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Automated Ambulatory Medical Record Systems in the U. S.

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AUTOMATED AMBULATORY MEDICAL RECORD SYSTEMS IN THE U.S.

An Overview of The Evolution of Automated Ambulatory Medical Record Systems from 1975 to 1981

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ABSTRACT

This report presents an overview of the developments in Automated Ambulatory Medical Record Systems (AAMRS) from 1975 to the present. A summary of findings from a 1975 state-of-the-art review is presented along with the current findings of a follow-up study of a selected number of the AAMRS operating today. The studies revealed that effective automated medical record systems have been developed for ambulatory care settings and that they are now in the process of being transferred to other sites or users, either privately or as a commercial product. Since 1975 there have been no significant advances in system design. However, progress has been substantial in terms of achieving production goals. Even though a variety of systems are commercially available, there is a continuing need for research and development to improve the effectiveness of the systems in use today.

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EXECUTIVE SUMMARY

From October 1974 through June 1975, a state-of-the-art review of automated ambulatory medical record systems (AAMRS) was performed to determine how automated systems were being developed to improve the use of the patient's medical record in different types of health care settings. Automated Ambulatory Medical Record Systems (AAMRS) are defined as systems that use computers to automate a substantial amount of the medical record for ambulatory care settings. The 1975 study revealed that automated ambulatory medical record systems still required substantial development and evaluation. However, there were indications that effective systems were being designed and that, eventually, they would have an important impact on the delivery of health care and on the management of that delivery?

In recognition of a need for more current information on the nature of present AAMRS, a follow-up study was performed to determine whether the findings and conclusions of the 19'75 study were still valid, and whether the field had progressed in ways that may have a significant impact on the design and implementation of future AAMRS. The follow-up study involved contacts to every site visited in 1975 for current information on the status of the medical record system, and visits were made during 1981 to six AAMRS sites throughout the country. Even though this study reviewed only a small sample of the AAMRS that are operational today, the systems and sites visited can be considered as representative of the systems developed for and implemented on minicomputers. The follow-up study team consisted of persons with expertise in medicine, medical information systems, health economics, and evaluation methodology.

The sites and systems visited in the follow-up study follow.

COSTAR	Computer-Stored Ambulatory Record System Laboratory of Computer Science, Massachusetts General Hospital, Boston, Massachusetts; North End Community Health Center, Boston, Massachusetts; and North County Health Services, San Diego County, California.
TMR	The Medical Record Division of Information Science, Department of Community Medicine, Duke University, Durham, North Carolina.
RMIS	Regenstrief Medical Information System Regenstrief Institute, Indianapolis, Indiana.
ARION	Arthritis Research Information Office Network Arthritis Center, Wichita, Kansas.
FMIS	Family Practice Medical Information System Community Electrocardiographic Interpretative Service (CEIS), Denver, Colorado.

Status of Systems Visited

Several of the promising systems visited in 1975 have matured to become operational and are undergoing transfer from a prototype demonstration in the research setting to the commercial market. Clearly, the leader in commercial availability of an in-depth medical record system is COSTAR. Other systems in the process of becoming commercially available are TMR and RMIS.

There is still a need for research and system development to address the following issues:

- The best match of the scope of automated services with the practice setting. For the smaller primary care practice, is automation of the medical record cost effective?
- User Interface. Particular areas identified for further development include (1) encounter form design, (2) information presented to the user: surface behavior, explanations, CRT displays, graphic presentations, and (3) factors influencing effective human acceptance of the automated system.
- User Acceptance and Motivation. In addition to user interface, acceptance problems may be linked to the need for better user training and documentation; or to the failure of the system services to adequately address the users needs.
- System Transferability. What are the factors in system design and development that facilitate transfer from a prototype demonstration in a research setting to practical applications in a variety of settings?

Design Objectives, System Benefits, and Realization of Objectives and Benefits

The design objectives are more clearly defined than they were in 1975. Improved quality of care continues to be considered a major system objective. A well-organized display of historical, laboratory, and drug data in patient summaries and flow charts is available from the COSTAR, RMIS, and TMR systems. These systems also improve the ease of ordering lab tests or medicines and the ease of accessing the results. Management benefits are still an important objective. Financial and administrative services continue to be a major factor in facilitating system transfer, particularly in the commercial market. There still is little evidence for the larger AAMRS that their benefits justify their costs. It is still difficult to compare system benefits to costs, because of problems associated with the quantification of benefits and lack of detailed cost data.

Clearly the realization of objectives is much greater than it was six years ago. The progress is most noticeable with the larger systems. Today, there is evidence that the medical record can be successfully stored on the computer, that the data can be used on a regular basis in the ambulatory health dare setting, and that the systems can be transferred to other settings.

Evaluation

Formal evaluation studies of the impact of AAMRS were meager in 1975. This condition continues today, or the findings from such studies have not been reported. Of the few studies reported in the literature, most have addressed only a selected aspect of the effect of automation on the ambulatory care process.

In considering ways to evaluate the impact of AAMRS on the delivery of health care, a distinction should bc made between a site-specific evaluation and an assessment of the general adaptability of a prototype AAMRS to other settings. Different factors should bc taken into account. For a site-specific evaluation, the factors arc resources required, installation time frame and costs, technical support ncedcd, training of personnel, start-up, transition, and routine operation. For an assessment of the general adaptability of an AAMRS, the factors arc system flexibility, modularity, programming language, compu tcr and software support, and ease of modification.

For effective health planning and public policy making, there is a need for objective evaluation of both the impact and benefits of AAMRS. From the perspective of the marketability of an AAMRS, if a user or organization is willing to install a system and pay for it, that constitutes a practical evaluation of the system's worth. Additionally, continuing sales of AAMRS and evidence of profitable vendors may bc considered as indicators of a product for which the benefits outweigh the cost.

Implementation, Acceptance, and Cost Justification

Major factors in the success of a system are provider acceptance and effective communication between the provider and the system dcsigncr. Provider acceptance appears to bc best where the provider:

- was involved with system design,
- participated in the decision to install the system, and
- received training in the use of the system.

The importance of administrative services has been recognized for the systems that were originally designed to handle only medical data. Of the systems that were visited during the current survey, only one did not possess any financial subsystem.

New factors for successful implementation of an AAMRS were idcntificd. It was observed that at sites that were actively installing an AAMRS in a new setting, user training and system documentation arc critically important. There is a strong indication that the level of training has a direct correlation to the user's acceptance of the system.

Transferability

A conclusion of the 1975 study was that many systems or system components were suitable for transfer even though the dcvclopmcnt emphasis was to meet the unique local needs of the user institution. The current study has confirmed that AAMRS are transferable, even those that were not developed with transfer in mind. Nearly every system visited in the earlier study that is still active has had some type of system transfer, either through the addition of new users or by transfer to a new site.

For all systems visited, there is clear evidence of private sector interest to market the system or a component of the system. Today COSTAR is the most widely distributed system in the commercial market and has the greatest number of vendors. TMR is being marketed by its dcvclopcrs. Some

components of the RMIS system are commercially available from Digital Equipment Corporation (DEC). Except for the ARION system, all of the system developers were also directly involved in transferring a part or all of their system to new sites.

Significantly different design concepts exist for systems undergoing transfer. To permit implementation at a variety of health care settings, the COSTAR system is designed to be highly flexible in terms of permitting modifications upon installation to meet the unique needs of the user. The design philosophy of the TMR system is that a particular health care setting can meet its unique needs by selecting an appropriate subset of reports from the large menu of standard reports which were designed to meet the needs of a variety of health care settings. Regardless of the design concept, all systems require a substantial amount of technical support from the vendor or from in-house capability for the initial implementation. Technical support is most important in the areas of software, documentation, and user training.

Design characteristics that influence the transferability of a system include (a) the degree of general applicability, (b) the ability to meet specialty needs, and (c) the extent to which the system was designed to meet the specific needs of the site in which it was developed. A system that has a high degree of general applicability may serve a wider market than one that is designed to meet specific specialty needs or the unique needs of a site. However, a system that has both general applicability and the ability to meet specialty needs may have an even broader potential market.

In addition to design characteristics and availability of technical support, several other factors will have either a negative or positive influence on system transfer. These factors include:

- Leadership characteristics at the development site and at the user site.
- The nature of the computer language used and whether it is widely available and supported.
- The cost of the system.
- Ease of installation in terms of timing, training requirements, site specific system modifications, and impact on existing procedures.
- The existence of any hardware restrictions.
- The demand for the system, or the existence of a market for the system.

Marketing constraints on system transfer is an area of concern today. It is expected that the first lessons may be learned from COSTAR, because that system is on the market from a variety of vendors. It will be interesting to learn whether the cost of selling, installing, and supporting a highly flexible system can prove to be economically feasible. Also, to what extent does the use of an uncommon computer language represent a constraint?

Based on the follow-up study, the characteristics of a market for the larger AAMRS are:

- A group practice with four or more providers.
- A need for automated financial and administrative services. Practices have justified automated administrative services where there is
  - o a need for practice management data,
  - o evidence of lost charges, or
  - o a problem with cash flow.
- The potential to improve medical care by the acquisition of automated medical data services. The greatest potential for improved care from the use of medical services exists where there is:
  - o A need for record availability, legibility, and common organization.
  - o A need for data organization and report formatting.
  - o A desire to improve quality of care or to improve procedures for quality of care assurance review.
- A setting where there is a desire to use the database for research.
- Research needs resulting from either the institutional setting or individual physician motivation.'

System Characteristics:

The systems visited in 1975 and 1981 evolved from the characteristics of the setting in which they were designed. That is, system services first meet the needs of the local setting. As the systems are prepared for transfer, modifications are made to make the systems suitable for different settings. New modules were added to the COSTAR system to facilitate transfer of the system. These modules provide financial services, and data retrieval and report formatting services. For TMR, the set of standard reports and services has been expanded to meet the anticipated needs of a variety of settings.

The most common vehicle for data capture is still the encounter form. Data entry is predominantly performed by clerical personnel. Experiments in physician interaction with direct data input and retrieval appear to have not been fruitful. While it was recognized in 1975 that encounter form design required careful attention and research, there is little evidence of improvements to the encounter forms in use today.

Technical Aspects

With respect to technological system design, it is the conclusion of the study team that there have been no significant changes or innovations since 1975. Systems were developed along lines intended. There was little evidence of new innovations in design or termination of significant features. It appears that the use of new technology has been definitely slower than the rate of development of new technology.

The predominant hardware for AAMRS at the present time are minicomputors. Most of the developers planned to remain at the minicomputer level. The developer of TMR is in the process of

implementing and testing a version of their system that will run on a microcomputer. The micro-version is being developed in addition to the current minicomputer version, not as a replacement.

A major concern that was found in this area was a lack of software competence at the user sites. Except for RMIS and ARION, which are written in BASIC, the other systems visited in this study were written in languages that are not being taught in data-processing or computer science curriculums. At each of the sites visited, with the exception of those sites where the developer was in residence, there were no individuals that felt comfortable with making even minor software modifications. 'This puts the burden of tailoring the system for the specific sites on the vendor or system developer. It is the opinion of the visit team that in order to implement one of these systems, it is essential to have some software competence at the site during the implementation.

Future Potential of AAMRS

It appears that the general development and growth of AAMRS is following that of Hospital Information Systems (HIS). The development, implementation, and acceptance of H I IS have been slow, and most systems are primarily administrative/financial in character. It is predicted that the large AAMRS will take the same path.

The large AAMRS available today should be considered first generation systems that have evolved through modifications and additions to those systems examined in the earlier 1975 study. As lessons are learned from the transfer and commercialization of these systems, new generations should be developed that will be more responsive to the needs of the market and that will incorporate current and future technological advances. Important issues to be addressed in the development of new AAMRS include (1) how to get the practitioner more involved with using the system; (2) more efficient methods of data capture and entry; and (3) improvements to user interaction with the system.

For the private physician or small group, there is strong evidence that the microcomputer will have an influence on the development of ambulatory medical record systems. Because the use of a micro does require initiative on the part of the physician to acquire some level of technical computing competence, it is not clear how widespread the USC of micros will be. As soon as acceptable and effective medical record software packages are available for the micros, the use of computers as aids to the practice of medicine may change significantly.

In the short run, it is not expected that an AAMRS will have a measurable impact on patient outcome. That is because the AAMRS provides services to the process of providing health care. Even though the process may be improved, it is not clear that the patient will be healthier. 'l'he extent of AAMRS impact on the process of providing health care will depend on the providers' acclamation to the idea of an automated record, and whether they learn to use the system effectively.

In the long run, there is every indication that AAMRS can have a significant influence on patient outcome, particularly from the results of productive research using data from and the analytical capability of the larger AAMRS.

BACKGROUND

The 1975 Study

From October 1974 through June 1975, a state-of-the-art review and analysis of automated ambulatory medical record systems (AAMRS) was performed by the Office of Medical Information Systems of the University of California, San Francisco under a contract with the National Center for Health Services Research. Automated Ambulatory Medical Record Systems (AAMRS) are defined as systems that use computers to automate a substantial amount of the medical record for ambulatory care settings. Ambulatory care settings include hospital outpatient clinics, neighborhood clinics, group practices, and private physician practices. The major focus of the study was to examine how automated systems were being developed to improve the use of the patient's medical record in different types of health care settings. In the 1975 study, a multidisciplinary team with expertise in medicine, medical information systems, health economics, and evaluation methodology made visits to 16 AAMRS sites throughout the country. For an additional 150 sites where the medical record was automated to some degree, information was accumulated by correspondence. The report of the 1975 study described in extensive detail the 16 sites visited and summarized the information collected for all other sites.[1] Some of the findings of the 1975 study were also reported by individual members of the study team in articles and at conferences.[2,3,4,5,6,7,8,9,10]

A conclusion from the 1975 study was that automated ambulatory medical record systems still required substantial development and evaluation. However, there were indications that effective systems were being designed and that, eventually, they would have an important impact on the delivery of health care and on the management of that delivery. The significance of the role played by the AAMRS management services indicated that the ideal automated ambulatory medical record systems of the future probably would have strong links with the laboratory, the pharmacy, and the billing systems of each ambulatory care organization.

