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ANNOTATED BIBLIOGRAPHY OF PUBLICATIONS DEALING WITH
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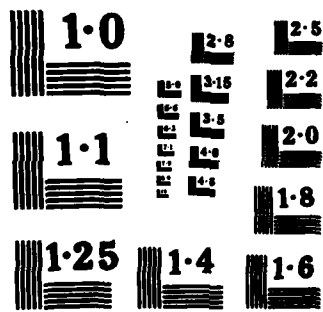
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ANNOTATED BIBLIOGRAPHY OF PUBLICATIONS DEALING
WITH OCCUPATIONAL HEALTH AND MEDICAL
INFORMATION SYSTEMS, COST ANALYSIS
PROCEDURES, EVALUATION METHODOLOGY,
AND RELATED LEGAL ISSUES

The purpose of this selective bibliography is to provide a sense of the scope of the literature relevant to the subject matter of interest in this project to test and evaluate the Navy Occupational Health Information Management System (NOHIMS). The intent has been to describe the contents of each reference in sufficient detail so that a decision could be made whether or not to obtain a copy of the complete article. There may be important omissions in this compilation of references because of the limitations of time and contract resources. However, the hope is that this annotated bibliography will provide a foundation upon which others can build in order to maintain a comprehensive and up-to-date guide to the pertinent literature on this subject.

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Barnett, G.O. The application of computer-based medical-record systems in ambulatory practice. The New England Journal of Medicine, June 21, 1984, 310(25), 1643-1650.

The author of this paper presents support for the gradual replacement of manual medical record systems with computer-based systems. He states as limitations of manual record systems the following:

1. The record can be physically unavailable because of loss or use by another practitioner.
2. The information can be poorly organized and illegible, making retrieval difficult.
3. Transcription errors can occur because the same information is required in several places in the medical record.
4. Quality of care and clinical studies are cumbersome and require many hours of searching by trained personnel.

The author describes the characteristics of a computer-based record system, which he bases largely on his experience with COSTAR. These characteristics are the following:

1. A computer-based record system should be comprehensive and should have no duplication of entry.
2. In most systems, data are collected on an "encounter form," which is prestructured. These forms allow both coded forms of data and narrative text.
3. There are two types of reporting functions: the first is immediate recall through inquiry at the terminal, and the second is the variety of reports available through the system.
4. A good computer-based system should provide a special query language that nonprogrammers can use to retrieve and analyze data and print ad hoc reports.
5. A good system should also provide new advances in quality assurance.

The implementation issues discussed by this author are cost justification and physician acceptance. Cost justification is difficult because there is little quantitative information available on the costs and benefits of manual versus automated systems, and because there are many functions made possible by an automated system which were formerly impossible with a manual system. The main objections physicians seem to have toward an automated medical record system are that it will impose limitations on how data are recorded and maintained, that data may be less secure, and that the system may disrupt staff working habits. The author suggests that these attitudes will only be overcome as automated systems are made more reliable and easier to use, and as physicians gain a better understanding of their potential advantages.

Barnett, G.O., McLatchey, J., Smith, M.M., Morgan, M.M., Zielstorff, R.D., Shusman, D., Piggins, J., Beaman, P.D., Barrett, S.M., & Colloff, E. COSTAR--1981. In H.G. Heffernan (Ed.), Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1981. Pp. 86-87.

This article reviews the current (as of 1981) status of COSTAR and identifies the factors which have facilitated and inhibited implementations at various sites.

Objectives which make COSTAR an attractive technology are as follows:

1. COSTAR consists of a comprehensive set of relatively independent components.
2. The medical structure and content of COSTAR are defined by the individual practice, without requiring extensive programming.
3. There is active support of COSTAR.
4. COSTAR can be implemented on a variety of computer systems.

Among the major problems which have been encountered thus far are:

1. Programming errors and functional limitations existed in the early versions of COSTAR.
2. The start-up effort required of personnel in the medical practice has been greater than desired.
3. COSTAR is a complex system, and there is sometimes inadequate documentation.
4. The cost of the required computer hardware has been greater than anticipated.

Barnett, G.O., Zielstorff, R.D., Piggins, J., McLatchey, J., Morgan, M.M., Barrett, S.M., Shusman, D., Brown, K., Weidman-Dahl, F., & McDonnell, G. COSTAR: A comprehensive medical information system for ambulatory care. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 8-18.

This paper describes COSTAR--Computer-Stored Ambulatory Record--which is designed to replace the traditional paper medical record with a comprehensive, centralized, and integrated information system. Aside from describing COSTAR itself, the authors discuss implementation issues of COSTAR, and criteria and issues involved in the evaluation of COSTAR. One of the most common pitfalls in introducing a computer-based information system is underestimating the magnitude and complexity of the effort required in the implementation phase.

Beck, D.D., & Pugh, W.M. Specifications for a Navy Occupational Health Information Monitoring System (NOHIMS): II. A functional overview. San Diego, CA: Naval Health Research Center, Report No. 82-6, 1982.

The objective of the Navy Occupational Health Information Monitoring System (NOHIMS) is to provide an information system that will coordinate the components of the Navy's occupational health program in order to meet the requirements of the Occupational Safety and Health Act of 1970. The present report develops in greater detail the design concepts introduced in an earlier report (No. 81-36), providing more specific information on the content of the personnel, environmental, and medical databases contained in NOHIMS. In addition, an overview of the functional specifications for NOHIMS is presented.

Belk, H.D., Sussman, N., & Bonney, T.B. The Alcoa Health Information System. Journal of Occupational Medicine, 1982, 24(10), 815-818.

This paper describes the health information system envisioned by a team at the Aluminum Company of America. It includes a broad definition of the objectives, scope, and requirements of a computer-based program.

The Alcoa HIS will consist of four major data files. The Medical File will contain all medical/health data acquired from the time of the preemployment medical history and examination through active employment until retirement or work termination. The Industrial Hygiene File will incorporate all industrial hygiene information concerning workplace exposures to chemical, physical, and biological agents. The Job History File will include complete work histories for the length of each worker's employment as well as pertinent demographic information for all participating employees. The Materials Inventory will contain and keep current a complete inventory of all chemical substances and physical and biological agents used or produced as products or by-products within the company.

The authors believe that the Alcoa HIS will permit development of an adequate, accessible health information base and will allow health personnel to evaluate systematically associations between work, work exposures, and changes in employee health. The system will enable medical and industrial hygiene personnel to divert their manual recordkeeping efforts to increased activities in preventive medical programs and health education. As a result, health personnel will become more efficient and effective in carrying out their responsibilities for the health and well-being of all employees.

Bonnett, J.C., & Pell, S. Du Pont's health surveillance systems. Journal of Occupational Medicine, 1982, 24(10), 819-823.

Du Pont maintains a comprehensive occupational health program that combines medical surveillance, industrial hygiene, toxicology, and epidemiology. This discussion is limited to information about those elements of the employee health protection program that have been made more useful and effective by computerization.

Real-time source data collection and conventional data processing are combined in this system. Some advantages the authors see of a source data entry system are the following:

1. On-line data validation.
2. Maintenance of confidentiality.
3. More accurate encoding of data.
4. Encoding of data directly from testing equipment.
5. Provision of a flexible base for future improvements.
6. Elimination of manual recording and of the need for keypunching.

Further discussed in this article is the file structure of the system and the sources of data for each file.

Bowie, J. Design of a user-defined patient medical summary. In J.T. O'Neill (Ed.), Proceedings of the Fourth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1980. Pp. 1353-1361.

One of the major features of COSTAR, and systems like COSTAR which contain on-line medical records, is their ability to modify the classical "encounter oriented" presentation of data and display summaries of medical items organized by problems or classes of data. The COSTAR Status Report is an example of this type of summary output. The header of the status report gives basic patient identification and demographic information. The remainder of the report presents an index of the patient's medical history grouped by medical areas or divisions. The order of these divisions is fixed, as is the data format within each division.

User acceptance of the Status Report has not always been satisfactory. In the fall of 1979, The MITRE Corporation held a meeting of COSTAR designers, implementors, and users to discuss the implementation of a new patient output report. The result of the meeting was a preliminary specification of the Patient Summary report, a medical output document which would summarize a medical record in a user-defined format and structure. The majority of this paper discusses the issues brought forth at the design meeting and describes the resulting implementation of the Patient Summary.

Four decisions formed the basic design criteria of the Patient Summary:

1. The order of data presentation should be user-definable.
2. The format of the data lines should be user-definable.
3. The amount of data to be printed should be user-definable.
4. A new data presentation, the data matrix, should be developed.

The Patient Summary is now in regular use in a number of COSTAR sites. Its customization features have been used extensively in these practices to meet the varied demands of medical providers. In the opinion of these practitioners, the Patient Summary has successfully met its design criteria.

Brannigan, V.M., & Dayhoff, R.E. Liability for personal injuries caused by defective medical computer programs. American Journal of Law & Medicine, 1981, 7(2), 123-144.

During the past ten years, the use of computer programs in medicine has become increasingly prevalent. As these programs proliferate, however, their potential to injure patients also increases. Although the question of liability for personal injuries caused by defective medical computer programs has not been addressed by the courts, it is inevitable that this question will arise in a judicial forum.

In this article, the authors examine the questions a court will face when addressing this novel cause of action. They attempt to resolve some of these questions by exploring the relevant characteristics of medical computer programs and examining their relationship to the tort law doctrines of negligence and strict products liability. The authors conclude that medical computer programs will be treated as products by the courts, subjecting their manufacturers to strict liability in tort for any defects in the program that cause injury. As a result, the authors contend, hospitals are likely to face a new source of liability for patient injuries if, under the particular circumstances, they are deemed to be the manufacturer or the distributor of a medical computer program that causes an injury.

Can computers keep us healthy? Navy Lifeline, September/October 1982, 18-20.

This article reviews the capabilities of the prototype Navy Occupational Health Information Monitoring System (NOHIMS) at its state of development in mid-1982. The advantages of this computer-based system over the inadequate manual system in use previously are described by an industrial hygienist, an occupational health physician, and Navy epidemiologists and researchers. The NOHIMS database consists of three major types of information: information about employees--names, ages, where they have worked, and what job duties they have performed; environmental hazard data; and confidential medical data on each worker. The data in the NOHIMS database are referred to a number of reference tables to determine if a worker has been overexposed to any substances in the workplace, to document what medical exams are required for various exposures, and to flag any abnormal lab test results to help the physician interpret medical findings and decide if a particular worker is fit to keep working. The major tangible benefits of NOHIMS are a series of regular reports that are more current, informative, and useful than previously available.

