
Computers in Family Practice

Roger A. Rosenblatt, MD, MPH

The Use of MUMPS in a Departmental Computerized Clinical Data System

Robert C. Davidson, MD, MPH, Mark A. Diaz, MD,
John L. Horton, MA, and Martin Mendelson, MD, PhD
Sacramento, California

The Department of Family Practice of the University of California–Davis, School of Medicine established in 1977 a major priority to develop a department-based computer system. The major goal identified for the clinical data system was to link the Family Practice Center at the university with its five affiliated family practice residency programs to serve as a laboratory for family medicine research. Faculty and residents identified additional needs that could be addressed by a computerized data management system. These potential uses of the system were in educational activities for residents and medical students, in the

provision of clinical services in the centers, and in professional service billing for the centers.

Development

Once it was agreed that a computer system was a major priority for the department, a thorough search of options was undertaken. The decision was made to contract with an outside vendor system for computer services because the department had limited financial resources available and it was assumed that the system could be developed much faster by utilizing existing machines and programs.

Working with the vendor service for a 12-month period proved frustrating and nonproductive. The service did not have the flexibility to rearrange data to respond to the needs of the department. Turnaround time for reports became excessively long. A four-week wait was not uncommon. The

From the Department of Family Practice, School of Medicine, University of California–Davis, Davis, California. Requests for reprints should be addressed to Dr. Robert C. Davidson, Department of Family Practice, 2221 Stockton Blvd, Sacramento, CA 95817.

identification of errors in the data became a major source of frustration because of poor communication between the data entry and data processing people. The indifference of service bureau personnel to multiple requests for help and the increasing recognition of the inadequacy of the system prompted the department to abandon this first approach and to begin developing its own computer system.

The department has developed two parallel, but separate, computer systems over the past five years. One of these is the Clinical Data System, which is described in this paper in detail. The other system is dedicated to departmental support including word-processing and accounting functions. Both of these systems are housed in the department. The computers are connected by hard-wired cable or by telephone to faculty offices, clinical space, and clerical support areas. The use of two separate systems, each accessible from multiple terminals, allows each system to be designed and dedicated to specific departmental functions.

Clinical System Description

Hardware

The clinical data system utilizes a Digital Equipment Corporation (DEC) LSI-11/23 processor with 1,024 kilobytes of internal random-access memory (RAM). Data are stored on a 160-megabyte Winchester-type hard disk. A $3/4$ -in magnetic tape drive memory unit is used for back-up of data storage and for long-term storage of data not needed immediately. The use of the magnetic tape unit provides safe back-up of important clinical data stored on the disk drive and offers infinite expansion of data from other sources with similar systems.

Hard-wired terminals located in the Family Practice Center and throughout the department provide system access. Each of these terminals will ultimately have access to both the clinical data system and the department support system by a software switch. In addition, the system has two automatic answering telephone modems that allow access to any user with a terminal and modem. This allows the department faculty and clinical facilities in affiliated network residency programs

to utilize the same system. Security of the system is ensured through a password code system that can be regulated by the system manager to allow access to only those programs or portions of the data base appropriate to the user's needs.

Software

The selection of a language and operating system was the most critical decision in the development of the system. After reviewing available alternatives, the decision was made to utilize MUMPS. MUMPS is an integrated language and operating system developed at the Massachusetts General Hospital and Harvard Medical School Laboratory of Computer Science,¹ thus, its name—*Massachusetts General Hospital Utility Multi-Programming System*. MUMPS was designed primarily for the textual data prevalent in medical practice and provides for manipulation of clinical data sets by easily developed programs designed to respond to varying needs. Publications by Barnett and his colleagues have described the MUMPS system^{2,3} and have compared it with other programming systems available for medical data systems.⁴

Several characteristics of MUMPS make it particularly suitable for clinical data systems. It is an easily learned interactive language. MUMPS utilizes a data base system that allows constantly changing and expanding information to be stored in a manner that does not require predetermined storage space. Thus, the user does not need to define a storage area in the memory to be reserved for future use. The system is often described as a "branched tree" in which new data are added, as new leaves are added, at the periphery. The operating system automatically makes space available as new data are added and prunes the tree as data are discarded. The system can search the entire data base, or subsets of the data base, looking for particular information without altering the basic data set. Thus, if the user wanted to study only men aged between 30 and 50 years who have hypertension, a simple program can be written to identify these individuals. This new data set can then be stored separately for use in a variety of ways while leaving the basic large data base intact and available for other uses.

