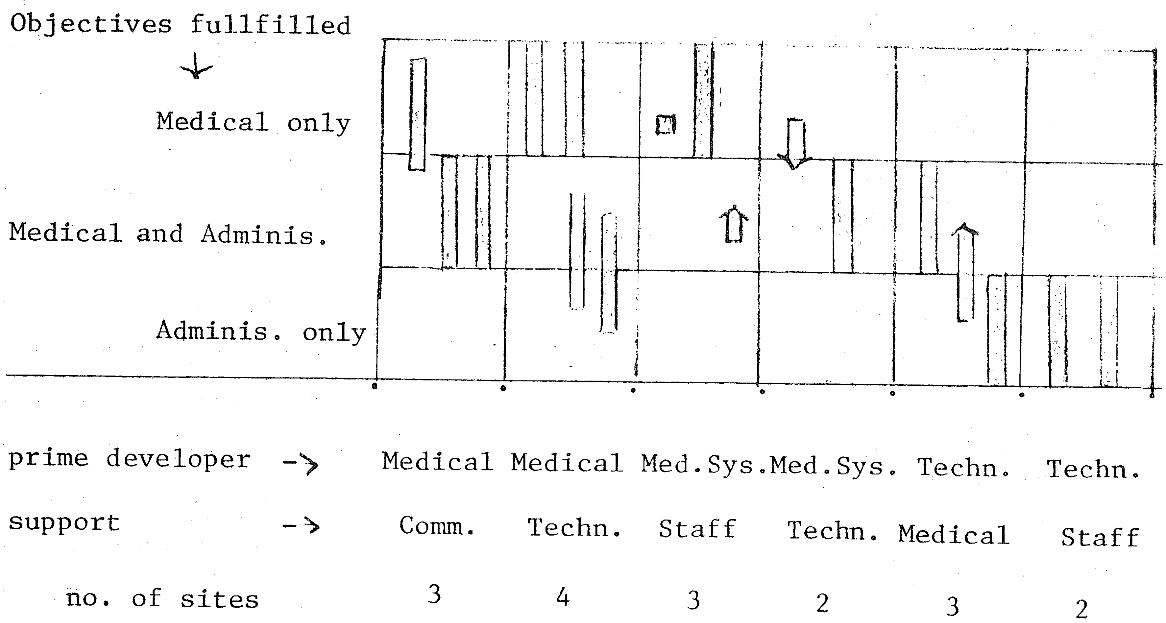
A common aspect of the sites which we visited was that they became operational, and hence achieved, from a practical point of view, in some measure the proper balance between the medical and technical components. In Section 4H, the sites visited are discussed and classified; but it cannot be stated from these findings that now the picture is entirely clear. There is considerable difference in the approach taken at these sites, although most have had both medical and technical direction; we might hence conclude that success depends more on the competence of the individuals than on any hard and fast rules. In reviewing the sites from the comprehensive list we find a number of sites which are no longer in operation: these show a distribution of sponsorship similar to the sites that succeeded.

Background of Developer and Fulfilled Objectives:

A rough classification of fulfilled objectives, as obtained from our site evaluation versus the background of the developers at the sites that we visited is given in Figure 6H1. It shows, on one hand, that operations managed wholly by technical staff have not fulfilled medical needs, either because they disregarded medical services or because they were not able to implement them at an acceptable level. The fact that

Figure 6H1

DEVELOPERS' BACKGROUND VERSUS OBJECTIVES FULLFILLED



enterprises under strong medical sponsorship seem not to fulfill administrative needs is certainly also influenced by our selection criteria: since we tried to avoid visiting sites where only administrative services were being delivered. These services can also be obtained by physicians from commercial firms.

Developers were identified in the table as a "medical" if they had had only a limited technical education or experience prior to the start of the project. After the project they can justly consider themselves system experts! A medical systems developer is a physician, who had devóted a considerable effort to innovation in the health care systems field or had a high level of education in this area. In the technical area were grouped people without a medical education.

Commercial support is defined as support from a commercial vendor in the area, so that major technological concerns for the developer did not arise. Technical support refers to senior professional technical personnel, whereas staff support indicates technical employees hired to carry out the objectives of the developer.

There is, of course, an interaction between the objectives which were set out initially and the objectives that were fulfilled. At some sites we came to the conclusion that the objectives were fulfilled only partially, as indicated by the length of the bars in Figure 6H1.

Academic Institutions:

Seven of the sites which were visited could be considered academic institutions. It was at these institutions that all of the developers with medical systems background were found, as well as two of the medical developers who had technical support. The quality, however, of the technical support seen varied a great deal. The technical support was generally not provided by individuals from the computer science departments but was mainly provided by technical staff with experience or an interest in medical data processing. At some sites not visited by us as part of this contract, where there is recent and innovative development, we find computer scientists who are actually involved in the development of applied systems for health care delivery. We should note again an exception, namely at Greenville, where Dr. Peck from Clemson University, supports operations at the Greenville Public Health Department. The fact that both institutions are supported by the state and hence receive their rewards from the same source, may be a positive factor in this interaction. A problem in academia is obviously the lack of recognition obtained for applied work from one's peers in the computer sciences. Since it is difficult for computer science professionals to find recognition for their work in medicine from their peers, it is at least desirable that they are treated within the medical field as professionals in their field. This presupposes, of course, that they are indeed technically competent and behave in a professional manner.

Physical Distance:

There were five sites where the entire operation was in-house, and at two other sites the facilities were adjacent. Six sites were of the "across town" variety, and four were actually remote - a days commute was required for any personal contact. Three of these latter four sites used commercial services. It seems, then, that for new development reasonable access is still a requirement. A number of computing networks, where the computer user can be anywhere in the United States, are now available and yet it remains to be seen whether the intensive cooperation between medical and the technical personnel required to bring a project jointly to fruition can be obtained through computer aided communication. This may be a particular problem in an area as poorly defined, as applications of computer technology to health care tend to be. Experience with the Prophet network for pharmacology research indicates that while this network has provided powerful facilities for many researchers, little intercommunication has taken place (RAU74). We do not know whether this is merely due to bandwidth limitations or also due to basic limitations of automated transmission of sensory perception data.

Evaluation:

Evaluation efforts can proceed on two levels: documentation of achievement of the objectives in terms of quality, access and cost, and the measurement of the appropriateness of the information system used in terms of process and data. Both aspects are receiving more stress as the systems mature, but there is often a lack of available evaluation competence in AAMRS projects. Many medical health care practitioners and researchers are developing an interest in this area, whereas technical staff, if interested at all, have often been concerned with low-level measurements of CPU idle-time and mechanical system response time.

To respond to more sophisticated requirements both medical and technical staff have to develop some appreciation for this area and also some competence to judge efforts by others in health services research.

A health care researcher should be regarded as a professional in his own right by the medical or technical developer. It is poor practice if the developer of a system can dictate to the evaluation project the result to be produced. To properly evaluate an AAMRS, it is essential to have a formal evaluation plan before its implementation, rather than defer this aspect to a more advanced stage in the system development cycle.

A critical review by someone knowledgeable in this area of evaluation can be important, since the measurements made for evaluation by system designers have at times been irrelevant. Any evaluation effort in the health care field poses major design problems. It is often difficult and possibly unethical to use concurrent controls to differentiate between offorts on populations receiving services and those not receiving services. The establishment of an adequate base-line,and tracking of similar institutions or of national patterns to compare institutional data becomes necessary.

Medical Record Organization:

There is a strong correlation between the organization of the medical record and the intentions of the founder. In sites where the innovator had less computer systems experience, he tended to stress the functions of individual patient care and attenuate the systems oriented aspects. Systems that were developed in such a patient-care oriented environment tended to have a greater amount of free text, which is subsequently difficult to analyze by automatic processes. The develoment of adequate coding structures for a medical record data entry is yet an unsolved problem. We found that many users modified standard coding methods to cope with the needs of their ambulatory proactice. It found that on the order of 200 distinct problem codes were used at most of the sites visited. The coded description could often be augmented by written free text.

The decision whether to implement a "total" medical record system relates to the confidence of the system implementor to make it work. It seems here that only medical innovators who could expect some control of the health care environment tried to do so. Technical people often question the usefulness of much of the content of the medical record, and hence may discourage "total" systems.

Section 6D suggests some strategies to reach a better decision-making algorithm in this area. If then, for reasons of proven utility of the information most medical record data is to be kept within the computer system, then it may make sense to also take the remaining step and eliminate all of the regular use of the paper medical record, since considerable personnel savings can accrue at this point. A correlary to the above statement is the fact that the largest data bases collected do not necessarily have the greatest utility.

There is a strong relationship between medical record organization choices like the use of the problem-oriented medical record and the file structures chosen to support them. Many of the analyses which are carried out in health care delivery cut across individual patient records; and even summaries done for individual patients cut across problems in order to identify conflicts in drug administration, redundant laboratory tests, and similar items. Only one of the systems visited had given some thought to adequately merging observed problems, splitting them when required, and eliminating resolved problems from active consideration. At the same time, such a problem management supporting design has to provide an adequate audit trail so that, when needed, the history of a complaint can be traced back. This presents a difficult technical problem, but without these facilities, the problem-oriented record will obfuscate, rather than clarify, patient care issues. It can hardly be stated that we have a capable computer system in the area of the POMR because it has a capability to remember more than 1000 active problems, if all these problems are presented willy-nilly to the provider for consideration at every visit. An extended problem list, while technically satisfying, can imply an unbearable obligation to a physician who has ten minutes available to take care of some immediate complaint presented by the patient.

Flexibility:

The required degree of flexibility in a system is yet another issue which has to be resolved in a balanced manner between medical and technical interests. Initially a physician may feel that he understands the entire care system and can specify it rigorously while the technical person will defend flexibility since medicine seems so complex and incomprehensible. After some experience both of the opinions may well be reversed!

There is often a high cost to flexibility, and it may be that currently computer science tools which are designed to give the ultimate in data flexibility, for instance, relational data bases as being studied at the University of Illinois, and schema-driven file systems as being developed and used at Regenstrief and Stanford, provide such a flexibility only at a cost intolerable for production operation. The right level of flexibility, at the right interfaces in the system, is an issue which is just now being formally addressed in applications of computer science.

Another area in which much flexibility is required is in the terminal area, because this module provides the interface between providers and the system. It is difficult to upgrade a terminal interface that has been used for clerical use to become satisfactory in terms of response time and interaction to a physician. At the same time, it may be unwise to present to clerical staff the ideal physician's interface since presentation of more directed data may enable them to carry out this task in a more effective manner.

The closing of feedback loops at the appropriate places in order to provide error detection and correction capabilities at the most effective level is another important issue that has not generally been solved at the sites visited. It also would seem to be wise for system designers to determine a level of data quality which is sufficient for effective use in a certain setting, since the cost of guaranteeing perfect data in large quantities is astronomical. The health care provider has learned to live with imperfect data for a long time and it might be good if computer systems were less apt to fail due to the occurence of an error in single data elements. It is not obvious how we can teach computer systems to think according to the Baysian model, but quantized definitions of data quality to be expected can help in the implementation design of an AAMRS.

Proper Balance:

The proper balance for a system has been achieved if clinical, financial, management, and evaluation information has been given equal concern in the design of the AAMRS. Except in isolated institutional settings, it is impossible to justify computer systems for any single function. How this balance is achieved will remain a matter of taste, modified by experience gained by them or transmitted to them by others. We hope that this report can help in this process.

I POPULATION AND SYSTEM EFFECTIVENESS

The goals of the health care system are affected by the type of population served, and the effectiveness of the AAMRS achieved is also related to the population served at the sites. Both at the sites visited, as described in Chapter 4, and at other sites surveyed in Chapter 5, we find that automated systems providing medical services have been developed where large populations had to be served. For example, at Los Angeles, in Indianapolis served by Regenstrief Institute, in the Appalachia II District surrounding Greenville, and at Bellevue in New York City, there is a large population which is not adequately served with traditional medical record systems. The administrative task of organizing the retrieval of the paper medical record can be aided considerably by registration and identification systems; and frequently adequate emergency or drop-in medical care can be provided in the clinics if a summary sheet, a patient profile of the patient's medical status, is available in lieu of the medical record. In many large operations, it is also important to maintain adequate utilization records to support budget requests and to allocate funds to the areas most in need of support. This was an aspect also addressed by the services provided from the Rockland Center and at East Los Angeles.

At Bellevue, at Regenstrief, and at Greenville, patients seeing certain clinics had extensive data collected in their AAMRS; only at Greenville was a broader population served with registration facilities at the same time. Los Angeles was able to justify its system entirely for the registration aspects; a few flags to potential medical problems are an incidental benefit. The aggregation of minor benefits over the large populations seen at these sites can add up to a dramatic savings in the health care delivery system.

More critical is population data to the management needs of the health maintenance organizations, since utilization data, which provide the background for the setting of the capitation rate, may depend very much on the type of population acquired.

The type and ethnic background or the size of the population has not seem to have had an intrinsic effect on the success of the ambulatory record systems, as long as these systems were designed with the appropriate objectives in mind and as long as adequate operational funding stability could be achieved. Computer systems have the potential of bridging language barriers existing in our patient populations. We find that the indication of primary language in the patient profile has been considered beneficial in systems serving Spanish speaking population groups. Outside of the area of automated medical history, we do not see multilingual capabilities in the computer systems surveyed which is, of course, related to the fact that nearly all providers in the United States have had their education in the English language.

It may be simpler to design comprehensive medical records for specialty populations. One reason for this observation is based on the management aspects of system development. In such a setting a single provider will be knowledgeable about the value and uses of all of the medical data elements in the population group that he is serving. In the more limited institutional environment he can also be effective and persuasive due to his medical expertise and understanding of the benefits of an information system. Protocols for diabetes, TB, and hypertension management are reasonably well agreed upon and experience is available, which can form a solid base for the development of a specialized AAMRS. Similar developments are occurring in other specialty areas and may indicate a parallel maturing of those specialties.

The technological development in the area of mini-computers can make it possible to apply AAMRS developments economically to smaller populations, and it is not inconceivable that suitably organized networks of small systems could serve large population groups. The integration of separate systems offering specialized services within a larger regional patient population has not yet been successfully achieved at any site that we are aware of. Greenville may come closest, but only serves the indigent population in health care areas which receive federal or state support. The largest non-specialized population now receiving comprehensive services and served by an AAMRS is the group enrolled in the Harvard Community Health Plan.

J EFFECTS OF FUNDING

Financial Planning:

The extent to which the AAMRS receives external support, particularly Federal Research Grants, appears to have a direct inverse correlation to the extent to which the AAMRS developers have planned for future financial viability of the system without heavy subsidies. Table 6J1 presents a summary of our findings with respect to Federal Grant support and indicators of the extent of financial planning. The sites indicated as having limited financial planning, are those sites where it appeared to the site visit team that in general the extent of planning for future financial independence of the AAMRS was very limited or non-existent. The sites indicated as being suitable for services charges, are those sites where the nature of the AAMRS service is suitable for services charges but plans for implementation of services charges were not evident. The extent to which the AAMRS user is currently contributing to the support of the AAMRS may also be considered an indicator of adequate financial planning. For Table 6J1 the extent of user support is classified as either limited or substantial. User support is also classified as to type, service charges or direct support.

It can be seen from Table 6J1 that of the seven sites with substantial Federal grant support, the extent of financial planning was limited at four sites. Of the six sites that were suitable for service charges without apparent plans for service charge implementation only two did not receive substantial Federal grant support. One of these two sites was a county public health facility, and the AAMRS support comes from the county budget, but not as a cost of clinic operations. The other site received its primary support from a private foundation, which could be considered similar to a Federal grant. Of the eight sites with limited or no user support, six sites had substantial Federal grant support. The two sites with no user support are the same two sites

Table 6J1

INDICATORS OF FINANCIAL PLANNING

Sites*	SGC	SSC	LFP	User Support: No	Limited: D	Limited: SC	Substantial: D	Substantial: SC
Yale	X	X	X		X			
Casa	X	X	X		X			
Bellevue	X	X	X		X			
HCHP	X	X			X			
MUSC	X	X			X			
Stanford	X		X			X		
Rockland	X							X
Los Angeles		X	X	X				
Regenstrief		X	X	X				
Duke							X	
Cardiovascular							X	
Greenviile								X
ITC								X
Automed								X

Legend:

SGS Substantial federal grant support for development and ongoing operations (greater than 40% for operations).

LFP Limited financial planning

SSC Suitable for service charges, with no plans

SC Service charges

D Direct

* IHS and NAS not included as applicable to this discussion, since they are direct operations of the Federal Government.

discussed above with no plans for service charges and with no substantial Federal grant support. It is interesting to note that of the six sites with substantial user support, only one had substantial Federal grant support. Also of interest is the source of user support: where user support is limited, only one of the six sites has implemented service charges, and where user support is substantial, four of the six sites have implemented service charges. It could be suggested that the stage of the development cycle may be a factor in the establishment of service charges and the extent of user support. For example, Rockland appears to be the major exception in the group of Federally supported sites, in that it is deriving substantial support from user charges and it is one of the older and more mature sites visited. This observation is contradicted by our findings at two other sites. One older project, Bellevue, has substantial Federal grant support from categorical grants, and limited user support; and the other is Greenville, a newer project, that had no Federal grant support and is deriving substantial support from user charges, for both development and routine services.

Effectiveness of Federal Funding:

During our visits an interesting reaction developed among the site visitors with respect to AAMRS accomplishments in relation to the nature of supporting funds. It appeared to us that the sites supported by private investment, internal funds, or user support were more effective in the use of funds than those supported with external grant or foundation funds. Upon completion of our data gathering efforts we examined some factors that could be considered indicators of effectiveness with respect to the project achievements.

The first factors that were examined were the per visit cost of the AAMRS based on an estimate of routine operational cost as compared to the depth of the medical data in the patient record. The per visit cost of the AAMRS is reported in section 4G. Based upon the information obtained from the visits with respect to the size of the file and content of the medical record, the sites were rated with a score of low, medium-low, medium, medium-high, or high for the depth of the medical record.

Each site was then plotted on a graph with the cost per visit on the vertical axis and depth of medical data on the horizontal axis, to determine whether some pattern of relationship or effectiveness could be determined. The effectiveness in this case would be high depth at low cost. The results of the plot are shown in Table 6J2. It is evident that the obvious relationship is present, that the higher cost sites are also those with greater depth, and it is interesting to note that the sites with external support, primarily Federal grants appear to be those with greater depth of data. From this point of view however, there appears to be no support to the impression that sites which were not federally supported were more efficient.

The data did indicate however that the project complexity, with respect to the amount and depth of medical record services was greater with Federally supported projects, and the amount of administrative services were greater with projects funded from other sources. For the nine sites that received substantial Federal grant support the number of administrative services per site averaged 2.4 per site, and for the remaining seven sites, the number of administrative services averaged four per site. Scoring the depth of the medical record from one to five, with one for low, and five for high, the nine Federally supported sites have an average score of 3.4 per site while the remaining sites have an average score of 2 per site.

Other factors examined as potential indicators of effectiveness included: level of objective achievement, cost-benefit status measures, status and nature of production services, period of development and level of funding, and size of population served. These factors were examined in a variety of ways and combinations and as with the first two examined no definite conclusions could be drawn from the data with respect to effectiveness in project achievement.

TABLE 6J2

EFFECTS OF FEDERAL FUNDING

Cost per Visit	low	low-medium	medium	medium-high	high
$14			O		
13					
12			X		X
11					
10					
9					
8					
7					
6			X	X	
5			O	X	
4	O O				
3	O		X	O	
2		X			X
1	O				
.5		X			

Depth of Medical Record

Key: X-Federal Grant Supported activities
O-Support primarily derived from private investment, internal funds, or user support.