Comparison of medical surveillance at the North Island Naval Air Rework Facility before and after implementation of the interim Navy Occupational Health Information Monitoring System. San Diego, CA: Naval Health Research Center, 1982.

The purpose of this study was to provide an evaluation of the effectiveness and impact of the semi-automated interim Navy Occupational Health Information Monitoring System (NOHIMS) on operational procedures by making a pre- and post-comparison of medical surveillance at a selected naval facility, the North Island Naval Air Rework Facility (NARF), using established criteria of optimal medical testing for workers exposed to hazardous environments. The study covered five consecutive months--the month prior to introduction of NOHIMS (February 1982) and the four subsequent months.

The following findings resulted from this study:

1. Prior to implementation of the interim NOHIMS, few of the workers at the NARF exposed to the four substances that require monitoring (acrylonitrile, asbestos, benzene, and lead) received the medical test(s) required because of their exposure.
2. After the implementation of the interim NOHIMS, more workers received the required medical tests even though there was no increase in the total number of tests performed. In fact, there was a decrease in total number of tests performed.
3. As a result of the interim NOHIMS, proportionately more medical tests were being performed on workers with critical exposures.
4. As a result of the interim NOHIMS, proportionately fewer medical tests were being performed on workers with no exposure to any hazards.

Computerized Occupational Health Program (COHP): Feasibility study. Brooks AFB, TX: USAF Occupational and Environmental Health Laboratory, June 1982.

This study was conducted to determine the most feasible method of managing occupational and environmental health data to support all elements of the U.S. Air Force's Occupational Health Program. In order to document the findings and provide the best practicable solutions, the feasibility study was comprised of the following components:

1. Background review.
2. Occupational health capability and requirements determinations.
3. Current methods review.
4. Alternative methods determination.
5. Cost of alternatives.
6. Evaluation of alternatives.

This paper presents the study findings and recommendations. Based on an analysis of 14 hardware alternatives weighed against 11 criteria, including cost, a decentralized computer system built on an expansion to the ADPS 59 (UCA/ASDC) hardware was considered to be the best choice. It was concluded that custom development of COHP software would be more cost effective than purchasing and modifying off-the-shelf software.

Congleton, M.W., Glogower, F.D., Ramsey-Klee, D.M., & Roberts, A.S. Navy Mental Health Information System (NAMHIS): A psychiatric application of COSTAR. In G.S. Cohen (Ed.), Proceedings of the Eighth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1984. Pp. 437-441.

The Navy Mental Health Information System, NAMHIS, is a comprehensive, automated recordkeeping and reporting system designed to meet the needs of clinicians and administrators in Outpatient Navy Mental Health Clinics. The public domain version of the Computer-Stored Ambulatory Record (COSTAR) was extensively modified to fulfill the software requirements of NAMHIS and covers the following five system functions: Patient Registration, Encounter Data, Patient History, Mental Status Examination, and Reporting capability. Data collection forms have been developed, along with standardized reports of individual patient/clinician consultations.

A software package of approximately 50 psychodiagnostic tests written in the MUMPS language has been developed by the Veterans Administration and is available from the VA. It is planned to interface this psychological testing module with NAMHIS so that selected psychological tests can be rapidly scored by computer and reports generated for use by clinicians in the mental health clinic setting.

Conklin, G.S., Craig, T.J., Vickers, R., McCleery, G., & Mehl, B. Of computers in medical care and quality assurance: Why do systems fail? And what can be done? In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 423-424.

This paper is an introduction to a panel discussion held by the authors, the purposes of which were to explore the application of computers in medical care from the standpoints of system developers, implementors, and users of data; present some thoughts on the quality assurance/clinical service interface; and propose strategies for insuring a smooth clinical system implementation.

Two major pitfalls in system acceptance offered in the introduction are developers, implementors, and users who consider only a fragment of a need outside of their organizational context within which a system will operate, and concern by clinicians that data generated by the system are often used insensitively by evaluators who attempt to render judgments on clinical care without knowledge of the many and complex issues surrounding medical decisions.

Included with the introduction are abstracts of the topics presented by some of the authors:

Raymond Vickers--"Problems Encountered in Orienting Physician Users to an EDP Drug Ordering and Monitoring System."

Gerald McCleery--"Hospital Information Systems: Why Staff Don't Always Embrace the Revolution."

Bernard Mehl--"Quality Assurance and the Computer: Drug Therapy Monitoring in General Hospital Settings."

Drexler, J.A., Jr., Jones, A.P., & Gunderson, E.K.E. (Eds.). Problems and strategies of implementing Navy occupational health and safety programs. Seattle, WA: Battelle Human Affairs Research Centers, and San Diego, CA: Naval Health Research Center, June 1979.

A conference on Navy occupational health was held at Battelle Human Affairs Research Centers, Seattle, Washington on January 29-30, 1979. This publication presents the proceedings of that conference. The conference was designed to provide a forum in which issues of implementing Navy occupational health and safety programs could be addressed from a number of perspectives. The conference objectives were to consider organizational factors in the implementation of Navy occupational health programs, to address issues of cost effectiveness in Navy occupational health programs, and to facilitate the development of a meaningful research program in this area. Participants included operations and line managers, safety experts, industrial hygienists, epidemiologists, behavioral researchers, and physicians. Individual perspectives, viewpoints, and goals were diverse and often contradictory. The threads that bound the participants together were a deep commitment to improved occupational health care in the Navy and a clear conviction that the current occupational health program faces serious difficulties.

The conference demonstrated the wealth of available expertise that can be brought to bear immediately on the Navy's current occupational health problems. It also pinpointed several areas that require extensive research and development. Among the major areas in the latter group were epidemiological studies to identify additional hazardous agents in the work environment, development of environmental monitoring techniques, the design of training and reward systems that will increase compliance with sound occupational health practices, and the design of future work environments to minimize occupational health risks.

Eagan, G.D., & Grier, R.S. Automated medical information system of the Los Alamos Scientific Laboratory. In J.T. O'Neill (Ed.), Proceedings of the Fourth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1980. Pp. 343-346.

The Medical Information System (MIS) at the Los Alamos Scientific Laboratory automates the acquisition, storage, and retrieval of medical information concerning 9,000 project-connected personnel. MIS incorporates an on-line, interactive medical history questionnaire, mark-sense form processing, and automated coronary risk assessment in the medical evaluation process. Also, MIS has created the ability for long-term study and comparison of employee health as well as made the physician's time more effective.

The MIS software is written in MUMPS and runs on a Digital Equipment Corporation PDP 11/40 processor. Because core memory is divided into 26 different partitions, up to 26 separate jobs can be running simultaneously. This allows two telecommunication links to operate continuously as well as provide dial-up access to the system.

Elmer, C., & Coleman, D.L. Monsanto's Medical and Environmental Health Information (MEHI) system. Journal of Occupational Medicine, 1982, 24(10), 788-790.

Monsanto's MEHI system was originated in 1977 by the Department of Medicine and Environmental Health in recognition of an existing corporate need for storage and ready retrieval of information being collected on personnel locations, materials in the workplace, exposure levels, toxicity, and personnel health. It consists of a family of seven systems, each independent but capable of being integrated with and drawing information from the others.

Four of the systems are described in this paper as follows:

1. The Materials System, which identifies the total corporate inventory of materials in manufacturing environments, pinpoints their properties, published biological effects, process relationships, and regulations.
2. The Occupational Exposure System, which comprises two modules, one of which maintains industrial hygiene measurements from both personal and area monitoring and is integrated with the second module that contains the work histories of all employees.
3. The Medical System, which contains health histories and all ongoing health determinations derived from questionnaires, physical examinations, clinic visits, and external medical events.
4. The Statistical Data Analysis/Epidemiology System, which contains no entered information but provides tables and programs, as well as data search and correlating routines that may be used to identify trends in exposure or health, or to make statistical evaluations of employee groups compared with nonexposed employees and the public.

Fiddleman, R.H. Who uses COSTAR and why. In H.G. Heffernan (Ed.), Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1981. Pp. 88-90.

By late 1980, The MITRE Corporation was receiving numerous requests for information about the characteristics of the COSTAR community. In order to answer these requests, a survey of COSTAR users and vendors was conducted in January 1981. This paper presents the results of that survey. According to the author, the results clearly showed that COSTAR is a flexible, adaptable system, used by a wide variety of organizations. At the time of the survey, COSTAR was primarily being used as a medical record/accounts receivable/scheduling system, but there were numerous other patterns of usage. The results also indicated that the number of installations had grown moderately since October 1980, when MITRE listed the installations known to it. Also, it was clear that most organizations used the installation and programming service of a COSTAR vendor or support group.

Fiddleman, R.H. Proliferation of COSTAR--A status report. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 175-178.

In early 1979, the National Center for Health Services Research (NCHSR) was faced with the problem of how to transfer the Computer-Stored Ambulatory Record (COSTAR) system from a research setting to a widespread operational setting. The dissemination strategy postulated by NCHSR was based on the use of commercial COSTAR vendors as the main dissemination agents along with a dissemination contractor--The MITRE Corporation--who could perform a variety of software documentation, technical assistance, and information dissemination tasks. The vendors were expected to enhance the software, as well as install and support it. This has occurred. The number of COSTAR installations is growing, and most installations use COSTAR vendors for support. The vendors, as hoped, have made numerous creative changes to the software.

It is unclear at this time (1982) whether the system (in its current form) will be widely disseminated. The 74% growth rate in COSTAR installations over the last fifteen months (preceding November of 1982) is encouraging to the author, especially considering that the rate of system dissemination is typically slow during the initial dissemination period, and then rapidly increases once the system's benefits become well known. The actual number of installations is small, however, in comparison to the number of potential users. The author states that only time will tell if the major objective of the dissemination effort, the widespread proliferation of COSTAR, will be met.

Fiddleman, R.H., & Kerlin, B.D. Preliminary assessment of COSTAR V at the North (San Diego) County Health Services project. McLean, VA: The MITRE Corporation, MITRE Technical Report MTR-79W00404 (Revision 1), February 1980.