The Follow-up Study

In recognition of a need for more current information on the nature of present AAMRS, a follow-up study was performed by the Department of Computer Science, Stanford University with grant support from the National Center for Health Services Research and with personnel support from The MITRE Corporation, McLean, Virginia. The objective of the follow-up study was to determine whether the findings and conclusions of the 1775 study were still valid, and whether the field had progressed in ways that may have a significant impact on the design and implementation of future AAMRS.

The scope of the follow-up study was not as comprehensive as the original study. The follow-up study involved contacts to every site visited in 1975 for current information on the status of the medical record system, and visits were made during 1981 to a selected number of AAMRS sites. Visits were made to four sites that were examined in the earlier study or that are users of a system visited in the earlier study, and to two sites not included in the earlier study. Additionally, a brief visit was made by

three members of the visit team to a private practitioner who was developing a system for a microcomputer. The system for the microcomputer was not operational at the time of the visit. Consequently, information derived from this visit is not included in this report. In consideration of the limited scope of the follow-up study, the findings presented herein must be qualified in that they are derived from only a small sample of the AAMRS in existence and operating today.

While this study reviewed only a small sample of the AAMRS that are operational today, the systems and sites visited can be considered as representative of the systems developed for and implemented on minicomputers. During the earlier study the minicomputer was the most predominant type of equipment used for the AAMRS. Today, there is evidence that there are a large number of efforts currently underway to develop AAMRS for the microcomputers.[11,12,13] The developers of these systems are individual physicians, commercial organizations, and researchers. Considering that only one site was visited where an AAMRS was operational on a microcomputer, this study cannot be considered as having examined a representative sample of the micro applications. Even though the systems and sites visited may not be representative of all the types of computers for which the AAMRS have been developed, many of the findings of this study apply to systems and their implementation regardless of the nature of the hardware used. This is particularly true for the findings relating to system objectives, evaluation, implementation, acceptance, and cost justification and transferability.

To permit a longitudinal comparison between the findings of the 1775 study and the follow-up study, the follow-up study used the same methodological approach as the 1975 study? During the visits, information was collected with the same interview guides that were developed for the 1975 study. The follow-up study team consisted of the following persons, of whom the first four were members of the original study team.

INGEBORG M. KUHN, Ph.D.‘

Through December 1981, a Research Associate for the Heuristic Programming Project and Project Director for the AAMRS follow-up study, Department of Computer Science, Stanford University. Her Ph.D. from the Graduate School of Business, Stanford University, is in management science with special emphasis upon Health Economics and Health Systems Analysis. Her research interests include the implementation and evaluation of innovative programs in the health services sector. Her experience includes the planning and evaluation of national programs supporting biotechnological research resources and health care technology, and the evaluation of health service programs. For the original AAMRS study, she was responsible for economic evaluation of the AAMRS. Tn the follow-up study she was responsible for the overall project direction and management, and for the preparation of the final project report.

GIO WIEDERHOLD, Ph.D.

Principal Investigator for the AAMRS follow-up study, is an Assistant Professor, Dcpartmcnt of Computer Science, Stanford University. He has managed the analysis, design, and implementation of databases and medical research support systems. Currently, he is a member of the study section for Health Care Technology for the Department of Health and Human Services. As project manager of the original AAMRS study, he was responsible for the overall direction of the work and preparation of the final project report. In addition to coordinating all of the data collection activities, he was responsible for the technical description of the individual projects. For the follow-up study, he provided overall technical supervision and participated in visits to the Regenstrief Institute in Indianapolis, Indiana and to the Arthritis Center in Wichita, Kansas.

DIANE M. RAMSEY-K LEE, Ph.D.

Director of R-K Research and System Design, Malibu, California. She designed and developed the Navy Medical Information Storage and lictricval System (NAVY MEDISTARS). She has provided editorial assistance to numerous institutions in preparing reports to different Federal agencies. More recently, she has consulted with the Navy Health Research Center in the design and development of a Navy Mental Health Information System and a Navy Occupational Health Information Monitoring System. For the original AAMRS study, she concentrated on the attitudinal analyses of the AAMRS users. For the follow-up study, she was involved in all aspects of the data collection and editing of the final project report.

JONATHAN E. RODNICK, M.D.

Associate Clinical Professor and Vice Chairman, Division of Family and Community Medicine, University of California, San Francisco and from the Family Practice Program of the Community Hospital in Santa Rosa, California. His residency training was at the University of Vermont in Burlington, where Dr. Lawrence Weed developed the problem oriented medical record. For the original and follow-up study, Dr. Rodnick was responsible for the collection of information regarding the content of the automated medical record.

SANFORD BENETT, M.S.

The MITRE Corporation, McLean, Virginia. At MITRE, Mr. Benett participated in the National Library of Medicine development of a Micro Based Intelligent Terminal, the PLATO computer-assisted instruction system, updating the MEDLARS user interface, and in the system support activities for various modules of the COSTAR system. Prior to joining MITRE, Mr. Benett was Chairman of the Computer Science and Data Processing Department, Anne Arundel Community College, Maryland. For the follow-up study, he was responsible for the collection of information regarding the technical and operational aspects of the au tomated medical record system.

DONALD D. RECK

Head of Computer Services, Naval Health Rcscarch Ccntcr, San Diego, California. Mr. Beck has had extensive cxpcricnce in the development of medical and psychiatric information databases and statistical analyses systems, one of which was the Naval Medical History Data Base and Retrieval System, which maintains and accesses chronologically ordered medical and service data histories on all naval personnel. He currently is tasked with the development of an Occupational Health Information System. For the follow-up study, he was responsible for the collection of information regarding the technical and operational aspects of the automated medical record system.

The sites and systems visited in the follow-up study arc listed in Table 1, on page 11. Summary visit reports for each of the sites and systems visited in the follow-up study arc presented in Appendix I. Appendix II contains a list of sites visited in the 1975 study, with brief comments on their status today.

Acknowledgments

This study was supported by a grant from the National Center for Health Services Research (NCHSR Grant Number MS 04152-01). Dr. Coralic Farlee, the original project officer for the NCHSR grant, participated in the site visits to Duke University in Durham, North Carolina and to the . Regenstrief Institute in Indianapolis, Indiana. During the early part of this study she provided h·lpful comments and direction to the follow-up effort.

Additional support for this study was provided by the Mctrek Division of The MITRE Corporation, McLean, Virginia. The MITRE Corporation provided the services of one of the members of the site visit team and paid his travel costs for the site visits.

A great deal of appreciation is cxprcsscd to the individuals with whom wc met at each of the site visits. They were all very generous in making their time available to us and in the contributions of their knowledge and insights concerning the AAMRS.

An earlier version of this report was prepared for the Fifth Annual Symposium on Computer Applications in Medical Care, held in Washington, D.C. in November 1981.[14] Members of the site visit team contributed to the subsequent revision. Comments on the .dcscriptivc information contained in this report were obtained from the developers of each of the systems visited. Many valuable review cotnmcnts were rcccivcd from each of the sites visited, from Dr. Barbara Kcrlin of The MITRE Corporation, and from Mr. James R. Ullom, the current project officer for the NCHSR grant.

The computing resources provided by Stanford University's Dcpartmcnt of Computer Science and the Medical School's SUMEX facility were essential in the preparation of this report. The original 1975 AAMRS study was sponsored by NCHSR and conducted by the University of California, San Francisco Medical Center.[1]

Table 1: SYSTEMS AND USER SITES VISITED FOR THE FOLLOW-UP STUDY

COSTAR Computer-Stored Ambulatory Record System

A modular system with the capability to totally computerize the medical record. This system was visited in the 1975 study.

Developer: Laboratory of Computer Science, Massachusetts General Hospital, Boston, Massachusetts.
- NE User: North End Community Health Center, Boston, Massachusetts.
- NC User: North County Health Services, San Diego County, California.

TMR The Medical Record

A modular system with the capability to totally computerize the medical record. This system was visited in the 1975 study.

Developer: Division of Information Science, Department of Community Medicine, Duke University, Durham, North Carolina.
Users: Renal Dialysis Unit and Nephrology Clinic, Veterans Administration Hospital; OB/GYN Clinic, Duke University Medical Center.

RMIS Regenstrief Medical Information System

A modular system that supplements and replaces some of the paper medical record. This system was visited in the 1975 study.

Developer: Regenstrief Institute, Indianapolis, Indiana.
User: General Medicine Clinic, Regenstrief Institute, Indianapolis, Indiana.

ARION Arthritis Research Information Office Network

An administrative and medical data system developed by a private physician for practice management and data input to the ARAMIS project at Stanford University. The ARAMIS project was visited in the 1975 study (see Appendix II).

Developer/User: Arthritis Center, Wichita, Kansas.

FMIS Family Practice Medical Information System

A family-oriented informatic system providing administrative assistance to the family practice. This system was not visited in the 1975 study.

Developer: Community Electrocardiographic Interpretative Service (CEIS), Denver, Colorado.

User: Crow Hill Family Medicine Clinic, Bailey, Colorado.

Organization of the Report

This report is organized by different subject areas. The subjects covered in the following sections are as follows: Status of Systems Visited; Design Objectives, System Benefits, and Realization of Objectives and Benefits; Evaluation; Implementation, Acceptance, and Cost Justification; Transferability; System Characteristics; Technical Aspects; and the Future Potential of AAMRS. Within the subject areas, tables are used to provide descriptive information on the systems visited in the follow-up study. Unless noted otherwise, the information presented in the tables describes the systems in general rather than the specific implementation of the system at the user sites visited.

In order to provide a perspective over time, the first part of each section contains a summary of the findings and conclusions from the 1975 study. The second part of each section presents the status of these conclusions today along with new findings that have evolved.

STATUS OF SYSTEMS VISITED

In 1975 it was found that the status of Automated Ambulatory Care Medical Record Systems (AAMRS) was predominantly developmental. Only one third of all systems identified had achieved full operational status. In most cases, these systems were limited in medical scope or primarily were providing administrative services such as patient registration, billing, and appointment scheduling. Systems oriented toward dealing with medically significant data were early in the developmental stage. While some systems with a high content of medical data were actually operating in ambulatory care settings (e.g., COSTAR), there were still plans for a substantial amount of development. Furthermore, with only a few exceptions, there was very little evaluation of the systems' effectiveness in or impact on the health care setting.

CURRENT STATUS

Several of the promising systems have matured to become operational and are undergoing transfer from a prototypedemonstration in the research setting to the commercial market. Clearly, the leader in commercial availability of an in-depth medical record system is COSTAR. While COSTAR may be the most publicized example of system transfer, other systems are in the process of becoming commercially available. These include TMR and RMIS.

Even though several AAMRS have evolved into commercial products, there is still a need for research and system development to address the following issues:

- The Best Match of Automated Services with the Practice Setting. Not all ambulatory health care settings need or can afford a system that is the scale of the COSTAR-NC system (the system installed at the North County Health Services, San Diego County, California). For the smaller primary care practice, is automation of the medical record cost effective?

- User Interface. All sites visited acknowledged that further system development should pay more attention to user interface. . Particular areas identified for further development include (1) encounter form design, (2) information presented to the user: surface behavior, explanations, CRT displays, graphic presentations, and (3) factors influencing effective human acceptance of the automated system.

- User Acceptance and Motivation. Health care provider acceptance and motivation to fully utilize the system is a continuing problem. In addition to user interface, the problem may be linked to the need for better user training and documentation; or to the failure to adequately address the users needs with respect to services offered by the system. It is interesting to observe that one of the systems visited in 1975 which did not have a reasonable user interface failed to gain user acceptance. 'l'hat system is no longer in existence.

- System Transferability. What are the factors in system design and development that facilitate transfer from a prototype demonstration in a research setting to practical applications in a variety of settings? Divergent beliefs exist among system developers, and there is inadequate experience, study, and evaluation to date to provide answers.

DESIGN OBJECTIVES, SYSTEM BENEFITS, AND REALIZATION OF OBJECTIVES AND BENEFITS

In 1975 there were strong beliefs that an automated medical record system would have a positive impact on health care in a wide range of areas. The design objectives of the different systems reflected this belief. In every case, the main underlying desire was to improve the quality of health care. Additionally, improved access to care and reduced costs of care were expressed as objectives for system design. The expected benefits from the systems may be itemized as follows.

- Access to Care: This includes benefits from:
  - o record availability, legibility, and completeness,
  - o appointment scheduling and follow-up, and
  - o patient referrals and clinic scheduling.

- Quality of Care: The primary benefits were expected from a well-organized, reliable, and available record which would provide for:
  - o improved diagnostic procedures;
  - o better communication among providers;
  - o quick identification of abnormal tests, patients needing preventive care, and follow-up of chronic disease; and
  - o a more thorough and accurate approach to managing patient problems.

  Other goals for improving quality of care included:
  - o improved patient compliance resulting from summary sheets given to patients, preparation of pharmacy labels with directions, and patient reminders;
  - o improved drug ordering from notifications to the physician of drug interactions, and better documentation of medicines prescribed;
  - o a decrease in unnecessary drugs, lab tests, or X-ray tests resulting from a better display and availability of previous medicines or test results;
  - o improved quality of care review procedures facilitated by speedier availability of medical data, and more accurate and reliable medical information;
  - o availability of a large medical database for research, health planning, and to increase knowledge of the natural history of disease, medical decision making, and utilization of medical resources; and
  - o improvements in provider education through better information exchange, the use of computer prompting or reminders, interfaces with learning modules, and improved monitoring and feedback of performance.