K FACTORS FOR TRANSFERABILITY AND DIFFUSION

Transfer of Innovation:

One of the most frequently stated goals for the development of an automated ambulatory medical record system is to facilitate the utilization of computer technology in providing health services and in the processing of biomedical information relevant to the provision of such health service. Implicit in this statement is the realization that:

1. There already exists a mature body of knowledge in computer science,
2. That extensive production experience exists in the application of this knowledge to practical problems of information manipulation, and
3. That that the adoption of this technology as a means of solving problems of information manipulation in the health services areas has not been extensive.

The problem can be restated in more general terms:

1. Given that a mature body of scientific knowledge exists, and
2. Given that the processes of invention (bringing together of technical elements in a new way) and innovation (the first application of an invention to satisfy demand) has successfully taken place,
3. What elements are necessary to achieve adoption and diffusion of the innovation?

In Section 4K the importance of training, documentation, hardware, and software; transfer intent; and cost have been considered. In this section we will deal primarily with the human factor in the transfer of technology.

The transfer of technology can be modelled as a four staged process (GRU69):

1. The current state of technical knowledge and its use, i.e., an inventory of technical knowledge.
2. Invention: activity that advances the level of technical knowledge by the utilization of existing knowledge for some new use.
3. Innovation: the first use of technology to satisfy a demand and the demonstration of at least one economic use of the technical advance.
4. Adoption and diffusion: multiple uses occur as the economic value of the technology is recognized.

It is clear from this description that most of the activities that we have observed in automating ambulatory medical record systems are in the innovation stage. There is a clear difference between the innovator and adoptor. It takes more courage, foresight, imagination, and willingness to take risk at stage three than at stage four. The relative lack of developers in the AAMRS field with commercial intent is thus better understood.

Restating the problem in a somewhat different way, in this section we deal with the problems of technology transfer that result from the relationship of people to the technology utilization process. What are the important factors that account for the variance in the utilization of available technology.

It has been noted that scientists are educated in such a way as not to seek practical use from their discoveries. This is equally true of medical scientists, who in other aspects of their professional work are eminently capable of providing health care which reflects the state of the art of medical knowledge.

The potential benefits to be derived from an increase in the efficiency of technology transfer naturally leads to an interest in uncovering the determinants of variance in transfer capability (UTT74). When the determinants are understood, these attributes can be made the design criteria for projects whose purpose would be further promotion of the hoped for technology transfer. While we are focusing here on the human factor, a total set of determinants of the ability or willingness of humans to transfer technology must include economic variables, capital resources, market potential, stet. The focus on the human factor, although at a lower level than that of the total systems analysis, reflects the key role of the human factor in the transfer of information science technology to the development of an AAMRS.

Innovation is most likely to be initiated when recognition of a specific demand and a feasible technical solution for this demand are fused and a satisfactory technical response to a user requirement is formulated. Evolution of medical care from the status of one of many other human "needs" to that of a "right" to a basic level of care in our society reflects the fact that society may be willing to allocate resources to meet the demand for health care. Since increasing resources are being allocated for health care, a public demand exists for accountability on the part of the medical profession. This need for accountability to the public has recently been mandated by legislative action and has been translated into demand for documentation of the medical process. The technical feasibility to create computer files which can be manipulated to produce individual patient care records, as well as to provide mandatory reports and serve in an analysis of health care, is recognized uniformly by developers of both successful and as yet incompletely implemented AAMRS's.

The expectation of successful fusion of demand recognition and technical feasibility has led to numerous attempts at innovation in this field. As a result numerous solutions fitted to the variety of medical settings in which the demonstrations are taking place have been proposed. Considerable difficulty has been encountered with the ability and willingness to utilize the solutions proposed. The developers and users of an automated medical record system are frequently not the same set of individuals, this vastly complicates the problem of demonstrating an unequivocal effect of the medical record system on the economics of patient care. Frequently there are two innovations that are competing for the attention of the ultimate user of the system. First, there is an attempt to restructure the record to incorporate the problem-oriented medical record of Lawrence Weed (WEE69), and secondly there is an attempt to substitute an automated record for the traditional record or to augment the medical record with output from the computer system. At some of the sites visited the physician is also obliged to fill out special forms or to enter data via a visual display terminal. All of these changes compete for available provider time and often with no immediate reward, i.e., an improved or more complete record.

It is interesting to compare the sites visited according to how many of the system developers are actual system users. At only 5 of the 17 sites visited was one of the system developers actually practicing medicine using the automated medical record system.

Gruber and Marquis (GRU69) enumerate six factors affecting the transfer of technology relating to people:

1. Training and experience
2. Individual personality characteristics
3. Communication patterns
4. Organizational effects
5. Mission orientation
6. Motivation

Training and Experience:

"The mechanism of technological transfer is one of agents, not agencies; of the movement of people between establishments, rather than routing of information through (formal) communication systems." (BUR61). The trend toward greater specialization of technical effort, the increase in the volume of technical information, and the speed of technological advance are all factors leading to the idea that it is more efficient to bring into an organization someone experienced in a given technology rather than to try to develop expert personnel in the organization. Given the great mobility of scientists in the academic community they should exert a positive force for technology transfer. It has also been suggested that internal sources are more effective in generating useful technical information than sources external to an organization. Thus an organization which was interested in developing an automated medical record system would be well advised to recruit members for its own staff that are equal in breadth to the technical needs of the efforts to be undertaken, rather than to rely upon outside consultants or contractors for areas of technical weakness. The validity of this argument was perhaps most vividly demonstrated in Oklahoma City where the Cardiovascular Clinic employed a full-time medical student with an undergraduate computer sciences background to do most of the applications programming.

Individual personality characteristics :

Frustration tolerance, need for achievement, and other such personality traits clearly vary among individuals and classes of individuals. The ability to formulate a design concept, the fusion of demand and technical feasibility recognition, is one of the rare qualities about which little is known at the individual personality level. Transfer of technology is an activity that requires a high level of motivation due to the difficulties inherent in the process. In six large organizations innovation was achieved in four cases in spite of bureaucratic inertia, whereas in the other cases the innovators used the organizational structure to accomplish their goals.

Communication patterns :

In industry it has been observed that the commercial value of research and development projects initiated in response to customer demands is far greater than that of projects initiated within the research establishment of the organization itself. The difference in the achievement of a successful AAMRS at the cardiovascular clinic in Oklahoma City and the lack of success of the Yale AAMRS project tends to confirm these notions.

Organizational Effects :

Organizations often have a vested interest (because of capital investments and other considerations) in maintaining the status quo. This may in part explain some of the resistance to the transfer of AAMRS technology. This may well change as a result of the mandatory reporting requirements for PSRO. It is also suggested that organizations with the greatest degree of flexibility of funding and objectives are most apt to successfully utilize a new technology. With respect to AAMRS's, the current economic climate in the United States is apt to have a damping effect on the diffusion of computer technology in medicine unless major cost benefits can be demonstrated.

Mission Orientation:

The mission oriented systems development program characteristic of the Department of Defense (DOD) is said to increase the probability of design conceptualization because demand and technical factors are considered simultaneously. This state also characterizes the health care establishment even in an academic setting. Because the DOD does not have a commercial market to which it can respond, it has devoted much attention to systems analysis for the specification of future weapon systems. This important lesson has unfortunately not been adequately learned by developers of AAMRS's.

Motivation:

Four factors are considered important in the analysis of individual and organization behavior:

1. Competition
2. Reward structure
3. Visibility of results
4. Government regulation

All of the above motivation determinants have positive and negative values and can be seen to affect the adoption of an AAMRS.

The visibility of poor performance is low and until recently the government has shown little inclination to regulate this aspect of medical care. All this will change when PSRO's review ambulatory care. Increasing public accountability and increasing visibility of results will impact the earnings of those physicians who are unable to demonstrate that they are practicing at an acceptable level. Certainly any major shift in the number of physicians entering the profession or the use of paramedical personnel on a large scale would change the competitive situation for individual practitioners and would lead to more rapid utilization of available technology.

In government supported sites (such as Yale, Stanford) transferability was not originally considered an objective in the support decision set. The recent weight on direct system transferability rather than the development and evaluation of concepts, which may be adopted by others has caused problems for some users. Direct physical transferability can only be achieved by hewing to the lowest common denominator of technical facilities.

Of the various factors mission orientation and the motivation to innovate appear to be the key determinants of transfer, not the availability of an inventory of technical information (BAK74-1).

The Science - Technology Relationship:

Academic scientists are primarily rewarded by publication and not by the implementation of their discoveries. There often is a difference in the motivation between a scientist working in industry and a scientist working in an academic institution. The lack of motivation for demand recognition may explain some of the difference between academic and industrial scientists. These differences are blunted in medicine because the academic physician is both an academic scientist working in the research laboratory on one hand and also providing professional services on the other. In other disciplines the contribution of the academic scientist is the training of other scientists who then enter into applied projects thus making immediate contributions to the advance of technology. Because the evaluation and reward structure in medical schools is based not only upon scientific competence and teaching ability but also on provision of health services, the medical scientist is less insulated from the outside world than other scientists.

One would expect the more mission-oriented schools, i.e. those with strong orientation toward community health programs and with active family practice programs to be more apt to attempt to innovate in this field. Indeed, such has been our experience.

L ATTITUDES

The tools available to carry out the objective evaluation of attitudes remain beset with many problems of subjectivity. This is perhaps even more true when working within the medical establishment. We cannot state that the attitude questionaires which we presented were administered in a controlled manner, nor that the responses from the sites were not influenced positively by our enthusiasm or negatively by some questions raised during our visit which would otherwise have been kept dormant. Differences of wording in the presentation and discussion of future potential of the AAMRS versus its current problems are certain to influence transient attitudes.

An interesting complement to our study is the questionnaire subsequently administered at the Harvard Community Health Plan's Kenmore Square and Cambridge Centers. It indicated a general satisfaction with a slightly improved version of the current AAMRS, both by the current users as well as by the somewhat more guarded prospective users. This survey is probably a contributing factor in the recent decision at the Cambridge facility to adopt also the AAMRS used at Kenmore. An important factor in the acceptance of automated medical record systems may be the physicians' realization that medical record requirements are becoming more strict. The use of an AAMRS may be seen in fact as a reduction of the potential burden of HMO record-keeping, of PSRO legislation, and of similar activities, rather than as solely a simplification of current habits.

This general impression is in concert with opinions expressed at other sites, and leads us to conclude that the attitudes toward the use of AAMRS are generally favorable, and that any scepticism shown in terms of "show me what you can do" is probably a healthy and necessary defense mechanism. Some extrapolations based upon these observations will be noted in Chapter 7.

M STATUS OF EVALUATION METHODS

Introduction:

In general the evaluation methodology used at the sites relied heavily upon subjective measures. While a subjective approach may provide valuable insights, a meaningful and convincing evaluation must also include objective measurements of relevant data. The following sections discuss both the implications of the evaluation of the AAMRS's at the sites and some methodological issues concerning evaluation.

Quality of Care:

As indicated in section 4M, objective evaluations applied to the quality of care were limited, even though this area is considered as one of the primary reasons for the development of the AAMRS. Record accuracy and record validity probably have been enhanced, but the effect on the process or quality of care has not been well demonstrated. Because of the difficulty in defining quality the evaluation methodology in this objective area is still in the state of initial development and is subject to many diverse opinions and issues.

In the model for inquiry: system effects (Chapter 3) we discussed the need for monitoring the status of patient-specific, problem-specific objectives to achieve purposeful control of an individual's health care, and noted the lack of such structured information being routinely and systematically obtained in the delivery of ambulatory health services. In this section we will consider our ability to measure patient-specific objectives, i.e. to measure the quality of care. Recent reviews (BRO73, LEW74, SHO74) have stressed the methodological quandaries in determining quality. One can judge care in terms of structure, process or outcome. Implicit or explicit methods can be used; the choice of method will greatly influence the ultimate quality judgements, even using the same patient data. (BRO74, RIC72) One result of these efforts has been a critical re-appraisal of what results can be expected from the provision of health care. (COC72) Increasingly, we are recognizing that clinical medical research must focus on producing controlled studies that demonstrate relationships between the application of health processes and the achievement of improved patient outcomes. However, as Donabedian (DON66) emphasizes, other factors also circumscribe the applicability of outcomes analysis to assessing the quality of care.

> One must limit inferences about the care process utilizing outcomes data to "closed system" diseases, in which poorly controllable psycho-social or biological factors do not have appreciable effects on the outcomes. One must select objective and relevant outcomes parameters, which are both factual and indicative of the disease's altered natural history. One must specify from the onset whether the uniformity of the application of the process is assured or whether that uniformity is, in

fact, the question to be resolved by the study of the outcomes data. In summary, outcomes analysis is both possible and attractive, but important strategic factors relating to process limit its applicability.

Clinical Considerations:

Traditionally, the clinical medical researcher, rather than the health care provider, has focused on controlling these factors. The clinical researcher's methods are focused on evaluating the efficacy of alternative care maneuvers, i.e. the randomized controlled trial (RCT). The health care provider's methods are focused on implementing "proven" care maneuvers routinely and effectively. In an RCT, the protocol explicitly states those outcomes data that should be collected to effect the analysis. In rendering health care, the provider is under no explicit data collection obligation. The provider could conceivably collect those outcomes data which were analyzed during the RCT, but this is not a necessity. Such efforts are, in fact, discouraged by the material and labor costs of complex data collection systems. These important tactical factors have limited the applicability of the RCT - like data acquisition style, but that does not lessen the desirability of such practices.

A remaining question is how does one select the specific diseases for RCT-based analyses, over and above the previously cited factors. Kessner (KES73) has described one alternative which depends heavily on the prevalence rate of the "tracer condition." Another and more general selection scheme can be derived by considering the patterns of utilization behavior. Greenlich (GRE68) has proposed a disease classification scheme that delineates illnesses by the uniformities in their processing by the medical practitioners. Problems are grouped by whether they routinely require emergency hospitalization, short-term ambulatory care, chronic ambulatory care, and so on. Although the intent for developing the Kaiser Clinical-Behavioral Classification System was to facilitate the modeling of patient utilization behavior, its value from our point of view is to provide a systematic analysis of the medical practitioner's intent over the spectrum of encountered disease conditions. For instance, "acute, micro-organism - produced" illnesses are characterized by episodic, short-duration ambulatory encounters. The common management goals that characterize these illnesses include symptomatic relief, avoidance of complications, and case-finding, if the agent is potentially epidemic. In contrast, patients that present "symptoms of undiagnosed disease" utilize complex and expensive services for varying durations of time. The common management goals that characterize these illnesses include the achievement of certain and accurate diagnosis and the minimization of adverse consequences due to delayed therapy. The above-described management goals are phrased in a clinician's usual terms of disease-specific system goals. It is apparent that a wider spectrum of outcome parameters are available and that these are more or less applicable to the particular encounter category. For instance, system goals such as longevity, comfort, and satisfaction are not closely linked to the outcomes of iron-deficiency anemia management. In fact, this is as we should suspect; health care goals should be modulated in kind and degree by the stimulus. Our medical literature review of diseases within all categories of the Kaiser Clinical - Behavior Classification Scheme indicates its capability to delineate classes of disease which share common sets of goals. These goal sets differ from class to class. We consider this observation to be important, because it provides a general method by which to satisfy our initial requirement, that of defining patient-specific objectives, over a wide range of clinical situations.

Access to Care:

The evaluation of the AAMRS effect upon access to health care in many cases reflected the management issues relating to the availability of medical record information, once the patient has entered the health care process. As indicated in section 4M, the ability to have access to information in the medical record or to locate the paper record was considered a major system benefit at several sites. Additionally, at some sites the AAMRS was providing data for patient follow-up on missed appointments and positive laboratory results. This type of access should be considered as secondary, in that it relates to the access to care after the patient has presented himself to the provider for health care.

There was little to indicate that the AAMRS was going to have an effect upon the problem of initial access: the initial entry of an individual into the health care system. An exception to this may be the sites that were using data provided by the AAMRS to analyze appointment data in order to gain some insights into patient utilization behavior, and in particular the Indian Health Service with its patient surveillance efforts carried out by Community Health workers, assisted by work lists obtained from the AAMRS.

Cost of Health Care:

The status of the evaluation and nature of methodology appeared to be directly related to the nature of financial support. Most sites are not dependent upon self generated income, so that there is little motivation for an objective economic evaluation with respect to the effect of the AAMRS upon primary health care costs (health manpower and cost of services). Based upon the information obtained, there appears to be little indication that the AAMRS will have a direct effect upon the cost of individual medical services. With respect to the amount of services provided, however, it was indicated that use of an AAMRS may have some impact. In most cases it was believed that the number of some services, such as lab tests, as being reduced due to the reduction of lost data from prior tests. One exception to this was Stanford, where it was indicated that the number of tests may have increased, but the increase was considered to be more than offset by a reduction in hospital stays. At ITC increased medical, psychiatric and social services in all areas are credited with the avoidance of the very high cost of long term disability.

While a complete analysis of secondary costs (managemenet functions) was generally lacking, nearly all sites had obtained some indication of the AAMRS impact. The secondary cost savings were the major contributing factor at the four sites that were totally cost justified. It is interesting to note that three of these four sites were private organizations dependent upon self generated income.

Summary:

It is important to recognize that the cost of the AAMRS must be justified in some rational manner in order to facilitate acceptance and dissemination of the AAMRS. While the eventual societal benefits relating to the quality of health care may be significant, the problems associated with the assignment of a value to these benefits will continue to exist. Thus the managers of health care delivery systems will continue to look at the more tangible benefits of the AAMRS as its primary justification.

CHAPTER 7

PROSPECTS

A THE DELIVERY OF CARE AND TECHNOLOGICAL SYSTEMS

Change:

The health care delivery system changes only gradually. This effects the speed and methodology with which technical innovation can be introduced. The health care delivery system is a large, multi-faceted, loosely integrated operation in this country. It consists of many people: providers, managers, and institutions - all with their habits based on their experience in the delivery of health care and the maintenance of the viability of their institutions. Stability is a necessary ingredient for the functioning of such a complex system. The oscillations that were, for instance, introduced by the legislation on Medicare have not yet simmered down (SOM71), and there is still tenseness in the system, particularly between the Federal funded operations and private enterprise. Whereas, for instance, a trend towards health maintenance organizations has been encouraged by the government, we find that an even stronger trend to group practice is perceptable. Sometimes a reaction to Federal funding and private development can work in parallel, and reinforce system oscillation. An example of this combination is the utilization review activity instituted in hospitals to reduce the excessive costs of inpatient care when not appropriate, and the development of ambulatory surgical centers by private enterprise. The combination of these two developments leads to low occupancy and gives concern to the management of many hospitals; this in turn has caused hospitals to increase the number of outpatient services and to establish outreach clinics.

We see no instances where the introduction of technology by itself can make major changes in the development and maturation of the health care delivery system. We rather expect that technology will assist and develop those trends which are medically and sociologically justified.

The Medical Record:

Medical care is delivered both with or without the presence of the medical record. In the offices of many private practioners, the medical record plays a negligible role in the delivery of care, and might be completely avoided if no billing and legal minimum requirements existed (HIR75). Emergency care is delivered generally without the medical record being available, and the fragmentation of the health care delivery system makes the medical record kept at a single institution in general incomplete. Even in European countries, with more centralized health care delivery systems, the development of central medical records has been slow and the medical content of the system has not been very deep (HAL70, COL74).

On the other hand, there is a general belief that a good medical record can make a significant difference in the quality and outcome of the medical care delivered (WEE69), and the members of this AAMRS study group tend to agree with this premise. We do recognize, however, that the case- outside of selected areas in special disease categories- has not yet been proved unequivocally. If it were to be convincingly shown that the presence of the medical record at the provider/patient encounter makes a consistent and significant difference in the delivery of medical care, many secondary issues of methodology, and implementation could be settled more easily. Then the medical information system which supports this record can be considered a medical care device to be judged as any other medical device. In 1975, it is inconceivable that if somebody were to be admitted to the hospital with an acute myocardial infarction, that a hospital would not make available the tools, i.e., an electrocardiograph machine to record the information that would be necessary to document the occurrence of that disease and to provide a handle on following the problem. Secondary issues remaining would then be the selection of the actual system alternative to be used, based on their relative effectiveness. For example, a cobalt X-ray machine for high voltage therapy has been shown to be the only effective way to treat a tumor, and we would not go back to using cruder methods of treating cancers today. One of the reasons that information technology is less acceptable or saleable is that its effect is less evident. It does not resolve in the dramatic improvement of a few people, but rather, results in a small increase in health care quality to a broad population. There is the question if society is willing to pay for such small incremental benefits if issues like fluoridation of drinking water to reduce tooth decay or elimination of cigarette smoking have not yet gained general acceptance. (The AAMRS study group consisted entirely of non-smokers and it can hence be assumed that there are certain biases in this observation).