This report describes the process of installing the Computer-Stored Ambulatory Record system (COSTAR V) at the North County Health Services (NCHS) project in San Marcos, California, and presents cost and performance information after three months of system operations. The COSTAR V project at NCHS was a demonstration effort designed to provide detailed information about this system's flexibility, costs, benefits, and performance characteristics when used in a rural community health clinic environment. Lessons learned during the installation effort at NCHS include:

1. When used as a total medical/management information system, COSTAR V will impact on virtually everyone's job.
2. A time-consuming part of the installation effort involves updating COSTAR V directories.
3. The major issues involving the organization's use of COSTAR V should be resolved before detailed design work begins.
4. In planning the time and costs of the installation effort, particular attention should be paid to COSTAR V's ability to meet the organization's billing and accounts receivable needs.
5. Two-person months of MUMPS programming should be planned for writing billing programs and special data entry programs (e.g., lab test results, if these are complex).
6. Training is an ongoing process and is best performed by first having the staff review appropriate sections of the COSTAR User Manuals, and then conducting brief overview presentations followed by practice sessions at terminals.
7. The adequacy of the encounter form design can only be known by its use.
8. On-site technical support at the start of patient registration and encounter form usage is essential.
9. Users should consult with a COSTAR V expert to determine if the Report Generator is capable of producing periodic, special format reports; special MUMPS programs may have to be written or special features may have to be added to the Report Generator to meet the user's needs.

All of the preceding comments pertain to a complex operating environment, as typified by NCHS. The less complex the operating environment, the simpler the installation effort. System implementation at NCHS proved to be particularly challenging because of NCHS's network of dispersed clinics linked to the central computer in San Marcos by sophisticated telecommunications equipment, desire to fully automate the medical record, multiplicity of third-party carriers, and complexity of accounts receivable requirements.

Finucane, R.D. General Foods Medical and Environmental Health Systems (MEHS).
Journal of Occupational Medicine, 1982, 24(10), 794-798.

In 1976 General Foods determined that an automated means was required to track employee exposure, to comply with Occupational Safety and Health Administration regulations, to perform epidemiological studies, and to schedule examinations. They chose the Amoco Health Environmental Management System (HEMS). This paper focuses on the application of HEMS at General Foods.

The author first describes the specific modifications made to the system to make it suitable for use at General Foods. He then describes the strengths and weaknesses of the resultant system.

Strengths:

1. Utilizing an existing system greatly decreased start-up costs and enabled them to become operational three or four years earlier than if they had developed their own system.
2. The use of an optical scanner facilitates input and improves the confidentiality and accuracy of data.
3. The medical history capability is relatively strong.
4. The industrial hygiene form is adaptable. Its use does not require a trained professional. It will accept information from personal monitoring equipment or time-weighted averages from walk-through surveys.
5. Programming for the reporting of medical examinations and laboratory results provides for ease of communication with an employee's private physician.
6. Data contained within the system are accessible on-line, thus providing very timely access to the information.
7. The capability to input laboratory data via magnetic tape has greatly decreased routine paperwork and computer processing time.

Weaknesses:

1. Modifications to the optical scanner forms require costly programming.
2. The lack of a batch update capability using tape input for walk-through survey, audiogram, and morbidity and mortality studies forces rather costly manual input of forms.
3. The laboratory input as originally designed required manual input on an Opscan form.
4. Prior to modification of the system, the entire medical history had to be repeated each year or at each examination.
5. Operating the system effectively outside the Amoco environment requires both medical and computer expertise. Additionally, due to the size and complexity of the system, ongoing maintenance and operation are difficult and require continuous contact with the original designers.

Finucane, R.D., & McDonagh, T.J. Medical Information Systems Roundtable.
Journal of Occupational Medicine, 1982, 24(10), 781-782.

According to these authors, the basic force behind the development of computer-based occupational health information systems is the need to manage more effectively the data growth that occupational health programs have experienced. To be maximally effective, they say, the computerized health information system should incorporate as a minimum the following types of information:

1. Detailed worker and job histories and demographic data.
2. An inventory of potential exposures and their possible associated adverse health effects related to specific workplace location.
3. Work site exposure data.
4. Employee medical information collected throughout the worker's career, or if available, throughout his/her entire life.

A well-designed computerized health information system should improve the effectiveness and efficiency of the program's health professionals, create a database for population studies, provide a comprehensive management reporting system, and support company regulatory affairs programs and compliance activities. More specifically, it should allow for the following:

1. Standardized consistent recordkeeping procedures and data collection, thus improving the overall quality of health records.
2. A database of continuous health and exposure information on employees that will facilitate epidemiologic studies.
3. Facilitation and improvement of procedures for the collection and interpretation of workplace exposure monitoring data and the identification of the need for additional environmental controls.
4. Efficient handling and analysis of the large amounts of data generated in occupational health programs via electronic data management technology.
5. Support of administrative professional activities within the medical department on a day-to-day basis.
6. An effective reporting system that will allow both health professionals and company management to evaluate potential problems and the effectiveness of programs.
7. Enhancement of the response capabilities of the company to external and internal inquiries and allegations about health-related matters.

Flagle, C.D. Chairman's introduction: Some terminology of evaluation. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 439-440.

As techniques for evaluation of health care technology evolve and the context of evaluation moves from clinical to institutional and societal levels, a terminology associated with the techniques has emerged.

The terms formative and summative evaluation are used to recognize the difference in evaluation procedures appropriate to early development and later application. Formative evaluation is the prerogative of the developer in the evolution of a product. Once implemented in the context of its intended application, summative evaluation is appropriate, that is, evaluation against the intended service objective of the development.

The terms structure, process, and outcome distinguish the classes of variables to be identified. Physical and human resources involved are examples of structural variables. Volume of service, costs, accuracy, and productivity are all process variables, and changed health status and levels of dependency are outcome variables.

Internal and external validity warn of the pitfalls in evaluation. Internal validity may be threatened by changes that may occur during the evaluation, or by a bias in the selection of subjects for an evaluative experiment. External validity is the validity of extending the inference from a particular study to the population in general.

Cost/benefit and cost/effectiveness analysis typify the struggle for rational criteria for evaluation. The objective of cost/effectiveness analysis is to determine the alternative technology or modality that achieves the specified effect at lowest cost. Cost/benefit analysis implies comparison of programs, each with its own set of costs and benefits.

The author concludes that proper understanding of this terminology will allow evaluators to better appreciate and critique evaluations of systems.

Garrett, L.E., Stead, W.W., Hammond, W.E., McDonald, C.J., & Buecher, M. A method of handling subjective and physical data: Experience with two systems. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 232-235.

The future usage of automated medical records in part depends upon the development of a user-acceptable format for the storage of subjective and physical data which allows these data to be clinically usable, while remaining formalized to the degree that the data may be used for retrospective analysis in research or quality assurance. The authors of this paper describe their attempt at developing such a system of nomenclature.

The authors identified four types of data which must be stored: (1) purely numerical with or without units, (2) data usually associated with numerical responses but which can be associated with descriptive textual phrases, (3) those parameters which have a consistent textual response, and (4) those descriptive terms which have an associated textual phrase that is inconsistent but has the same purpose as the phrase found in the third group.

The use of data within a medical record is directly dependent upon the data structure of the system's dictionary. The actual storage of data is dependent upon the internal configuration of the data file. Therefore, as long as the system's dictionary can provide the response limitations necessary, transfer of a nomenclature set into the system's data should only require dictionary modification. A useful nomenclature set should be compatible with dictionaries of different formats.

The system of nomenclature described in this paper has been effectively used in one system and was easily adaptable to a second system. Though the nomenclature is somewhat different from that used routinely by providers, it was found to be acceptable by the users, although certain modifications were recommended.

Garrett, R.W. Environmental tracking at Eli Lilly and Company. Journal of Occupational Medicine, 1982, 24(10), 836-839.

Eli Lilly and Company is developing a computer-based employee-environmental tracking system. This paper presents an overview of this new program, the Worker Exposure Inventory System (WEIS). The system will provide information on the who, what, when and where of employee exposure or potential exposure. It utilizes a location code to identify the where; a process, job or area (P/J/A) chemical inventory to describe the what; and monthly time reporting to describe the who and when.

The backbone of WEIS will be the Industrial Medicine database. This is the database that will link records of employees with those of the chemicals to which they have been potentially exposed and of the severity and frequency of the potential exposures. This database will be composed initially of two files: the Work Environment Inventory or P/J/A Inventory file, and the Degree of Hazard file. During the next phase of the project two more files--Monitored Exposure file and an Environmental Elements file--will be added to this database.

There are other portions of the system which will be needed. One is the addition of a file containing information on the employee's exposure to chemical substances by P/J/A code to the Industrial Relations database. To facilitate access to the information contained in the Industrial Medicine database, a series of cross-reference files, or secondary indexes, will be needed. A number of directories, used to translate codes from the database into descriptive terms, will also be required to support WEIS.

Reports can be produced using virtually any combination of data elements. The system is being designed so that the industrial hygienists can produce their own reports on an ad hoc basis.

Gavin, J.H. SunHealth--A flexible IBM oriented system for both large and small organizations. In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1983. P. 393.

Sun Information Services Corporation (SIS) and Sun Oil Co. recognized the need for a comprehensive yet flexible occupational health and safety system and jointly developed SunHealth. SunHealth is modular in design and contains the following functional units:

1. Medical records.
2. Audiometrics.
3. Occupational illness and injury.
4. Materials/agents inventory.
5. Industrial hygiene.
6. Material Safety Data Sheet (MSDS).
7. Safety training.
8. Employee work history.

SunHealth can be installed on an IBM mainframe owned by the customer, or optionally can be used on the SIS National Timesharing Network.

Gunderson, E.K. Epidemiological uses of an occupational health information system. In W. van Eimeren, R. Engelbrecht, & C.D. Flagle (Eds.), Third International Conference on System Science in Health Care. New York: Springer-Verlag, 1984. Pp. 294-297.

This paper describes key functions and features of the Navy Occupational Health Information Management System (NOHIMS) and the epidemiological uses of the system. The primary functions performed by NOHIMS include the following: identifying individuals exposed to workplace hazards, scheduling exposed workers for periodic examinations, providing medical personnel with exposure histories and a list of recommended tests and procedures, storing and retrieving medical and environmental data, generating management reports, and compiling standardized information for epidemiologic analyses.

NOHIMS consists of two principal subsystems--an occupational health information component and a medical information component--which can operate as separate, stand-alone systems or can be merged into a unified system. The occupational component was created specifically for NOHIMS and contains six primary modules: (1) Agency data, (2) Personnel data, (3) Environment data, (4) Survey data, (5) Hazard data, and (6) Maintenance functions. The medical component of NOHIMS is an existing software package called COSTAR (Computer-Stored Ambulatory Record), the most widely used software for medical applications in the United States.

