

A Family Medicine Information System: The Beginning of a Network for Practicing and Resident Family Physicians

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This Family Medicine Information System is presented as a problem-oriented, family-oriented, selectively automated medical information system useful in family medicine residencies, as well as in the office practice of family medicine. Still developmental, the system is already used in five residencies and five practices by 97 providers caring for 13,205 families with 34,989 members. The automated function is integrated by a family registration document and an encounter form, and is organized into three modules: patient accounts, practice analysis, and patient management.

Several examples of how this system is being used are offered to illustrate its breadth of application. Calculations are presented which indicate that the system is economically competitive with commercially available billing systems while offering increments of: (1) access to information on the part of the practice 23 hours per day; (2) family orientation; (3) flexibility in cross relating patients, services, providers, diseases, and costs; and (4) ready comparisons across teaching, nonteaching, urban, and rural settings.

Future directions for this system are toward: (1) implementation in additional practices; (2) more intelligent automated analysis; (3) application directly into the physician/patient encounter; (4) the exercise of its research potential; and (5) the maintenance of the data bank.

This Family Medicine Information System (FMIS) is a selectively automated medical record and information system for family medicine residencies and private practices. It is designed to serve the practicing family physician who has developed "the mind set of critical inquiry."¹ Using the information required to register patients and

bill for services and little or no additional provider work, the FMIS relates families, providers, services, diseases, and costs across urban, rural, teaching, and nonteaching settings. It consists of: (1) a paper record developed in the University of Colorado family medicine residencies, similar to the record described by the University of Rochester,² and (2) automated aspects developed by the Mountain Plains Outreach Program and Community Electrocardiographic Interpretative Service.

The Mountain Plains Outreach Program is a consortium composed of Rose Medical Center, the

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University of Colorado Medical Center Departments of Family Medicine and of Preventive Medicine, the School of Nursing, the Dental School, Colorado State University, and the US Department of Health, Education, and Welfare's Health for Underserved Rural Areas Program (HURA). The goal of the Mountain Plains Outreach Program is to address the reasons why physicians do not enter practice in rural areas and to provide the necessary support systems to attract well-trained primary care physicians who intend to remain in rural communities. The FMIS was developed to support practice operations, patient care, physician and patient education, and research.

The Community Electrocardiographic Interpretative Service is a non-profit, physician-operated company that performs research and development in computer-assisted clinical systems. Prior to its involvement in the FMIS development, the Community Electrocardiographic Interpretative Service had developed and operated similar systems for ECG interpretation, medical history, physician consultation and education, and clinical data storage and retrieval. The group became involved in the FMIS because of its interest in demonstrating that computer-assisted ambulatory care data management can be a powerful tool to the practicing and training physician in urban and rural areas.

The basic premises of the FMIS include: (1) systems describing family medical care are needed; (2) the information required to bill for services and operate a private practice includes much of the information required to analyze the practice from the viewpoints of patient care, education, and research; (3) data systems must assist, not disrupt, the day-to-day practice of family medicine; (4) the family physician's system should be family-oriented; (5) flexibility to relate multiple factors across multiple settings should be assured; and (6) the system must be affordable.

The system is now operational in ten practices representing urban, rural, teaching, and nonteaching practices, including residents and fully trained family physicians. This paper presents the basic anatomy and physiology of the data system and, by examples, the way this system is beginning to be used. As of March 1978, 13,205 families representing 34,989 patients have generated 44,114 encounters involving 16,189 active patients.

Ninety-seven providers have made 56,743 diagnoses. Participating practices are located in communities as small as 1,000 persons and as large as Denver.

General Description

The FMIS is bionic, ie, it integrates manual and automated parts. The manual part consists of an effective chart system and is very important. However, the automated part is the focus of what follows.

The automated sections of the FMIS include a complete patient accounts module, a practice analysis module, and a patient management module. The information required for these three modules is collected onto two documents. The Family Information Sheet (Figure 1) is the registration document that describes families in the practice. It records basic demographic and fiscal responsibility information about the entire family. It is completed when the first member of the family becomes a patient in the practice. Data for all members of the family are recorded even though they may not be patients in the practice. The Encounter Form (Figure 2) records the patient's identification, problems, and all services performed or ordered for each patient visit.