- Cost of Care: Reduced medical and administrative costs were predicted from:
  - o fewer repeated lab tests due to lost records or lab results,
  - o more effective use of provider time,
  - o reduction of unnecessary patient visits ,
  - o improved collections, decreases in lost charges, and decrease in personnel as a result of automated billing services, and
  - o fast and accurate information processing for report preparation.

- Other Benefits: Other benefits were anticipated in the areas of:
  - o Practice Management - resulting from the availability of data for utilization reviews, budgeting, and long-range planning;
  - o Physician Training - because information contained in the automated medical record would facilitate training; and
  - o Patient Services - reduced waiting time and fewer redundant lab tests.

Because of the continuing emphasis on development, the realization of objectives and benefits in 1975 was very limited for most of the systems. Only three of the 16 sites visited had fulfilled system objectives and could be considered in full production status. Those sites that had achieved full production status served very large patient populations, and simple improvements were the major objective of the system, such as record retrieval. While the marginal benefit per transaction was small, the aggregated benefit was sufficient to help justify the system. At sites where the system was more complex, problems were noted in the ability to effectively evaluate the attainment of system objectives. For complex systems it is difficult to identify, measure, and control all of the variables that are influenced by the introduction of the system. Thus, it is correspondingly difficult to develop an effective evaluation that will indicate whether the objectives of the system have been met or that will measure the benefits derived from it. This is particularly true for systems that have an objective of improving the quality of health care.

Problems in quantifying the benefits derived from the systems made it difficult to identify actual health care costs savings. For example, sites could not document cost savings from better utilization of providers. However, it was found that administrative cost savings were the major factor in cost justification of many systems.

In 1975 there was some evidence of improvement in quality of care resulting from the availability of the medical record. It was most noticeable at sites where the traditional record was not readily available, and when available, was not complete **(such as** RMIS and Bellevue). Improved quality of care was also demonstrated in relation to the management of chronic diseases. Other gains in quality were less vivid, and at some sites frustration with system shortcomings may have even decreased quality of patient care.

CURRENT STATUS

Today, the design objectives and expected benefits are more clearly defined. Although a complete medical record system such as COSTAR or TMR could include most of the previous list as part of their objectives, the primary goals of current systems are more narrowly defined in terms of improved quality of care and known administrative benefits. There is not as much emphasis on objectives to improve access to care, although improved record availability and patient scheduling are parts of many systems. The major design objectives for the systems and sites visited during this study are summarized in Table 2, on page 16.

Table 2: OBJECTIVES - REASONS FOR IMPLEMENTING THE AUTOMATED SYSTEM

SYSTEM / SITE	COSTAR NE	COSTAR NC	TMR	RMIS	ARION	FMIS
IMPROVE QUALITY OF CARE THROUGH:						
Data Acquisition and Availability	XX	XX	XX	XX	XX	X
Record Accuracy and Legibility	XX	X	X	X		
Follow-up of Abnormal Tests	X	X	X	X		
Patient Surveillance	X	X	X	X	X	
Preventive Care	X	X	X	X		
Treatment Planning	X	X	X	X		X
Patient Compliance			X	X		
Feedback to Physician	X	X	X	XX		
MAINTAIN CONTINUITY OF CARE THROUGH:						
Record Availability	X	X	XX			
IMPROVE PATIENT SERVICES THROUGH:						
Patient Scheduling			X	X		
Pharmacy Management			X	X		
Laboratory Ordering and Reporting	X	X	X	X		
FACILITATE RESEARCH IN THE AREAS OF:						
Quality of Care Review	X	X	X	X	X	X
Health Services		X	X	X		X
Medical Decision Making			X	XX	X	
FACILITATE HEALTH PROVIDER TRAINING			X	X		X
IMPROVE ADMINISTRATIVE SERVICES BY:						
Providing Information for:						
Utilization Review	X	X	X	X		X
Budgeting		X	X		X	X
Long-Range Planning		X	X			X
Funding Agencies	X	X				X
Faster Information Processing	X	X	X	X		X
Increased Accuracy	X	X	X	X	X	
Reduced Administrative Costs	X		X			X

XX - MAJOR OBJECTIVE X - OBJECTIVE

Improved quality of care continues to be considered a major system objective. A well-organized display of historical, laboratory, and drug data in patient summaries and flow charts is available from the COSTAR, RMIS, and TMR systems. At some sites these summaries are given to the patient to improve communication and perhaps compliance. These systems also improve the ease of ordering lab tests or medicines and the ease of accessing the results. The pharmacy "subsystems" of TMR and RMIS are well thought out and provide additional information not usually available -- such as telling the physician how much the prescription costs. The ability to use an AAMRS for quality of care review has been demonstrated (see page 19), and there is a high potential for the AAMRS to facilitate the development of procedures for quality of care review.

Increased medical record availability continues to be important in the large clinics where the traditional record is difficult to obtain for each visit. Record availability is a key objective at RMIS and access to the computer record has been taken one step further by having on-call physicians take a portable terminal home. These physicians can then have access to an emergency patient's record by a telephone communication link to the computer.

Management benefits are still a primary system justification. Financial and administrative services continue to be a major factor in facilitating system transfer, particularly in the commercial market. While reduction in administrative costs provides an incentive for installing an AAMRS, there is no indication that the potential for a reduction in the direct cost of providing health care is considered a justification for a system. At one site, a question was raised as to whether the system may in fact lead to increase costs of health services by prompting the provider to order more services or tests than may actually be needed.

Benefits that were seen as potentially important six years ago, but are considered less so now, include the use of medical diagnostic algorithms, notifying providers about drug interactions, and a heavy emphasis on meeting future PSRO requirements. At that time issues of privacy and confidentiality of systems were being debated; now these issues are less of a concern and are found primarily in the new systems.

It is still expected that the AAMRS will facilitate health services research. This is particularly true for those systems that provide the capability to search files and retrieve data on any combination of variables by means of query languages or report generators. The areas of research to be served by the AAMRS are:

- Health services research
- Quality of care review methodology
- Medical decision making
- Epidemiology of disease
- Medical education.

In each of these areas the AAMRS has significant potential for assisting in gaining new knowledge. The knowledge may be acquired by investigators directly affiliated with the institution where the system is installed, or alternatively by making the database available to other investigators. Whether

the research will result in key and unique advances probably has more to do with the investigator than the system.

A new intangible benefit was revealed during the follow-up study. At the Regenstrief Institute, there is the belief that an AAMRS with a high quantity of medically significant data and the ability for flexible data retrieval provides a stimulating environment to the provider that helps in physician recruitment and retention. This expectation was considered an important factor where the health care facility was related to an academic setting. Physician interest in the ability to retrieve and analyze data from the automated medical record may be increasing because more physicians are entering practice today with a strong scientific background and interest.

There still is little evidence for the larger AAMRS that their benefits justify their costs. As it was six years ago, it is still difficult to compare system benefits to costs, because of problems associated with the quantification of benefits and lack of detailed cost data. Controlled studies for comparison of effects are still difficult. However, as some systems are installed at an increasing number of different sites, comparative data should become available for evaluative study. At most sites visited, there were inadequate data to determine the full cost of the system for a new user. Further experience with Duke's TMR and the vendors of COSTAR may provide such information in the near future.

A concern has been raised that the AAMRS may actually increase the costs of delivering medical care. In some settings it may require more provider time to fill out the new encounter form; it may require more personnel to enter all the medical/lab/drug data; and the system may be associated with increases in ordering of laboratory and other tests. These issues are definitely unresolved.

Clearly the realization of objectives is much greater than it was six years ago. The progress is most noticeable with the larger systems. It has been demonstrated that the system developers have accomplished what they set out to do. Today, there is evidence that the medical record can be successfully stored on the computer, that the data can be used on a regular basis in the ambulatory health care setting, and that the systems can be transferred to other settings. Successful achievement of objectives is also evidenced by the availability of a variety of medical record systems as commercial products.

EVALUATION

The 1975 study revealed that evaluation of AAMRS was a major shortcoming at most sites. There was a general lack of formal evaluation of system effectiveness, an assessment that could be made of most health care delivery systems in the mid-1970's. The lack of a well-formulated methodology for conducting evaluation studies of the impact of introducing automated information systems into the health care delivery process can be cited as the most probable cause for the dearth of such studies. Another factor contributing to the lack of formal evaluation may have been the lack of motivation or incentives to perform an extensive evaluation.

In the absence of objective and quantitative methods for evaluating the effect on the health care setting of the introduction of an AAMRS, most assessments about system effectiveness were qualitative and limited to subjective opinions of system designers and users. Without objective evaluations, it was difficult in 1975 to estimate the potential impact of AAMRS on the delivery of health care or on the management of the health care setting.

CURRENT STATUS

Formal evaluation studies of the impact of AAMRS still appear to be meager, or the findings from such studies have not been reported. Of the few studies reported in the literature, most have addressed only a selected aspect of the effect of automation on the ambulatory care process. For example, the issue of quality assurance was the focus of a collaborative study between the Harvard Community Health Plan (HCHP) and the Laboratory of Computer Science, Massachusetts General Hospital. In this study, the impact of a computer-based ambulatory quality assurance program was assessed.[15] Eighteen problem areas were selected for study such as hypertension, urinary tract infection, and prenatal care. The HCHP quality assurance program was greatly facilitated by the availability of COSTAR which made it possible to accurately monitor possible deviations from prescribed standards and to provide effective feedback to the responsible care provider about any deviation that occurs. In a series of evaluation studies of the AAMRS at the Regenstrief Institute, the focus was on assessing the impact of computer reminders on physician behavior. In one study, it was concluded that prospective reminders based on 390 protocols do reduce physician errors and that many of these errors are probably due to an individual's limitations as a data processor rather than to correctable human deficiencies.[16] In other evaluation studies at Regenstrief, physicians' responses to computer reminders were explored in a Diabetes Clinic and a General Medicine Clinic.[17] These reminders significantly increased the clinician response rate (in terms of test orders and treatment changes) to the events in question.

One study of an AAMRS was conducted by The MITRE Corporation of the COSTAR V installation at the North (San Diego) County Health Services (NCHS) project.[18] This study was a preliminary assessment of the NCHS initial experience and not a formal evaluation of COSTAR. It did provide important information with respect to the implementation of a large COSTAR system. The major conclusions were:

- when used as a total medical/management information system, COSTAR V will impact on virtually evcryonc's job;
- installing COSTAR V in a complex operational environment is a time-consuming and costly undertaking;
- in planning the time and costs of the installation effort, particular attention should be paid to COSTAR's ability to meet the organization's billing and accounts receivable needs; and
- training in the USC of COSTAR is an ongoing process.

Some additional studies in progress include (1) an evaluation of the TM R system by the Duke University Department of Community and Family Medicine, and an evaluation of the FMIS by JRB, Inc. and The MITRE Corporation. To date, results from these studies arc not available.

In considering ways to evaluate the impact of AAMRS on the delivery of health care, it is useful to distinguish between conducting a site-specific evaluation and performing an assessment of the general adaptability of a prototype AAMRS to other settings. The factors that should bc taken into account differ for the site-specific evaluation and the assessment of general adaptability. In the site-specific analysis, the following factors become significant: resources required, installation time frame and costs, technical support ncedcd, training of pcrsonncl, start-up, transition, and routine opcration.In the case of assessing general adaptability of an AAMRS, the following factors come into play: system flexibility, modularity, programming language, computer and software support, and case of modification.

For effective health planning and public policy making, there is a need for objective evaluation of both the impact and benefits of AAMRS. From the pcrspcctivc of the marketability of an AAMRS, if a user or organization is willing to install a system and pay for it, that constitutes a practical evaluation of the system's worth. The viability of the system once installed in the new setting may represent a further practical evaluation. Additionally, continuing sales of AAMRS and cvidcncc of profitable vendors may bc considered as indicators of a product for which the benefits outweigh the cost.

IMPLEMENTATION, ACCEPTANCE, AND COST JUSTIFICATION

Some of the major findings of the 1975 study related to factors influencing **successful** system implementation. Successful implcmcntation and operation of cvcry AAMRS was dependent on the health care providers, who in most cases were physicians. Even for systems that were primarily administrative, the provider is the initial point of data capture, and thus the provider's acccptancc and cooperation arc essential for success. Another important requirement is cffcctivc communication between the provider and system designer. The designer must have an understanding of the provider's needs and mode of operation. A conclusion from the 1975 study was that in order to realize the medical benefits of an AARMS, the system must bc responsive to the specific objectives of the health care providers? A high level of motivation and strong leadership appeared to bc a key to success or potential success. A strong leader was involved with development and implcmcntation of cvcry major AAMRS. In most cases the person was a physician turned computer specialist. It appeared that if the leadership was not there or if the leader would leave the project before it reached a high level of maturity, then the likelihood of success would bc significantly impaired.

Other major factors contributing to successful implcmcntation and acceptance were the administrative and financial scrvicc provided by the system. Benefits derived from these services were the major factors contributing toward cost justification. Although estimates of actual dollar savings and other tangible benefits had not been determined for most of the sites, the administrators within the health care settings served by the AAMRS believed that the administrative and financial services were very important and that they helped to justify the continued usc of the AAMRS.

At those sites where there were some data on cost savings, the savings for the most part were relatively small in comparison with the cost of the system. Labor savings, if any, were realized only in financial services. Health care settings with public funding support require a large quantity of data to meet the reporting requirements of their supporting agencics. Rcduccd or eliminated lost charges in the ambulatory setting provide measurable benefits. Accurate billing scrvicc and improved cash flow were also factors contributing to acceptance and cost justification.