Both components of NOHIMS are written in ANSI Standard MUMPS. The MUMPS language facilitates the great flexibility inherent in the NOHIMS design and the extensive cross-referencing capability that gives NOHIMS unique utility for epidemiologic investigations.

A current Navy study provides an example of an epidemiologic approach to investigating agranulocytosis or neutropenia, using total white blood cell (WBC) count as a measure of neutropenia. Possible etiologic agents implicated as causes of neutropenia are benzene, phosphorus, and inorganic arsenic. In this example, NOHIMS would allow for the successful control of an occupationally related disorder that could predispose to more serious disease by linking two crucial concepts: (1) rapid and complete case identification, and (2) accurate exposure measurements.

Hagstrom, R.M., Dougherty, W.E., English, N.B., Lochhead, T.J., & Schriver, R.C. SmithKline environmental health surveillance system. Journal of Occupational Medicine, 1982, 24(10), 799-803.

In 1980, SmithKline Corporation's Environmental Health and Safety staff initiated development of a computerized system to process and analyze information from corporation-wide medical surveillance and industrial hygiene programs. This paper describes the resulting system.

There are four sources of data for the system: cause-of-death data from death certificates, biochemical and hematological screening tests, regularly administered health questionnaires, and reports of accidents and injuries. Job codes were developed to identify employees by major division or product, by department, by group within a department, and, in some cases, by specific task within a group. The construction of the codes allows identification of persons with identical or very similar jobs at one site, at different sites, or in different departments.

The critical portion of the system is the Employee Master File, which defines cohorts and contains demographic data and job codes. This file will contain information on employees who receive medical surveillance and also on those who are not screened. The Employee Master File and Update System provide for input from both manual and computerized personnel systems. A computer program utilizing the Statistical Analysis System (SAS) software package was written to accomplish analyzing the periodic laboratory screening data. As of the publication date, the authors were still exploring ways to relate the data from the health surveillance system files with the industrial hygiene data.

Hattwick, M.A., & Hart, R.J. Medical exegesis: Getting the most out of a computer based information system. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp: 172-174.

Medical information systems are naturally evolving from isolated, to integrated, to intelligent forms. COSTAR is the first generally available example

of an integrated medical record system--one which simultaneously allows management of financial, administrative, and clinical information. Effective and efficient use of an integrated information system can be improved by following four basic principles:

1. Use the system for your most important tasks. The system must be inserted between the user and his/her goal, and not merely used in parallel.
2. Interact with the computer. The more the user interacts with the information system, the more he/she will be able to identify and improve incomplete, misleading, or erroneous parts of the system.
3. Exploit the epiphenomenon created by using and interacting with the system. To obtain maximum benefit from a system, one must take advantage of the multiple usefulness of the data.
4. Educate the system, and yourself. The third generation of medical computers will be intelligent systems. To be effective in modifying a physician's behavior, the computer must actively point out specific things that are being overlooked.

COSTAR is evolving into an intelligent information system which actively contributes to improved patient care. By following these principles, the authors claim to have increased the efficiency of patient encounters by 15 to 20%, and increased the extent to which they achieve their patient care goals by at least 25%.

Hermansen, L. NOHIMS users' guide: Introduction and OHS options. San Diego, CA: Naval Health Research Center, Report No. 84-23, 1984.

The Navy Occupational Health Information Management System (NOHIMS) will help coordinate various components of the Navy's occupational health program. This users' guide describes the various options available in the environmental component of NOHIMS, their uses, and rules for operation of the system. The six primary modules include Agency Data, Personnel Data, Environmental Data, Survey Data, Hazard Data, and Maintenance. Operations within each module are described in detail.

Hillman, D.W. A Computerized Occupational Health and Environmental Surveillance System. Journal of Occupational Medicine, 1982, 24(10), 785-787.

In 1975, Diamond Shamrock Corporation developed a Computerized Occupational Health and Environmental Surveillance System (COHESS). COHESS can be defined as a computerized vehicle that codes, stores, and reproduces, according to program, data on employee health, the work environment, and potential hazards therein for surveillance purposes.

The design and implementation of COHESS are such that information has been segmented into that which is people-related, including all health and personal monitoring; places-related, including all grid locations and area monitoring data; and things-related, including all materials. As a result, information can be obtained from the system in terms of employees, work areas, materials, health data, or monitoring data. Correlations can also be developed.

The principal features of COHESS are a Data Element Dictionary that specifically codes each health item input to the system; a Forms Table that handles any source input document, with flexibility to change data format without reprogramming; and a grid system that links workplace, employee, and environment. The utilization of output is open ended and includes reports, statistics, and epidemiological studies.

The ultimate objective is the surveillance of the health status of employee populations, in relation to their work environment, in order to detect the most subtle changes at the earliest possible moment. Although some items--for example, the grids--are innovative, the system has been designed to accommodate all health/safety and environmental information categories any employer might collect.

Hillman, G. ECHOES: IBM's Environmental, Chemical and Occupational Evaluation System. Journal of Occupational Medicine, 1982, 24(10), 827-835.

ECHOES, the Environmental, Chemical and Occupational Evaluation System, is a computer-based tool designed to help collect, store, retrieve, and summarize data related to health and the environment. The data-processing concept under which ECHOES was developed is one in which a database type of file organization is employed. There are two multifunctional physical databases that make up the principal components of the system, the Chemical Database and the Employee Database.

The Chemical Database is an extract of an on-line, easy-to-use, terminal-based set of programs known as the Chemical Data System. The Chemical Data System is a computerized repository of information about substances the company uses in the manufacture and maintenance of its products. Since 1978, a powerful on-line retrieval system has been operational, enabling users to access the most recent data entered. Using a retrieval system based on APL (A Programming Language), authorized individuals can query the Chemical Data System for information on specific or multiple substances.

The second basic component of ECHOES is the Employee Database. Information contained in this part of the system pertains to individual employees and includes demographic data, occupational and medical histories, and medical examination data. Entry of new or additional information to ECHOES will cause an automatic review of the Employee Database to determine if an employee's exposures require the scheduling of a medical examination.

Hohenemser, C., Kates, R.W., & Slovic, P. The nature of technological hazard. Science, 22 April 1983, 220, 379-384.

In this paper, technological hazards are evaluated in terms of quantitatively expressed physical, biological, and social descriptors. For each hazard a profile is constructed that considerably extends the conventional definition of risk. The profile, which is termed hazardousness, was understood in pilot experiments on perception and appeared to capture a large fraction of lay people's concern with hazard. It also suggests an orderly method for establishing priorities for the management of hazards.

Information systems used in support of occupational health programs (a post-graduate seminar presented at the American Occupational Health Conference, Anaheim, CA, April 30, 1979). Chicago, IL: American Occupational Medical Association, 1979.

This publication is a compilation of four papers presented in 1979 at the American Occupational Health Conference. The first of these papers by A.A. Whyte, BioTechnology, Inc., was entitled "Occupational health and safety information systems." The second paper, "The Du Pont medical examination system," was presented by F.L. Knowles of E.I du Pont de Nemours & Company. "Amoco's health/environment management system" was the third paper given by P.S. Kerr, Amoco Computer Services Company. In conclusion, D.W. Hillman, Diamond Shamrock Corporation, described his company's system called COHESS in a paper entitled, "An occupational health/environmental surveillance system." Handouts that were distributed at the conference are included in this publication.

Jennings, D.P., Fulton, D., & Roy, E. A COSTAR-based veterinary medical information system. In G.S. Cohen (Ed.), Proceedings of the Eighth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1984. Pp. 467-469.

During early 1982, the Mississippi State University College of Veterinary Medicine formed a task group to determine the most expeditious way to implement a college-wide computerized veterinary medical information and communication system. This group recommended that COSTAR make up the nucleus for developing such a system.

The following goals were adopted for the College's computerized system:

1. Facilitate patient care by improving the availability, accessibility, and timeliness of retrieval, legibility, and organization of medical information.
2. Enhance the financial viability of the Animal Health Center by providing a comprehensive billing system with accompanying accounting reports.

3. Facilitate Animal Health Center administration by providing data retrieval and analysis capability required by management for day-to-day operation, budgeting, and planning.
4. Provide communication and processing support for administrative and ancillary services.
5. Provide the capability to generate standardized and user-specified reports on any elements of the database.
6. Provide the capability of population medical/management records which merges with individual animal data of the Animal Health Center.
7. Provide processing capabilities to utilize a problem-oriented knowledge base for facilitating "diagnosis" and "case management."
8. Provide applications software support for approved remote practice sites.

All goals but 6 and 7 will be achieved through the implementation of COSTAR. Those goals relating to population animal medicine records and problem-oriented diagnosis/case management are being developed through alternative software.

Joiner, R.L. Medical Information Systems Roundtable. In H.G. Heffernan (Ed.), Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1981. Pp. 1057-1060.

Representatives of industry met in Chicago in early February of 1981 to discuss health and medical information systems in a roundtable conducted by the Committee on Medical Information Systems of the American Occupational Medical Association. The purpose of the roundtable was to report on the state-of-the-art of health information systems in industry so that companies just beginning to develop systems or contemplating the development of a system could see what has been accomplished to date. This paper is a reporting of the proceedings of that roundtable.

A series of common factors are remarkably consistent from system to system, whether the program began with in-house development or with the purchase of an existing system and modifications to suit company philosophy. Flexibility, modularization, interaction, economy, innovation, and corporate commitment are essential elements in developing functional systems. Development and implementation costs are dependent on the operating philosophy adopted for the system; the choices at each dichotomy can mean substantial differences in overall costs because of delimiting or expanding system capabilities.

The present systems are sophisticated and amazingly complete in their capabilities. However, the difficult questions that remain to be answered about health information systems are philosophical and legal in nature and have little

to do with system design or redesign. These include endpoints, quantity and quality of data, multiple exposure risk assessment, worker migration from company to company, and similar questions.

Joyner, R.E., & Pack, P.H. The Shell Oil Company's computerized Health Surveillance System. Journal of Occupational Medicine, 1982, 24(10), 812-814.

Development of the separate modules of the Shell Health Surveillance System (HSS) began in 1973 and was completed in 1979. The HSS is composed of six data modules linked together to form an information network. These databases operate in an Information Management System (IMS) database environment in an interactive mode. The modules are as follows: personal attributes, biometrics, morbidity, mortality, work histories, and exposure monitoring. The requirements which were addressed through design considerations were confidentiality, quality assurance, reliability, retrieval flexibility, expandability, and cost competitiveness.