Even some significant but less visible improvements in health care technology have not always gained general acceptance. Kirklin and Shepard's continuous monitoring and closed-loop transfusion system for the post-operative management of heart patients has not yet gained wide acceptance even though the effect on an individual patient over the short term can be conclusively demonstrated. The fact that in a largely publically-funded health care delivery system, the aggregate benefits due to these health care improvements may be greater than the benefits achieved by the more spectacular health care improvements with limited application raises questions regarding societal priorities that we are not equipped to resolve.

Attitudes and Expectations:

From the experience of our visits and the attitudes of the providers found, we do not believe that the managers and the workers in the health care system form an unscalable barrier to the introduction of automated medical record technology in the health care system. Better communication of goals envisaged both within the establishment and to the public can help. Care should be taken that extrapolation of benefits to be achieved in the future are done with care and not used to indicate today's status At a number of sites the implementors of the system pointed out features of their AAMRS's design which were not in routine use, either because they had been developed very recently, and were perhaps not yet debugged, or because the benefits to be obtained by their use were less than the perceived cost. Developers also were prepared to make cost extrapolations based on future hardware and utilization, this is also apt to lead to disappointments which are best avoided. We have learned to ask developers not what the system can do but rather what it does.

B TECHNOLOGY IN AAMRS APPLICATIONS

Technological Development:

Our visits have shown us that there is room for considerable improvement in the technological area. Due to the long lead times associated with current system development methodology we find only few instances where current technology has been profitably employed. Most of the computer equipment which we saw in actual productive use was new about ten years ago and even now continuing system development takes place using this equipment, whereas technical and economic judgement tends to accept a seven year cycle for this technological area.

One reason for the long lead times is the sequential process of the system development effort. When computers are new they require initially an effort directed towards basic software development in order to make them suitable for applications development. Applications development then takes its time, and the integration of the services into an ongoing health care environment takes even more time. Not infrequently are users disappointed and turned-off by the unfulfilled promises of new technology. It is to be hoped that better software development methods, transferrable application software, and education in the medical computer science interface can lead to reduced lead times, although we do not foresee the day when implementation delays will be eliminated. We have seen, in fact, instances where applications of new technology have failed since promises made by computer scientists have not met users' expectations. Results produced in academic computer laboratories or demonstrated as part of PhD theses provide directions for further development effort, they do not provide the brick and mortar for a foundation on which health care applications can be built. A careful assessment of maturity of the technologies proposed by computer systems people in the health care field is an important aspect of health care delivery system management.

Dissemination of Information:

A great demand for the relatively straight-forward information to be presented in this report was already in evidence during the data collection phase of this study. This has convinced us that there is a need for a reliable resource which is responsive to the information needs of medical system designers, health care planners, and health care researchers. There is currently no single journal in this area which carries the relatively pragmatic information required for operational decision making. A French journal in this area, Revue d' Informatique Medicale has unfortunately ceased publication in 1974 after three years of operation. The various newsletters see only limited distribution and cannot provide the required depth of information. We believe that there is a need for a journal in the English language of moderate frequency for which the criteria for acceptance of papers are not academic novelty, but lucid presentation of pragmatic data, and, if possible, even truth.

C EVALUATION AND FUNDING OF FUTURE AAMRS EFFORTS

Introduction:

Future funding of AAMRS development efforts will be critically dependent upon demonstration of the contributions of the AAMRS technology to health care delivery. As discussed throughout this report the contributions or benefits of an AAMRS may be evaluated with respect to process measures and outcome measures. Societal benefits will be primarily related to outcome measures, and health care provider benefits will be heavily related to process or operational measures.

Outcome:

While past technological development efforts have been supported with Federal funds, there is a changing emphasis and re-evaluation taking place with respect to the allocation of Federal funds for technological development. From the Federal government, or in general, the public sector point-of-view, there is an obligation to support activities that will have broad societal benefits, particularly if these are activities that may not find support in the private, commercial sector. As indicated above the measurement of AAMRS benefits will be primarily derived from the outcome measures on the quality of health care achieved and from the demonstration of a direct relationship between the AAMRS outputs and health care outcomes. It has already been mentioned that the development of methodology for the measurement of outcome benefits is still in its early stages and is subject to diverse views and opinions as to appropriate approaches and techniques. Thus it is difficult to envision the ability of the Federal government to justify the general support of technological advance in AAMRS's, in the absence of adequate measures of realized or potential societal benefits.

Process:

Some process measures also relate to societal benefits, such as the effect of the AAMRS upon the cost of health care. Thus to the extent that it can be shown that the AAMRS does have an effect upon government supported health care, there should be an interest in providing support for future development. The likelihood that a AAMRS will have a greater impact on costs of health care in comparison to other management information systems appears small. To date the major cost savings realized with the AAMRS has come from management services, rather than from services relating to the automated medical record. Areas that have potential for demonstrable cost savings are in the area of management of the amount of services provided, and particularly elimination of duplication of services due to lost information in the medical record. The potential savings to be realized in this area has not yet been determined except for speculation by system developers. To date there has been little evaluation performed with objective data to assess the impact of the AAMRS upon the quantity of services provided.

Federal Reporting Needs:

As the possibility of the implementation of some form of a national health insurance increases, there will be a rising desire on the Federal government and health care provider to support systems that will produce data necessary to process insurance claims and to support the reporting requirements of the insurance program. In many cases this type of support has already been identified, as evidenced by the systems that were developed to meet the reporting requirements of categorical support programs, such as the MSIS system developed Rockland. At Rockland the interest of its users stemmed from the reporting requirements which could be fulfilled, but as the system grew, interest in its potential for other services, such as quality of care review and individual record keeping, also developed.

Provider Support:

It is reasonable to assume that support for future AAMRS development from health care providers will depend heavily upon the extent to which the provider sees a direct benefit contribution by the AAMRS to the process of health care, either in the area of improved medical decision making or in terms of management and operational benefits. Thus provider support will be directed toward activities that have provider benefits unique to their perceived needs. An example of this type of support is at the Cardiovascular Clinic in Oklahoma, where the system was developed to enhance the medical decision making process as it developed in their group practice, as well as to provide service benefits in the operations of the clinic. Unless the provider represents a wide-spread or complex organization the support of technological development will be limited. Support from solo or group providers will be directed primarily to the adoption of technical achievements, rather than towards invention or innovation.

Commercial Support:

Commercial support of technical development is directly related to the market potential. Since for the funding of commercial operations, as well as during the subsequent sales activities tangible benefits have to be presented, investment in this area is limited. It has happened a number of times that companies with extremely limited commercial expertise, sometimes fresh from success in the aero-space field, entered this market and later withdrew. Even large commercial computer system vendors are currently limiting their exposure in this area.

Without adequate understanding of the health care system, the societal forces operating in this field, and the areas in which positive contributions can be made, investment will be risky and rare.

Insurance Carriers:

Third party health insurance carriers, like the providers, may demonstrate interest in the support of AAMRS to the extent that the systems can provide information directly related to their needs, or if services result in reduced claims totals due to reductions of the aggregate cost of health care. A considerable potential for funding exists here, since improved quality and access in outpatient care may be able to significantly impact hospitalization costs, as has been demonstrated in a number of HMO operations. At one institution visited AAMRS costs are submitted as reimbursable costs for patients in specialty outpatient care.

D SUMMARY

With respect to future funding of AAMRS development and implementation it is clear that the key decision makers, whether they represent Federal support programs, the health care provider, the third party insurers, or commercial interests, will be in a better position to make funding decisions based upon the demonstration of AAMRS technological contributions to health care. Such demonstrations will be enhanced through rigorous testing to establish the acceptability of the technology and cost justification. Evaluations must take into consideration the following questions:

1. Is the technology going to improve health care?
2. Is it going to have a sizable impact?
3. Have user needs that are served by the technology been adequately defined?
4. Does the technology employed satisfy the user needs?
5. What will be the social and economic effects of the adoption of the technology upon the providers and resources of the health care delivery system?

A variety of approaches can be taken to address these questions. Appendix C presents two possible approaches, one based on the assessment of the economic effects of the introduction of technology to the health care process (a), and the other (b) is based upon an operational analysis from the health care perspective. In addition, section 6M addresses the question of evaluation of the impact of technology upon the quality of health care. These approaches need not be considered independently, nor as an all-inclusive description of suitable methodology to address the above questions. It is important to recognize that in order to assess technical contributions to health care it is necessary to carefully develop and apply methods of evaluation and feedback.

A further requirement is that regular communications channels be established to permit the transmission of the results to appropriate decisions makers and the public at large. Many current political pressures find their origin in needs perceived by the public at large. The societal feedback loop, while in many ways unwieldy and large, can often move faster than our system can adapt. In the absence of measurable benefits, the perception of the public rather than the factual data regarding the AAMRS's will play an important role.

In conclusion, there appears to be a quandary as to the appropriate sequence of funding. The Federal government needs demonstration of societal benefits in justification of the support of technological advancement, whereas the methodology for measuring societal benefits may be dependent on the successful implementation of technological innovation.

Chapter 8

GLOSSARY

This glossary contains only selected terms in the AAMRS area. We have included those terms which required definition within our own study group, as well as some of those which had to be defined in order to communicate at the sites visited.

access: the process of finding data in a computer file.

accounts receivable: payments for services rendered not yet received from clients, measured sometimes as number of days outstanding of the average daily income.

ADAMHA: Alcoholism, Drug Abuse and Mental Health Administration of HSA.

algorithm: a set of procedural rules to find a solution to a well formulated problem, or terminate with a message if no solution is possible.

assembly language: a language close to the hardware of the computer.

asynchronous: serial data transmission of characters according to the speed of the transmitter.

background processing: processing of a low priority program taking place only when no higher priority or real-time processing function is present.

bandwidth: transmission capacity of a communication or file transfer system measured in terms of bits/second.

BASIC: a simple high-level language with some character manipulation capability available on many computers.

batch: operation of a computer where processing is performed on a substantial collection of data at a time.

baud: unit of data transmission speed, often used for video terminals; one baud is equivalent to one bit per second. To transmit one character in asynchronous mode 10 or 11 bits may be required, so that 300 baud allows 30 characters per second to be transmitted.

BHSR: Bureau of Health Services Research, earlier (1972-1974) title of the NCHSR.

binding: the process of committing a design to a firm structure; see section 6F.

bit: smallest unit of data storage or transmission; encodes a two-way choice (0 or 1).

block: a unit of file data on a disk.

buffer: temporary storage for a block in core memory.

byte: unit of 8 bits, frequently used to represent a character; allows 2^8 choices or up to 256 distinct characters and codes.

capitation: the health care service is provided for an annual fixed fee.

categorical grants: government funding to support health care for specific categories of patients.

central processing unit: main part of a computer, contains the logical and arithmetic circuits and controls connected devices.

character: basic unit of data, may require 6 to 8 bits for storage, possibly more for transmission.

character/second: unit to measure transmission or printing speed of serial devices.

COBOL: a high-level language for business problems, with character manipulation and strong file facilities, available on some mini, and on most medium size and large computers.

compiler: translator for source programs to generate directly (without an interpreter) executable computer codes.

core: primary processing memory of a computer.

cost-benefit analysis: identification, measurement and valuation of all cost and benefits over time with respect to a single project.

cost-effectiveness analysis: a comparison of the economic efficiency of alternative systems directed toward the same objective.

cost-justified: an AAMRS is justified in terms of cost-savings and other tangible benefits.

CPU: central processing unit.

CRT: Cathode Ray Tube, common name for video display terminals using a TV-like display to present computer generated data.

data: collection of symbols to represent observations or records of events.

data base (computer science): a comprehensive data file containing information in a format applicable to a user's needs and available when needed.

data base (medical): information on a patient used for clinical judgement.

disk: device for the permanent storage of data.

disk pack: a stack of removable disks, which can be used to keep data off -line.

dot matrix: presentation of characters using a matrix, generally 5x7, of dots. To increase legibility or allow lower case letters, more dots (7x9) may be used.

EMCRO: Experimental Medical Care Review Organization (see PHS 73).

family number: number assigned so that all family members are grouped together.

fee-for-service: the health care is supported by payment for every individual service provided.

feedback: the part of a closed system which is used to bring back information about the condition under control.

file maintenance: the activity of keeping a file up to date by adding, changing, or deleting data.

flag: indication in a record to watch for certain categories of problems or data, without a detailed specification.

flow chart: a description of an algorithm process in graphical form.

flow sheet: a method of presentation of clinical findings on a patient in a matrix form, where the visit dates are placed on one axis and the type of finding on the other axis.

foreground processing: the execution of computer programs that have been designed to preempt the use of the computing facilities.

FORTRAN: a high-level language available on most computers, mainly algebraically oriented.

FTE: full time equivalent effort of part time or part and full time personnel.

hardcopy: printed or micro-filmed, permanent computer output.

hardware: computer equipment.

hard-wired: connection of terminals to a CPU which avoids telephone line switching and allows definite identification of terminals.

hash coding: method to store and retrieve single data records rapidly from disks, etc.

high-level language: a computer language close to algebra, generally with extensions for character processing.

HMO: Health Maintenance Organization, specifically a prepaid health plan as defined by the HMO Act of 1973 (PL93-222).

impact printing: typing or printing process using pressure and an ink ribbon. Plain paper can by used and multiple copies can be produced with carbon paper.

information: data presented, processed, or selected so that decisions can be made or action may be taken.

interpreter: analyzer for programs; directs the CPU to carry out source program functions.

HRA: Health Resources Administration Public Health Service agency supporting research and development of health services.

HSMHA: Health Services and Mental Health Administration, earlier title of the operations of the Public Health Service now carried out by HRA and ADAMHA.

HSA: Health Services Administration,Public Health Service agency supporting delivery of health services.

joystick: small handle used to control the position of a marker on a CRT screen, used to select data elements displayed.

K: 1000 or 1024, depending on the number base (decimal or binary) used to describe parameters of a system. Often used to describe the size of primary (core) storage in binary.

key-data: relatively invariant data important for patient care as: allergies to medicines, the presence of a pace-maker, or the existence of diabetes.

keypunch: device for data recording by typing characters on a data processing card.

large computer: general purpose computer system, often shared by diverse users, system cost generally greater than $600,000, and less than $6 million. If they are larger they are called supercomputers.

lightpen: an indicator instrument available with some CRT's, used to select data elements displayed on the screen.

lines per minute: unit of measurement for the speed of high speed printing devices. Net speed in terms of characters per second depends on the actual length of the lines printed. If average lines are 60 characters long, then lines per minute are equal to characters per second.

M: 1,000,000 or 1,048,576, depending on the number base (decimal or binary) used to describe parameters of a system. Often used to describe the size of secondary (disk) storage in decimal.

magnetic tape unit: a device used to read and write on reels of tape coated with a magnetizable material.

maxi computer: see large computer.

micro computer: special purpose computer system, mainly single user oriented, system cost less than $30,000.

midi computer: combines aspects of mini computer and large computer, system cost about $300,000 to $600,000.

mini computer: limited purpose computer system, generally used on-line by one or several users with similar applications, system cost generally between $30,000 and $300,000.

MIS: Management Information System, operating systems providing a variety of file and disk organization services, as well as scheduling of file oriented programs.

monoprocessing: use of a computer to finish one task at a time.

morbidity: state of being diseased.

multiprocessing: use of computers to work on multiple tasks at a time.

multiprogramming: computer system to implement multiprocessing.

MUMPS: a computer system and a simple high-level language able to run on minicomputers.

NCHSR: National Center for Health Services Research, an agency of the HRA.

NCHSRD: National Center for Health Services Research and Development, earlier (to 1972) title of the NCHSR.

network: system of interconnected computers and terminals.

NIH: National Institutes of Health; Public Health Service agency supporting medical research.

NIMH: National Institute for Mental Health; now part of ADAMHA.

objective evaluation tools: quantitative measurement of tangibles; questionnaires or structured interviews to determine intangibles.

off-line: not physically connected to a computer.

on-line: with direct physical and operational connection to a computer.

operating costs: current costs associated with an AAMRS, includes support of developmental efforts, and user personnel interacting with production aspects of the system, e.g., data entry clerks.

operating system: integrated collection of programs for the scheduling of application programs and sharing of computer resources as CPU time, core, and disk storage.

page: a unit of program data on a disk, has to be moved to core in order to be usable.

patient profile: a concise summary of the patient's status for clinical care use.

PL/I: a high-level language with strong character manipulation and file facilities, mainly available on large IBM computers.

plasma panel: flat glass plate containing a fine matrix of gas cells which can be made to glow selectively to display letters or graphs.

POMR: problem oriented medical record.

primary care: management of the problems by primary providers: family physician, neighborhood clinic, etc.

problem oriented medical record: a format of the medical record, promulgated by Dr. Weed, which among other features, links all findings noted to problems perceived by the physician or patient.

program: algorithm coded into a computer usable form.

programming: the process of translating a problem into a language that a computer can understand and obey. The process of planning the procedure for solving a problem.

progress note: physician's statement of patients problem status after an encounter.

protocol: algorithm for medical personnel.

PSRO: Professional Standards Review Organization.

real-time system: a system where transactions are processed on-line as they occur in order to satisfy defined and rigorous time constraints.

remote batch: operation of a computer where a set of messages from a terminal is collected to be handled together as a batch.

review-of-systems: methodical review of major body systems, i.e., cardio-pulmonary, skeletal-muscular, etc.

secondary care: care given by specialist in his office in the community.

selection entry: a method to enter data by selection, with a finger-touch or lightpen, e.g., elements chosen from a table or menu presented on a CRT screen.

self-coding: the placement of a mark or a number in a specified labeled position on a form provides the coding of the response. The code corresponding to the position is either entered by a data-entry person or determined by a mark sense or optical reader.

self-encoding: data collection by placing a check mark in a labeled box. A code corresponding to the box is entered into the computer.

sequence number: number assigned to an episode, encounter, or visit, generally in chronological order of occurence at the site.

sequential file: a file on which information is stored in the same order in which it is accessed by the central processing unit.

SOAP: Subjective, Objective, Assessment, Plan: sequence of an encounter process when using the POMR.

softcopy: data presentation as a CRT image or in audio format.

software: programs to provide the required services.

source program: program as written by a programmer.

strokegenerator: CRT character generation by explicit movement of the writing beam to form the symbols to be displayed. Also: cigarette.

suboptimization: optimization of activity within a small group or function, rather than as a part of a larger system.

synchronous: data transmission according to a predetermined rate for the characters in message.

systems analyst: a person skilled in solving problems with a digital computer. He analyzes and develops information systems.

table lookup: a method of searching a table to locate items of a certain type or value.

teletype: a printing terminal originally developed for message transmission. It prints at a rate of 10 characters/second.

terminal: the point of data entry or output of a system, often an automated typewriter or CRT device.

tertiary care: in ambulatory care: office visit at a regional medical center.

thermal: printing process using heat-sensitive paper and heat-generating elements in a dot-matrix.

time-sharing: operation of a computer where multiprogramming is arranged to provide continuous service to each active terminal.

transaction processing: operation of a computer where each message entered into the computer starts a task which is processed separately and completely.

trauma: health problems related to external injuries.

triage: selection of health service level according to patient needs and health care delivery service capabilities.

TRIMIS: plan for automation of military health care delivery for the joint services, currently managed by the US Air Force in Montgomery, Alabama.

turn-around document: an output from a computer, which when appropriately completed, can serve after the encounter as an input document to computer processing.