CURRENT STATUS

The conclusions about factors leading to the success of an AAMRS system that were reached six years ago have been borne out in the systems that arc successful today. A major factor in the success of a system is provider acccptancc. In all of the sites visited, a large emphasis has been placed on gaining this acccptancc. Provider acccptancc appears to bc best where the provider:

- was involved with system design,
- participated in the decision to install the system, and
- received training in the usc of the system.

For RMIS, TMR, and ARION, some of the providers using the system were also involved in the design of the system. This gave them unique insights into the needs of the system and the concerns of their collcagucs. For both COSTAR and FMIS, a large emphasis was placed on user training and

ongoing interaction bctwccn the user/provider and the dcvcloper. This interaction has led to a gradual evolution of each of the AAMRS to better serve the providers and thereby gain their acceptance. At one of the North County Health Scrviccs' clinics where some of the providers did not feel that they had been adequately trained in the use of the system, acceptance was not as good. The comments of the providers were that if they possessed a better knowledge of the system, they would tend to use its facili tics more.

The issue of leadership is as important today as it was in 1975. Each of the systems visited possessed an individual or several individuals who were the driving force behind the system. For COSTAR, Dr. Octo Barnett has been a very strong force in the dcvclopmcnt of the system. He has also played a major role in the implcmcntation and acceptance of COSTAR at the North End Community Health Center in Boston and at other sites. At the COSTAR system at North County Health Scrviccs in San Diego County, the director, Dorothy Rcno, was primarily responsible for its introduction and implcmcntation. The TMR system at Duke has basically been the work of two individuals, Dr. William E. Hammond and Dr. William Stead. They were the designers, implementors, and disseminators of the system. The same situation is true with the RMIS work at the Regenstrief Institute, with Dr. Clement McDonald as the driving force. At FMIS, Dr. Roger Simmons has been involved since the beginning and directs the evolution and implcmcntation of the system. At the Arthritis Ccntcr, Dr. Fred Wolfe is the dcsigncr, the programmer, and the provider.

The importance of administrative services has been recognized for many of the systems that were originally designed to handle medical data. Of the systems that were visited during the current survey, only RMIS did not possess any financial subsystem. Financial modules were added to COSTAR to make it more versatile and more useful to a larger variety of users. Administrative and financial capabilities have been part of TMR since its inception. The FMIS is basically an administrative and financial system, and a "mini-medical record" capability is only now under dcvelopmcnt. The system Dr. Wolfe devised for the Arthritis Ccntcr includes administrative as well as medical data.

There continues to be a lack of economic data to evaluate cost benefits derived from the AAMRS. Where cost savings are rcalizcd, they arc most often rcalizcd from the administrative services provided by the system. While most system developers bclicvc that the medical benefits of an AAMRS arc the primary justification for the system, there is some evidence that the administrative services may be a primary justification to those who purchase and install the systems. For some of the modular systems, such as COSTAR, the administrative services arc the first to bc implcmcntcd, and in some cases, they are the only ones that arc implemented.[19]

During the course of the current survey, several new factors for successful implcmctitation of an AAMRS were identified. It was observed that at sites that were actively installing an AAMRS in a new setting, user training and system documentation are critically important. There is a strong indication that the level of training has a direct correlation to the user's acceptance of the system. Each of the dcvclopcrs that were visited recognized this factor and have attempted to incorporate comprchcnsivc training in to the system installation process.

There appear to be two views regarding system documentation. All of the developers recognize that for their systems to gain widespread acceptance, good quality and comprehensive user documentation is essential. However, some developers indicated a reluctance to provide technical documentation in order to retain control over the system and the installation process.

Because it is recognized that user documentation is necessary in order to efficiently use the system, each of the developers has undertaken the task of preparing comprehensive user manuals. COSTAR and FMIS have also prepared technical documentation.

Clearly, training and documentation go hand in hand in promoting acceptance. If a user does not know about the system's capabilities or how to use them and if there are no instructions for interacting with the system, it is unlikely that there will be strong incentives to effectively use the system. A few failures in attempting to use a system will lead to a high level of frustration and negative attitudes toward it.

TRANSFERABILITY

At most of the systems visited for the 1975 study, the development emphasis was to meet the unique local needs of the user institution rather than to design a system with general applicability to other settings. However, some system components or total systems were suitable for transfer. Only a few sites were actively considering marketing the system. Considering that Federal funding agencies were placing a greater emphasis on technological evaluation and transfer, it was predicted that in the future more consideration would be given to the commercial distribution of the systems under development.

In the 1375 study, transferability was examined for three different types of transfer. They were:

Conceptual Transfer

Conceptual transfer is the use of ideas or techniques developed at one site and implemented at another, without necessarily using the same software or hardware. Conceptual transfer was found in such areas as appointment scheduling, medical record formatting, and data collection techniques.

Service Transfer

Service transfer involves expanding the number of users through the time-sharing capabilities of the system. Some sites were expanding the service capability by the placement of terminals in remote locations or by bringing new user groups on to the system at its original location.

System Transfer

Total system transfer involves the duplication of components of a system or a total system at another setting on different hardware.

In 1975 conceptual and service transfer were far more predominant than system transfer. As the developmental history of each system was reviewed, it was clear that many of the services provided by the system benefited from some form of conceptual transfer. Ideas derived from the literature or from visits to other A AM RS were incorporated in the design of the system.

Several systems were designed with the intent to achieve large-scale service transfer. Primarily these were the systems that were implemented on a large computer system designed for shared services. The sites that had some plans for total or partial system transfer had the systems implemented on the smaller scale computers.

While most developers indicated that some transfer was planned or desirable, the design objectives of most systems were not directed toward transferability. The primary exceptions to this finding were found at the sites where the system was designed as a service bureau activity to meet the needs of several users within a group. For the most part, no plans for implementation of transfer were developed. Where some considerations had been given to total system transfer, the plan assumed that the system would be implemented on a similar hardware configuration at the new site. Only a few of the systems that were developed within academic or research settings were considering the commercial market as the vehicle for system transfer.

The 1975 study concluded that effective system transfer would be influenced by the following factors:

Compatibility between Environment and System Objectives

The system design must be such that the services provided by the system meet the needs of the organization in which it is to be implemented. Since most of the systems were designed to meet specific needs of the organization in which they were developed, it appeared that only similar settings would make logical candidates for system transfer.

Software

While high level languages cannot completely mask differences in the underlying operating system and hardware, the use of high level languages would facilitate system transfer in that applications programs could be transferred or implemented without major redesign of the application. When high level languages are not used, transfer may be possible only by moving the entire system.

Documentation

Only the two systems available commercially had documentation or formalized procedures to the extent that they could be considered adequate to facilitate system transfer.

Costs and Tangible Benefits Derived from the System

Clearly, low costs would facilitate system transfer. However, closely coupled to low costs are the actual benefits derived from the system. Some cost savings or specific management improvements provide an incentive for system implementation.

History of Effective Operations

Over time, a good track record should influence the marketability of a system.

CURRENT STATUS

The current study has confirmed that AAMRS are transferable, even those that were not developed with transfer in mind. Nearly every system visited in the earlier study that is still active has had some type of system transfer, either through the addition of new users or by transfer to a new site. Table 3, on page 26, shows the status of system transfer and the nature of factors relating to system transfer for each of the systems visited. In this table, three types of system transfer are identified. The first is total system transfer, which applies to the installation of a complete system at a new site. The second is partial system transfer, which applies to the installation of components or modules of a system at a new site. The third is timesharing, which applies to systems that offer services to several independent users on a timesharing basis.

Transfer Agents

For all systems visited, there was clear evidence of private sector interest to market the system or a component of the system. This interest was not evident in the earlier study. At the time of the first visits, only two of the systems were being distributed with the intent of gaining profit by commercial

Table 3: TRANSFER OF SYSTEMS

SYSTEM	COSTAR	TMR	RMIS	ARION	FMIS
TYPE OF TRANSFER					
Total System	X	X			X
Partial System	X		X		
Timesharing	X				X
TRANSFER AGENTS					
Commercial Vendors	X	X	X		
Developer	X	X	X		X
Other	X				
DESIGN CHARACTERISTICS					
High Degree of Standardization		X	X		X
Highly Flexible - allows modifications	X				
High Degree of General Applicability	X	X			X
Specialty Applications		X		X	
Site-Specific Design			X	X	
Modular Design	X	X	X		
AVAILABILITY OF TECHNICAL SUPPORT					
Software	X		X	X	
Documentation - Technical	X		X	X	
Documentation - User Manuals	X	X	X		X
User Training	X				X
FACTORS INFLUENCING TRANSFER POTENTIAL					
Strong Leadership/Key Individuals at:					
Development Site	X	X	X	X	X
Transfer Site	X				
Language - widely available and supported	X		X	X	
Low Cost				X	X
High Cost	X	X			
Minimal Installation Requirements				X	X
Hardware Restrictions				X	X
Existing Demand for the System	X	X	x		X
SOFTWARE STATUS					
Publicly Available	X			X	X
Proprietary	X	X	X		

agents. Today the COSTAR system is the most widely distributed in the commercial market and has the greatest number of vendors. The TMR system is being marketed by a commercial organization jointly owned by the individual developers of the system and Duke University. Since the follow-up study visits, some components of the RMIS system have become commercially available from Digital Equipment Corporation (DEC). Except for the ARION system, all of the system developers were also directly involved in transferring a part or all of their system to new sites.

Design Characteristics

While the technical constraints on transfer are diminishing, there is no evidence of "turnkey" AAMRS systems being developed that also provide for the collection of a moderately high level of medical data. A "turnkey" system is a system that can be installed and implemented by the purchaser without any technical support from the vendor or other agent. One design feature leading to ease of transferability is the development of modular systems such as COSTAR. Such a system can be transferred in whole or in part depending on the needs of the user.

Significantly different design concepts exist for systems undergoing transfer. The COSTAR system is designed to be highly flexible in terms of permitting modifications upon installation to meet the unique needs of the user. A design objective of the COSTAR system is to permit implementation at a variety of health care settings. A System Maintenance module permits some modifications to be made by a trained, non-programmer user in order to tailor the system to a particular site. While extensive modifications can be made to the system, such modifications are made by technical persons with expertise in the software. Additionally, at most installations there is a continuing need for technical support. This support has been available and provided by the transfer agent, whether the agent has been the developer, a government agency or its contractor, or a commercial vendor.

The Duke TMK system is designed with a high degree of standardization, permitting little or no modifications for user special needs. TMR provides a wide range of standard reports which are designed to meet the needs of a variety of health care settings. The design philosophy of TMR is that a particular health care setting can meet its unique needs by selecting an appropriate subset of reports from the large menu of standard reports. The reasoning behind this philosophy is to eliminate or decrease the amount of programming support required to implement and maintain the system. The developers of TMR report that a track record is being developed to support the claim that TMR is a "programmerless" system.

Other design characteristics that influence the transferability of a system include (a) the degree of general applicability, (b) the ability to meet specialty needs, and (c) the extent to which the system was designed to meet the specific needs of the site in which it was developed. A system that has a high degree of general applicability may serve a wider market than one that is designed to meet specific specialty needs or the unique needs of a site. However, a system that has both general applicability and the ability to meet specialty needs may have an even broader potential market.

Availability of Technical Support

Regardless of the design concept, all systems require a substantial amount of technical support from the vendor or from in-house capability for the initial implementation. Technical support is most important in the areas of software, documentation, and user training. The need for adequate technical support to facilitate system transfer was recognized at every site. The availability of technical support varied among the sites as indicated in Table 3, on page 26.

Factors Influencing Transfer Potential

In addition to design characteristics and availability of technical support, several other factors will have either a negative or positive influence on system transfer. These factors include:

- Leadership characteristics at the development site and at the user site.
- The nature of the computer language used and whether it is widely available and supported.
- The cost of the system.
- Ease of installation in terms of timing, training requirements, site-specific system modifications, and impact on existing procedures.
- The existence of any hardware restrictions.
- The demand for the system, or the existence of a market for the system.

Table 3, on page 26, shows how these factors relate to the systems visited in the current study.

Software Status

The status of system software is characterized in terms of being publicly available or proprietary; Software that is publicly available includes software in the public domain and software that is available from the developer without restrictions on its use. Publicly available software may be free, or there may be a small fee for the cost of preparing the magnetic tape. Proprietary software includes software that is owned by the developer or a commercial vendor and that is generally available only under licensing or other contractual agreements. The fees associated with proprietary software may be significant. On the basis of this study, it is not clear whether these characteristics will influence the ability to transfer a system, but they may have a bearing on the manner in which it is transferred. Publicly available software may be obtained by anyone; however, there may not be adequate documentation or technical support available to permit duplicating the system.

Market Characteristics

As indicated above, the demand or existence of a market for a system will influence the ease of transfer. Based on the follow-up study, the characteristics of a market for the larger AAMRS are:

- A group practice with four or more providers. A smaller size will not find the cost of the system affordable. The benefits of an AAMRS increase as the number of providers and sites using the system increases. An exception is the FMIS, which is a timesharing system designed for the rural solo practitioner.

- A need for automated financial and administrative services. The primary need and justification for the larger systems are to serve administrative needs of the practice. This confirms a prediction made in the 1975 study. It is interesting to observe that COSTAR started with development of the medical modules, and the financial/administrative modules were added later to achieve acceptance and transfer. Practices have justified automated administrative services where there is:

  o a need for practice management data,
  o evidence of lost charges, or
  o a problem with cash flow.