A second major advantage to MUMPS is its uni-

formity throughout systems. In 1977, agreement was reached by developers and users of MUMPS to standardize the language. This standardized MUMPS language is called "ANSI X II.1."⁵ Standardization has allowed multiple users to share programs and to avoid the problems of language dialects, which are common in computer languages such as BASIC. For example, in BASIC, programs written for one machine often cannot run on another without major modification. Programs written in Standard MUMPS will run with only minor change on any processor that contains the MUMPS operating system. This standardization has allowed the growth of an extensive literature⁶⁻⁹ that documents user experience and is extremely helpful in the development of each user's system. A MUMPS users group shares programs and experience and works to protect the standardization of the language.

Another advantage of MUMPS is that much of the development of the system was done with public financial support. Thus, all programs become public domain and are available for use at minimal or no cost. One such public domain program is a powerful data-handling program called VA File Manager.¹⁰

File Manager, developed by the Veterans Administration for use in hospitals and clinics, is a collection of programs that allows the user to enter, store, and manipulate constantly changing data whose content is defined by the user. Utilizing File Manager, the UC Davis clinical data system now stores data on a growing number of patients and enables multiple users at affiliate residency programs to use the same system while maintaining the integrity of their own data bases. The flexibility of the system allows maintenance and growth of the data base while responding to a variety of users with individual needs. For example, it is possible for the residency director to review the patient records of a particular resident while another faculty member experiments with the impact of a preventive medicine recall program; another works on identifying a study group of patients with particular characteristics; and the clinic manager reviews the billing and utilization statistics of particular providers in the clinic.

File Manager allows for expansion of the data set collected for each patient to include as many items as the user wishes to store. Currently, 17 data items are collected on each patient visit.

Demographic data are also collected on each patient new to the system and do not need to be re-entered. Future plans for the system include the addition of the capability to store information on medications, allergies, immunizations and other preventive measures, a problem list, laboratory results, and other textual data.

System Uses

The department continues to find additional uses for the clinical data system. New ideas are continually being tested as faculty become more familiar with the system. The system's adaptability facilitates the development of programs to address problems within the delivery system. Faculty can generate some reports directly with the File Manager software. If different formats or more specific reports are desired, MUMPS enables users to individualize programs. Several programs have been written by one of the authors (MM) with little previous computer experience and approximately one year's experience with MUMPS. One of those programs accepts each day's abnormal laboratory and x-ray results, generates reminder notices a week later, and allows the department's quality assurance program to audit clinic records for adequacy of follow-up and treatment. Another program permits attending staff to maintain a daily record of patients seen on hospital rounds and generates lists of inpatients, their diagnoses, and procedures performed. These data are also used for billing purposes.

Numerous other programs written in MUMPS are available for users. One of the first and most widely used computerized medical records is COSTAR (*Computer Stored Ambulatory Record*).¹¹ COSTAR offers a paperless medical record system that has been adopted for use in the outpatient clinics of the US military medical system as well as by several private clinics in the US and Canada.

Commercial versions of MUMPS generally run on computers larger than those in most residency programs. However, MicroMUMPS is now available for several microprocessor systems.¹² Such a system can be totally self-sufficient if the complexity of the programs used and the size of the data base are not excessive. Alternatively, such a MicroMUMPS installation can be used for data

entry, verification, and formatting, after which the files can be transferred over public telephone lines to a larger MUMPS system for inclusion in a comprehensive data base and for more complex manipulation.

Future of the System

The system, although slower to develop than originally expected, is now expanding rapidly. Faculty are finding new uses for the clinical data base. An appointment system program is currently on the UC-Davis system and will be implemented in the near future for the Sacramento residency program. Several faculty are now actively using the data system in pilot research studies with the intent of seeking extramural research support for larger studies.

The goal of linking each of the affiliated family practice residency programs that constitute the UC-Davis Network¹³ in the same system is in

progress. This computer linking will provide the same clinical data system for each program and will allow for large research projects with a combined data set of 200,000 outpatient visits per year.

Summary

The development of clinical data systems is an important task for family medicine academic units and residency programs. A computer system offers family medicine a unique opportunity to achieve its educational, clinical service, and research potential. MUMPS is recommended as a language and operating system. It was designed for medical information systems and is easily adapted to meet multiple needs.

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