TV-raster scan: CRT image generation, as used by TV sets, through 525 horizontal lines varying intensity.

unit number: permanent number assigned to an individual, for instance, the Social Security Number.

variable-length record file: a file whose records are not uniform in length.

virtual memory: a technique for managing a limited amount of core memory and a much larger amount of lower speed drum or disk memory in such a way that the distinction is largely transparent to a computer user.

warmstart: restart of a computer system, after a failure, with most of the data intact.

CHAPTER 9

SELECTED BIBLIOGRAPHY

This bibliography is not intended to be exhaustive. It has been compiled from two major sources:

a) References used by the members of the AAMRS study group in the preparation of this report. This includes both references cited in the text as well as significant background material;

b) References from sites surveyed as listed in the comprehensive site list. Here only one recent reference is given and only if that reference is reasonably obtainable from a good library or documentation service. For sites where no reference is listed, we advise contacting the principals directly if more information is desired.

We hope that even with these limitations this bibliography will be helpful to readers who wish to follow up on work of interest to them.

ABR70 Abrahamsson, S., S. Bergstrom, K. Larsson, and S. Tillman: "Danderyd Hospital Computer System--Total Regional System for Medical Care," Computers in Biomedical Research, 1970, Vol. 3, pp. 30-46.

ABR71 Abrahamsson, S., and K. Larsson: "Danderyd Hospital Computer System 3--Basic Software Design," Computers in Biomedical Research, April 1971, Vol. 4, pp. 126-140.

ACE74 Proceedings of the Annual Conference on Engineering in Medicine, The Alliance for Engineering in Medicine and Biology (publishers), Washington, D.C., 1974.

AFI72 Proceedings of the 1972 Fall Joint Computer Conference, AFIPS Press, Montvale, N.J., 1972, Vol. 41.

AFI74 Proc. of the National Computer Conference, AFIPS Press, Montvale, N.J., 1974, Vol. 43.

ALL66 Allen, S.I.: "Use of a Time-Shared General-Purpose File-Handling System in Hospital Research," Proceedings of IEEE, December 1966, Vol. 54, pp. 1641-1648.

AND70 Anderson, J., and J.M. Forsythe (eds.): "Information Processing of Medical Records," Proceedings of the IFIP-TC4 Working Conference on Information Processing of Medical Records, Lyon, April 1970, North Holland Publishing Co., Amsterdam, 1970, pp. 6-10.

AYE72 Ayers, W.R., et al.: "Description of an On-Line Information System for Pediatric Pulmonary Patients--Operational Experience in the Emergency Rooms of Three Hospitals," American Review of Respiratory Diseases, June 1972, Vol. 105, pp. 914-919.

BAK74-2 Baker, R.L.: "An Adaptable Interactive System for Medical and Research Data Management," Meth. of Inf. in Med., 1974, Vol. 13, No. 4, pp. 209-215.

BAL72 Baloff, N., J.C. Hershey, and J.R. Moore, Jr.: "An Integrated Health Services Data System," Research Paper No. 106, Grad. Sch. of Bus., August 1972.

BAR69-1 Barnett, G.O., and A. Robbins: "Information Technology and Manpower Productivity," Journal of the AMA, 1969, Vol. 209, p. 546.

BAR69-2 Barnett, G.O., and R.A. Greenes: "Interface Aspects of a Hospital Information System," Ann. N.Y. Acad. Sci., September 30, 1969, Vol. 161, pp. 756-768.

BAR69-3 Barnett, G.O., R.A. Greenes, and J.H. Grossman: "Computer Processing of Medical Text Information," Meth. Inform. Med., October 1969, Vol. 8, pp. 177-182.

BAR70 Barnett, G.O., and R.A. Greenes: "High-Level Programming Languages," Comput. Biomed. Res., October 5, 1970, Vol. 3, pp. 488-494.

BAR71-1 Barber, J.H.: "Computer Assisted Recording in General Practice," J.R. Coll. Gen. Prac., December 1971, Vol. 21, pp. 726-736.

BAR71-2 Barnett, G.O.: "The Use of Computers in Clinical Data Management," Proc. of AMA Symposium on Computers in Medicine, 1971.

BAR74 Barrett, I.P, and D. Norwood: "Selected Indicators of the Cost Benefits of a Medical Information System in a Community Hospital," in Clinical Medicine and the Computer (M. Jenkin, ed.), Society for Computer Medicine, Minneapolis, Minnesota, 1974.

BAR75 Barnett, G.O.: "The Computerized Medical Record," National Computer Conference, Anaheim, May 1975, Convention Seminar Cassettes, North Hollywood, 1975, NCC-57.

BAT73 Battelle Laboratories, Columbus, Ohio: "Evaluation of the Implementation of a Medical Information System in a General Community Hospital," to NCHSRD, 1973.

BEK72 Berkey, G.A., and M.D. Schwartz: "Hospital Information Systems," Biomedical Engineering Monograph, Marcel Dekker, 1972.

BEI74 Beilin, L.J., et al.: "Computer-Based Hypertension Clinic Records--A Cooperative Study," British Medical Journal, 1974, Vol. 2, pp. 212-216.

BER71 Berkley, C.: "Privacy and the Patients' Right to Information," Medical Research Engineer, January/February 1971, Vol. 10, p. 3.

BHA74 Bhargava, B.K., and C.J. McDonald: "Tree Systems for Medical Information Processing," Biomed. Sci. Instrum., April 1974, Vol. 10, pp. 93-99.

BJO71 Bjorn, J.C., and H.D. Cross: "Problem-Oriented Practice," Modern Hospital Press, Chicago, 1971.

BLS74 Occupational Outlook Handbook (1974-75) U.S. Department of Labor, Bureau of Labor Statistics Bulletin 1785, 1974.

BOL72-1 Bolt, Beranek, and Newman, Inc.: The CAPO Project, Phase I, "Evaluation of an Automated Medical History in Office Practice," Report No. 2471, submitted to NCHSRD, March 1972.

BOL72-2 Bolt, Beranek, and Newman, Inc.: The CAPO Project, Phase II, "Development and Deployment of Computer Aids in the Physician's Office," Report No. 2512, submitted to NCHSRD, December 1972.

BOU75 Bouhana, J.: "Versatile Data Displays with a Computer Performance Example," Proceedings of the ACM, Pacific 1975 Conference, May 1975.

BOY73 Boyd, D.R., et al.: "Trauma Registry," JAMA, Jan. 22, 1973, Vol. 223, No. 3, pp. 422-428.

BOY74 Boyle, C.M.: "Scottish Automated Follow-Up Register for Thyroid Disease--Four Years' Experience in Glasgow," British Medical Journal, June 1974, Vol. 2, pp. 490-492.

BRA74 Braunstein, M., J.R. Cahn, L. Chansky, and D. James: "Family Practice Residents Learn 'COMPUTER'," Patient Care, March 1974.

BRO73-1 Brook, R.H.: "Quality of Care Assessment--A Comparison of Five Methods of Peer Review," Rockville, Md., Bureau of Health Services Research and Evaluation, Health Services Administration, Department of Health, Education, and Welfare, 1973.

BRO73-2 Brown, J.J.: "Computer-Based Records in the Clinic (B)," Proc. R. Soc. Lond. (Biol.), December 1973, Vol. 184, pp. 399-402.

BRO75 Broida, J.H.: "Impact of Membership in an Enrolled, Prepaid Population on Utilization of Health Services in a Group Practice," New England Journal of Medicine, April 10, 1975, Vol. 292, pp. 780-783.

BRU71 Brunjes, S.: "An Anamnestic Matrix Toward a Medical Language," Comput. Biomed. Res., December 1971, Vol. 4, pp. 571-584.

BUC73-1 Buckley, J.D., V.X. Gledhill, J.D. Mathews, and I.R. Mackay: "SEARCH--A Language for Retrieval and Statistical Analysis of Medical Records," Computers and Biomedical Research, 1973, Vol. 6, No. 3, pp. 235-244.

BUC73-2 Buckley, J.D., V.X. Gledhill, J.D. Mathews, and I.R. Mackay: "A Computer-Based Medical Record System," Methods of Inf. Med., July 1973, Vol. 12, pp. 137-142.

BUR61 Burns, T., and G. Stalker: Management of Innovation, Quadrangle Books, Chicago, 1961.

BUR74 Burch, J.G., Jr., and F.R. Strater, Jr.: "Information Systems--Theory and Practice," Hamilton-Wiley, Santa Barbara, California, 1974.

CHA74 Chang, E., and J. Landers: "A Distributed Medical Data Base," Meth. of Inf. in Med., 1974, Vol. 13, No. 4, pp. 221-225.

CLA71-1 Clarke, A.H., et al.: "Automating Management of Routine Medical Records in General Practice," Meth. Inform. Med., 1971, Vol. 10, pp. 207-215.

CLA71-2 Clayton, G.M.: "Experience with an ICL 1905 Computer in General Practice," J. Roy. Coll. Gen. Practit., 1971, Vol. 21, p. 620.

CLA74 Clark, R.R.: "The Impact of a Computerized Peer Review System on Continuing Medical Education," Ohio State Med. J., December 1974, Vol. 70, No. 12, pp. 748-751.

COC72 Cochrane, A.L.: "Effectiveness and Efficiency--Random Reflections on Health Services," The Nuffield Privincial Hospitals Trusts, London, 1972.

COD70 Codd, E.F.: "A Relational Model for Large Shared Data Banks," Comm. of the Association for Computer Machinery, June 1970, Vol. 13, No. 6.

COH72 Cohen, S.N., M.F. Armstrong, L. Crouse, and G. Hum: "A Computer-Based System for Prospective Detection and Prevention of Drug Interaction," Drug Information Journal, January/June 1972.

COL71 Collen, M.F., L.S. Davis, and E.E. Van Brunt: "The Computer Medical Record in Health Screening," Meth. Inform. Med., July 1971, Vol. 10, pp. 138-142.

COL72 Colorado Foundation for Medical Care, Denver, Colorado: Final Report, Contract No. HSM 110-71-89 to the NCHSRD, 1972.

COL73 Collen, M.F. (ed.): Technology and Health Care Systems in the 1980's, DHEW Pub. (HSM) 73-3016.

COL74 Collen, M.F.: Hospital Computer Systems, Wiley, 1974.

COR72 Cordle, F.: "The Automation of Clinical Records--An Overview, with Special Emphasis on the Automation of Office Records in the Primary Medical Care Setting," Med. Care, November/December 1972, Vol. 10, pp. 470-480.

COS71 Cosby, R.S., et al.: "Physician/Computer Interaction as a Clinical Research Technique," JAMA, December 6, 1971, Vol. 218, pp. 1548-1551.

COS75 Costanzo, G.A., and I. Vertinsky: "Measuring the Quality of Health Care--A Decision-Oriented Typology," Medical Care, May 1975, Vol. B, No. 5, pp. 417-431.

CRA74 Crandell, C.E.: "A Dental System That Works," Cyberdent, 1974, Vol. 2, No. 1.

CRE70 Creech, B.A.: "Architecture of the B-6500," in Software Engineering (Julius T. Tou, ed.), Academic Press, 1970.

CRO69 Crouse, L., and G. Wiederhold: "An Advanced Computer System for Medical Applications," Computer and Biomedical Research, December 1969, Vol. 2, No. 6, pp. 582-592.

CUR69 Curran, W.J., B. Stearns, and H. Kaplan: "Privacy, Confidentiality, and Other Legal Considerations in the Establishment of a Centralized Health-Data System," New England Journal of Medicine, July 31, 1969, Vol. 281, No. 5, pp. 241-248.

DAL71 Dales, L.G., MPH, MD: "Automated Multiphasic Health Testing Evaluation," in 1971 Annual Report, Health Services Research Center, Kaiser Permanente Medical Care Program, Oakland, Calif.

DAV70 Davis, L.S.: "Prototype for Future Computer Medical Records," Computers and Biomedical Research, 1970, Vol. 3, pp. 539-553.

DAV72 Davis, K., and L.B. Russell: "The Substitution of Hospital Outpatient Care for Inpatient Care," Review of Economics and Statistics, May 1972, Vol. 54, No. 2, pp. 109-120.

DAV73 Davis, L.S.: "A System Approach to Medical Information," Methods of Information in Medicine, January 1973, Vol. 12, pp. 1-6.

DAV74 Davis, G.B.: "Management Information Systems," McGraw Hill, 1974, pp. 413-429.

DEL69 Deland, E.C., W.F. Raub, R.W. Stacey, and B.D. Waxman: "Computers and the Delivery of Medical Care," Rand Corporation, Santa Monica, February, 1969.

DIN70 Dinwoodie, H.P.: "Group Practice--Computers and Record Keeping," J. Roy. Coll. Gen. Pract., Suppl., 1970, Vol. 2, pp. 31-34.

DON66 Donabedian, A.: "Evaluating the Quality of Medical Care," Milbank Fund, 1966, Vol. 44, Part 2, p. 166.

DON73 Donabedian, A.: Aspects of Medical Care Administration, Specifying Requirements for Health Care, Harvard University Press, 1973.

EID71 Eiduson, B.T.: "Automating Narrative Records," Int. J. Psychiatry, 1970-1971, Vol. 9, pp. 628-637.

ERT70 Ertell, P.Y., E.L. Pritchett, R.C. Chase, et al.: "An Outpatient Data System--New Techniques to Meet New Demands," JAMA, February 9, 1970, Vol. 211, pp. 964-972.

FIL72 Filiatrault, L.J.: "Problem-Oriented Record at the University of Minnesota Family Practice Clinic," Proc. of the Seminar Workshop on Data Recording, Data Retrieval, and Research in Primary Care, April 1972.

FLA70 Flagle, C.D.: "Evaluation Techniques for Medical Information," Comput. Biomed. Res., 1970, Vol. 3, pp. 407-414.

FLA72 Flagle, C.D.: "Evaluation and Control of Technology in Health Services," Proceedings of a Conference on Technology and Health Care Systems in the 1980's, DHEW pub. 73-3016, San Francisco, California, 1972.

FOO70 Foote, R.J.: "Computerizing Medical Records," Obstet. Gynecol., November 1970, Vol. 36, p. 812.

FOR62 Forkner, C.E.: "Special Methods of Recording the History and Physical Examination," The Medical Clinics of North America, May 1962, Vol. 46, No. 3.

FOR70 Forbes, J., and D. Grant: "Information Retrieval in General Practice," Proc. Roy. Soc. Med., September 1970, Vol. 63, pp. 917-920.

FAR72 Farmer, R.D., and K.W. Cross: "An Automated Records System for General Practice," British Journal Prev. Soc. Med., August 1972, Vol. 26, pp. 148-152.

FEI70-1 Feinstein, A.R.: "Taxonorics, I, Formulation of Criteria," Arch. Intern. Med., October 1970, Vol. 126, pp. 679-693.

FEI70-2 Feinstein, A.R.: "Taxonorics, 2, Formats and Coding Systems for Data Processing," Arch. Intern. Med., December 1970, Vol. 126, pp. 1053-1067.

FEI73 Feinstein, A.R.: "The Problems of the Problem-Oriented Medical Record," Annals of Int. Med., 1973, Vol. 23, pp. 751-762.

FES72 Fessel, W.J., and E.E. Van Brunt: "Assessing Quality of Care from the Medical Record," N. England. J. Med., 1972, Vol. 286, pp. 134-138.

FRE67 Freed, R.N.: "Legal Aspects of Computer Use in Medicine," Law and Contemporary Problems, 1967, Vol. 32, pp. 674-706.

FRE68 Freed, R.N.: "A Legal Structure for a National Medical Data Center," American Federation of Information Processing Societies AFIPS Conference Proceedings, 1968, Vol. 33, Part 1; Fall Joint Computer Conference, San Francisco, December 9-11, 1968; Thompson, Washington, D.C., 1968, pp. 387-394.

FRE69 Frey, H.S.: "An On-Line Graphic System for Analysis of Tumor Registry Data," in Computers in Biomedical Research (Stacy and Waxman, eds.), Academic Press, 1969, Vol. 3.

FRI72 Fries, J.F., MD: "Time-Oriented Patient Records and a Computer Databank," JAMA, December 18, 1972, Vol. 222, pp. 1536-1542.

FRI74-1 Fries, B.E.: "Determining the Minimum Cost Configuration for a Two-Level Medical Record Storage System," Comput. Biomed. Res., February 1974, Vol. 7, pp. 56-63.

FRI74-2 Fries, J.F., E.V. Hess, and J. Klinenberg: "A Standard Database for Rheumatic Diseases," Arthritis Rheum., May/June 1974, Vol. 17, pp. 327-336.

FRO74 Fromm, J.: "An Integrated System for the Recording and Retrieval of Medical Data in Primary Care Setting," J. Fam. Practice, 1974, Vol. 1, No. 1, pp. 47-48.

GAI75 Gaines, B.R., and P.V. Facey: "Some Experience in Interactive System Development and Application," Proceedings of the IEEE, June 1975, Vol. 63, No. 6, pp. 894-911.

GIE74 Giebink, G.A., and L. Hurst: "Ambulatory Health Care Applications," Report submitted to the Robert Wood Johnson Foundation, Health Care Management Systems, Denver, Colo., 1974, 3 vols.

GIL71 Gillings, D.B., and J.F. Preece: "An Analysis of the Size and Content of Medical Records Used During an On-Line Record Maintenance and Retrieval System in General Practice," Int. J. Biomed Comput., 1971, Vol. 2, pp. 151-169.

GIR71 Girardi, S., R. Frey, and G. Wiederhold: "A Filing System for Medical Research," Int. J. Biomed. Domput., 1971, Vol. 2, No. 1, pp. 1-26.

GLE72 Gledhill, V.X., and J.D. Mathews: "An Operational Medical Records System--Acquisition, Storage, and Retrieval of Formalized Medical Data," Int. J. Biomed. Comput., January 1972, Vol. 3, pp. 59-70.

GLE73 Gleser, M., and M.F. Collen: "Towards Automated Medical Decisions," Computers in Biomed. Research, April 1972, Vol. 5, pp. 180-189.

GLU74 Glueck, B.C., R.P. Ericson, and C.F. Stroebel: "The Use of a Psychiatric Patient Record System," Proceedings of the FASEB Conference on the Computer as a Research Tool in the Life Sciences, Aspen, Colorado, June 1974.

GOL70 Goldberg, M.: "Features of a Medical Records Information System--Results of a Survey," J. Am. Coll. Health Assoc., December 1970, Vol. 19, pp. 121-124.

GOL73 Goldfinger, S.E.: "The Problem-Oriented Record--A Critique from a Believer," New England J. Med., March 22, 1973, Vol. 288, No. 12, pp. 606-608.

GOR64 Gordon, B.L., and J.H. Talbott: Current Medical Terminology, AMA, Chicago, 1964.

GOR70-1 Gordon, B.L.: "Content and Terminology of the Medical Record," Computers and Biomedical Research, 1970, Vol. 3, pp. 436-444.

GOR70-2 Gordon, B.L.: "Regulation and Stylization of Medical Records," Journal of the AMA, 1970, Vol. 212, pp. 1502-1507.

GOT72 Gottlieb, G.L., R.F. Beers, C. Bernecker, and M. Samter: "An Approach to Automation of Medical Interviews," Comp. Biomed. Res., Vol 5, No. 2, pp. 99-107.

GRE68 Greenlick, M.R., A.V. Hurtado, C.R. Pope, E.W. Saward, and S.S. Yoshioka: "Determinants of Medical Care Utilization," Health Serv. Res., 1968, Vol. 3, p. 296.

GRE69 Greenes, R.A., A.N. Pappalardo, C.W. Marble, and G.O. Barnett: "Design and Implementation of a Clinical Data Management System," Computers and Biomedical Research, 1969, Vol. 2, pp. 469-485.

GRE70 Greenes, R.A., G.C. Barnett, S.W. Klein, A. Robbins, and R.E. Prior: "Recording, Retrieval, and Review of Medical Data by Physicians/Computer Interaction," N. Eng. J. Med., 1970, Vol. 282, pp. 307-315.