The authors report that the implementation of the system in the manufacturing plants has proceeded smoothly, due primarily to general recognition of the need for recording medical and industrial hygiene information and making it available to the company. The system has met user expectations and has operated at costs less than forecast. They anticipate system maintenance costs will approximate 35% of the system life-cycle costs, which is significantly below the 60% range for typical commercial systems.

Judd, S.H. Occupational Health Information System (OHIS). Journal of Occupational Medicine, 1982, 24(10), 806-808.

Standard Oil Company of California's Occupational Health Information System (OHIS) is a computer-based system designed to manage data relevant to the effects of occupational exposures on employee health. In brief, each job is assigned an "environ" code. Each employee's current job assignment is recorded with its environ code in a data file. Jobs are tracked by adding the environ code to payroll reporting and personnel records. Each new assignment is recorded in the same file. Exposures associated with each job are recorded by environ code in a separate file.

Changes in exposure are tracked by field evaluations and by an inventory maintained for known hazardous agents present in the workplace. Occupational injuries and illnesses, biomedical test results, and lost-time sickness and injury are also recorded. OHIS uses personnel data from existing payroll earnings and personnel record systems, minimizing data entry and duplication of computerized data. Retrospective data can be included when available.

Kaplan, B., Maxwell, J.A., Conklin, G.S., Fischer, P.J., & Harbort, B. Systems analysis, project management, and evaluation: Are quantitative methods enough? In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1983. Pp. 674-676.

Important aspects of good systems analysis and evaluation are frequently considered "soft" or "unscientific" because they are neither quantitative nor quantifiable. However, according to this group of authors, system requirements can be determined and system impacts assessed on a sound, scientific basis by combining quantitative and qualitative methods. This approach goes beyond the usual interviewing of a few key users, and documenting of such quantitative features as work flow, amount of data handled, timing of reports, speed of information retrieval, and cost-benefit ratios.

"Qualitative methods" refer to methods of gathering and analyzing information that (1) utilize detailed, context-embedded descriptions of activities and settings, and (2) inductively develop categories of description and analysis based on the perceptions of participants in the setting being studied rather than employing the prior categories of the researcher. These methods include interviews, observation, open-ended questionnaires, analysis of reports and other documents, and some forms of unobtrusive data collection. Research and evaluation designs can effectively combine qualitative and quantitative methods, as long as the strengths and requirements of each type are recognized.

The authors describe in four short essays how qualitative and quantitative methods can be combined to take advantage of the strengths of each. They agree that, in project design, implementation, evaluation, and management, quantitative methods are not enough.

Kerlin, B.D. COSTAR: History of survival. In H.G. Heffernan (Ed.), Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1981. Pp. 91-92.

COSTAR's (COmputer-STored Ambulatory Record) history of survival is the topic of this brief paper. Although COSTAR incorporates an accounts receivable/billing package, the financial function was considered necessary but secondary in importance to the automated medical record. The intangible benefits of potentially improved patient care through the automated medical record are understandably not as attractive to the commercial marketplace as the direct benefits of an efficient billing system. Without federal funding from NCHSR (National Center for Health Services Research), therefore, COSTAR might never have come into existence.

The COSTAR software reflects a mix of skill levels and changing staff. "Bugs" were reported in the software; different versions existed at the demonstration sites. Without federal funding and encouragement from NCHSR, COSTAR might never have survived the early field experience.

NCHSR took the lead in funding a nonprofit organization--The MITRE Corporation--to promote the transfer of COSTAR into the marketplace by

1. Consolidating the software.
2. Debugging the software.
3. More fully documenting the system.
4. Disseminating information to potential vendors.
5. Providing limited technical assistance to selected vendors.

At present (1981), the barriers to technology transfer of COSTAR V have been partially overcome. Twenty-four vendors are marketing COSTAR. The COSTAR community is growing and a User's Group has been formed. Without federal funding, encouragement, and leadership from NCHSR, however, COSTAR might be on the "endangered species" list.

Kerlin, B., & Green, P. COSTAR: An overview and annotated bibliography. McLean, VA: The MITRE Corporation, MITRE Technical Report MTR-80W179 (Revision 1), November 1980.

COSTAR is an automated medical/management information system designed for adaptation to a wide range of settings. In its history of over a decade, the COSTAR system has undergone many changes, and several versions of the software exist. The most recent version is COSTAR V, a general purpose, flexible system which can be tailored to diverse ambulatory care settings.

This publication briefly summarizes the functions and highlights of COSTAR V--past, present, future--and directs the reader to relevant reports and journal articles for more detailed information. Although this document focuses on COSTAR V, a few articles pertaining to an earlier version of COSTAR are also cited because the topic, quality assurance, is virtually timeless.

This report has been prepared and is being distributed by The MITRE Corporation as a COSTAR clearinghouse activity, one of several technology transfer tasks under a contract from the National Center for Health Services Research, Public Health Service, Department of Health and Human Services.

Kjerulff, K.H. Measuring attitudes toward computers. In G.S. Cohen (Ed.), Proceedings of the Eighth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1984. Pp. 528-535.

The primary purpose of this study was to examine the degree to which attitudes toward computers were related to adaptation to computerization. Two questionnaires were developed, one to measure general attitudes toward computers (ACG) and the second to measure attitudes toward the medical information system which was being implemented (ATMIS). The ACG was a significant predictor of the change scale, which was a measure of adaptation to the computer system.

The ACG was also a significant predictor of desire for additional training. The ATMIS significantly predicted individual's overall evaluation of training and self-rated competence at working with the MIS. The ATMIS was also strongly related to concurrent measures of job satisfaction and adaptation to the MIS.

The author feels that, clearly, attitude is related to response to computers, but it depends upon how it is measured. Attitudes toward computers in general was predictive of adaptation to the MIS, while the scale designed to assess attitudes toward the MIS was more reflective of concurrent measures of adaptation. Both scales were predictive of different aspects of perceptions of training. The author concludes, therefore, that attitudes toward computers are related to a variety of relevant measures of response to computers, but these relationships will vary depending upon how the attitudes are measured.

Kjerulff, K.H., Counte, M.A., Salloway, J.C., & Campbell, B.C. Who can't get no satisfaction? Reactions to medical information system training. In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1983. Pp. 668-672.

This paper presents the results of a questionnaire given to a group of Medical Information System (MIS) users concerning their perceptions of the training they received. The questionnaire focused on perceived adequacy of the training received and felt competence utilizing the MIS after training. A variety of information gathered from the MIS users prior to and shortly after training was also related to perceptions of training. The results indicate, according to the authors, that the employees who were more satisfied with their training were subsequently more positive toward the MIS and toward the changes the MIS created in their jobs. Users who were high on Cognitive Structure (a personality measure) indicated that they wished to have more training, but felt competent at working with the MIS. The more educated employees perceived themselves as being more competent at working with the MIS.

Kuhn, I.M., & Wiederhold, G. The evolution of ambulatory medical record systems in the U.S. In H.G. Heffernan (Ed.), Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1981. Pp. 80-85.

This paper is an overview of the developments in Automated Ambulatory Medical Record Systems (AAMRS) from 1975 to the present (1981). A summary of findings from a 1975 state-of-the-art review is presented with the current findings of a follow-up study of the AAMRS.

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, the authors conclude that there is a continuing need for research and development to improve the effectiveness of the systems in use today.

Kuhn, I.M., Wiederhold, G., Rodnick, J.E., Ramsey-Klee, D.M., Benett, S., & Beck, D.D. Automated ambulatory medical record systems in the U.S. Stanford, CA: Department of Computer Science, Stanford University, Report No. STAN-CS-82-928, August 1982.

This report presents an overview of the developments in Automated Ambulatory Medical Record Systems (AAMRS) from 1975 to 1982. 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 in 1981-1982.

The sites and systems visited in the follow-up study included the following:

1. Computer-Stored Ambulatory Record (COSTAR) system at North End Community Health Center, Boston, MA; and North (San Diego) County Health Services, San Marcos, CA.
2. The Medical Record (TMR), Duke University, Durham, NC.
3. Regenstrief Medical Information System (RMIS), Regenstrief Institute, Indianapolis, IN.
4. Arthritis Research Information Office Network, Arthritis Center, Wichita, KS.
5. Family Practice Medical Information System (FMIS), Community Electrocardiographic Interpretative Service (CEIS), Denver, CO.

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.

Kuritz, S.J. The Ford Motor Company Environmental Health Surveillance System. Journal of Occupational Medicine, 1982, 24(10), 844-847.

Ford's Environmental Health Surveillance System (EHSS) is a complex interaction of several subsystems which are designed to encompass the basic components of an occupational health and safety surveillance system: (1) exposure data, (2) health and safety status/effects data, and (3) worker status/history data. The subsystems used in EHSS are the following: the Materials and Toxicology (MATS) and Industrial Hygiene subsystems that provide exposure data; Medical Records and Surveillance, Biological Monitoring, Mortality, and projected Safety which provide health and safety effects data; Work History which provides

work histories; and Epidemiology which coordinates the effective use of all of the subsystems. The highlights of each of the subsystems are described in this paper.

Magerlein, J.M., Yager, C.A., & Cernik, J.J. Occupational Health Surveillance System (OHSS) at The Upjohn Company. Journal of Occupational Medicine, 1982, 24(10), 809-811.

To provide accurate, up-to-date, and accessible information on employee health and exposures, The Upjohn Company has developed an Occupational Health Surveillance System (OHSS). This paper describes the components and uses of the system.

Three distinct categories of information define the three major components of OHSS. The Employee Medical Module is the repository of all information pertaining to the health status of the employee. This information, collected primarily from clinic visits and surveillance examinations, is used to provide medical care, to construct medical histories, and to provide data for population studies.

The second major component, the Agents Database, is a comprehensive collection of data on all of the agents used within The Upjohn Company. It focuses on workplace-related elements that could affect the health of the employee. Data stored in the Agents Database include synonyms, chemical and physical properties, and emergency procedures.

The Employee Medical Module and Agents Database provide basic information to support company operations related to occupational health and safety. Only by linking the two components is it possible to relate information on workplace hazards to information pertaining to employee health. Providing this link is the function of Worker Exposure Tracking (WET), the third major OHSS component. The integration of the WET information with the other two components of OHSS permits studies that analyze the short- and long-term effects of exposure to agents.