- The potential to improve medical care by the acquisition of automated medical data services. The greatest potential for improved care from the use of medical services exists where there is:

  o A need for record availability, legibility, and common organization such as in groups with multiple sites, multiple providers providing care to the same patient, or a patient population with complex or chronic problems resulting in high volume medical data.

  o A need for data organization and report formatting. These needs may be found in certain subspecialtics and for chronic diseases which require a great deal of lab work. These settings would derive significant benefits from the analytical and formatting powers of the AAMRS.

  o A desire to improve quality of care or to improve procedures for quality of care assurance review. .

- A setting where there is a desire to use the database for research.

- Research needs resulting from either the institutional setting or individual physician motivation.

Marketing constraints on system transfer is an area of concern today. It is expected that the first lessons may be learned from COSTAR, because that system is on the market from a variety of vendors. It will be interesting to learn whether the cost of selling, installing, and supporting a highly flexible system can prove to be economically feasible. Also, to what extent does an uncommon computer language used for the system represent a constraint? Some preliminary information derived from the COSTAR transfers indicates that the MUMPS software does create a marketing problem.[20] As other systems become commercially available, comparative information should be developed as to the relative advantages or disadvantages of marketing and installing either a highly standardized system such as TMR or a flexible system such as COSTAR.

SYSTEM CHARACTERISTICS

A summary of the services provided by the AAMRS visited for the 1975 study follow.

Medical Services:

- Patient profiles - a concise summary of a patient's medical status.
- Patient surveillance reports - information used in preventive care and management of chronic disease.
- 'l'imc-oriented flow charts, or other standard formats for data presentation showing a sequence of medical data.
- Computer-gencratcd cncountcr forms.
- Progress notes, in text form.
- Medical histories.
- Database searches - data rètrieval to serve the information needs of training, research, and medical audit.

Administrative Services:

- Accounts receivable and billing
- Third party claims: eligibility determination and claims preparation
- Reports for management and supporting agencies
- Input to other accounting systems

Other Services Provided by the System:

- Appointment Scheduling
- Registration
- Medical Record Accession for Hospital-based Clinics
- Medical Education
- Data for Research

Medical Data Entered in the Record

The amount of medical data entered varied considerably, from practically none to the complete medical record. Data entered consisted of both free text and code. In general, coded input was used for vital signs and lab results, and text was used for the medical history, some portions of the physical exam, and some parts of the plan. Diagnosis, problem lists, and medications could bc cntcrcd with either text or code.

Data entry was from an cncountcr form, filled out by the provider. The length of form ranged from a simple one-page document to complex multiple page documents. Computer-generated forms were used at some sites. Thcrc appeared to bc a direct relationship bctwccn provider acccptancc of the encounter form with length and complexity: acceptance varied inversely with length and complexity.. Provider participation in the design of the cncountcr form also was a factor in acccptancc. A few

systems accepted direct input by provider. Encounter form design was considered to be an area where more research was needed.

CURRENT STATUS

The systems visited in 1975 and 1981 evolved from the characteristics of the setting in which they were designed. That is, system services first meet the needs of the local setting. Table 4, on page 32, summarizes the system services available from the AAMRS visited in the current study. As the systems are prepared for transfer, modifications are made to make the systems suitable for different settings. New modules were added to the COSTAR system to facilitate transfer of the system. These modules provide financial services, and data retrieval and report formatting services. For the Duke TMR, the set of standard reports and services has been expanded to meet the anticipated needs of a variety of settings.

The most common vehicle for data capture is still the encounter form. As shown in Table 5, on page 33, data entry methods are relatively consistent for all systems visited. Data entry is predominantly performed by clerical personnel. Experiments in physician interaction with direct data input and retrieval appear to have not been fruitful. While it was recognized in 1975 that encounter form design required careful attention and research, there is little evidence of improvements to the encounter forms in use today. There continues to be a need for additional research in the design and use of the encounter form as well as a need for research in other areas of data entry. Other types of data entry that may prove suitable for AAMRS are on-line menu selection or voice data entry. On-lint menu selection is currently used in some hospital information systems. Voice data entry is a more recent development without any applications in practical use today, but it has promise for the future. A potential advantage of these types of data entry is that the providers may find them easy to use and thus they may be more receptive to direct data input and retrieval.

Table 6, on page 33, shows the capability of the systems for storing data in the computer. It can be seen that for the systems that can capture a large amount of medical data, there is little variation in the types of data that are stored in the computer. Even though a system has the capability to store large quantities of medical data, the amount actually stored varies among different installations. Based on the systems reviewed, the trend is to provide for the storage of a large quantity of medical data, with the exception of FMIS in Colorado.

Table 4: SYSTEM SERVICES

SYSTEM	COSTAR	TMR	RMIS	ARION	FMIS
MEDICAL:					
Patient Summary	X	X	X		X
Encounter Form for Visit	X	X	X		
Medical Flow Sheets	X	X	X		
Encounter Reports	X	X		X	X
Hard Copy Output Integrated with Traditional Medical Record			X	X	
Fully Automated Medical Record	X	X			
ADMINISTRATIVE:					
PATIENT SERVICES AND REPORTS					
Appointment Scheduling	X	X	X		
Visit Reminders	X	X	X		
Visit Registration	X	X	X	X	X
OPERATING SERVICES AND REPORTS					
Medical Record Pull Lists	X	X	X		
Pharmacy Labels		X	X		
Drug Costs Reported to Physician		X	X		
Third Party Eligibility	X	X	X		X
BILLING AND ACCOUNTING SERVICES					
Accounts Receivable and Billing	X	X		X	X
Patient - Bills and Statements	X	X		X	X
Third Party - Statements	X	X		X	X
Other Accounting Services	X	X		X	X
Accounting Data Input to Other Systems			X		
UTILIZATION REPORTS					
For Internal Use	X	X			X
For Outside Agencies	X	X			X
OTHER REPORTS AND DATA					
Quality of Care Review	X	X	X		
Health Care Planning	X	X	X		X
DATA RETRIEVAL					
On-line Inquiry	X	X	X		X
Database Searches	X	X	X	X	X
Terminals in Off-Site Locations	X	X	X		X
User-Defined Reports	X	X	X		X
OTHER USES MADE OF THE SYSTEM					
Medical Education		X	X		X
Research	X	X	X	X	X

Table 5: METHODS OF DATA ENTRY

SYSTEM		COSTAR	TMR	RMIS	ARION	FMIS
SOURCE:	Encounter Form . . .	X	X	X	X	X
DATA TYPE:	Values - Codes	X	X	X	X	X
	Free Text - Notes . .	X	X	X		
ENTRY METHOD:	CRT - Interactive. . .	X	X	X	X	X
	CRT - Fill in Blanks.	X	X			
DATA COLLECTED BY:	Physician/Provider	X	X	X	X	X
	Nurse	X	X	X	X	X
	Clerk	X	X		X	X
DATA ENTERED BY:	Physician/Provider		X			
	Nurse			X		
	Clerk.	X	X	X	X	X

Table 6: CONTENT OF THE AUTOMATED RECORD

SYSTEM	COSTAR	TMR	RMIS	ARION	FMIS
MEDICAL DATA					
Medical History and Physical Exam	X	X	X	X	
Problem Lists.	X	X	X		
Progress Notes					
Free Text	X	X			
Coded	X	X	X	X	
Patient Care - Plans/Follow-up					
Lab Orders.	X	X	X		X
Lab Results	X	X	X	X	
Drug Orders.	X	X	X	X	
Disposition	X	X	X	X	X
AMOUNT OF MEDICAL DATA					
Comprehensive	X	X		X	
Medium	X		X		
Sparse.	X				X
ADMINISTRATIVE DATA					
Patient Identification.	X	X	X	X	X
Patient Financial Information					
Account Status	X	X		X	X
Billing Information.	X	X	X	X	X
Payment Information.	X	X		X	X
Patient Visit Information.	X	X	X	X	X
Appointments.	X	X	X		

TECHNICAL ASPECTS

With respect to hardware, the 1975 study revealed no single approach to be superior in all cases to its alternatives. Both large and small computers, and both local and remote operations were used successfully. Nearly all system visited in 1975 provided on-line services. Communications problems were the predominant cause for lack of system reliability at the sites visited.

One site (AUTOMED) had a fairly large but obsolescent UNIVAC 494 computer when visited in 1975, but reports now to have successfully expanded its services with a Perkin-Elmer minicomputer. It is interesting to note that the site where the base system used by AUTOMED was developed, Stockholm, has also since then transitioned successfully to IBM 370 series equipment.[21]

CURRENT STATUS

With respect to technological system design, it is the conclusion of the site visit team that there have been no significant changes or innovations since 1975. Systems were developed along lines intended. There was little evidence of new innovations in design or termination of significant features. No truly distributed systems were seen, although some sites have multiple computers. It appears that the use of new technology has been definitely slower than the rate of development of new technology.

This conclusion is not meant to imply that important changes or improvements have not taken place, just that there have been no surprises. For example, all of the clinical sites visited in the 1975 study had database searching capabilities. Eleven sites could search any coded variable and boolean combination. In 1975 this capability was used to prepare standard reports either scheduled or upon request. Since 1975 significant progress in this area was observed with the development and addition of report generating or query language capability. The systems that have added this capability include COS'I'AR, 'I'MR, and RMIS. The report generators permit the user to select the information to be retrieved and the report format for the output. In addition to simple data retrieval, these report generators provide for analyzing the data along varying degrees of complexity.

Table 7, on page 35, shows the designer, computer language, and computer used for each site visited in the current study along with associated costs.

Hardware

The predominant hardware for AAMRS at the present time are minicomputers. Four of the five systems that were observed ran on minicomputer systems. The fifth, at the Arthritis Center, was a microcomputer-based system. The capability and plans to go to a microcomputer vary. Most of the developers planned to remain at the minicomputer level, but hoped to replace current computers with new, more powerful machines. For example, Dr. McDonald has replaced two DEC PDP-11 computers he was using at the time of our visit with a DEC VAX 11/780 computer to provide the RMIS with more memory for programs and data, and with more speed. The developer of TMR is in the process of implementing and testing a version of their system that will run on a microcomputer. 'I'he micro-

Table 7: SYSTEM SUMMARY DESCRIPTION

SYSTEM	COSTAR-NE	C O STAR-NC	TMR
DESIGNER	Laboratory of Computer Science, Massachusetts General Hospital	Laboratory of Computer Science, Massachusetts General Hospital	Div. of Information Science, Dept. of Community Medicine, Duke University
LANGUAGE	MUMPS	MUMPS	GEMISCH
COMPUTER SYSTEM			
Type	DEC POP 11	OEC PDP 11/70	Variety of DECs
Services	Shared	Dedicated	Shared
Size	Mini	Mini	Mini/Micro
Operating System	On-Line	On-Line	Timeshared
Terminals and Other User Interfaces	CRT, Printer	CRT, Printer	CRT, Printer
Num. of Terminals	20	30	2 0
Terminal Users	Medical, Clerical	Medical, Clerical	Medical, Clerical
COSTS			
Investment		$284,100	
Operating Per Year	$33,420	$82,000	
Source of Funds	Grants In House	Grants	In House

SYSTEM	RMIS	ARION	FMIS
DESIGNER	Regenstrief Institute	Arthritis Center	Community Consortium
LANGUAGE	VAX BASIC	BASIC	MIIS
COMPUTER SYSTEM			
Type	DEC VAX 11/780	WANG	DEC PDP 11/50
Services	Shared	Dedicated	Dedicated
Size .	Mini	Micro	Mini
Operating System	Timeshared	On-Line	On-Line
Terminals and Other User Inter-faces	CRT, Printer	CRT, Printer	CRT, Printer
Num. of Terminals	. 45	2	25
Terminal Users	Medical, Clerical	Medical, Clerical	Medical, Clerical
COSTS			
Investment		$25,000	
Operating Per Year		$22,000	$348,000
Source of Funds	In House	Private Some Grant	Grant User Fees

version is being dcvclopcd in addition to the current minicomputer version, not as a rcplacemcnt. If they are successful in this endeavor, it may open the possibility of placing an AAMRS into the small practice. The current minicomputer-based systems are too expensive for anything less than a group practice which has several providers. The dcvclopmcnt of a usable, well-documented system that runs on a microcomputer would do much to increase the number of systems in the field.

Hardware is not a determining factor in describing the diffcrcnccs of the observed AAMRS. The hardware is basically the same for most of the systems. The hardware being used today is generally rcliablc. While system rcliability was discussed extensively during the 1975 visits, it is not an issue today. There have been instances where the processing speed of a particular system is not as fast as was expected or desired by a particular site. This has generally been attributed to either a lack of computing power (too small a model of the computer for the work load) or to inefficiencies in the software of the AAMRS.

Software

Although each of the d&lopers appears to have used standard programming techniques, there is some variation in the ways these techniques were used. Though wc have a general understanding of each of the approaches taken, due to visit time restrictions and in some instances a reluctance to divulge detailed information, a thorough understanding of detailed program specifications was not obtained. It appears that each of these systems used tried and true software tcchniqucs, which is the best approach to take when developing a svstcm that is to bc widely disseminated.

As can be seen in Table 7, on page 35, each of these systems has been written in a different programming language. This is insignificant as long as each of these languages gains widespread support and acceptance. The acceptance is important if personnel at the user site arc expected to make site-specific modifications. All of the languages used by the visited systems arc fairly well known with the exception of GEMISCH. The clevclopcrs of TMR do not see this as a drawback since at the present time they do not envision allowing users to modify the system. Furthermore, the TMR developers characterize GEMISCH as a well-known, relatively little known language, which irnplies that the language may not be widely used or common, but it is well understood by those who use it. Languages which earlier were considered uncommon, MUMPS and MIIS, have been promoted and are now more widely used. Howcvcr, when compared to other high level languages in use today such as PASCAL, FORTRAN, or BASIC, the MUMPS and MIIS languages arc still relatively uncommon.