GRO73 Grossman, J.H., G.O. Barnett, et al.: "An Automated Medical Record System," JAMA, June 18, 1973, Vol. 224, pp. 1616-1621.

GRO74 Groner, G.F., M.D. Hopwood, N.A. Palley, and N.Z. Shapiro: "A Plan for the Development and Evaluation of a Data Management and Analysis System for Clinical Investigators," Report R-1542-NIH, August 1974, Rand Corporation, Santa Monica, California.

GRU69 Gruber, W.H., and D.G. Marquis: "Research on the Human Factor in the Transfer of Technology," Proc. MIT Conference on Human Factors in Transfer of Technology, MIT Press, 1969.

GRU72 Gruer, K.T.: "Livingston New Town--Using a Computer for General Practice Records," J. R. Coll. Gen. Pract., February 1972, Vol. 22, pp. 100-107.

HAL70 Hall, P.: "Information Science--The Patient and the Medical Record," Information Processing of Medical Records, 1970, pp. 31-41.

HAM73 Hammond, W.E., et al.: "GEMISCH--Mini-Computer Information Support System," Proc. of IEEE, November 1973, Vol. 61, pp. 1575-1583.

HAR74 Hargreaves, W.A., M.H. McIntyre, and L.M. Siegel (eds.): Resource Materials for Community Mental Health Program Evaluation, University of California, San Francisco, published by NIMH, San Francisco, 1974.

HEA74 Health Computer Applications in Canada, Health Computer Information Bureau, Ottawa, Ontario, Canada.

HIR75 Hirsh, H.L.: "Medical Records--Their Medico-Legal Significance," J. Fam. Prac., 1975, Vol. 2, No. 3, pp. 213-216.

HOF69 Hoffman, P.B., and J.F. Rockart, Ph.D: "Implications of the No-Show Rate for Scheduling O.P.D. Appointments," Hospital Progress, August 1969, pp. 35-40.

HOW70 Howland, D.: "Toward a community Health-System Model," Biomed. Comput., 1970, Vol. 1, p. 11.

IBM73 IBM: "Data Processing in the Missouri Devision of Mental Health," Document No. GK20-0659-0, August 1973.

JOH68 Johnson, W.L., and L.S. Rosenfeld: "Factors Affecting Waiting Time in Ambulatory Care Services," Health Services Research, 1968, Vol. 3, pp. 283-295.

JOH71 Johnson, J.L.: Clinical Laboratory Computer Systems--A Comprehensive Evaluation, J.L. Johnson Associates, 1971.

JUS74 Justice, N., G.O. Barnett, R. Lurie, and W. Cass: "Development and Implementation of a Medical/Management Information System at the Harvard Community Health Plan," Proc. AFIPS National Computer Conference, 1974, Vol. 43, pp. 159-165.

JUT72 Jutier, P., G. Vermeil, et al.: "An Essay on Realization of Medical Records System Using Plain Language without Prescribed Structure and in Interactive Mode" (in French), Revue d'Informatique Medicale, March 1972, Vol. 3, No. 1, pp. 13-20.

KAR70 Karpinski, R.H., and H. Bleich: "MISAR--A Miniature Information Storage and Retrieval System," Computers and Biomedical Research, 1971, Vol. 4, pp. 655-660.

KES73 Kessner, D.M.: "A Strategy for Evaluating Health Services," Institute of Medicine, National Academy of Sciences, Washington, D.C., 1973.

KIE68 Kiely, J.M., J.L. Juergens, B.L. Hisey, and P.E. Williams: "A Computer-Based Medical Record," JAMA, 1968, Vol. 205, p. 99.

KLA74 Klarman, H.E.: "Application of Cost Benefit Analysis to Health Systems Technology," J. Occup. Med., March 1974, pp. 172-186.

KNI73 Knight, J.R., and W.F. Conrad: "A Literature Review of Computer-Oreinted Pharmacy Services in Hospitals," J. Clin. Computing, November 1973, Vol. 3, No. 3.

KOL74 Kolodny, G.M., H.I. Cohen, and A. Kalisky: "Access of Radiology Reports," Radiology, June 1974, Vol. 3, No. 3, pp. 597-601.

KOR71 Korein, J., M. Lyman, and L.J. Tick: "The Computerized Medical Record," Bulletin N.Y. Acad. Med., July 1971, Vol. 47, pp. 824-826.

KOZ74 Koza, R.C. (ed.): Health Information Systems Evaluation, Colorado Associated University Press, 1974.

LAM67 Lamson, B.G.: "Hospital-wide System for Handling Medical Data," Hospitals, May 1, 1967, Vol. 41, pp. 67-80.

LAN71 Lane, W., MD: "The Last Word in Appointment Systems," Med. Econ., June 7, 1971, pp. 96-101.

LAS71 Laska, E., and G.W. Logemann: "Computing at the Information Sciences Division, Rockland State Hospital," Proc. ACM Annual Conf., November 1971, pp. 672-683.

LEA71 Leavitt, S.S., T.L. Johnston, and R.D. Beyer: "The Process of Recovery--Patterns in Industrial Back Injury," Industrial Medicine and Surgery, 1971, Vol. 40, No. 8, and 1972, Vol. 41, No. 1.

LEB74 LeBeux, P.J.: "Frame Selection Systems and Languages for Medical Applications," Technical Report No. 7, Laboratory of Medical Information Science, University of California, San Francisco, 1974.

LEV64 Levy, R.P., M.R. Cammarn, and M.J. Smith: "Computer Handling of Ambulatory Care Clinic Records," JAMA, December 21, 1964, Vol. 190, pp. 1033-1037.

LEW74 Lewis, C.E.: "The State of the Art of Quality Assessment--1973," Med. Care, 1974, Vol. 12, p. 77.

LIN70 Lindberg, D.A.R.: "A Statewide Medical Information System," Computers and Biomedical Research, 1970, Vol. 3, pp. 453-463.

LIP71 Lippmann, E.O., et al.: "A Pilot On-Line Data System for General Practitioners," Comput. Biomed. Res., August 1971, Vol. 4, pp. 390-406.

LLO71 Lloyd, S.C., B.A. Brantley, W.E. Hammond, W.W. Stead, and H.K. Thompson, Jr.: "A Generalized Medical Information System (GEMISCH) for Practicing Physicians," Proc. ACM Annual Conf., November 1971, pp. 684-692.

LOG73 Logemann, G.W.: "Multi-State Information System--Problems and Solutions," Proc. ACM Annual Conf., 1973, pp. 271-272.

LUB72 Lubin, J.W., et al.: "Statistics for Comprehensive Health Planning," Nat. Center for Health Statistics, HSMHA, June 1972.

LUC74 Lucas, H.C.: Towards Creative System Design, Columbia University Press, New York, 1974, p. 147.

LUS68 Lusted, L.B.: Introduction to Medical Decision Making, Charles C. Thomas, Springfield, Ill., 1968.

MAN75 Manacher, G.V.: "On the Feasibility of Implementing a Large Relational Data Base with Optimal Performance on a Minicomputer," Unnumbered report, University of Illinois, Dept. of Information Engineering and Dept. of Ophthamology, 1975.

MAR73 Martin, J.: Design of Man-Computer Dialogues, Prentice-Hall, 1973.

MCC74 McCormick, Bruce, et al.: "Clinical Decision Making--Design of a Data Base in Ophthamology," Report MDC1.1.1, Medical Information Systems Laboratory, University of Ill., Chicago, October 1974.

MCD75 McDonald, C., B. Bhargava, and D. Jeris: "A Clinical Information System (CIS) for Ambulatory Care," Proceeding of the 1975 NCC, AFIPS Press, Vol. 44, pp. 749-756.

MCL71 McLaughlin, C.P.: "Technology and Medical Care Costs--Some Basic Evaluation Problems," Economic and Business Bulletin, Fall 1971, Vol. 24, No. 1, pp. 36-43.

MCN68 McNamera, James J.: "Legal Aspects of Computerized Medical Records," Journal of American Medical Association, August 26, 1968, Vol. 205, No. 9, pp. 153-154.

MED74 Proceedings of MEDINFO, First World Conference on Medical Informatics, Stockholm, Sweden, North Holland Publishers, 1974.

MES71 Mesel, E., and S.C. Klein: "Provisional Users Manual--On-Line System for Submitting Medicaid Claims," University of Alabama, 1971.

MES75 Mesel, E., and D.D. Wirtschafter: "Automation of a Patient Medical Profile from Insurance Claims Data--A Possible First Step in Automating Ambulatory Medical Records on a National Scale," manuscript available from authors upon request.

MOO65 Moore, J.F.: "Mechanizing a Large Register of First Order Patient Data," Meth. Inf. in Med., 1965, Vol. 4, No. 1, pp. 1-10.

MUR72 Murnaghan, J.H. (ed.): "Ambulatory Medical Care Data," NCHSRD, 1972.

MUR73 Murnaghan, J.H.: "Ambulatory Care Data. Report of the Conference on Ambulatory Medical Care Records--Review of the Conference Proceedings," Med. Care, 1973, Vol. 11, Supplement, p. 13.

MUR74 Murnaghan, J.H., BA: "Health Services Information Systems in the United States Today," New England J. Of Med., March 11, 1974, Vol. 290, pp. 603-610.

NAS72 Alterescu, S., R.A. Schwarz, and L.S. Collins: "Medical Information Management System (MIMS)--A Generalized Interactive Information System," NASA Report X-207-72-374, September 1972.

OCO70 O'Connell, B.P., and A.H. McFarlane: " A Medical Care Information System--An Approach to the Computerization of Ambulatory Patient Records," Medical Care, January/February 1970, Vol. 8, pp. 82-87.

PEC74 Peck, J.C., and F.M. Crowder: "A Public Health Data System," Proc. AFIPS National Computer Conf., 1974, Vol. 43, pp. 77-80.

PET72 Petters, J.R.: "Comprehensive Hospital Computer Applications Program," Wuesthoff Memorial Hospital, 1972, report to NCHSRD, HS 167.

PHS68 International Classification of Disease--Adapted, DHEW, Superintendant of Documents, U.S. Public Health Service, Washington, D.C., 1968, Vol. 1.

PHS70 Automated Multiphasic Health Testing--Bibliography, PHS Pub. 2076, Supt. of Documents, Washington, D.C., May 1970.

PHS73 Experimental Medical Care Review Organization (EMCRO) Programs, National Center for Health Services Research and Development, Health Services and Mental Health Administration, U.S. Department of Health, Education, and Welfare, DHEW Publication No. (HSM) 73-3017, March 1973, Washington, D.C.

PHS74 Ambulatory Medical Records--Uniform Minimum Basic Data Set, National Center for Health Statistics, DHEW Publication No. (HRA) 75-1453, Series 4, No. 16, August 1974, Supt. of Doc., Washington, D.C.

PRA69 Pratt, A.W., et al.: "Identification and Transformation of Terminal Morphemes in Medical English," Meth. Inform. Med., April 1969, Vol. 8, pp. 84-90.

PRE71 Preece, J.F., and E.D. Lippman: "Record Design for the Computer File in General Practice," Practitioner, August 1971, Vol. 3, Supplement, p. 12.

RAU74 Raub, W.F.: "The PROPHET System and Resource Sharing," Fed. Proc.; Fed. of Am. Soc. for Exp. Biology, December 1974, Vol. 33, No. 12, pp. 2390-2392.

REC73 Records, Computers, and the Rights of Citizens, U.S. Department of HEW, Report of the Secretary's Advisory Committee on Automated Personal Data Systems, MIT Press, 1973, pp. 1-344.

REI73 Reiffen, B., and H. Sherman: "The Use of Computers in Ambulatory Care--Lessons from 3000 Encounters," Comput. Biol. Med., September 1973, Vol. 3, pp. 101-105.

RIC72 Richardson, F.M.: "Peer Review of Medical Care," Med. Care, 1972, Vol. 10, p. 29.

ROB70 Robinson, R.E.: "Acquisition and Analysis of Narrative Medical Record Data," Comput. Biomed. Res., October 5, 1970, Vol. 3, pp. 495-509.

ROB75 Robbins, G.: "Use of a Computer in a Private Specialty Practice," Convention Seminar Cassettes, NCC-57, North Hollywood, 1975.

RUL72 Rule, B.F., A.S. Stone, R.D. Weir: "Free Text in Computer-Stored Medical Records," Int. J. Biomed. Comput., April 1972, Vol. 3, pp. 135-142.

SAM72 Samuels, G.: "Infringements of Individual Privacy," Med. Journal of Australia, August 12, 1972, Vol. 2, pp. 355-357.

SAN72-1 Sanazaro, P.J., R.L. Goldstein, J.S. Roberts, D.B. Maglot, J.W. McAllister: "Research and Development in Quality Assurance--The Experimental Medical Care Review Organization Program," New England J. Med., November 30, 1972, Vol. 287, pp. 1125-1131.

SAN72-2 Proc. of San Diego Biomedical Symposium, 1972, Vol. 11, published by San Diego Biomedical Symposium, P.O. Box 965, San Diego, Calif.

SAN73-1 Proc. of San Diego Biomedical Symposium, 1973, Vol. 13, published by San Diego Biomedical Symposium, P.O. Box 965, San Diego, Calif.

SAN73-2 Sanazaro, P.J.: "Federal Health Services R & D under the Auspices of the National Center for Health Services Research and Development in Health Services Research," in R & D in Perspective (E. Flook and P. Sanazaro, eds.), Health Administration Press, Ann Arbor, Mich., 1973.

SAU70 Saunders, J.: "Results and Costs of a Computer Assisted Immunization," Brit. J. Prev. Soc. Med., 1970, Vol. 24, pp. 187-191.

SCH70 Schneiderman, L.J., and S.M. Baylor: "Computer Assisted Research of Medical Records--A Facilitated Access File for Physical Examination, Laboratory and Diagnostic Data," Methods of Information in Medicine, July 1970, Vol. 9, pp. 171-176.

SCH71 Schultz, J.R., S.V. Cantrill, and K.G. Morgan: "An Initial Operational Problem-Oriented Medical Record System for Storage, Manipulation, and Retrieval of Medical Data," Proceedings of the Spring Joint Computer Conference 1971, Vol. 38, pp. 239-264.

SCH74-1 Schmidt, E.C., D.W. Schall, and C.C. Morrison: "Computerized Problem-Oriented Medical Record for Ambulatory Practice," Med. Care, April 1974, Vol. 12, pp. 316-327.

SCH74-2 Schulman, J., and C. Wood: "Flow Sheets for Charts of Ambulatory Patients," JAMA, August 16, 1974, Vol. 217, pp. 993-937.

SCH74-3 Schroer, B.J., and H.T. Smith: "A Family Practice Center Clinical Data System," Sch. of Primary Medical Care, Univ. of Alabama in Huntsville, Ala., 1974.

SCM74 Jenkin, M.A. (ed.): "Clinical Medicine and the Computer," Society for Computer Medicine, Minneapolis, Minnesota.

SEH74 Sehnert, K.W.: "Good Office Records Equals Accreditation and Dollars," Computer Medicine Newsletter, February 1974, Vol. 4, No. 2, pp. 2-3.

SEL74 Selmer, K.S.: "Protection of Privacy in Automatic Data Processing Systems in the Medical Services," Nord. Med., January 1974, Vol. 89, pp. 17-19.

SHO74 Shortridge, M.H.: "Quality of Medical Care in an Outpatient Setting," Med. Care, 1974, Vol. 12, p. 283.

SHO75 Shortliffe, E.: "MYCIN--Advice-Giving in Anti-Minobial Therapy," Computers in Biomedical Res., June 1975, Vol. 8.

SIM74 Simmons, R.L.: "Evaluation of a Computer-Assisted Electrocardiographic Interpretive System," in Health Information Systems Evaluation (Russel Koza, ed.), Colorado University Press, Boulder, Colo., 1974.

SMI70 Smith, J.C., and J.B. Goldsby: "A Family Planning Services Data System," Family Planning Perspectives, June 1970, Vol. 2, No. 3.

SOM71 Somers, Anne R.: "Health Care in Transition, Direction for the Future," Hospital Research and Educational Trust, Chicago, 1971.

SOX73 Sox, H.C., Jr., C.H. Sox, and R.K. Tompkins: "The Training of Physicians' Assistants--The Use of a Clinical Algorithm System for Patient Care, Audit of Performance and Education," New Eng. J. Med., April 19, 1973, Vol. 288, No. 16, pp. 818-824.

SPR71 Springer, E.W.: Automated Medical Records and the Law, Health Law Center, Aspen Systems Corp., Pittsburgh, Pa., 1971, pp. 1-177.

STA73 Starfield, B.: "Health Services Research--A Working Model," New England Journal of Medicine, 1973, Vol. 289, p. 132.

STA74 Starmer, C.F., R.A. Rosati, and J.R. Moneer: "Editorial--Data Bank Use in Management of Chronic Disease," Comput. Biomed. Res., April 1974, Vol. 7, pp. 111-116.

STE74-1 Stein, M.A., R. Odubo, L.R. Bennett, and J. Winter: "Natural Language Information Storage and Retrieval System for Nuclear Medicine--Two Years' Experience," Radiology, November 1974, Vol. 113, No. 2, pp. 387-389.

STE74-2 Sterling, T., S. Pollack, and W. Spencer: "The Use of an Information System to Humanise Procedures in a Rehabilitation Hospital," Int. J. Biomed. Comput., January 1974, Vol. 5, pp. 51-57.

STE75 Stemmer, A.L.: "A Computerization of Health Care Coordinating System--MEDITROL," Journal of Clinical Computing, 1975, Vol. 4, No. 4, pp. 262-276.

STO75 Stonebreaker, M., and G. Held: "Networks, Hierarchies, and Relations in Data Base Management Systems," Proc. ACM Pacific 75 Conference, Boole and Babbage, Palo Alto, California.

SWE72 Swedlow, D.B., G.O. Barnett, J.H. Grossman, and D.E. Sanders: "A Simple Programming System ('Driver') for the Creation and Execution of an Automated Medical History," Comput. Biomed. Res., Vol. 5, No. 1, pp. 90-98.

SYS65 "Systematized Nomencalture of Pathology," College of American Pathologists, American Medical Association, Chicago, 1965.

TER71 Terasaki, P.I., et al.: "National Transplant Communications Network," JAMA, December 13, 1971, Vol. 218, No. 11, pp. 1674-1678.

UTT74 Utterback, J.M.: "Innovation in Industry and the Diffusion of Technology," Science, 1974, Vol. 183, pp. 620-626.

VAL73-1 Vallbona, C, P.R. Tobias, C. Moffet, R.L. Baker, and S. Beggs: "Computer Support for a Neighborhood Health Clinic--Design and Implementation," IEEE Trans. Biomedical Engineering BME-20, May 3, 1973, pp. 180-184.

VAL73-2 Vallbona, C., et al.: "The Health-Illness Profile--An Essential Component of the Ambulatory Medical Record," in Ambulatory Care Data, Report of the Conference on Ambulatory Medical Care Records, 1973, pp. 117-124.

VAL75 Vallbona, C., et al.: "Computer Support of Medical Decisions in Ambulatory Care," Meth. of Inf. in Med., April 1975, Vol. 14, No. 2, pp. 55-62.

VAN70 Van Brunt, E.E.: "The Kaiser-Permanente Medical Information System," Computers and Biomedical Research, 1970, Vol. 3, pp. 477-487.

WAK71 "Critical Analysis of Cost-Effectiveness of Multiphasic Screening," Proc. of MCS Conference, Seattle, 1971, J.S. Wakefield (ed.), 1971.

WAK75 Wakefield, J.S., and S.R. Yarnall: "The History Database," 3rd edition, Medical Computer Services Association, Seattle, Washington, 1975.

WAR72 Warner, H.R.: "HELP--A Program for Medical Decision Making," Comp. Biom. Res., Vol. 5, No. 1, pp. 65-74.

WAS73 Wasserman, A.: "Issues in Programming Language Design," Proc. of the National Computer Conference, AFIPS Press, Montvale, N.J., 1975, Vol. 44.