McLatchey, J., Barnett, G.O., McDonnell, G., Piggins, J., Zielstorff, R.D., Weidman-Dahl, F., Hoffer, E., & Hupp, J.A. The capturing of more detailed medical information in COSTAR. In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1983. Pp. 329-332.

A heavy reliance on the use of narrative text to record information in the COSTAR medical record has made automated analysis of the data difficult. Front-end microprocessors and new data capturing mechanisms have made it possible to develop methods which facilitate entry of medical data in codable form. A prototype of such a system developed at the Laboratory of Computer Science is described by the authors of this paper.

The key to improved data capture suggested by the authors is to make the process more acceptable to the physician, which must involve an interface that can capture more precise data with little additional work or effort by the physician. The authors felt the following were necessary criteria for continued acceptance by the physician users:

1. Entry of data not delayed by system response time.
2. Reliable hardware.
3. Position in menu hierarchy obvious to user.
4. Easy selection of terms from menus.
5. Allow text to be appended to any item.
6. Allow user to record to any desired level of precision.
7. Allow order and form of presentation to be site-definable.

To create such a system, the authors relied upon the newly developed "mouse/window environment." These systems allow the user to view each menu within its own workspace known as a "window." Selection of an item from the window-menu causes a new window of choices to be displayed without completely overwriting the previous window. Windows may be overlapped in such a way that the path of all previous selections is visibly apparent. The mouse is a small hand-held device that can be moved across a flat surface to affect cursor movement on the terminal screen. The device was found by study groups to be the most natural and precise form of speedy menu selection. The authors conclude that these technical advances and their prototype system have opened the way for new user interfaces to be designed to further encourage physicians to use medical information systems.

Möhr, J.R., Sawinski, R., Kluge, A., & Alle, W. On selecting commercial information systems. In G.S. Cohen (Ed.), Proceedings of the Eighth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1984. Pp. 170-174.

This paper describes the selection of a laboratory information system by the University of Heidelberg. The authors felt that the method of assessment should allow evaluation of such characteristics and features as technical and functional adequacy, reliability of the vendor, costs, and compatibility with local conditions, but also avoid the common drawback of a fair extent of subjectivity. The assessment method chosen was "multilevel assessment."

Multilevel assessment consists of establishing a hierarchical system of criteria which are checked for completeness and lack of redundancies and contradictions. These criteria are weighted by distributing a total of points among the criteria. In a subsequent step, each system variant is graded for each criterion. This subjective grading results in projection of every system feature onto a single scale. Subjectivity can be controlled by using the Delphi technique. The composite value of an assessed system is determined by adding the products of grades and weights for each system. The authors further present evidence to support their contention that the method is comprehensive, reproducible, valid, and economical.

O'Neill, P., Volkert, J.J., & Koop, G.O. COMET: A system for micro, mini and mainframe environments. In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, Md: IEEE Computer Society Press, 1983. Pp. 394-396.

The Creative Occupational Medical and Environmental Tracking (COMET) system, which was developed in MUMPS and designed to be transportable from one computer to another, can now be operated on hardware ranging from micros, to large minis, and even IBM mainframes. This has particular advantages in occupational health applications where distributed processing and system networks may present distinct advantages. Individual departments or plants can install a system at minimal cost to meet their specific needs with the potential to evolve a corporate-wide system which may include a variety of micros, minis, or mainframe computers.

In the COMET system, data are organized in three modules that provide occupational health tracking: personnel information, medical information, and industrial hygiene/toxicology information. A unique feature is the on-line capture and storage of data through a questionnaire driver. The driver is a user-friendly computer program enabling the composition and editing of questionnaires or data collection instruments to cover any information needs. COMET also offers more than 30 reports in standard formats that can be tailored to each user's requirements.

Oppenheim, A.G. Facilitating a public health information system in California. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 157-161.

The State of California is assisting local government in the development of automated health information systems. The Computer-Stored Ambulatory Record (COSTAR) has gained the widest acceptance among systems being implemented. Several important COSTAR features have led to its growing acceptance in California. COSTAR can be used for registering patients and scheduling future appointments, for creating patient medical and treatment records, for billing patients and tracking accounts receivable, and for generating extremely complete reports on patient characteristics and clinical activities. The system's flexibility and adaptability, along with the fact that COSTAR's billing and accounts receivable components have the potential for substantially increasing provider revenues, have made COSTAR attractive to County Boards of Supervisors as well as county health departments.

Certain aspects of the system have created difficulties, however, COSTAR systems are expensive, and only a few brands of computers are suitable for COSTAR operation. There is a shortage of COSTAR vendors in California, and there is a similar shortage of programmers trained in MUMPS, the programming language used in COSTAR. Also, a large amount of time is required to obtain the necessary financial resources to implement a COSTAR system and the implementation itself takes time.

Despite the problems mentioned above, COSTAR is an extremely powerful health information system, with substantial advantages. California's Department of Health Services is interested in determining the applicability of the COSTAR system to the State's local health jurisdictions on a demonstration basis. There are current installations of COSTAR by local governments in San Diego County, Santa Barbara County, Ventura County, Riverside County, Fresno County, Santa Cruz County, and the City of Berkeley.

Osburn, A.E., Neches, N.M., Shissler, G.E., & Kittredge, D. Enhancement to COSTAR with a problem oriented record structure and decision making support functions. In H.G. Heffernan (Ed.), Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1981. Pp. 124-128.

The guiding design goal for the COSTAR enhancements described in this paper has been development of a package which can interactively derive and communicate the Knowledge Content from accumulating clinical data to a provider in order to support decisions he/she makes during the health care management process. This goal has been realized through implementation of a Problem-Oriented Record Structure which is automatically created from clinical data entered into the system. The Problem-Oriented Record Structure provides an interpretive frame of reference for clinical data, and facilitates automatic derivation from the results of decisions made by providers of a knowledge about features supporting identified health problems. This knowledge is used, in turn, for automated decision support functions during interactive data entry sessions. While it is felt by the authors that the development thus far is significant, they also feel that the most important feature of the system is the framework which it provides as a foundation for future development.

OSHA medical surveillance requirements and NIOSH recommendations for employees exposed to toxic substances and other work hazards (prepared for the NASA Occupational Health Office). Falls Church, VA: BioTechnology, Inc., January 1980.

This report was prepared by BioTechnology for the National Aeronautics and Space Administration (NASA) and was approved for distribution by BioTechnology. Permission was also given by NASA's Occupational Health Office. This publication summarizes OSHA Medical Surveillance Requirements of the Occupational Safety and Health Act as set forth in General Industry Standards, 29 CFR 1910.1000 and recommendations taken from NIOSH criteria documents. Specific relevant sources for this summary are shown in the first column accompanying each chemical name.

Piggins, J., McLatchey, J., Zielstorff, R., Barrett, S., Smith, M., Weidman-Dahl, F., Brown, K., & Barnett, G.O. Considerations in designing and implementing enhancements to COSTAR. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 182-186.

This paper describes recent experience in implementing two major COSTAR enhancements, namely a patient-specific encounter form and an order entry and dispatch subsystem. A number of points to be considered in regard to planning and implementing such enhancements are raised, and the relative success of these two enhancements at one particular site is discussed.

As illustrated by the authors' experience in implementing the Patient-Specific Encounter Form and Message Switching subsystems, enhancements to COSTAR can require a significant amount of time and effort in terms of initial design, programming effort, and subsequent modification. Careful and thorough analysis of existing workflow patterns and the potential impact of the proposed enhancement on those patterns is essential. Flexibility of program design is also important, since experience with a new feature in day-to-day operation may well lead to further requests for modifications. Overall, the concepts embodied in the Patient-Specific Encounter Form and Message Switching subsystems have proven viable and have made a positive contribution to COSTAR operation at Pease Air Force Base, the site of their implementation.

Pryor, D.B., Barnett, G.O., Gardner, R.M., McDonald, C., & Stead, W.W. Measuring the value of information systems. In G.S. Cohen (Ed.), Proceedings of the Eighth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1984. Pp. 26-28.

This paper is a publication of the opening comments given at a panel discussion whose purpose was to improve the quality of investigations designed to measure the value of an information system. The key questions around which the discussion was focused were the following:

1. Does an information system allow the medical community to do anything that would otherwise be impossible without an automated system; what is the greatest value of a patient database?
2. Can an information system save money or time in the patient care process; how can the cost of the data collection and storage be justified and make the system self-supporting?
3. How are observations made from a database validated; what are the limitations of drawing inferences from nonrandomized studies and how can they be minimized?
4. How can management information systems improve the practice of patient care and how are these improvements measured?
5. How does an information system impact on interactions between members of the health care team and how is this measured?

The remainder of the paper describes the systems each panel member was involved in evaluating.

Pugh, W.M., & Beck, D.D. Preliminary specifications for a Navy Occupational Health Information Monitoring System (NOHIMS). San Diego, CA: Naval Health Research Center, Report No. 81-36, 1981.

The objective of the Navy Occupational Health Information Monitoring System (NOHIMS) development project is to provide an information system that will coordinate the components of the Navy's occupational health program in order to meet the requirements of the Occupational Safety and Health Act of 1970, thus helping to provide a safe and healthful working environment for employees in Navy industrial facilities. This report describes the initial phases of the design and development of NOHIMS. The system is being designed and developed by the Naval Health Research Center (NHRC), San Diego, to insure that not only environmental health data are included but also that the data obtained can be used for epidemiological analyses.

Initial work on this project involved a comprehensive systems analysis of the recordkeeping and reporting requirements of a typical naval industrial facility--the North Island Naval Air Rework Facility (NARF) located at the Naval Air Station, San Diego. Preliminary specifications for collecting, processing, and displaying medical and environmental data within a prototype system were developed. In the design of this prototype system, extensive consultation was conducted with personnel from the Naval Regional Medical Centers in San Diego and Pearl Harbor because the regional medical centers are viewed as the primary users of the system.

Pugh, W.M., Beck, D.D., & Ramsey-Klee, D.M. An overview of the Navy Occupational Health Information Monitoring System (NOHIMS). MUG Quarterly (Proceedings of the 1983 MUMPS Users' Group Meeting), Spring 1983, XIII(1), 129-135. Also, San Diego, CA: Naval Health Research Center, Report No. 83-8, 1983.