The systems observed all run in an on-line mode. As far as could bc dctcrmincd, only RMIS ran a "batch-mode" to enter data into the system. All of the systems use on-lint CRTs to query the databases for patient medical and/or financial information. Two of the systems, COSTAR and RMIS, allow the user to define his or her own report format.

A major concern that was found in this area was a lack of software competence at the user sites. Except for RMIS and ARION, which are, written in BASIC, the other systems visited in this study were written in languages that arc not being taught in data-processing or computer science curriculums.

Typically, cxpcrienccd programmers require at least a half year's experience to attain a professional level of competence in new languages. At each of the sites visited, with the exception of those sites where the developer was in rcsidcncc, there were no individuals who felt comfortable with making even minor software modifications. This puts the burden of tailoring the system for the specific sites on the vendor or system developer. There arc mixed feelings about this from the developers intcrviewcd. Several want this direct control of their product, whereas others would not like to become involved with making modifications that may apply only at a specific site. It is the feeling of the visit team that in order to implement one of these systems, it is essential to have some software competence at the site during the implementation.

FUTURE POTENTIAL OF AAMRS

It appears that the general development and growth of the type of AAMRS examined in this study is following that of Hospital Information Systems (HIS). The development, implementation, and acceptance of HIS have been slow, and most systems are primarily administrative/financial in character. It is predicted that the large AAMRS will take the same path.

In consideration of the current lack of evaluative information on AAMRS today, it is recommended that for anyone considering the implementation of any type of AAMRS, a visit should be made to sites where the system is operational. Particular attention should be paid at the site to how the system actually works; the requirements for implementation; costs associated with implementation, training, and routine operations; and any special or unique problems that need resolving.

The large AAMRS available today should be considered first generation systems that have evolved through modifications and additions to those systems examined in the earlier 1975 study. As lessons are learned from the transfer and commercialization of these systems, new generations should be developed that will be more responsive to the needs of the market and that will incorporate current and future tech nological advances. Important issues to be addressed in the development of new AAMRS include (1) how to get the practitioner more involved with using the system; (2) more efficient methods of data capture and entry; and (3) improvements to user interaction with the system.

For the private physician or small group practice, there is strong evidence that the microcomputer will have a major influence on the development of ambulatory medical record systems. Individual physicians are acquiring the low cost microcomputers and slowly creating systems to meet individual needs. Because the use of a micro does require initiative on the part of the physician to acquire some level of technical computing competence, it is not clear how widespread the use of micros will be. Many of the initial systems will stress a few services out of the spectrum of the physician's personal needs. However, as soon as acceptable and effective medical record software packages are available for the micros, the use of computers as aids to the practice of medicine may change significantly.

In the short run, it is not expected that an AAMRS will have a measurable impact on patient outcome. That is because the AAMRS provides services to the process of providing health care. Even though the process may be improved, it is not clear that the patient will be healthier. However, the patient may be happier because the care was perceived to be better. The extent of AAMRS impact on the process of providing health care will depend on the providers' acclamation to the idea of an automated record, and whether they learn to use the system effectively.

In the long run, there is every indication that AAMRS can have a significant influence on patient outcome, particularly from the results of productive research using data from and the analytical capability of the larger AAMRS. Furthermore, future incorporation of new technologies such as artificial intelligence into AAMRS has great potential for improving medical decision making and medical education.

APPENDIX I

VISIT REPORTS FOR SITES VISITED IN THE FOLLOW-UP STUDY

VISIT REPORT: COSTAR

SYSTEM NAME	COSTAR V - Computcrd-Stored Ambulatory Record System
SITES VISITED	NE - North End Community Health Center, Boston, Massachusetts NC -North County Health Services, San Diego County, California
DESIGNER	Laboratory of Computer Science Massachusetts General Hospital Boston, Massachusetts

SYSTEM CHARACTERISTICS

A totally automated medical record system intended to permit complete replacement of the traditional medical record. The system is modular in design. Basic modules include patient registration, scheduling, accounts receivable/billing, medical data entry/display/print, report generator, and system maintenance. The system is designed to permit a high degree of flexibility in adapting the system to meet specific needs of individual users.

Literature References to System Descriptions:

Beaman, P.D., Justice, N.S., and Barnett, G.O., "A Medical Information System and Data Language for Ambulatory Practices," *Computer*, Vol. 12, 1979, pp. 9-17.

Barnett, G.O., Justice, N.S., Somand, M.E., Adams, J.B., Waxman, B., Beaman, P.D., Parent, M.S., and Greenlie, J.K., "COSTAR - A Computer-Stored Medical Information System for Ambulatory Care," *Proceedings of the IEEE*, Vol. 69, No. 9, September 1979, pp. 1226-1237.

SYSTEM OBJECTIVES

- To have medical information available when needed.
- Reduce duplicate data capture.
- Facilitate selective data retrieval.

SYSTEM BENEFITS

- Modular design - can be phased in.
- User flexibility.
- Organization of medical data - patient summaries.
- Ability to retrieve a variety of information.

SYSTEM PROBLEMS

- High cost for small group practices - this may change as service bureau activity increases.
- Limited number of experts in MUMPS.
- High cost of installation - training, system modification.
- Limited number of experts in installing and modifying COSTAR.
- Requirement for ongoing technical support.

LIMITATIONS

While the system is suitable for use by small group practices, some of the benefits derived from the system may have greater marginal economic value to a large multiple provider practice.

EVENTS SINCE LAST VISIT

The version of the system reviewed in the 1975 study, COSTAR IV, continues to be in operation at the Harvard Community Health Plan. As a result of the changes in system design that were made to the system, a new version now exists, COSTAR V. The significant changes and improvements that were made to the COSTAR system include:

- The adoption of a modular system design.
- The addition of the Accounts Receivable and Billing Modules.
- The addition of the Scheduling Module.
- The addition of a Report Generator Module.
- Improvments to the Registration Module.
- Enhancements of medical output including patient summaries and medical flow charts.
- The development of a Medical Query Language.

COSTAR V is a result of the development efforts of the Laboratory of Computer Science (LCS), the Digital Equipment Corporation, a Federally funded group at The George Washington University, and the National Center for Health Services Research.

Other significant events include:

- The standardization of the MUMPS language.
- Federal Government support of activities directed toward the transfer and comnicrcialization of COSTAR.
- The formation of a COSTAR users group.

In additon to its continuing research and development activities, the Laboratory of Computer Science is functioning as a service bureau and is providing the computing resources and software support to four COSTAR installations.

. SYSTEM TRANSFER

Of the AAMRS reviewed in 1975, the COSTAR system has undergone more extensive transfer than any other system. A major factor contributing to the extent of transfer was the direct involvement and support of the Federal Government. The National Center for Health Services Research participated in software design and development activities, supported the preparation of technical and user documentation, sponsored the installation of COSTAR at a demonstration site, and awarded a contract to The MITRE Corporation to facilitate the transfer of COSTAR. The Health Underserved Rural Areas (HURA) program, of the Department of Health and Human Services, also sponsored the installation of COSTAR at a demonstration site.

The purpose of the contract awarded to The MITRE Corporation was to:[19]

- refine and disseminate the public domain version of COSTAR,
- update the system's documentation,
- provide technical assistance to organizations interested in marketing COSTAR as a commercial product,
- conduct training sessions about the system on an as-needed basis, and
- disseminate articles and information about the system to interested individuals and organizations.

In December 1980 there were 26 operational COSTAR installations and 11 planned installation in this country. Additionally, there were five operational installations outside of the United States.[19] Currently there are about. LOO members in the COSTAR Users Group, and the COSTAR mailing list exceeds 1,000.[22]

As of December 1980 there were 17 different organizations involved in activities relating to the transfer and installation of COSTAR systems. These organizations include commercial vendors, technical support groups, developers, software suppliers, and implementors of the system.[19]

COMMERCIAL AVAILABILITY

COSTAR is available from a variety of commercial vendors. Commercial versions of COSTAR include (a) complete systems for group practices and small-to-medium sized hospitals, and (b) timesharing services for small practices.

HARDWARE	COSTAR can be implemented on any computing equipment that supports the MUMPS operating system.
SOFTWARE:	Standard MUMPS.

COSTS

The COSTAR V system was developed by the Laboratory of Computer Science with financial support from the National Center for Health Services Research (NCHSR) and collaboration from Digital Equipment Corporation (DEC), NCHSR, and the Department of Clinical Engineering, The George Washington University. There are no firm figures available as to the total cost of the development effort for the COSTAR system. At the Laboratory of Computer Science, the cost of COSTAR development is estimated to be between two and three million dollars. The total development and transfer efforts have been estimated to be as much as ten million dollars.[23]

Research funding of the Laboratory of Computer Science has continued but at a greatly reduced level. Currently, Federal research support is being directed toward the development of the Medical Query Language.

COSTAR USER SITE: NE

USER SITE VISITED — The North End Community Health Center
Boston, Massachusetts

NATURE OF HEALTH CARE SETTING

A nonprofit fee-for-service primary health care facility serving a lower middle working class patient population that is 50 percent Italian.

SYSTEM OBJECTIVES AT USER SITE

- Meet administrative reporting requirements of supporting agencies.
- Availability of medical records.
- Relatively inexpensive system with no major hardware investment.

SYSTEM BENEFITS AT USER SITE

- More accuracy than in previous manual system.
- Capture of lost charges and improved cash flow.
- Better follow-up of abnormal results.

SYSTEM PROBLEMS AT USER SITE

- Costs associated with system modifications and enhancements limit the number that can be implemented.
- Poor installation service from telephone company.
- 300 baud terminals are too slow. Cost constraints apparently precluded the installation of faster communication equipment.

SYSTEM USER - NORTH END

CHARACTERISTICS — Medium-size, multiple provider neighborhood clinic.

NUMBER AND LOCATION — One clinic in the North End area of Boston, Massachusetts.

PATIENT POPULATION

TYPE — Primarily a low income, urban worker population. Sliding fee scale.

SIZE — 10,000 patients.

VISITS — 50,000 per year; 175-200 encounters per day.

COMPUTER PROVIDER — Laboratory of Computer Science
Massachusetts General Hospital
Boston, Massachusetts

HARDWARE At the Laboratory of Computer Science, there are three DEC PDP 11/70's, two for production and the other for software development and back-up.

USER INTERFACE

DATA ENTRY Direct entry from encounter forms on cathode ray tube (CRT) terminals.

TERMINALS Fifteen CRTs and 2 printing terminals (1 at 300 BPS and 10 at 1200 BPS).

COSTS TO USER

HARDWARE Nine partitions at $225 per month, for a total of $2,025 per month. The fees paid by the user are only a part of the total cost of services provided, the remaining costs being subsidized by the Laboratory of Computer Science and the Massachusetts General Hospital.

SOFTWARE Programming support: $500 per month (also partial costs).

MAINTENANCE CRT and modem $12 per month; for 15, $180 per month. Printer $40 per month; for 2, $80 per month.

COSTAR *USER SITE: NC*

USER SITE VISITED North County Health Scrviccs (NCHS)
San Diego County
San Marcos, California

NATURE OF HEALTH CARE SETTING

North County Health Scrviccs (NCHS) is a fee-for-service organization that provides prcvcntive, acute, and chronic health care to residents of North San Diego County. Health care is dclivcrcd at five clinics primarily by nurse practitioners with physician back-up. Much of the patient population is Spanish speaking, and most members of the NCHS staff arc bilingual. Patient services include health education, outreach care,. home health care, patient transportation, and mental health counseling by bilingual counselors.

SYSTEM OBJECTIVES AT USER SITE

- Efficient review of the performance of mid-level practitioners (physician's assistants and nurse practitioners).
- Availability of medical records.
- Uniform medical record keeping.
- Report generation capability.

SYSTEM USER - NCHS

CHARACTERISTICS Medium-size, multiple provider, and multiple site health care setting. The system is used by providers and administrative staff. Providers use hard copy output from the system. Patient registration and updates are done interactively with a CRT by clerical staff.

NUMBER AND LOCATION
Five sites in the northern part of San Diego County.

PATIENT POPULATION

TYPE A large Spanish speaking component. Some Indians from nearby Indian reservations. Primarily a low income, rural, migrant worker population. A sliding scale payment program is available to eligible patients.

SIZE In 1979, NCHS provided care to over 14,000 pnticnts.

VISITS About 55,000 cncounters per year; at the individual sites the cncounters range from 1,600 to 24,000 per year.

HARDWARE At NCHS the computer services arc provided by an in-house facility consisting of a purchased DEC PDP 11/70, equipped with a main memory and a cache memory; three 28-million character disc drives; a medium-speed printer (180 characters per second); a 9-track magnetic. tape drive; console printers; and two 16-channel multiplexers.

USER INTERFACE

DATA ENTRY — Direct entry from patient encounter forms on four cathode ray tube (CRT) terminals, located immediately adjacent to the computer room, are used by a data entry group and the administrative office staff.

TERMINALS — Varies by site:

San Marcos Clinic - 4 data entry CRTs, 1 slow-speed printer, 1 IA-180 medium-speed printer in the administrative office, 2 CRTs in the clinic.

Ramona Clinic - 4 CRTs (physician office, data entry, front desk, screening room), 1 slow-speed printer.

Santa Ysabel Clinic - 1 slow-speed printer.

Valley Center Clinic - 2 CRTs (front desk and provider area), 1 slow-speed printer.

San Dieguito Clinic - 3 CRTs (providers, front desk, and screening room), 1 slow-speed printer.