WAX73 Waxman, B.D.: "Health Care Delivery--The Impact of Recent Technological Developments," Proc, AFIPS National Computer Conference, 1973, M45-M48.

WEC71 Wechsel, A.E.: "An In-Depth Evaluation of Patient Monitoring Systems," report to HSMHA, HSM 110-70-606, Acorn Park, Cambridge, Mass.

WEE68 Weed, L.L.: "Medical Records that Guide and Teach," New England Journal of Medicine, Vol. 278, pp. 593-600.

WEE69 Weed, L.L.: Medical Records, Medical Education, and Patient Care--The Problem-Oriented Record as a Basic Tool, Yearbook Medical Publishers, Chicago, 1969; also, Case Western Reserve University Press, Cleveland, Ohio, 1969.

WEE71 Weed, L.L.: "Quality Control and the Medical Record," Arch. Intern. Med., 1971, Vol. 127, pp. 101-105.

WEG68 Wegner, P.: Programming Languages, Information Structures, and Machine Organization, McGraw Hill, 1970.

WHA72 Whalan, D.: "Computers, Professional Responsibility, and the Privacy of the Individual," Medical Journal of Australia, August 12, 1972, Vol. 2, pp. 357-361.

WHI67 White, K.: "Improved Medical Care Statistics and the Health Service System," Public Health Report, 1967, Vol. 82, p. 847.

WIE72 Wiederhold, G.: "A Choice of Language to Support Medical Research," Proc. of ACM Conference, Boston, 1972.

WIE75 Wiederhold, G., J.F. Fries, and S. Weyl: "Structured Organization of Clinical Data Bases," Proc. of the 1975 National Computer Conference, AFIPS Press, Montvale, N.J., 1975, Vol. 44.

WIL70 Williams, T.K.: "Responsibility for Health--The Need for Improved General Practitioner Records," N.Z. Med. J., November 1970, pp. 304-307.

WIL71 Williams, J.I.: "Privacy and Health Care," Canadian Journal of Public Health, November/December 1971, Vol. 62, pp. 490-495.

WIL72 Williamson, J.W., and J.B. Tenney: "Health Services Research Bibliography--1972-1973," NCHSRD, DHEW Publication (HSM) 72-3034, Supt. of Documents, Washington, D.C., 1972.

WIN70 Winkel, P., M. Paldam, and N. Tygstrup: "A Numerical Taxonomic Analysis of Symptoms and Signs in 400 Patients with Cirrhosis of the Liver," Computers and Biomedical Research, 1970, Vol. 3, pp. 657-665.

WIR75 Wirtschafter, D.D., and E. Mesel: "A Strategy for Redesigning the Medical Record for Quality Assurance," Med. Care (in press), 1975.

WOO71 Wood, G.C.: "Cancer Information Services in the United States," Cancer Journal for Clinicians, May 1971, Vol. 21, pp. 246-230.

YAR72 Yarnall, S.R., and J.S. Wakefield (eds.): A Critical Analysis of the Cost Effectiveness of Multiphasic Screening, Medical Computer Services Association, Seattle, Wash., 1972.

YOD66 Yoder, R.D.: "Preparing Medical Record Data for the Computer," Hospital--Journal of the AHA, 1966, Bulletin 40.

APPENDIX A

Gio Wiederhold
Medical Information Systems
University of California
San Francisco, California

ESL-3
HRA Contract
June 30, 1975

COMPREHENSIVE SITE LIST

Introduction

This list is intended to be comprehensive in the sense that it includes:

All known sites of existing ambulatory medical records in operation.

Most sites with advanced plans to implement such records.

Some sites which seem very relevant to ambulatory record development.

Sites which have a significant ambulatory medical record system in operation but which are now discontinued.

The list is ordered alphabetically by site, except when the site name is of the form "University of X" the site is listed under X.

This list is backed up by individual forms on these sites, containing more data and references.

The name of the contact listed may be the principal investigator or the department head in an academic institution, a director of the operation, the principal author of publications reviewed, or the spokesperson we correspond with. Names in parenthesis indicate that the contact has left the site.

With every entry some coded information is included. This data is based on our best estimates of the activities at these sites. A short descriptive statement expands on this assessment. Cross references are given to link joint projects, suppliers and users. A list at the end of this note provides an index for these cross reference numbers. The identification refers to our file system.

A section entitled CODES indicates in summary form the major sources of our information in chronological order. Inquiries are listed mainly if the response took a long time.

Legend

Status:

1 Planning
2 Research
3 Development
4 Initial or pilot operation
5 Full operation, subsidized
6 Self-supporting
7 Discontinued
8 Temporarily suspended
9 Supplier

Outpatient Percentage (OP%):

Estimated ratio of outpatient encounters to inpatient days plus outpatient encounters, in percent.

Medical Content:

I Identification
F Financial
H Medical history
A Appointments and schedules
V Visit history, provider, procedures, diagnosis
K Key medical data
C Correspondence aids
L Laboratory or other diagnostic
D Diagnoses
P Problems
M More extensive medical information

Population:

G General practice, individual or group
O Outpatient service of hospital
A Area-wide service, often minority or underprivileged
I Inpatient
H HMO or other prepaid practices
D Special by disease
S Special by social class or occupation
M Military

Codes:

V Likely candidate for site visit
D Not a likely candidate for site visit
X Inquiry letter has gone out
Y Indirect inquiry
L Response letter
B Documentation available at UCSF (reports, reprints, or references)
S Site was visited
I Indirect reference
P Phone or personal contact

Organization / *location* / *synopsis*	*contact* / *supplier-user*	*status*	*OP%*	*med. cont.*	*pop.*	*ref.*	*ID #*	*codes*
Aberdeen, Univ. of Aberdeen, Scotland Patient follow-up at risk patients (thyroid disease).	A. Hedley	5	100	IVK	GD		85	DB BOY74
Alabama Medicaid Birmingham, Alabama Statewide drug utilization monitoring and reimbursement.	E. Mesel Univ. of Alabama	7	90	IFULD	A	110	196	PB MES71
Alabama, Univ. of Birmingham, Alabama Psychiatric patient system. Statewide Medicaid drug claims handling, monitoring.	M. Conley	6	90	IHVKDP	D	67	86	I
Alabama, Univ. of Birmingham, Alabama On-line physicians claims preparation for Medicaid and Medicare.	E. Mesel	8	90	IFVD	G	196	205	
Albany Medical College Albany, New York Studies to evaluate AAMRS's, Computer Resource Registry.	T. Gabriele	2	-	-	-	-	166	LXB
Ames Medical Record Systems Somesville, Massachusetts Medical record tracking system using bar code scanning, scheduling.	T. Goldman Mt. Auburn	9	10	IA	IO		195	BP
Arizona Health Plan Phoenix, Arizona Management oriented application; patient summary provided at visit.	D. Carroll Meditech	6	100	M	G		1	XBI SCM74

Organization	Location	Synopsis	contact	supplier-user	status	OP%	med. cont.	pop.	ref.	ID #	codes	
Arizona, Univ. of, Medical College	Tucson, Arizona	Telemedicine project for Indian Health Service.	D. Levinson	UCLA	2	?	?	S	35	87	L	SAN73-1
Arizona, Univ. of	Tucson, Arizona	Follow-up of TB patients.	C. Diener		5	100	IHKL	S		190	LB	SCM74
Arthur D. Little, Inc.	Cambridge, Massachusetts	TB surveillance system used by various agancies.	N. Webb		9	90	IVL	D	123	180	BL	
Automated Medical Laboratories	Phoenix, Arizona	History taking and health hazard appraisal, billing for private offices.	Rice		6	100	IFH	G		2	DL	
Bay Area District Hospital	Coos Bay, Oregon	Proposed statewide service, now developing a billing module.	M. McKeown		5	100	F	-		20	XL	
Bellevue Hospital	New York, New York	Application of NYU Systems to pediatric outpatient care.	M. Lyman	NYU	4	100	IVKL	OA	58	3	DSBPV	KOR71

Organization / location / synopsis	contact / supplier-user	status / med.	OP% / cont.	pop. / ref.	ID # / codes
Organization	*contact*	*status*	*OP%*	*pop.*	*ID #*
location	*supplier-user*	*med.*	*cont.*	*ref.*	*codes*
synopsis					
Beth Israel Hospital	H. Bleich	6(7)	100	0	4
Boston, Massachusetts	Meditech	M			VB
Protocol development for triage and practice, no longer automated.					
Biomedical Communications Systems, Inc.	J. Krismer	3	70	I	5
Minneapolis, Minnesota		IFHARCLDPM			DYLP
Design for comprehensive health information systems.					
Bishop Clarkson Memorial Hospital	G. Weinberger	3	50	OG	191
Omaha, Nebraska		IFHV			
Hospital provides services for area private physicians.					SCM74
Bjorn and Cross	J. Bjorn	7	100	G	7
Hampden Highlands, Maine	(Systemedics)	–		74	D
Model practice, several experiments, medical history on IBM MTST					
Bolt, Beranek & Newman	P. Castleman	9	100	G	8
Cambridge, Massachusetts	Meditech	IFHVK		158	B
Managers of a project (CAPO) supplying services to private MD's.					BOL72-2
Boston Children's Hospital	L. Cronkite, Jr.	6	100	0	9
Boston, Massachusetts		IV			
Appointment system, pull lists for medical record and appointment statistics.					
British Columbia, Univ. of	J. Milsum	3	10	IO	88
Vancouver, B.C.	BCSI	IPM		5	DLBP
Careful and comprehensive planning for pilot project, not funded.					HEA74

Organization / location / synopsis	contact / supplier-user	status / med.	OP% / cont.	pop. / ref.	ID # / codes
California Health Data Corporation	R. Deleney	9	0	0	150
Palo Alto, California		IF			LB
Development of hospital accreditation services to outpatients.					
California, Los Angeles, Univ. of	B. Lamson	6	90	IO	89
Los Angeles, California	IBM	IA		179	DI
Use of graphics, etc., automatic record analysis.					LAM67
California, Los Angeles, Univ. of	R. Robinson	1	100	IO	192
Los Angeles, California	Meditech	M			DI
Patient identification, minimal medical data set.					ROB70
Cardiovascular Clinic	G. Robbins	6	100	D	13
Oklahoma City, Oklahoma	Meditech	IHVPK		179	YBS
Privately developed and operated automated record system.					ROB75
Casa de Amigos	C. Vallbona	4	100	A	14
Houston, Texas	Baylor Univ.	IHPK		76	VBS
Medical record and practice analysis in neighborhood clinic.					VAL75
Case Western Reserve University	P. Clarke	4	100	A	111
Cleveland, Ohio	DEC	IF(HV)			I
Identification, followup, data base, and scheduling for urban indigents.					

Organization / *location* / *synopsis*	*contact* / *supplier-user*	*status* / *med.*	*OP%* / *cont.*	*pop.* / *ref.*	*ID #* / *codes*
Center for Community Health Systems	D. Frieder	2	100	A	15
New York, New York	–	–			XDLB
Analysis of automated record storage cost; planning pediatric area system.					FRI73
Centraal Laboratorium	G. Temmerman	4	100	G	189
Antwerp, Belgium	Excerpta Medica	IHLA			B
Physicians group laboratory expanding to history, risk evaluation.					MED74
Charlotte Medical Clinic	C. Lyle	6	100	G	16
Charlotte, North Carolina	Edelman (Searle Medidata)	IFH		120	V
History taking and billing system.					
Chicago, Univ. of	H. Fozzard	4	10	O	140
Chicago, Illinois	GEMISCH	IM		31	LB
Cardiology outpatient records.					LL070
Colorado Foundation for Medical Care	K. Platt	3	100	A	17
Denver, Colorado	AHS	?			B
Statewide service for Medicaid and union covered patients.					COL72
Columbia Medical Plan	D. Steinwachs	5	100	AH	132
Baltimore, Maryland	Johns Hopkins	IV			LBP
Process review, quality assurance, research.					MUR73
CEIS	R. Simmons	9	70	D	48
Denver, Colorado	St. Luke's	IL			IB
Cardiographic analysis services to physicians and hospitals.					SIM74

Organization / location / synopsis	*contact / supplier-user*	*status / med.*	*OP% / cont.*	*pop. / ref.*	*ID # / codes*
Compas Inc.	R. Wahrmund	9	100	G	18
San Antonio, Texas		IHM?			DXBL
Services in batch for HMO's and group practices.					
Cooper Clinic	R. Nelson	5	100	S	179
Camden, New Jersey	UCLA	M		89	I
Radiation treatment, planning, and monitoring.					
Creative Socio-Medics	M. Colandra	9	100	S	155
New York and San Francisco		IVL		109	LBP
Services primarily to mental health and drug maintenance clinics.					
Dalhousie Univ. Medical School	D. Shires	4	100	A (G)	21
Halifax, Nova Scotia	CDC6400	IPKV			XLB
Development for centralized basic health records for private offices.					HEA74
Danderyd Hospital	S. Abrahamsson	5	85	O	22
Stockholm, Sweden	Univac	IKVD			DI
Regional system to provide minimal, but critical, data on-line.					ABR71
Devon-Exeter Health Service Project	J. Preece	7	90	G	23
Exeter, England	IBM	IKD			DIB
Record data abstracted to mark-sense cards for public health study.					LIP71

Organization	contact	status OP%	pop.	ID #
location	supplier-user	med. cont.	ref.	codes
synopsis				

Diagnostic Clinic	J. Wilson, Jr.	3	100	G	170
Shreveport, Louisiana	ESI	KFVPC		120	L
Own development of medical record capability using financial system.					

Dikewood Corporation	R. Bahn	9			173
Albuquerque, New Mexico				121, 172	IB
Support for EMCRO's.					PHS73

Duke Univ. Medical Ctr., Lab. for HIS	C. Starmer	2	-	-	25
Durham, North Carolina		M		31	LPBS
Collection of data bases for prognosis.					STA74

East Anglia, Univ. of	G. Clayton	5	100	G	90
Norwich, England		IDLK			DB
Collec.of registry data directly by MD on to keypunch forms.Pilot disease indexes.					ICLA71-2

East Los Angeles Child & Youth Clinic	Gonzales	5	100	S	136
Los Angeles, California		IV			XS
Reporting for OEO clinic.					CLA71-[illegible]

Edelman Systems Inc.	J. Edelman	9	100	G	120
Baton Rouge, Louisiana		IFCHA			BVYLI
Supplier of mini-based systems for private practices.					

Organization *location* *synopsis*	*contact* *supplier-user*	*status* *med. cont.*	*OP%*	*pop.* *ref.*	*ID #* *codes*
El Camino Hospital Mountain View, California On-line inpatient system, registration, and ordering for outpatients.	J. Gall Technicon	5 IFL	5	10	26 DBIP BAR74
Electricom, Inc. Littleton, Colorado Proposal to computerize the total medical record,using Colorado as a pilot.	-	9 IFKV	90	A	27 DB
Exeter Clinic Exeter, New Hampshire Financial data and practice profiles.	White ESI	6 IFV	100	G 120	141 BP
Experimental Medical Care Review Org. Salt Lake City, Utah Expanding to monitor outpatient utilization.	A. Nelson	4 IVM	50	A	113 XL
Family Health Associates Damariscotta, Maine User of CAPO Services.	C. Morrison Meditech	5 IHF	100	G 8	28 DBI SCM74
Florida Medicaid Jacksonville, Florida Patient identification, eligibility.	R. Wilkerson	5 IF	-	A	137 I

Organization / location / synopsis	contact / supplier-user	status / med.	OP% / cont.	pop. / ref.	ID # / codes
Framingham Union Hospital Framingham, Massachusetts Computer and audio system to hold radiology reports prior to typing.	G. Kolodny Sudbury Systems	5 I	10	G	174 BLXL KOL74
Fresno Community Hospital Fresno, California Hospital in- and out-patient data collection, inquiry.	T. Hollister Computer Synergy	5 IF	50	IO	193 L
Georgetown University Washington, D.C. Pediatric pulmonary data collection; screening.	B. Ayers Cybernet	8 IVHM	50	O	148 LBP MED74
Goddard Space Flight Center Greenbelt, Maryland Record systems for astronauts.	R. Schwarz Mathematica	9 IKL	100	S	162 DBL NAS72
Grady Memorial Hospital Atlanta, Georgia Family planning records.	J. Goldsby Comm.Dis.Ctr.	IV	100	SA	128 IB SMI70
Greenville Public Health Department Greenville, South Carolina Comprehensive data base for integrated public health services.	R. Penick Clemson Univ.	4 IV	95	A	118 BLSV PEC74

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Group Health Co-op of Pudget Sound		7	90	H	164
Seattle, Washington		IFV			DI
Utilization report, peer evaluation.					
Guys Hospital	D. Kenny	1	–	0	29
London, England		–		–	D
Planning for services to general practitioners.					PRE71
Harvard Community Health Plan	O. Barnett	6	100	H	30
Cambridge, Massachusetts	MGH-LCS	IVKPDL		50	VBLS
Computer stored medical record supported by MGH.					GRO74
Health Care Systems, Inc.	E. Hammond	5,9	100	G	31
Durham, North Carolina	GEMISCH - HAM	IFHVKLD		140, 144	XVBLS
Development and operation of coded medical record used by Duke Univ.OP clinic.					HAM73
Health Care Systems, Inc.	L. Roy	9	100	G	32
Minneapolis, Minnesota		V		92	LB
Batch processing of encounter data for practice analysis.					
Health Care Management Systems	G. Giebink	6	100	A	33
Denver, Colorado	HDMS, UCHCIS	IFK			IBP
Area wide scheduling and key data sharing, off-line analysis.					KOZ74

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Health Maintenance Plan	J. McSweeney	4	100	H	127
Cincinnati, Ohio	Meditech	IA(P)			L
Registration, encounter records, billing					
Health Quest, Inc.	W. Lee	6/4	20	IB	144
Baltimore, Maryland	GEMISCH	IHKP		31	XLB
Obstetrics, prenatal care, histories, developing hospital outpatient service.					LL070
Health Application Systems-Paid Prescriptions		9	90	A	169
Burlingame, California		IFM			P
Medicaid intermediary.					
Illinois Department of Correction		1	-	S	34
Joliet, Illinois		IH			DBX
Proposal for multi-phasic screening and follow-up.					
Illinois Eye and Ear Infirmory	B. McCormick	3	90	O	20
Chicago, Illinois	Univ. of Ill., Chi.	IVKLDPM			PB
Data base system development to support network of subspecialty systems.					MCC74
Illinois, Univ. of, Cook County Hospital	R. Stemmer	5?	100	D	91
Chicago, Illinois		IFL			D
Records and billing of ENT workups.					STE75

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Indian Health Management System	M. Jenkin	3,4	IO	A	156
Rosebud Reservation, South Dakota	Control Data Corp.	IAK			IP
Pilot for computerized outpatient health record system.					
Indian Health Service	A. Garratt	4	100	S	35
Tucson, Arizona	Bell Aerospace	HIVK			VBSI
Area system providing record data at 4 locations to aid follow-up.					
Industrial Indemnity Co.	D. Terhune	6	90	S	36
San Francisco, California	ITC	IVD		176	VPIS
Follow-up of serious workman's compensation cases, reduce recovery cost.					LEA71
Institute for Aerobics Research	G. Purdy	5	100	S	138
Dallas, Texas		IM			LBP
Data collection of fitness and cardiovascular health.					
Institute for Cancer Research	M. Schleifer	?			160
Philadelphia, Pennsylvania					LX
Institute for Living	B. Glueck	6	10	S	38
Hartford, Connecticut	DEC-MUMPS	IFDMK			XOB
Extensive psychiatric record system.					GLU74
Insurance Technology Corp.	S. Leavitt	9,3	100	S	176
Berkeley, California	State Comp. Ins.	IFAKM		36, 11	PBSPB
Support systems for follow-up, workmen's compensation. Video storage development.					LEA71

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Interdisciplinary Research & Inf. Sys.	M. Underwood	8,9		0	37
Tucson, Arizona	Univ. of Ariz.	IFKD			XLB
Designed system with standard minimal ambulatory record.					SAN73-1
International Health Systems		S			156
Rollings Meadows, Illinois					L
History, planning medical record.					
Kaiser Permanente Medical Plan	M. Collen	7	90	H	40
Oakland, California	Med. Meth. Res.	IFHVDKLM			DIB
Data collection from several components of large HMO.					MED74
Kassenarztliche Bundesvereinigung		5,3	100	G	182
Köln, Germany	UNIVAC, IBM	IFVKDM			B
National system with 12 local centers, reimbursement control.					
Lahey Clinic Foundation	J. Rockart	5	100	A	42
Boston, Massachusetts	IBM	IVHKA			B
Scheduling of patients using data from medical history.					HOF69

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synopsis					

Lancaster General Hospital	H. Wentz	4?	?	0?	41
Lancaster, Pennsylvania		IVHK			XBL
Data collection for teaching and practice analysis.					