The Navy employs hundreds of thousands of workers (both civilian and military) who are scattered across the country, involved in a variety of diverse industrial operations, and exposed to multiple health risks from an array of chemicals and other agents. In order to provide a safe and healthful work environment for these workers as required by the Occupational Safety and Health Act of 1970, the Navy has developed the Navy Occupational Health Information Monitoring System (NOHIMS) and is currently implementing a pilot system at the Naval Air Rework Facility, San Diego. NOHIMS has been designed to insure that (1) all individuals exposed to hazardous agents within a facility are identified, (2) all exposed individuals are given periodic examinations, (3) examinations include those tests and procedures needed for prudent monitoring, (4) the environmental information which led to the decision to monitor or not to monitor an individual is recorded, and (5) sufficient data for epidemiological studies are retained in a readily accessible form.

In order to provide the information needed to coordinate the components of the Navy's occupational health program, NOHIMS utilizes a database consisting of several types of data entered into the system on an ongoing basis and a set of reference tables that makes it possible to interpret the significance of a

particular element of data. Once raw data have been compared to standard reference points, it becomes possible to compile various reports and to exchange this information on a timely basis.

NOHIMS consists of two subsystems: (1) an industrial tracking component, and (2) a medical information component. The medical information component consists of COSTAR--the Computer-Stored Ambulatory Record system. Each of these two components of NOHIMS can also operate as a stand-alone system. Because of the vast flexibility inherent in the design of NOHIMS and its extensive cross-referencing capability, it is possible to ask a virtually unlimited number of questions of the system.

Rappaport, W. FLOW GEMINI: A proven occupational health information system. In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1983. Pp. 391-392.

Nine major United States and Canadian corporations are now using FLOW GEMINI, a highly flexible and comprehensive software system for the storage, retrieval, and analysis of occupational health data. The functional components are scheduling, industrial hygiene surveillance, and medical surveillance. The software components are a database management system, a data dictionary, a data descriptor editor, a report program generator, a query language, several statistical package options, and an external system interface. FLOW GEMINI is available to run on a customer's own computer, as a time-sharing system on Flow General's computer, or as a service.

An unusual degree of confidentiality and security is achieved in the system via the separate control of access to the system's functions and access to the data. FLOW GEMINI's Report Generation System includes many standard reports. Its Report Program Generator and query language are easy-to-use, highly flexible tools for developing new standard and ad hoc reports.

Rappaport, W., & Steen, C. FLOW GEMINI: An occupational health information system. In H.G. Heffernan (Ed.), Proceedings of the Fifth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1981. Pp. 1061-1065.

This paper describes key functions and features of the FLOW GEMINI occupational health information system. The system performs a comprehensive set of functions to support monitoring of employee health and workplace conditions for industries in which there are potential health and safety hazards. To support monitoring of employee and workplace conditions, FLOW GEMINI performs the following functions: scheduling, medical and industrial hygiene surveillance, reporting, statistical analysis, and reference. A database manager is used so that each user can adapt the system to its own environment and to changing corporate and regulatory requirements. The Report Generator System offers flexibility in accessing, querying, analyzing, and displaying items from the

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database. The Report Generator System contains a Program Generator with a high-level language, designed for use by nonprogrammers, which generates a FORTRAN program for the production of a report. The Report Generator also has query language capability.

Reed, L.J., & Solomon, M.E. DEChealth: A comprehensive occupational health information system. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 144-147.

DEChealth, the DECmed Occupational Health System, developed by an interdisciplinary team of occupational health professionals and computer engineers, is designed to provide an information management tool in the industrial setting. The authors describe four aspects of the system: environmental tracking, industrial hygiene, health services, and reporting and statistical analysis.

The environmental tracking mechanism provides snapshot views of the workplace. The industrial hygiene portion of the system collects quantitative and qualitative information pertaining to the actual sampling of the work environment. It is these data which are integrated with the employee and medical modules to facilitate the determination of the effects of the workplace on employee health.

The health services subsystem provides for the storage of medical histories, physical examinations, laboratory results, and other relevant medical information pertaining to each employee throughout the course of his/her employment. This medical information is then used in conjunction with the environmental tracking and industrial hygiene data to develop a centralized storehouse of health and exposure information. Flexibility is provided for by allowing the user to define all questionnaires, lab tests, and the components of an examination.

The reporting and statistical analysis module provides for the retrieval and integration of all this systematically stored data. Together, the environmental and medical reporting functions provide a means of scanning, correlating, comparing, profiling, sensing, and probing the comprehensive database for evaluation by occupational health professionals.

Robinson, H., & Wood, L.W. The New York Telephone Company medical information system. Journal of Occupational Medicine, 1982, 24(10), 840-843.

The New York Telephone Company has developed a system they call Health Care Management (HCM). Basically, HCM is the application of business management methods to health care. They have arbitrarily divided HCM into three levels of management. Level I management occurs in response to acute departures from an individual's health norm, and constitutes that kind of disease care for which most physicians are trained. Its objective is to restore the norm, either the old one or a new one, as rapidly and as cost effectively as possible. Level II

management, also oriented to the individual employee, is the management of wellness by working with the employee to set long-range health objectives and to work out strategies to reach those objectives. Level III handles the management of the population and the system.

The New York Telephone Company MIS is being developed to satisfy the needs of HCM. It is a computer-based system utilizing the MUMPS programming language. The development is taking place in three phases which are discussed in this article:

1. The replacement of the medical chart by "user friendly" data input and display programs and a report-writing ability.
2. The grafting of a degree of intelligence onto the system by writing application programs for the diagnosis of Level II health entities requiring management and the automatic scheduling of employee appointments based on demographics and medical findings.
3. The ability to run comprehensive statistical programs to evaluate HCM and provide the information for decision making on the control of medically related costs.

Rossi, D.A., Cox, J.D., & Seger, M.J. Computerization of medical and exposure records in the semiconductor industry. Journal of Occupational Medicine, 1982, 24(10), 859-862.

An interdisciplinary team of occupational health professionals and computer engineers at Digital Equipment Corporation have developed a computerized system for maintaining employee medical and exposure records. The Industrial Health Monitoring System (IHMS) was designed to meet the occupational and public health needs of employees engaged in semiconductor manufacturing operation where potential exposure to hazardous chemicals and physical agents exists.

The system consists of a 3-tier continuum of input and output screens that creates a hierarchical information network composed of an historical environmental profile, industrial hygiene and health services activities, and summary and detailed reports. A main menu lists the major functional components, allowing the user to enter or retrieve data by selecting from the main menu screen a single function, and by continuing the process through one or more dependent submenus until the data entry or retrieval is completed.

To date the development of computerized recordkeeping in the system has been limited to medical and exposure data. Future plans include development and implementation of independently driven modules, such as hearing conservation and audiometry, radiation, and hazardous waste manifest programs.

Schauffler, H.H., & Koran, R.E. A methodology for estimating costs and benefits of medical information systems. In G.S. Cohen, (Ed.), Proceedings of the Eighth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1984. Pp. 152-155.

Accurate and timely information regarding the costs and benefits of automated medical information systems (MIS) is important to decision makers in the Tri-Service Medical Information Systems (TRIMIS) Program Office, DoD, as well as to administrators in civilian hospitals and clinics. A methodology for conducting an economic analysis of an MIS is described. Included are methods for identifying and estimating system benefits and system costs, calculating the incremental life-cycle net benefit or cost, and testing the sensitivity of the results of the analysis to changes in benefit and economic assumptions.

The authors conclude that the methodology for evaluation, as described in the paper, has been tested and has proven itself useful to program managers. It provides managers with much needed information on the costs and benefits associated with the purchase, installation, and operation of a medical information system and presents that information in a manner that is accurate, understandable, and useful for decision making.

Schteingart, R., Wachenchauzer, R., Jamschon, R., Uman, G., Visciglio, H., Donovan, K., D'Adamo, G., & Panuncio, C. Development of an integrated medical record system at a large hospital using COSTAR as a designing tool. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, Md: IEEE Computer Society Press, 1982. Pp. 166-171.

This paper describes the design, programming, and implementation of an integrated information system in Sanatorio Guemes, a private hospital in Buenos Aires, Argentina. Advantages and disadvantages of using COSTAR in a hospital with 850 beds and 2,500 daily outpatient visits are pointed out, and the new system designed on the basis of COSTAR functionality is described.

The authors conclude that the public domain version of COSTAR is an invaluable tool that can be used to analyze the feasibility of a computer-based medical record system. Changes have to be made, however, in order to meet the requirements specified by the hospital and to design a widely accepted system.

They conclude also that when changes are made in a large system, in order to minimize hardware costs and to interface with previously programmed systems, it is possible that redesigning of files and rewriting of programs will be necessary. However, the use of COSTAR specifications allows the hospital to decrease software development costs and time, and to obtain a made-to-measure system that can grow gradually.

Smith, F.R., Gutierrez, R.R., & McDonagh, T.J. Exxon's Health Information System. Journal of Occupational Medicine, 1982, 24(10), 824-826.

There are five modules in Exxon's Health Information System (HIS): Substance Monitoring, Employee Tracking, Medical Surveillance, Reporting, and Epidemiology. The Substance Monitoring and Employee Tracking modules are useful in identifying potential employee exposure to specific substances as well as level and duration of exposure. On the basis of this information, employees can be scheduled by means of the Medical Surveillance module for both medical examinations and toxic hazard training. The Medical Surveillance module also schedules routine health maintenance examinations and collects medical histories information on life-style habits, physical examination results, laboratory reports, and morbidity and mortality data.

The Reporting module provides analytical data from Substance Monitoring, Employee Tracking, and Medical Surveillance for use by Exxon's health professionals. Summaries can be generated by individual, by groups of individuals, by substance, by process, by post, by craft, by specific location, or by groups of locations.

A higher level, more analytically oriented system to help perform epidemiologic studies is also being developed by Exxon. The Generalized Epidemiology System (GES) utilizes data received from HIS and is a flexible system that can accommodate varying data requirements encountered in epidemiologic studies. Through the use of detailed programs, the epidemiologist can add, modify, process, and report on data in a variety of ways and with little or no assistance from a programmer/analyst.

Soto, R.J., Kalan, D.A., Tordoff, R., Falbo, L.L., Galatowitsch, J., & Smith, L.W. Data base management system for tracking occupational health. In J.T. O'Neill (Ed.), Proceedings of the Fourth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1980. Pp. 333-338.