COSTS TO USER

HARD WARE — $284,100.

SOFTWARE — $25 for public domain version.

MAINTENANCE — $12,300.

OPERATIONS — $70,500 per year.

VISIT REPORT: TMR

SYSTEM NAME TMR - The Medical Record

SITE VISITED Du kc Univcrsi ty Medical 'Center
Durham, North Carolina

DESIGNER Division of Information Sciences
Dcpartmcnt of Community and Family Medicine
Duke University Medical Center
Durham, North Carolina

SYSTEM CHARACTERISTICS

TMR is a total computerized medical record system which is basically completed, but still undergoing some system "enhanccmcnt." It is designed to replace the written record. TMR provides total administrative, financial, and medical management capabilities for the patient cncountcr. The TMR record focuses on the patient as an individual.

The system is composed of modules designed for collection of demographic data, appointment data, provider data, financial data, generation of problem lists, management of subjective and physical examination data, management of lab data, generation of requisitions and work sheets, prescription writing, identification of drug interactions, creation of flow sheets, and creation of drug information sheets for patients. The system provides well-formatted data, particularly cncountcr data and laboratory data. The pharmacy subsystem can do such things as generate lists of patients whose medicines will expire on a given date, prepare prescriptions giving dosage choices, and calculate the day the prescription will run out. TMR creates an integrated medical and accounting database which allows detailed review of both health and financial history. The system is designed to bc transferable to other health care settings. Formal evaluation of the system is currently being conducted.

TMR is in its most complete form and use at the Durham Veterans Administration Hospital Renal Dialysis Unit and Nephrology Clinic, where it was implemented starting in 1977. Some other Duke University clinics, including OB/GYN, will soon bc coming on to the system.

Literature References to System Descriptions:

Stead, W.W. and Hammond, W.E., "How To Realize Labor Savings with a Computerized Medical Record," *Proceedings of the Fourth Annual Symposium on Computer Applications in Medical Care,* Vol. 2, November 2-5, 1980, pp. 1200- 1205.

Hammond, W.E., Stead, W.W., Straube, M.J., and Jclovsck, F.R., "Functional Characteristics of a Computerized Medical Record," *Methods of Information Science,* Vol. 19, No. 3, July 1980, pp. 157-162.

Hammond, W.E., Stead, W.W., Straube, M.J., and Jclovsck, F.R., "A Clinical Data Base Managcmcnt System," *Policy Analysis and Information Systems,* Vol. 4, June 1980.

SYSTEM OBJECTIVES

- To create a medical record that physicians can use.
- To increase record availability, accuracy, and legibility.
- To be transferable to other health care settings.

SYSTEM BENEFITS

- A very good pharmacy subsystem.
- Good patient summary. Well-formatted encounter and laboratory data.
- Excellent USC of display capability.
- Large volume of standard reports; the system is dcsigncd to USC all data that are input in some meaningful output.
- Reports are well dcsigncd from physicians' and patients' standpoints.
- Financial reports and billing arc up and running.

SYSTEM PROBLEMS

- Good user documentation, but nosystcm documentation.
- Lack of flexibility to meet unique needs of user. At the time of the visit, the system did not provide for user-dcsigncd searches for data retrieval. Since the visit, a report generator has been added to the system, and it is receiving more use than anticipated.
- System encourages coded data, not "free text." However, free text may bc entered at any major element.

LIMITATIONS

None. The system can handle a small practice up to a large clinic, although some aspects of TMR are untried at present.

EVENTS SINCE LAST VISIT

This system has progressed as the designers said it would during the first visit. It has a unique leadership combination of an interested and talented computer scientist and a physician. The development of the software is almost complete. Five years ago TMR was primarily an administrative system; now it has all the components for a total computerized medical record.

SYSTEM TRANSFER

Even though TMR was designed to meet local needs, the developers also had transfer in mind from the beginning. In addition to the users in North Carolina, the system recently was installed in a large private group practice in Los Angclcs, California. The practice consists of forty to fifty MDs.

COMMERCIAL AVAILABILITY

Currently limited, but available. TMR is commercially available from a vendor organization formed by the developers of the system.

SYSTEM USERS

NUMBER AND *LOCATION* The users in North Carolina are:

University Health Services - multipurpose clinics, using administrative and financial services.

Family Medicine Clinic (FMC) - pharmacy module capturing drug and demographic data.

Veterans Administration Hospital, Renal Dialysis Unit and Nephrology Clinic - full medical record.

OB/GYN Clinic - appointment system, some medical record, other modules being introduced, goal to tie in with the hospital's information system.

MPDC (Medical Private Diagnostic Clinics) - appointment system.

SPDC (Surgical Private Diagnostic Clinics) - appointment system.

PATIENT POPULATION Renal Dialysis Unit and Nephrology Clinic:

All patients have severe renal disease and most are on chronic renal dialysis. Twice the patient load per staff compared to other VA clinics.

COMPUTER PROVIDER At Duke the computer services are provided by the Division of Information Sciences.

HARDWARE At the time of the visit the system was running on a PDP 11/45, a DEC minicomputer, with plans for micro applications. The system is now available on the following additional computers: PDP 11/23, PDP 11/40, PDP 11/44, PDP 11/70, VAX 750, and the VAX 780.

SOFTWARE GEMISH, a relatively little known, higher level language.

USER INTERFACE

DATA ENTRY Data are collected on an encounter form, either by provider or administrative personnel. Data may be entered by either clerical or medical (MD) personnel.

TERMINALS CRTs, the number varies among individual clinics.

COSTS

UNIVERSITY CLINICS

Clinics with their own computer are charged $18,000 a year for the software and software sup'port. The rate is negotiable. If the clinic has no hardware, the service charge is $4,000 per terminal plus $.10 per block per year for storage. A typical annual charge is $20,000 to $30,000 per year. Users buy their own terminals.

HARDWARE

Division of Information Sciences' equipment: $100,000.

COMMERCIAL SYSTEM

Cost of software package to outsiders is $60,000 plus expenses during installation. Software maintenance is 10% of selling price. Software modifications are done at additional costs if the modifications are unique to the clinic.

VISIT REPORT: RMIS

SYSTEM NAME	RMIS - Kcgcnstricf Medical Information System
SITE VISITED	Regenstricf Institute Indianapolis, lndiana
DESIGNER	Clcmcnt J. McDonald, M.D. and his staff Regenstricf Institute Indianapolis, Indiana

SYSTEM CHARACTERISTICS

The system consists of five modules: (1) Medical Record, (2) Pharmacy, (3) Lab, (4) Scheduling, and *(5)* a Data Base System. 'J'hc system was designed to meet the specific needs of the environment at the Regenstricf Institute. The medical module includes all diagnoses, diagnostic study results, records of all medications prescribed, and vital signs recorded since the patient was registered. The information contained in the computer record and-represented in the summary prepared by the computer is, in general, not duplicated in other parts of the medical record. Physician notes and inpatient medications arc not included. The medical data provided by the system arc considered a partial rather than a total replaccmcnt for the medical record. A unique feature of the system is that it supplies the providers with reminders and some generic rules of treatment. The nature of the health cat-c settings currently using the system are medical outpatient clinics in a large county hospital.

Literature References to System Descriptions:

McDonald, C., Blevins, L., Chamness, D., Glazener, I'., and Haas, J., "Minicomputer Improves Clinical Heal th Care," *Mini-Micro System,* Oc tober 1979, pp. 86-92.

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SYSTEM OBJECTIVES

- Improve access to the medical record.
- Improve quality of care by having the computer do some of the analysis.
- Provide better feedback to the provider.
- To improve patient compliance.
- To reduce the number of redundant lab tests.

SYSTEM BENEFITS

- Provides a comprehensive patient summary.
- Does scheduling for the clinics.
- Greatly improves access to medical record.
- Provides flexible report generating capability.
- Monitors lab procedures and results.
- Writes all prescriptions, maintains a record of them, and prints reminders when they must be refilled.
- Generates problem lists from database.
- Provides billing transaction information for all the laboratory and pharmacy transactions.

SYSTEM PROBLEMS

- Little system documentation available.
- No financial package.

LIMITATIONS

The system is most applicable to large clinics and hospital environments. Planning is underway for conversion of the medical record system to a microprocessor for smaller environments.

EVENTS SINCE LAST VISIT

Five years ago the RMIS system was only in use in the Diabetes Clinic. Now it is operating in the General Medicine Clinic and is providing a much broader scope of capabilities. The system now includes a hospital and full outpatient pharmacy module. New reporting capabilities include patient surveillance, patient summaries, pharmacy labels, and all of the lab and pharmacy reports. The use of OCR data entry has been discontinued.

SYSTEM TRANSFER

The system is written in VAX BASIC (registered trademark of Digital Equipment Corporation) which is supported by the Digital Equipment Corporation. At the time of visit, the apparent lack of documentation indicated that implementation of the system at other sites would be difficult. Currently, the designer states that some of the modules are now well documented and ready for transfer. Documentation for other modules is insufficient for transfer.

COMMERCIAL, AVAILABILITY

Two modules, the database management system and the pharmacy system, can be purchased from the Digital Equipment Corporation through their external application software library. Other modules are likely to be made available through the same mechanism.

SYSTEM USERS

CHARACTER ISTICS Large-scale county hospitals.

NUMBER AND LOCATION
There are two operational RMIS installations. One at the Rcgenstrief Institute and one at St. Vincent's Hospital, both in Indianapolis, Indiana.

PATIENT POPULATION

TYPE Outpatients at the clinics of the hospital.

SIZE Records arc stored for 60,000 rcgistcrcd patients.

VISITS 50,000 visits per year.

COMPUTER PROVIDER In-house facilities of the Regcnstricf Jnstitute.

HARDWARE One Digital Equipment Corporation VAX 11/780.

SOFTWARE BASIC-PLUS 2, a DEC product.

USER **INTERFACE**

DATA ENTRY Done by pharmacy, laboratory, and clerical staff from encounter forms filled in by the provider and frorn various source documents.

TERMINALS CRTs, approximately 45.

COSTS The only cost figure made available is that it costs St. Vincent's Hospital $14,000 per year to run the system. This was stated as a marginal cost. Other detailed costs were not or could not be made available.

VISIT REPORT: ARION

SYSTEM NAME	ARION - Arthritis Research Information Office Network
S JTE VISITED	Arthritis Center Wichita, Kansas
DESIGNER	Fred Wol fc, M.D. Arthritis Center Wichita, Kansas

SYSTEM CHARACTERISTICS

A medical record sysrcm that s·rvcs the local record keeping needs of the Arthritis Center and as a data collection activity for the ARAMIS Project at Stanford University. ARAMIS (the American Rheumatism Association Medical Information System) maintains a group of nine parallel databanks accessible through a national communication network. The AR ION system was dcvclopcd over a five year period on minicomputers (Wang). The primary objective of the system is to collect research data to be used in studying the long-term epidemiology of rheumatic discasc, and for the use of these data in patient care. The system is designed for data capture rather than data analysis. Thus, the system is primarily a data entry and data formatting system. For the Arthritis Center, the system provides an organized printout of the medical data.

The Arthritis Center is a specialty clinic in Wichita, Kansas. It is a private practice under the direction of one physician, who has a staff consisting of a physician's assistant, nurses, and clerical help. The clinic is a major referral center for Kansas. It serves a population of 290,000 in Wichita and 390,000 in the surrounding county from rural, urban, and suburban areas. The practice sees about 1,000 new patients a year.

Literature References to System Descriptions:

Wolfe, F., "Computer Research in Clinical Practice," *Arthritis and Rheumatism,* Vol. 25, 1982, p. 526.

Wolfe, F. "A Computer Version of the Uniform Database for Rheumatic Disease" (Abstract), XIV International Congress of Rheumatology, 1977.

SYSTEM OBJECTIVES

- To collect rcscarch data for the Stanford ARAMIS Project.
- To provide data that will improve on patient follow-up.

SYSTEM BENEFITS

- Major contributor of data for rcscarch.
- Data collection process has helped organize office procedures.
- Data helps ongoing patient care.

SY STEM TRANSFER

The system has been given to the Department of Rheumatology at Hancmann Medical College and Hospital, Philadelphia, Pennsylvania.

COMMERCIAL AVAILABILITY The system is not commercially available.

SYSTEM USERS

CHARACTERISTICS Specialty clinic, a major referral center for the city of Wichita and surrounding county area. Medical and clerical personnel within the Arthritis Center.

Researchers utilizing the ARAMIS database at Stanford University.

NUMBER AND LOCATION
One clinic location.

PATIENT POPULATION

TYPE Patients with specialty needs in rheumatoid arthritis coming from the general population in the surrounding county and State.

SIZE A population of approximately 400,000 in the area served. Patient population is over 7,000. The clinic sees about 800 to 1,000 new patients a year.

VISITS About 3,000 per year.

HARDWARE Wang MODEL 2200 VP computers purchased by the clinic:
two processors - one used for business applications and the other used for medical data.

SOFTWARE BASIC.

USER INTERFACE

DATA ENTRY Direct cntrj from encounter forms on CRT terminals.

TER MINA LS Five CRTs ,1 mag card typewriter, 3 printers.

COSTS The system was dcvclopcd with some financial support from the ARAMIS project at Stanford University.

HARDWARE Maintenance about $5,000 per year.

OPER ATIONS Total costs about $38,000 per year; net costs to the clinic about $22,000 a year. The costs include research activity.

VISIT REPORT: FMIS

SYSTEM NAM E	FMIS - Family Mcdicinc Information System Community Electrocardiographic lntcrprctativc Service Denver, C o l o r a d o
SITE VISITED	Crow Hill Family Medicine Clinic Bailey, Colorado
DESIGNER	A consortium consisting of the following organizations: Community Electrocardiographic Interpretative Scrvicc Denver, Colorado, Department of Family Medicine University of Colorado Medical Center, and Mountain Plains Outreach Program.