Langley Porter Institute	B. Hargraves	5	90	D	108
San Francisco, California	UCSF	IFVH		143	LP
Analysis of cost, effectiveness of mental health treatments.					HAR74

Latter Day Saints Hospital	H. Warner	2,5	10	O	43
Salt Lake City, Utah	Medlab	IHLD		100	DIB
Several projects extending from an extensive inpatient service.					SCM74

Laval, Universitè	C. Poirier	4	100	G	175
Quebec, Canada		IVKLP			BL
Common registration and encounter data collection from multiple facilities.					HEA74

Light, Frederick V.	F. Light	4?	100	G	44
Cleveland, Ohio	Med. Data Sys.	M		53	VIB
Family practice maintaining detailed records using MDS.					

Lincoln Community Health Center	D. Gillings	4	100	H?	45
Durham, North Carolina	?	?			IX
Evaluation site for health care delivery by Univ. of North Carolina.					GIL71

Livingston Community Health Services	(N. Baloff)	7	90	A	116
Livingston, California	HIP, Stanford	IVF			DIB
Evaluation of health services requirements in a rural community.					IFI74

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Livingston New Town	K. Gruer	4,5	90	A	46
England	ICL	?			B
Dictated summaries are collected mainly for public health use.					GRU72
Los Angeles County Data Bank	G. Thompson	5	90	A,Q	47
Los Angeles, California	County,MCAUTO	IA			XLBS
Large registration and appointment system for county patients.					
Marshfield Clinic	G. Coombs	4	100	G,H?	49
Marshfield, Wisconsin					XLB
Experiments with patient history,evaluation of prepaid health services utilization					BRO75
Massachusetts General Hospital	O. Barnett	5,9	0	I	50
Boston, Massachusetts		H		30	BS
Major development site of medical computing applications.					SWE72
Mathew Thornton Health Clinic	M. Thornton	?	100	G	52
Nashua, Vermont	Meditech	IVH		8	B
Participant in CAPO project.					
Medical Advances Institute	P. Ertell	9		A	131
Columbus, Ohio	Ohio State Univ.				I
PSRO for Ohio.				CLA74	ERT70

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Medical Care Group	G. Perkoff	3	100	G(H)	61
St. Louis, Missouri		IVL			
Encounter data for an HMO.					
Medical Data Systems Corporation	J. Fakan	9	90	G	53
Cleveland, Ohio		IFHV		44	VYLBS
Services to MD's offering flexibility of files and involvement (Automed).					MED74
Medical Passport Foundation	C. Forkner	9,2	100	S	54
Deland, Florida		K			DBLL
Portable medical records support, developing automated support.					FOR62
Medical Research Council	L. Beilin	4			142
Harrow, England					B
Hypertension follow-up support system.					BEI74
Medical Univ. of South Carolina	H. Curry	4	95	O	55
Charleston, South Carolina	Meditech	IL			XBS
Family Practice Training Center, automated records based on dictation.					BRA74
Meditech	N. Pappalando	9	30	-	158
Cambridge, Massachusetts	MGH, DEC			50	LB
Supplier of MUMPS based record and billing services.					
Meyer Memorial Hospital	E. Gabrieli	3		A	56
Buffalo, New York					XB
Planning and community relations development for countrywide records.					

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Michigan, Univ. of	L. Felgner	5	10	D	165
Ann Arbor, Michigan		optional			B
EEG reports and encounters in children's psychiatric clinic.					

Minnesota, Univ. of, Dept. of Fam. Prt.	D. Spencer	4	100	G	92
Minneapolis, Minnesota	Health Care Sys.			32	BLXL / FIL92
Diagnostic and billing data collection for model family practice audit and f.u.					

Minnesota, Univ. of (VA Hospital)	D. McQuarrie	5	0	I	93
Minneapolis, Minnesota		M			
Surgical patient follow-up.					SAN73-1

Missouri Institute of Psychiatry	I. Sletten	4	?	?	57
St. Louis, Missouri		IM			XBL
Data collection from psychiatric encounters, for prediction of behaviour.					IBM73

Missouri, Univ. of , Radiology	J. ~~Lebre~~ hr	5	90	OS	94
Columbia, Missouri	MUMPS	IVL			B
Radiology scheduling and follow-up.					AFI72

Missouri, Univ. of Md Surg	O. Miller	4	?	?	95
Columbia, Missouri		HKLM			I / SAN72-2
Automated physician assistant, non patient specific records on symptom clusters.					

Montefiore Hospital & Medical Center	P. Hurzeles	4	100	D	161
New York, New York		IM			B
Pacemaker follow-up system.					ACE74

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synopsis					
Mount Sinai Medical Center	C. Safir	3	100	0	203
New York, New York	Rutgers-SUMEX	HKLDPM			
Glaucoma Diagnosis and Treatment model.					
Multinomah Foundation for Medical Care	R. Jorgensen				172
Portland, Oregon	Dikewood				
Experimental Medical Care Review Organization (EMCRO).					PHS73
Nebraska, Univ. of	G. Fleischli	2	?	?	97
Omaha, Nebraska					B
Family planning, radiology reports with teaching emphasis.					MED74
Necker Hospital	G. Vermeil	5	10	IO	200
Paris XV, France	Fac. de Med.Pitié	IM			PB
Hospital systems using free text and specialty dictionaries.					JUT72
New Mexico Found. for Medical Care	W. Wood	4?	60		121
Albuquerque, New Mexico	Dikewood				B
Utilization review for HMO's, etc..					PHS73
Northeastern University	W. Mela	3	100	S	119
Boston, Massachusetts		-			
Pediatric services, manpower studies.					

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synopsis					

Northwestern University	O. Haring	4	?	D	59
Chicago, Illinois		ILM			XBL
Evaluation of benefit of summaries of medical record.					MED74

North Carolina, Univ. of	C. Crandell	5	100	S	151
Chapel Hill, North Carolina	Hydra Comp. Co.	IVA			LLB
Treatment planning, follow-up and schedules for dental students and patients.					CRA74

Ohio, State of (Social & Rehab. Svc.)	G. Goodmere	5		A	130
Ohio				131?	I
Medicare Management Information System.					

Ophthalmic Associates	P. Carmichael				146
Lansdale, Pennsylvania	MUMPS				XLI

Orange County Dept. of Mental Health	R. Elpers	6	100	S	143
Santa Barbara, California	Gen.Res.Corp.	IFV			I
Reporting systems for mental health.					

Oregon, Univ. of , Medical School	D. MacFarlane	5	100	S	187
Portland, Oregon	DEC	IKVP			B
Profiles and follow-up for handicapped children.					MED74

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synopsis					

Patient Care Systems	D. Werdegas	9-3	100	G	60
Darien, Connecticut	ROCOM	H-M			DLI
Patient history forms design, now also developing automated record system.					

Pelam, Inc.	F. Failing	9	100	G	133
Chicago, Illinois		H			LBI
Histories, multiphasic, quality control, audit services, and lab reporting.					

Pennsylvania State University	K. O'Kane	6	50	S	157
University Park, Pennsylvania	IBM	IV			B
Obstetrics and Oncology.					AFI74

Penobscot Bay Medical Center	D. Michaud	3	50	H?	125
Rockland, Maine	Meditech	IFVK			ILB
New clinic planning extensive use of AAMRS.					

Pennsylvania State Dept. of Health	E. Riehl	6	99	D	123
Harrisburg, Pennsylvania	A. D. Little	IHVAKL		180	BDI
TB control through patient management techniques.					

Physicians Ass. of Clackamas County	D. Billmeyer	2	100	H	63
Gladstone, Oregon					PB
Evaluation of AAMRS capabilities in physician and clinical offices.					

Pittsburgh, Univ. of	R. Pople	2	-	OI	202
Pittsburgh, Pennsylvania	Stanford-SUMEX	HKLDPM			P
Development of a model of the diagnostic process in internal Medicare.					

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Purdue University	D. Klein	?	100	S	62
W. Lafayette, Indiana		?			XBL
Monitoring of children and youth comprehensive health care delivery.					KOZ74
Rand Corporation	N. Palley	1	-	-	64
Santa Monica, California		-			PXB
Support for data bases for clinical studies.					GRO74
Regenstrief Institute	C. MacDonald	4	100?	D	65
Indianapolis, Indiana	DEC	IVL			(L)BS
Outpatient summaries and surveillance, clinic and case tailored.					MCD75
Rhode Island Health Services Research	S. Lorch	1	-	A	66
Providence, Rhode Island		-			DB
Planning for improved statewide health care management.					KOZ74
Rochester Neighborhood Health Center	J. Pifer	5	100	A	152
Rochester, New York	Univ. of Roch.	IFV			L
OEO reporting plus patient follow-up and audit.					PRI72
Rochester, Univ. of, School of Medicine	J. Fromm	6	100	G	98
Rochester, New York		IDK			LB
Use of an E-book, as British N.H.S. to record events and morbidity					FRO74

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synopsis					
Rockland State Hospital	E. Laska	5,9	80	DA	67
Orangeburg, New York	IBM	IHVKDP			XBLS
Large data bank service for mental health encounters.					MED74
Roosevelt Hospital	R. Klein	6	100	0	124
New York, New York	Meditech	IA			(L)
Registration, appointment scheduling for Child and Youth Clinic.					
Rush Presbyterian St. Lukes Med. Ctr.	G. Gottlieb	4	?	D	68
Chicago, Illinois		H			
Medical histories.					GOT72
Sacramento Community Health Plan	G. Deubel	6	90	H	112
Sacramento, California		IFV			LX
Claims review and PSRO monitoring, EMCRO.					PHS73
St. Joseph's Hospital	J. Genegler	4	20	IO	69
Milwaukee, Wisconsin	Burroughs	IF			
Expansion of in-patient system.					
St. Peter's Hospital		4	20	0	197
Albany, New York	Searle Medidata	IAF			BP
Use outpatient modules of ordering and communication system.					

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San Francisco Dept. of Mental Health	B. Hargraves	S	100	D	109
San Francisco, California		IV		67,155	BP
Methadone program.					
San Joaquin Found. for Medical Care	D. Harrington	6	90	GH	70
Stockton, California		IVF			DXLB
Claims processing and peer review data collection & analysis for area physicians.					
Shaw & Co.	D. Jessup	9	10	G	171
Cherry Hill, New Jersey		I			DBL
Tracking system for manual medical records.					
Southern California, Univ. of	J. Moore	?	5	I?	99
Los Angeles, California		?			I
Registration, pharmacy, and clinical data development.					
Southhampton, Univ. of	E. Clark	2	90	G	177
Southhampton, England		IV			LX
Practice analysis, byproduct is printed POMR.					
Stanford University Medical School	J. Fries	6	95	O	71
Stanford, California	Stanford-ACME	IVDKLM			VBPS
Speciality clinic system with detailed data for prognosis and analysis.					FRI74
State Compensation Insurance Fund	R. Hassard	6	90	S	11
Fresno, California (and others)		IVDPK		176	VBLI
Workmen's compensation cases, follow-up system, used ITC.					

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Systemedics	J. Tobin	9	100	G	74
Princeton, New Jersey		IF			XBL
Supplier of primarily billing oriented services to private practice.					
Systems for Medicine	J. Knight				135
Salinas, California					X
TEKA Trends Inc.	T. Kumbaraci	9	50	GD	134
New York, New York		M			XL
Study support, data collection and analysis.					
Texas Institute for Rehab. & Research	B. Baker	5	10	S	76
Houston, Texas		IHVA		14	BS
Medication and care schedules for in- and out-patients.					STE74
Texas, Univ. of , Medical Branch	D. Layton	1	100	G	159
Galveston, Texas		A			DB
Appointment system.					
Texas, Univ. of, Health Sciences Ctr.	S. Mize	5,3	100	S	186
Dallas, Texas		FIVA(M)			LB
Family planning and obstetrics appointments, more data planned.					

Organization	*contact*	*status*	*OP%*	*pop.*	*ID #*
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synopsis					

Texas, Univ. of, Health Sciences Ctr.	J. Thomas	6	100	S	184
Houston, Texas	Baylor	IHVKLDPM			B
Fully computerized record for weekly diabetes clinic.					SCM74

Trans-A-File Systems Company		9	10	IO	198
Sunnyvale, California	Med. Col. of Virg	IM			BP
Storage and retrieval of Medical Record Images in digital form.					

Troy Family Practice	R. Buchan	5	100	G	75
Troy, Ohio		IVDF			BLP
Collection and detailed coding of encounter data for billing & practice analysis.					

Tufts University School of Medicine	C. Granger	6	100	O	149
Boston, Massachusetts	MIT	HM			BP
History taking. Hypnosis formation of diagnostic process.					

U.S. Air Force	C. Grabner	3	90	M	79
Montgomery, Alabama					I
Development of new military care delivery systems for tri-service use (TRIMIS).					

U.S. Army	(G. Charles)	7	100	M	78
Fort Belvoir, Virginia	Meditech				DI
Development of protocols for outpatient care.					SCM74

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U.S. Naval Air Station / Brunswick, Maine / Fully automated medical record.	J. Craemer / Meditech	6	100	IPVM	M		80	VBS SCH74
U.S. Navy Hospital / Long Beach, California / Triage for dependents on hospital ship.		2	60	–	MS		122	DYI
U.S. Public Health Service Hospital / Baltimore, Maryland / A number of limited projects using various timeshared services.	E. Naddor	8	90	IPL	HO		83	BXP
University Hospital of Case Western / Cleveland, Ohio / Diabetes clinic, record generation from formal English input.	A. Levy	7	90	?	D		84	D
Utah, Univ. of / Salt Lake City, Utah / Screening, quality of care, management, provider, and patient feedback.	H. Warner / Medlab Comp. Svces.	6,5	10	IVP,H	H	43	100	B WAR72
Vermont, Univ. of / Burlington, Vermont / Planning to extend computerized POMR to interns in clinical family practice center	L. Weed / CDC	3	100	IHPL	I		101	DYPB SCM74

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synopsis					
Veterans Administration Hospital	G. Charles	3	90	S	103
San Francisco, California		M			PL
Development and evaluation of triage protocols.					
Veterans Administration Hospital	H. Sox	1	-	S	163
Palo Alto, California		-			DP
Individualized protocols.					
Virginia State Dept. of Health	W. Apperson	6	99	D	199
Richmond, Virginia	D. D. Little	HIVAKL		180	I
TB Control.					
Virginia, Univ. of		5	90	OA	204
Charlottesville, Virginia		IVLD			I
Child and Youth reporting and follow-up.					
Walter Reed Army Institute	J. Levy	3	0	M	104
Washington, D. C.				79	I
Outpatient module developed, not implemented. Waiting for TRIMIS.					
Walt. & Eliz. Hall Inst. of Med. Res.	J. Buckley	4	0	I	105
Victoria, Australia		IDKLM			DB
Development and evaluation of data elements for long term storage.					BUC73

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Waterloo, Univ. of	E. Chang	2	–	–	139
Ontario, Canada		–			B
Design of a distributed medical data support system.					CHA74
Welsh National School	R. Davis	1	90	A	106
Cardiff, Wales		–			DB
Forms design to simplify recording for public health data.					
Western Health Center	E. Mesel	5	100	D	117
Birmingham, Alabama	Univ. of Ala.	IHVKLD P		110	IB
Support systems for neighborhood health center.					WIR75
Wiscasset Health Center	D. Travers	7	100	G	126
Wiscasset, Maine	Meditech	IV			L
Registration, encounter records, billing. Funding by NIH discontinued.					
Wisconsin, Univ. of	Renner	3	.00	G	153
Madison, Wisconsin					LP
Records for family practice.					
Yale University School of Medicine	S. Brunjes	4	95	G	107
New Haven, Connecticut		IHDPK			PVBS
Support for HMO using deeply structured medical data.					BRU71

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1. Arizona Health Plan
2. Automated Medical Laboratories
3. Bellevue Hospital
4. Beth Israel Hospital
5. Biomedical Communications Systems, Inc.
7. Bjorn and Cross
8. Bolt, Beranek & Newman
9. Boston Children's Hospital
11. State Compensation Insurance Fund
13. Cardiovascular Clinic
14. Casa de Amigos
15. Center for Community Health Systems
16. Charlotte Medical Clinic
17. Colorado Foundation for Medical Care
18. Compas Inc.
20. Bay Area District Hospital
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75. Troy Family Practice
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79. U.S. Air Force, Montgomery, Ala.
80. U.S. Navy, Brunswick, Maine
~~81. U.S. Navy, Jacksonville, Florida~~
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88. British Columbia, Univ. of
89. California, Univ. of, Los Angeles
90. East Anglia, Univ. of
91. Illinois, Univ. of, Cook County Hosp.
92. Minnesota, Univ. of
93. Minnesota, Univ. of, (VA Hospital)
94. Missouri, Univ. of (~~J. Lebre~~) Radic
95. Missouri, Univ. of (~~O. Miller~~) Med E
97. Nebraska, Univ. of
98. Rochester, Univ. of, Sch. of Med.
99. Utah, Univ. of
100. Southern California, Univ. of
101. Vermont, Univ. of
102. VA Hospital, Salt Lake City
103. VA Hospital, San Francisco
104. Walter Reed Hospital
105. Walt. & Eliz. Hall Inst. of Med. Res.
106. Welsh National School of Medicine
107. Yale Univ. School of Medicine
108. Langley Porter Institute
109. San Francisco Dept. of Mental Health
110. Alabama, Univ. of
111. Case Western Reserve University
112. Sacramento Community Health Plan

Index for Cross Reference Numbers

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113. Experimental Med. Care Review Org.
114. OEO Neighborhood Centers, S.F.
116. Livingston Comm. Health Services
117. Western Health Center
118. Greenville Public Health Dept.
119. Northeastern University
120. Edelman Systems Inc.
121. New Mexico Found. for Med. Care
122. U.S. Navy, Long Beach, Calif.
123. Pennsylvania State Dept. of Health
124. Roosevelt Hosptial
125. Penobscot Bay Medical Center
126. Wiscasset Health Center
127. Health Maintenance Plan
128. Grady Hospital
130. Ohio, State of (Social & Rehab. Svc.)
131. Medical Advances Institute
132. Columbia Medical Plan
133. Pelam, Inc.
134. TEKA Trends, Inc.
135. Systems for Medicine
136. East Los Angeles Child & Youth Clinic
137. Florida Medicaid
138. Institute for Aerobics Research
139. Waterloo, Univ. of
140. Chicago, Univ. of
141. Exeter Clinic
142. Medical Research Council
143. Orange County Dept. of Mental Health
144. Health Quest, Inc.
146. Ophtalmic Associates
148. Georgetown University
149. Tufts Univ. School of Medicine
150. California Health Data Corp.
151. North Carolina, Univ. of
152. Rochester Neighborhood Health Center
153. Wisconsin, Univ. of
154. Indian Health Management
155. Creative Socio-Medics
156. International Health Systems
157. Pennsylvania State University
158. Meditech
159. Texas, Univ. of
160. Institute for Cancer Research
161. Montefiore Hospital & Medical Center
162. Goddard Space Flight Center
163. VA Hospital, Palo Alto, Calif.
164. Group Health Co-op of Pudget Sound
165. Michigan, Univ. of
166. Albany Medical College
167. Texas, Univ. of, Medical Branch
168. Dalhousie Univ. Medical School
169. Health Application Systems
170. Diagnostic Clinic
171. Shaw & Co.
172. Multnomah Found. for Medical Care
173. Dikewood Corporation
174. Framingham Union Hospital
175. Laval, Universitè
176. Insurance Technology Corp.
177. Southhampton, Univ. of
178. Meditech, Inc.
179. Cooper Clinic
180. Arthur D. Little
182. Kassenarztliche Bundesvereinigung
184. Texas, Univ. of (Houston)
186. Texas, Univ. of (Dallas)
187. Oregon, Univ. of, Medical School
189. Centraal Laboratorium
190. Arizona, Univ. of
191. Bishop Clarkson Memorial Hospital
192. Calif., Univ. of, Los Angeles
193. Fresno Community Hospital
195. Ames Med. Rec Systems
196. Alabama Medicaid
197. St. Peter's Hospital
198. Trans-A-File
199. Virginia State Dept. of Health
200. Necker Hospital
201. Illinois Eye and Ear Infirmary
202. University of Pittsburgh
203. Mount Sinai Medical Center
204. Virginia, Univ. of
205. Alabama, Univ. of, Birmingham

Appendix B

SITE SUMMARIES

This appendix provides, in a tabular form, the gross characteristics of the sites visited. While it provides a useful summary as such, it would be unfair to attempt to understand the sites visited only from this characterization, since it, of necessity, omits the individual areas which distinguish one AAMRS effort from the other.