An Occupational Health Information System (OHIS) which is a data base management system for tracking occupational health has been developed by S. C. Johnson & Son, Inc. A primary feature is its ability to correlate employee workplace environment with health. Hardware implementation of OHIS is on a minicomputer. Application programs were written in ANSI Standard MUMPS language. OHIS is comprised of three basic modules that contain Personnel, Medical, and Industrial Hygiene/Toxicology information. Each module contains information that has been integrated into one data base. The Personnel module is comprised of demographic information collected and updated by the Corporate Personnel Department. The Medical module utilizes an interactive terminal-driven questionnaire subsystem and multiphasic testing subsystem that are selectively assessed by authorized users. The backbone of OHIS is a dictionary of all possible data elements which contain parameter abbreviation, name, grouping, and normal values. A final medical report includes a medical history summary, physical findings and x-ray interpretation, highlighted and normal test findings, computer interpretations, and a final 1-page summary of problem and health risk

information. Workplace environment information is captured and reported by the questionnaire driver. This questionnaire is designed to define (1) monitoring conditions, (2) sample analysis, (3) measurement results, and (4) personal protective equipment. These data provide a means of assigning environmental measurements in a work area to the appropriate employees.

Stallard, C.W., Jr. The SOHIO health information system: A system for data collection and computer processing in an occupational health program. Journal of Occupational Medicine, 1982, 24(10), 853-858.

This paper describes the SOHIO health information system, which is based on the concept of "profiling" coupled with code systems and data processing. The principal element of the system is the Medical Summary Sheet, which encapsules virtually all of the information about an employee. The data elements included on the Medical Summary Sheet are primary, secondary, and tertiary identifiers; Job Exposure Table codes; Qualification and Surveillance Program codes; and Medical Profile codes. The author describes in detail the derivation and uses of these identifiers and codes.

Also described is the file system used in SOHIO's health information system. The system consists of six basic files: (1) the master file containing employee data and all demographic identifiers along with the medical profile and the job exposure table, (2) the coded diagnostic entries, (3) a job exposure inventory, (4) master code inventory which lists all chemicals present in the company, (5) industrial hygiene data, and (6) toxicological information file.

Stewart, W.W., Allen, J.W., Bilella, J., & O'Neill, P. ETHOS, a health surveillance data base system. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 135-138.

The basic purpose of a health surveillance system is to detect changes in an employee's health status. These changes may uncover health threats from newly introduced or existing industrial/consumer substances. Stewart-Todd Associates has provided employee health monitoring services to a variety of industries for over 10 years. From these experiences the company developed a computerized health surveillance system called ETHOS. ETHOS was developed on an IBM System/38 with the QUERY capability. The computer program has four modules: Personnel/Administrative, Medical, Industrial Hygiene, and Safety. Advanced features of ETHOS include its adaptability to a variety of users' requirements, flexible data input structure, and reports that highlight trends for individuals or groups. Several companies in unrelated industries use ETHOS on a time-sharing basis. The storage of their employee data plus the reporting capabilities of ETHOS permit accumulation of a large employee data base. Such a data base is a valuable resource for detecting adverse health effects to employees or substantiating claims of a substance's harmlessness.

Sugano, D.S. Worker tracking--A complex but essential element in health surveillance systems. Journal of Occupational Medicine, 1982, 24(10), 783-784.

This author believes that the overall effectiveness and usefulness of an occupational health surveillance system are to a great extent determined by the system's ability to track the work experience of individual employees throughout the course of their employment. He states that it should be possible to extract or reconstruct from the database three general kinds of information: (1) the type(s) of hazards to which an employee may be exposed, (2) the degree or severity of that exposure, and (3) the time and duration of such exposure.

In existing health surveillance systems, three basic methods for defining worker exposure groups appear to be in use. These are the following: (1) grouping by job description or title, (2) grouping by work location, and (3) grouping by process or activity unit. Most companies attempt to identify worker exposure groups by a combination of two of these three methods of classification.

The author feels that four basic qualities that all systems should possess are (1) uniformity within exposure groups, (2) accuracy of classifying workers into proper exposure groups, (3) adequacy (e.g., are the job assignments or work locations of an individual employee reviewed frequently enough to ensure proper classification into the appropriate exposure groups?), and (4) cost-effectiveness. Each employer is perhaps best able to make the complex trade-offs between these and other criteria for an adequate worker tracking mechanism. Once the technical specifications have been determined by industrial hygienists and epidemiologists, the job of defining the type of worker tracking system that will be most cost-effective or practicable with respect to money, manpower, and organizational constraints becomes considerably easier.

Torrance, J.L., Torrance, G.W., & Covvey, H.D. A "cookbook" cost analysis procedure for medical information systems. In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1983. Pp. 621-624.

The authors have developed a costing procedure for medical information systems, incorporating state-of-the-art costing methods (opportunity costs, annuity method for one-time costs, reciprocal allocation for overhead costs, etc.) in a "cookbook" format. To use the procedure, one simply fills out a series of forms--the Mac-Tor EZ-Cost Forms. The authors have field tested the procedure and the forms by applying them to the costing of a cardiovascular database system. Although the entire procedure, forms, and application could not be presented in so brief a paper, the authors summarize the major features and encourage interested readers to write for more detailed material.

Walter, D.F. Control Data Corporation's occupational health and safety system. Journal of Occupational Medicine, 1982, 24(10), 848-852.

This paper describes Control Data Corporation's model for an Employer Health Affairs system. The modules of the system reflect the major types of interaction with health-related data. The Employee Personnel Data Module is the source of data needed for all of the other modules. Records from all modules flow into an integrated database. Thus, the modules may be put in place separately, with the capability of extracting integrated information being applied to whichever modules are present.

The main topic of this paper is the Medical Services Module (MSM). The MSM contains five files. The Question Pool file contains responses to questions and performs condition checks. The Logic file contains all logical interconnections among data elements. The Output Text file contains all output text. The Client Profile file contains client demographic information, company name, data on locations, responsible individuals, and other information. The Employee Record file contains all data collected by MSM. In addition to describing the system itself, the author also describes the implementation of a representative screening examination and gives an example of tailoring MSM to a client's requirements.

Watson, B.L. Medical data and computer generated evidence. In R.E. Dayhoff (Ed.), Proceedings of the Seventh Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1983. Pp. 633-638.

The author presents a history of the use of automated medical records and associated data in litigation in the United States. His major conclusions are as follows:

Computerized records are now treated as similar to--if not identical with--other, more traditional records for purposes of discovery and subpoena. Although a discovering party may be required to develop and utilize its own program to access a particular subset of data, cooperation on the part of the records' custodian is clearly appropriate when the discovery has been judicially compelled or agreed to by the parties.

On the other hand, material prepared expressly for litigation (e.g., a compilation of medical billing or service records involving a particular provider) should be protected by the work product doctrine. The introduction of computer printouts as evidence in an administrative or judicial proceeding depends upon an adequate foundation regarding the process of recording the data at issue and the software utilized to select these records, and support for or challenge to this foundation should form the core of any controversy over admission of these records.

Finally, the projection of the characteristics of a large population of records through random sampling has been supported in the billing context by a sufficient number of judicial decisions, and will receive more widespread appli-

cation in the future, particularly in quality of care review. While providers at risk through the application of these procedures may focus their assault upon the randomness of the sample and its margin of error, the better course for us all is likely to include genuine efforts to improve the quality of care, to increase the efficiency of its delivery, and to police billing honesty.

Whyte, A.A. Information requirements of the National Aeronautics and Space Administration's safety, environmental health, and occupational medicine program. Falls Church, VA: BioTechnology, Inc., Contract NASW-3119, May 1978.

The information requirements of the Safety, Environmental Health, and Occupational Medicine Programs at the National Aeronautics and Space Administration were studied to assess the need for a computerized information system. A survey of the internal and external reporting and recordkeeping procedures of these programs was conducted at Headquarters and five National Aeronautics and Space Administration Centers. This report describes these reporting and recordkeeping procedures and the major problems associated with them. The impact of probable future requirements on existing information systems was evaluated. This report also presents the benefits of combining the safety and health information systems into one computerized system and recommendations for the development and scope of that system.

Wolkonsky, P. Computerized recordkeeping in an occupational health system: The Amoco system. Journal of Occupational Medicine, 1982, 24(10), 791-793.

Standard Oil Company (Indiana) has developed a comprehensive computerized occupational health recordkeeping system that has been in use throughout the consolidated company for six years. The system's primary focus is the storage and retrieval of a large database. It permits analyses of the data that can provide correlations among disease and medical findings, work history and environmental exposure, accident information, and demographic factors such as social and workplace history.

The primary focus of this paper is on the measures taken to ensure the integrity and security of the data contained in the system. To ensure the integrity of the data, a complex series of edit checks is performed as the data are entered. The first-level check ascertains that the data are complete. The second-level check assures that all tests designated as required have been done. The third check tests the value of a numeric result against a clinically normal range and a clinically impossible range.

Extensive safeguards have been built into the system to prevent access by unauthorized individuals. In addition to sign-on codes and secret passwords, each terminal is hard-wired to return information only if the requesting terminal is one authorized to process the data requested. Data are stored in several files, with the social security number the only common data element, and that number is scrambled. The data are stored in a numerical format so that without

access to a Translation and Code Table, or TACT file, information cannot be determined by the entry in the data file. The data are stored in a specific order in the internal records so that an unauthorized interrogator would have to be familiar, not only with the programming itself, but also with the layouts of the internal records in order to identify individual results. All input forms and subsequent sensitive reports are kept under lock and key in secure medical departments.

Zielstorff, R.D., Barrett, S.M., Weidman-Dahl, F., & Barnett, G.O. An integrated program for user training: Experience with COSTAR. In B.I. Blum (Ed.), Proceedings of the Sixth Annual Symposium on Computer Applications in Medical Care. Silver Spring, MD: IEEE Computer Society Press, 1982. Pp. 520-524.

COSTAR (Computer-Stored Ambulatory Record) is a flexible, complex medical record system involving users of diverse backgrounds and interests. The challenge is to provide at the implementation site a training program and appropriate support tools so that each user is able to learn the different COSTAR capabilities and to function appropriately in the new system. Training programs that the authors developed for two different sites and implemented one year apart are described in this paper. Experience gained at the first site resulted in the development of an integrated program for the second site. Effectiveness of each program is discussed, and user reactions to each program are presented.

From their experiences, the authors conclude that an integrated orientation program founded on a general overview of the system and including review of procedures, demonstration of programs, one-on-one practice sessions at the terminal, and functionally oriented compact user guides seem effective in orienting workers of various backgrounds to a complex medical information system such as COSTAR. The drawbacks to this approach are the number of sessions required by such a program (since each work category is oriented separately), the consequent burden on trainers (which might be alleviated by training local trainers to conduct some of the sessions), and the necessity for user compliance in the program (since each component builds on the material previously given).

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