SYSTEM CHARACTERISTICS

The Family Medicine Information System (FMIS) is an ambulatory care family-oriented information system, serving practices and family practice residency programs in urban and rural areas in Colorado. The major emphasis of this system's services is to provide administrative assistance to the family practice. The FMIS system is an on-line, centrally located system in Denver, with leased lines and terminals at outlying sites. The FMIS has three modules:

1. The Business Module: used for financial management and to improve cash flow. This is the FMIS billing system.
2. The Practice Analysis Module: used for practice management and provider training. It produces reports describing the patient population and types of services provided by provider seen within a practice, and by practice.
3. 'l'hc Medical Data Module: this module was under dcvclopmcnt and will bc used for patient managcmcnt to improve patient care. Scrviccs will include a mini medical record and special patient reports.

FMIS was designed as a part of the Mountain Plains Outreach Program (MPOP). The Mountain Plains Outreach Program's objectives arc to attract physicians to the rural areas and then to have them stay there. To accomplish these objectives, MPOP provides free WATS lines to the Rose Medical Ccntcr in Dcnvcr for consultative advice, free consulting scrviccs, practice coverage services, and support to FMIS. FMIS in turn provides financial and administrative support scrviccs to the rural physician.

Literature References to System Descriptions:

Green, L.A., Simmons, R. L., Frank, M. R., Warren, P.S., and Morrison, J. D., "A Family Medicine Information System: The Beginning of a Network for Practicing and Resident Family Physicians," *The Journal of Family Practice,* Vo1.5, No. 3, 1978, pp. 567-576.

SYSTEM OBJECTIVES

- To support primary care training programs, primary care physicians in both urban and rural settings, health care planning groups as well as clinical and epidemiological research.
- To provide a complete patient accounts receivable package for the physician, and demographic and clinical descriptions of populations at risk and populations under care.
- To assist the practicing physician in providing care for the individual patient.

SYSTEM BENEFITS

- Financial and administrative services.
- The system is designed as an administrative aid for small practices.
- The system produces a variety of standard reports (not all reports are used by all practices.)
- New users of the system are given instructions in using the system along with written documentation. Training is provided by a professional staff member of FMIS and lasts about six weeks.
- User group meetings are held regularly, and often are used to help explain certain features of the system,
- A user manual is provided to all new users of the system.

SYSTEM PROBLEMS

- For small practices the system may be considered expensive without MPOP subsidies.
- This system is very limited in the quantity of medical data that it contains.

LIMITATIONS

The system was designed and is used primarily as an administrative and financial system.

SYSTEM TRANSFER

The system is easily transferred by adding new users to the existing system. Total system transfer was being implemented at the time of the visit. A new system was being installed in Casper, Wyoming.

COMMERCIAL AVAILABILITY

FMIS services are available from CFIS to any family practice in Colorado. The software is available at no charge to anyone who requests it.

SYSTEM USERS

CHARACTERISTICS Urban and rural family practices throughout the State and family practice residency programs in Denver. About half of the user sites are sites supported by the Mountain Plains Outreach Program.

NUMBER AND LOCATION

Eight family practice rcsidcncies: six in Denver and two in Wyoming.
Five urban family practices in Denver.
Ten rural family practices: nine in Colorado and one in Wyoming.

PATIENT POPULATION

TYPE The patient population comes from all socioeconomic classes.

SIZE There arc 1,000 to 12,000 active patients per practice. For thc entire system there are 135,000 registered patients and 65,000 patients in the active file.

COMPUTER PROVIDER The Community Electrocardiographic Interpretative Service.

HARDWARE One DEC 11/50, with 256 KB.. Two CDC mass storage discs, with 300 MC.

SOFTWARE MIIS, a dialect of MUMPS.

USER INTERFACE

DATA ENTRY Direct entry from an Encounter Form, Family Information Sheet, Receipt and Adjustment Form, and Jnsurancc Vouchers.

TERMINALS Each site has at lcast one CRT and one printer. Terminals operate at 30 characters per second or at 120 characters per second.

COSTS

DEVELOPMENT $600,000 - $700,000, with the Department of Health and Human Services' I-fcalth Undcrscrvcd Rural Areas program providing about 40-50% of the costs.

FMIS MONTHLY SERVICE AND OPERATION COSTS - as of February 1981

HARDWARE (includes Maintenance)		
	PDP 11/50 Computer System	$4,844
	Mass Storage	3,230
	Terminals and Modems at Practices	3,083
COMMUNICATIONS	Leased Lines	4,404
SOFTWARE MAINTENANCE		1,101
FMIS SERVICE	Service Manager, Travel, Telphone, Postage, and Photocopying	3,796
OPERATIONS	Includes Personnel and Delivery	7,520
SUPPLIES		955
TOTAL MONTHLY COST		$28,933

SERVICE BUREAU - TIMESHARING

Users are charged fixed monthly fees for equipment installation and operation and for data storage, plus additional fees for special services. When compared to other systems reviewed in this study, the cost to users of the FMIS is relatively low. However, when compared to other billing systems, the cost to individual users may be high. Some of the standard fees as of March 1980 were:

INSTALLATION (One Time Charge)	
Computer Terminal and Telephone Line	$250
FMIS Charge, includes Training	$500
OPERATION (Monthly Fee)	
Each CRT and Printer Terminal	$105
Each Additional CRT Terminal	$ 85
Each Computer Section - per Terminal	$100
Data Storage and System Operation - per Active Patient	$ 0.18
Supplies - per Statement	$ 0.16
OPTIONAL SERVICES (Monthly Fee)	
General Ledger - per Entity	$ 45
Payroll Reporting	$ 5

Special research studies and system programming services are available at $40 per hour. Cost of travel, lodging, and food are charged separately when incurred in connection with installation and management consulting services.

APPENDIX II

SITES VISITED FOR THE 1975 STUDY AND THEIR CURRENT STATUS

SITES VISITED FOR THE 1975 STUDY AND THEIR CURRENT STATUS

The following information on the current status of systems not visited during the follow-up study is taken from correspondence, reports, and personal conversations with the system developers.

ARAMIS Division of Immunology, Stanford University Medical Center TOD (Time-Oriented Data Bank), ARAMIS (American Rheumatism Association Medical Information System).

STATUS: ARAMIS remains operational and has increased the number of sites serviced by remote (TELNET) lines. Development work has concentrated on improved analysis and patient subset facilities. Medical issues addressed are patient education and treatment effectiveness analyses. Transfer of the underlying database system, TOD, to satisfy demand by non-ARAMIS users has been initiated. A service center for remote **use** is to be operated by the illinois Institute of Technology Research Center, using VAX equipment, with PL/1 under VMS.

AUTOMED

Medical Data Systems Corporation, Olmsted Falls, Ohio. A private for-profit service bureau. Primarily financial services for solo practitioners and small groups. Some medical data in the record; amount depended upon individual user.

STATUS: This system is still in full operation. Changes in this system include the implementation of a very large software package on two Perkin-Elmer 8/32 series machines which allowed a considerable expansion of the capacity and range of services, and a growth in the user base to a convincingly profitable level. The Perkin-Elmer machines supplement a UNIVAC 492 which provided the total processing capability for the system in 1975. An alternative product line, a stand-alone system using mini-micro hardware installed at user sites, was considered. However, it was determined that the approach cannot as yet be made economical for users and still provide more than trivial capabilities. Accordingly, consideration is being given to hybrid approaches that provide some on-site processing capability while allowing for central maintenance of the database and software. Service improvements have revolved around the system's scanning and report generation capabilities. A number of family practices are using AUTOMED to collect and analyze demographic, medical, and utilization data.

BELLEVUE

Pediatric Outpatient Clinic, Bellevue Hospital, New York City. Hospital-based clinic and emergency services. A supplement to the medical record, and medical record pulling service.

STATUS: The computer project serving the Pediatric Outpatient Clinic was terminated in 1976 because it was considered to be too expensive by the Chairman of the Department of Pediatrics. None of the services provided by the computer system is in use at this time, neither in Bellevue nor elsewhere. The Comprehensive Health Care Project, within which the computer system was developed, is still active.

BUMED The BUMED Computer Project, U.S. Naval Air Station Dispensary, Brunswick, Maine. Military dependents health services. A fully automated medical record.

STATUS: The project was cancelled at Brunswick in 1976. The Officer-in-Charge at the Naval Air Station could not locate correspondence regarding the cancellation; he recalled that it was considered too costly to operate and maintain at a branch clinic facility.

CC Cardiovascular Clinic, Oklahoma City, Oklahoma. Private group practice. A fully automated medical record system.

STATUS: This system apparently is still in operation. No information was provided by the Medical Director in response to several letter and telephone inquiries.

COSTAR Harvard Community Health Plan, Laboratory of Computer Science, Massachusetts General Hospital, Cambridge and Boston, Massachusetts. A fully automated medical record system.

STATUS: This system was visited for the current study; see the main body of this report.

DHD Appalachia II District Health Department, Greenville, South Carolina. Public health clinics: program orientation.

STATUS: System is primarily administratively oriented, but is collecting medical data. The medical record in this system is a component of a total management information system. The system was designed to support management in the agency, with the objective to improve the quantity and quality of health care via improved management efficiency. While all design objectives of the system as described in 1975 may not have been met, it is the view of the District Medical Director that outstanding progress has been made in meeting the overall objectives of the system. Documentation provided by the Director appears to support this view.

HIP Casa de Amigos, Department of Community Medicine, Baylor College of Medicine, Houston, Texas. Community - neighborhood clinics. A supplement to the medical record, the Health Illness Profile (I-HP).

STATUS: The system is still in existence, but not at the level it was when visited in 1975. Cutbacks were necessary due to funding reductions.

IHS Indian Health Service, Tucson, Arizona. Clinics on the Papago Indian Reservation. A supplement to the medical record.

STATUS: The system is now named the Patient Care Information System (PCIS). Several hardware changes have been made. The system now serves a wider geographic area, but in a microfiche rather than an on-lint mode. The PCIS databases now contain data for more than a quarter of a million patients. Third-party automated billing capabilities, Medicare and Medicaid in particular, have been developed.

ITC Insurance Technology Corporation, Berkeley, California. An information system used in processing Workman's Compensation Claims.

STATUS; The site visited in 1975 was discontinued when the company was taken over by a larger concern. Other sites remain operational and a large new installation, for the State of Washington's Workmen Insurance Plan, was commissioned a few years ago. That system includes the capability to enter, store, select, and display imaged documents with the keyboarded data, so that no paper record is needed at all. The technology of that system has been transferred outside of the medical field to utilities, oil companies, and some military installations.

LA County of Los Angeles, Department of Health Services, Los Angeles, California. A patient identification and record retrieval system serving hospital-based clinics in the County Medical Center and another system serving the East Los Angeles Child and Youth Clinic (ELACYC).

STATUS: The County Medical Center system has had significant changes. In particular, the system now provides (1) medical alert information at the time of registration: (2) it compares prescriptions given to patients and provides notices when certain combinations could be interactive or toxic: (3) medical record tracking; and (4) automated laboratory specimen handling and billing. The ELACYC system for maintaining records has not changed significantly.

MSIS Multi-State Information System, Rockland State Hospital, Orangeburg, New York. Mental health services hospital and community-based clinics. The system collected primarily administrative data used to prepare required reports to supporting agencies.

STATUS: Significant changes have occurred with this system. The changes include (1) since 1974 it has been operating as a nonprofit, 100% user-supported system (it is no longer dependent upon grant support); (2) new hardware was installed in 1980, an IBM 4341 - equipment changes include replacement of optical scanners with CRTs; (3) use of optical scan forms has decreased drastically (most forms now are keypunched); (4) new systems include drug ordering and exception reporting, incident reporting, automated treatment planning, behavioral rehabilitation, revised billing (Titles XIX and XX), personnel assignment, inventory control, and diagnosis recording; (5) national and local user groups have been formed, and the MSIS newsletter is now in its fifth year; and (6) statistical packages have been installed, including SAS, SPSS, SSP, BMDP, and P-STAT.

MUSC Department of Family Practice, College of Medicine, Medical University of South Carolina. Charleston, South Carolina. Residency family practice clinics. A fully automated medical record system, used in training.

STATUS: The philosophy and implementation of the system have been extensively revised. The orientation has shifted from training and administrative uses to one in which the system can be used as a clinical, administrative, and research tool for practicing physicians. Some of the new features include (1) the SCAMP system, which provides a tool for practice management and primary care physicians to perform research; (2) a clinical reminder system, which uses rules based on patient problems, medications, laboratory values and trends in laboratory values, and vital signs to identify patients needing further attention; (3) work has progressed toward a truly automated medical record - currently any portion of the record can be retrieved and printed in a very flexible inquiry and display system; and (4) other redesigns and improvements are underway.

RMIS Regenstrief Institute, Indiana University Medical Center, Indianapolis, Indiana. Hospital-based clinics. Development of a medical record supplement.

STATUS: This system was visited for the current study; see the main body of this report.

TMR Duke University Medical Center, Department of Community Health Services, Durham, North Carolina. Student health services and hospital-based clinics. A total medical record system was planned; administrative services were operational in 1975.

STATUS: This system was visited for the current study; see the main body of this report.

YALE Section of Medical Computer Sciences, Yale University School of Medicine, New Haven, Connecticut. A medical record information system for an HMO group practice. Goal to have the total medical record automated; minimally operational at time of visit.

STATUS: The system is no longer in existence. The project was terminated when funding ended and the project leader left.

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