Cost figures reflect direct costs only when we could separate them. Investment costs indicated may include research costs related to AAMRS development in general, but not applied to the particular AAMRS services in operation. Operational costs include charges, equipment, and allocated personnel.

This list describes the following sites:

SITE SUMMARIES

- LEGEND -

The following categories are included in the site summaries, whenever appropriate :

Org : Organization visited

PC : Principal Contact at the site visited

R : Reference name and Report code used

M : Mnemonic or Acronym used for the system

N : Nature of the health care delivery institution

U : Users of the system at the Institition

O : Major Objective of the users

P : Provider of the computer service

D : Designer's objectives for the system

L : Languages used for the application

C : Computer and operating system type

T : Terminal type or other user interface

E : Entry means for data

Y : Years (for development) and service: current activities

St : Current Status

$I : Investment cost and annual development costs

$O : Operational cost

Pt : Patients served currently

A : Particular Achievements

B : Benefits obtained

Pr : Problems encountered

F : Source of Funds for development and operation

SITE SUMMARY

Stanford Immunology Clinic

Org	:	Division of Immunology, Department of Medicine Stanford University Medical Center Stanford, California
PC	:	Dr. James F. Fries
R	:	Stanford; CDS
M	:	TOD Time-Oriented Data Base
N	:	University medical center specialty clinic
U	:	Medical clinician researchers
O	:	Increased medical knowledge
P	:	Stanford Center for Information Processing (ACME Project)
D	:	Direct support for medical researchers, now academic service operation
L	:	PL/1 programming in-house and ACME project assistance
C	:	IBM 370/158 timesharing
T	:	Typewriter and CRT's
E	:	Flowsheets completed by MD's
Y	:	(1972 to 1974), 1973: Research, clinic support
St	:	Operational, development, and transfer of computer systems effort
$I	:	$100,000 + $61,000 per year
$O	:	$20,000 per year
Pt	:	900 patients with 4,000 visits per year
A	:	Analysis capability for medical record data
B	:	Better understanding and follow-up in a complex chronic disease
Pr	:	Changes in university computer system support
F	:	Research grants, some fee-for-service

SITE SUMMARY

ITC Users

Org : Insurance Technology Corporation
2118 Milvia
Berkeley, California

PC : Dr. Stephen Leavitt

R : ITC; CDI

N : Workmen's compensation insurance company (wanted to remain anonymous)

U : Claims management

O : Control over the recovery process - Management of financial researves

P : Insurance Technology Company (Berkeley)

D : Application of technology in recovery process management, commercial

L : Assembly language for ITC

C : Packaged data general Nova system

T : Computer with CRT, keyboard, printer complete on-site

E : Special time-oriented prognosis charts by claims personnel

Y : (1970 to 1973), 1973: Production, process surveillance

St : Routine operation at a number of West Coast sites

$I : Not made public

$O : $60,000 per year (user)

Pt : 1,200 patients with 4,200 contacts per year

A : Monitoring of recovery process

B : Reduction of financial reserves for workmen's compensation cases

Pr : Insurance rate setting is based on overhead to payout ratio

F : Commercial purchase or lease by private corporate funds

SITE SUMMARY

Los Angeles County

Org : Department of Health Services
County of Los Angeles

PC : Gene Thompson

R : LA; CDL

N : Public agency, county health services

U : Medical records retrieval

O : Improvement of medical service logistics

P : Health Care Computer Center
Los Angeles County Data Processing Department

D : Removal of unacceptable bottlenecks in health care delivery

L : Assembly language for health care

C : Multiple IBM 360/50's, transaction processing

T : CRT terminals and keypunch cards

E : Identification forms entered in patient presence by registration
registration clerks

Y : (1966 to 1971), 1968: Production, medical record pull lists,
more locations

St : Routine operation, transfer to more modern equipment,
integration plans

$I : $4,400,000 + $200,000 per year

$O : $2,000,000 per year

Pt : 2,000,000 per year with 550,000 visit registrations per year

A : Medical record delivery management

B : Better availability of traditional record and reduced patient waiting time

Pr : No control over costs of operation, mobile population

F : County-budgeted funds

SITE SUMMARY

East Los Angeles Child and Youth

Org : The East Los Angeles Child and Youth Clinic
Los Angeles, California

PC : Gene Thompson

R : East LA; CDE

N : County categorically funded neighborhood clinic

U : Government agency

O,D : Fulfill federal reporting requirements

P : In-house operation

L : RPG and COBOL in-house

C : IBM System/3 batch processing

T : Keypunch

E : Abstracting of Medical Records

Y : (1971), 1971: Production, activity reports generation

St : Routine operation

$O : $98,000 per year

Pt : 10,000 patients with 32,000 visits per year, all off-line

A : Reporting

B : Satisfies Child and Youth reporting requirements

Pr : Not an AAMRS as defined by us

F : Included in Child and Youth categorical grants

SITE SUMMARY

Rockland Psychiatric Center Users

Org : The Research Center
Rockland Psychiatric Center
Orangeburg, New York

users: Pomona Outpatient Clinic, Rockland County
Connecticut Medical Health Center

PC : Dr. Eugene Laska

users: Dr. William Block (Pomona)
Mr. Michael Levine (CMCH)

R : Rockland; CDR

M : MSIS - Multi-State Information System

N : Public agencies, county and state psychiatric health

U : Psychiatric health care delivery management

O : Fulfill reporting requirements,

P : Research center of the Rockland Psychiatric Center

D : Improved management of psychiatric patients, began early with inpatients, service

L : PL/1 for research center

C : IBM 360/67 with remote batch processing

T : Remote batch stations with keypunch and optical mark reading

E : Specialized forms check-marked by physicians

Y : (1967 to 1974), 1969 (Connecticut) 1971 (Pomona): Production, outpatient service development, activity reports generation, quality of care monitoring

St : Routine service operation to many sites, development of new services

$I : $10,000,000 + $557,000 per year at Rockland

$O : $394,000 per year at Rockland
$ 90,000 at Pomona
$108,000 at CMCH

Site Summary (Continued)

Rockland Psychiatric Center Users

Pt : 300,000 patients total in MSIS
9,000 patients with 200,000 visits for Pomona
19,000 patients with 40,000 visits for CMCH

A : Reporting

F : Research grants and recharges to state, federal and county user agencies

SITE SUMMARY

Yale University Users

Org : Section of Medical Computer Sciences
Yale University School of Medicine
New Haven, Connecticut

PC : Dr. Shannon Brunjes

R : Yale; CDY

N : Health Maintenance Organization (CHCP)

U : Clinical physicians

O : Modernize care process

P : Section of Medical Computing Sciences, Yale University

D : Introduce new record concepts into medical care

L : FORTRAN at Yale

C : DEC PDP 11/20 with batch processing

T : Keypunch

E : Generalized forms to be completed by MD

Y : (1971 to 1975), 1972 to 1975: Medical record organization research, pilot service (discontinued)

St : Discontinuation of service, re-evaluation and development

$I : $1,000,000 + $214,000 per year

$O : $100,000 per year

Pt : 15,000 patients with 33,000 visits recorded per year

B : Development of new concepts in medical records

Pr : Poor management interface between CHCP and Yale SMCS

F : Federal research grants

SITE SUMMARY

Harvard Community Health Plan

Org	:	Laboratory of Computer Science Massachusetts General Hospital Boston, Massachusetts	Harvard Community Health Plan Kenmore Station Boston, Massachusetts
PC	:	Dr. G. Octo Barnett	
R	:	HCHP; CDH	
M	:	COSTAR Computer Stored Ambulatory Record	
N	:	Health Maintenance Organization	
U	:	Clinical physicians	
O	:	Improve care process and management	
P	:	Laboratory of Computer Science (LCS), Massachusetts General Hospital	
D	:	Develop modules for automation in health care	
L	:	MUMPS for LCS	
C	:	DEC PDP 15 with timesharing	
T	:	CRT and printers	
E	:	Specialized forms to be completed by MD, some dictation	
Y	:	(1969 to 1974), 1971: Development and production, HMO support	
St	:	Operational, continuing development	
$I	:	$2,500,000 + $154,000 per year at LCS	
$O	:	$378,000 per year	
Pt	:	36,000 patients with 150,000 visits per year	
A	:	Near totally computer stored medical record, in largely coded form	
B	:	Data for clinic management and patient services integrated and available	
Pr	:	Man-machine interaction limited	
F	:	Federal research grants and support from the HMO	

SITE SUMMARY

Users of Medical Data System Corporation

Org : Medical Data Systems Corporation
24541 Bagley Road
Olmsted Falls, Ohio

PC : John Fakan

R : Automed; CDM

M : Automed

N : Private physician practices (solo and group), some clinics

U : Private physicians

O : Improve practice operation

P : Medical Data Systems Corporation

D : Provide acceptable services to physicians, commercial

L : Assembly for Medical Data Systems, system commands for users

C : Univac 492 transaction processing service

T : CRT and printers

E : Notes made by physicians and data from receptionist

Y : (1970 to 1975), 1971: Development and production, billing service

St : Operational, major expansion of use foreseen, development

$I : $1,000,000 (MDS)

$O : $300,000 (MDS) production and development
$ 8,000 to $12,200 per year (users)

Pt : 5,700 average per user, with 9,000 visits per year

A : Cost justified services for physicians, record manager billing service

B : Automatic billing, clerical savings, flexible files

Pr : Usage pattern of individual practitioners is not the same

F : Recharges to users and private investment

SITE SUMMARY

Medical University of South Carolina

Org : Family Practice Center
Department of Family Practice
College of Medicine
Medical University of South Carolina
Charleston, South Carolina

PC: : Dr. Ronnie Schneeweiss

R : MUSC; CDC

N : Family Practice Center, University affiliated resident training

U : Family practice residents and medical staff

O : Family practioner training, provide feedback

P : In-house, Meditech was original source

D : Introduce modern techniques into training program

L : MUMPS in-house

C : DEC PDP 15 timesharing

T : CRT

E : Dictation by MD's

Y : (1970 to 1975), 1973: Development, teaching support

St : Operational, more development required to realize benefits

$I : $1,000,000 + $57,000 per year

$O : $208,000 per year

Pt : 7,000 patients with 25,000 visits per year

A : Computer stored medical record

B : Training quality control

Pr : Voluminous text

F : Federal grants and state support

SITE SUMMARY

Appalachia II District Health Department

Org : Appalachia II District Health Department
Greenville, South Carolina

PC : Dr. R. W. Penick

R : Greenville; CDG

N : State public agency managing state and county public health services

U : Public health care delivery personnel and management

O : Manage the provision of comprehensive care for indigents

P : Clemson University

D : Develop computer support in health care

L : COBOL at Clemson and in-house

C : IBM 370/158 transaction processing

T : CRT's and printers

E : Specialized forms completed by paramedical personnel and some MD's

Y : (1973 to -), 1974: Development, activity reporting, integration of services

St : Early operation, integration of files for various services

$I : $400,000 + $197,000 per year

$O : $323,000 per year

Pt : 46,700 patients with 93,500 visits per year

A : Central service records for many clinics and services

B : Integrated management of services supported by categorical grants

Pr : Diversity of agencies, record formats and service requirements

F : User support through service contracts and user charges. (User's supported by State funds and categorical grants.)

SITE SUMMARY

Duke University

Org : Duke University Medical Center
Department of Community Health Sciences
Durham, North Carolina

PC : Dr. Ed. Hammond

R : Duke; CDD

M : GEMISCH

N : University affiliate, University Health Services
Department of Community Health Sciences (DCHS)

U : Clinical physicians, clinical management

O : Improved patient services, health services research

P : Division of Information Sciences
Department of Community Health Sciences

D : Develop improved techniques in health care data processing

L : Assembly and GEMISCH (tabular) language used by
Division of Information Sciences of PCHS

C : DEC PDP 11/45 timesharing

T : CRT, some mark sense reading

E : Generalized encounter forms completed by MD's, entered in patient presence

Y : (1972 to -), 1974: System improvements, outpatient application
development and production

St : Early operation, much development

$I : $550,000 + $56,000 per year

$O : $186,000 per year

Pt : 11,000 patients with 40,000 visits per year

A : Compact system for health science applications

B : Technical development of services, research

Pr : Limited experience in AAMRS

F : Research grants foundation support and recharges

SITE SUMMARY

Regenstrief Institute User

Org : Regenstrief Institute
Indianapolis, Indiana

PC : Dr. Clement MacDonald

R : Regenstrief; CDF

M : CIS Clinical Information System

N : Public agency, county hospital outpatient clinics (at Marion County)

U : Clinic personnel and physicians

O : More systematic and effective patient care

P : Regenstrief Institute (on site)

D : Apply advanced patient care techniques,
apply management sciences to health care

L : Basic and CARE (tabular language) used by Regenstrief

C : DEC PDP 11/45 timesharing

T : Optical character reading and CRT

E : Computer generated patient and clinic specific encounter forms,
completed by laboratory technicians, MD's and paramedical personnel

Y : (1972 to –), 1973: Development of patient care tools, production

St : Operation at two initial sites, development

$I : $236,000 + $169,000 per year (Regenstrief)

$O : $53,000 per year

Pt : 2,200 patients with 10,000 visits per year

A : Routine clinic support with surveillance and other services

B : Patient surveillance, appointment registry for record retrieval lists

Pr : Organization structure of county, Indiana University, and
Regenstrief is complex

F : Institute philantropic founding grant

SITE SUMMARY

Cardiovascular Clinic

Org : The Cardiovascular Clinic
Oklahoma City, Oklahoma

PC : Dr. Galen Robbins

R : Cardiovascular; CDO

N : Private specialty group practice

U : Physicians

O,D : Improved communication within group practice, Information management

P : In-house, original source, Meditech

L : MUMPS in-house

C : DEC PDP 15 timesharing

T : CRT

E : Coded data form, with some free text, by MD's

Y : (1970 to 1975), 1971: Development and production in medical records

St : Routine operation

$I : $230,000 + $18,000 per year

$O : $75,000 per year

Pt : 12,000 patients with 26,000 visits per year

A : Cost justified operation with little technical innovation

B : Management, operation and patient care services integrated on AAMRS

F : Clinic operating budget

SITE SUMMARY

Casa de Amigos Clinic, Houston

Org	:	Department of Community Medicine Baylor College of Medicine Texas Medical Center Houston, Texas
PC	:	Dr. Lynn A. Evans, Dr. Carlos Vallbona
R	:	Casa; CDA
M	:	HIP Health Illness Profile
N	:	County neighborhood clinic
U	:	Clinical physicians, health care delivery research
O	:	System improvements in health care delivery
P	:	Baylor College of Medicine Department of Community Medicine
D	:	Evaluate and support health care delivery system improvements
L	:	PL/1 for Baylor
C	:	IBM 360/50 batch
T	:	Keypunch
E	:	Abstracting by clinical staff from traditional medical record
Y	:	(1970 to 1975), 1974 (HIP): Research of alternative systems in health care delivery, development and production of source
St	:	Operational in selected functions
$I	:	$745,000 at Baylor including several other projects
$O	:	$48,000 per year
Pt	:	6,000 patients with 21,000 visits per year
A	:	Evaluation of services, health illness profile
B	:	Summarized patient record, management data
Pr	:	Limited services provided
F	:	Federal research funds

SITE SUMMARY

Indian Health Service, Tucson

Org : Health Programs Systems Center
Indian Health Service
San Xavier (Papago) Indian Reservation
Tucson, Arizona

PC : Alfred E. Garratt, PhD

R : IHS; CDT

N : Direct operating of federal agency, Regional Indian health care delivery service

U : Health care delivery personnel, physicians

O : Achievement of an adequate standard of health care

P : Bell Aerospace, Tucson

D : Provide services, commercial

L : COBOL and FORTRAN, in-house and at Bell Aerospace

C : IBM 370/135 transaction processing

T : Key-to-tape, CRT

E : Encounter forms completed by nurses and MD's , some encoding by staff

Y : (1966 to -), 1971: Development and production of distributed health care support

St : Routine operation, some devleopment

$I : $450,000 excluding terminals + $533,000 per year

$O : $487,000 per year (Some of these costs are related to development needs.)

Pt : 12,000 patients with 40,000 visits per year

A : Central data base to serve mobile population and variety of providers

B : Integrated area-wide health record, surveillance, follow-up

Pr : Unique environment

F : Indian Health Service budget, direct federal appropriation

SITE SUMMARY

Naval Air Station Dispensary, Brunswick (Maine)

Org : Brunswick Naval Air Station Dispensary
Brunswick, Maine

PC : Lt. Cmdr. J. Craemer

R : NAS: CDB

N : Direct operating of federal agency. Military outpatient clinic

U : Clinic personnel

O : Obtaining the benefits of the problem-oriented record

P : Meditech, Cambridge, Mass.

D : Apply develöpments from MGH, commercial

L : MUMPS mainly at Meditech

C : DEC PDP-15 timesharing

T : CRT, a few printers

E : Dictation by MD's, laboratory orders direct on CRT

Y : (1970 to 1973) 1971 to 1975: Development to production of automated POMR

St : Routine operation

$I : $500,000

$O : $233,000 per year

Pt : 15,700 patients with 20,000 visits per year

A : Smooth operation, computer stored record

B : Effective help in patient encounter, scheduling, clinic management

Pr : Lack of interest from Navy management

F : Bureau of Medicine and Surgery research and service funds (direct federal appropriations)

SITE SUMMARY

Bellevue Hospital, New York City

Org : Pediatric Department
Bellevue Hospital
New York University Medical Center
New York City

PC : Dr. Margaret Lyman

R : Bellevue; CDN

N : Public agency, city hospital specialty clinic

U : Pediatric clinic operational and health care delivery personnel

O : Comprehensive health care delivery

P : New York University

D : Develop computer services in medicine

L : FORTRAN in-house

C : Univac 1108 transaction processing

T : Teletypes

E : Free text forms completed by MD's and paramedical personnel

Y : (1966 to 1973), 1969 to _ : Development and production of clinic support

St : Operational, increasing use of data

$I : $3,000,000 + $222,000 per year

$O : $394,000 per year

Pt : 30,000 patients with 70,000 visits per year; 40,000 patients have medical data available and 7,500 of them detailed data on-line

A : Record delivery management and backup

B : Record availability in clinic and pediatric emergency room, record retrieval lists

Pr : City finding intermediary agency (HHC) has other priorities

F : Categorical federal grants (Pediatric services)