The patient accounts module accepts charges for all services, prepares insurance forms, writes family statements, and produces fiscal reports such as the family ledger, aged accounts receivable, detailed charge and receipt listings, and monthly summaries of all the charges, receipts, and adjustments to patient accounts.

The practice analysis module prepares each quarter an age/sex registry, age/sex distribution of patients seen, morbidity reports, and service (procedures, patient visits, laboratory) reports for each provider and practice, and for the entire system. These reports allow each provider to compare his/her experience with other providers in the same practice or residency and with all other practices in the system.

The patient management module enables the users to extract any cohort of patients. The cohort can be presented as a list or as mailing labels for use in outreach, audit, and research.

Figure 1. Family information sheet.

Figure 2. Encounter form.

Anatomy

The anatomy or structure of the automated FMIS includes a nervous system, some muscles, and a skeleton.

The nervous system is the brain power of the system's users (who control its design and function), coupled with a time-sharing computer system. This computer is a Digital Equipment Company PDP 11/40 with 96,000 characters of main memory and 80 million characters of disc storage. It uses a Meditech Interpretative Information System (MIIS) operating system and programming language. The MIIS system, a dialect of Massachusetts General Utility and Multiprogramming System (MUMPS), is supplied by Medical Information Technology of Cambridge, Massachusetts. This system allows multiple practices to use the computer simultaneously, each with its own partition in the memory. It appears to the user that he/she has a personal computer in his/her office.

The muscle of the system is supplied by users at the practice site combined with complex applications programs at the computer center. These programs were derived from the Business Office System of the Cardiovascular Clinic in Oklahoma City. Through this practice-computer center interaction, the data entry, some report generation, and the interrogation of the data base are usually done at the practice, while the computer center assists with complex tasks.

The skeleton of the automated FMIS is formed by a communication network leading to each practice from the computer center. In eight of the ten practices using the system, the skeleton is built with leased telephone lines connecting the computer with one or two computer terminals at the practice site. At two sites, communication between the practice and the regional computer center is done by mail and/or messenger.

Physiology

In general, the functions of the automated FMIS are to ingest family, medical, and fiscal data about the patient populations of the practices, and analyze the data to produce useful patient accounts, practice management, and patient management reports.

The *patient accounts* functions are similar to other well-designed, automated billing systems.

Briefly, the purpose of this module is twofold: first, it is intended to provide a practice with assistance in maintaining an adequate cash flow; secondly, the data used in performing the first function are also used to generate files used for practice analysis and patient management reports.

The *practice analysis module* provides quarterly reports describing the patient population of the practice, problems and diagnoses of this population, and services performed or ordered by the provider. The first of these takes the form of two reports: the age/sex registry and the age/sex patient distribution report.

The *age/sex registry* is a graphic representation of those family members registered in the practice. It displays the percentage of males and females in each of 16 age groups who have been registered and who claim to be patients of the practice. These percentages are displayed for each provider, each practice, and for the entire system. The display of these data allows easy comparison of one provider's patient population with that of other providers in the same practice and of the population of one practice with all the practices using the system. Since the users of the FMIS currently include training practices as well as private practices in urban and rural areas of Colorado, the graph for all patients represents a cross-section of the family medicine patient population in the state. This characteristic allows meaningful comparison among geographic regions, teaching and nonteaching settings, and urban and rural settings.

The *age/sex patient distribution report* takes the same form as the registry and displays the number and percentages of patients seen during the time period covered by the report. It is important to note that this is not an encounter or patient visit report, since a patient visiting multiple times during the period will only be counted once. In addition to its usefulness for studying and comparing the distribution of patients seen by a provider, a practice, and all practices, this report, compared to the age/sex registry, determines what portion of the registered population is actually visiting the provider, the practice, or all practices.

The practice analysis reports include a *morbidity report*. This quarterly report describes the problems seen by each provider, each practice, and all practices. The problems are listed in a ranked frequency distribution with the most frequent problem first, the next most frequent sec-

ond, and so on. The rank of each problem in the provider's practice and in all practices is displayed along with the provider's rank. Also listed is the number of times the problem has been recorded, the number of patients with the problem, their percentage of the visiting patient population, and the maximum and mean number of visits for the problem.

Again, as with all reports in the practice analysis module, the morbidity report allows study of the experience of any single provider in comparison with the experience of other providers in the system. It also provides a basis for monitoring the incidence and prevalence of primary care problems in an entire state.

The *service analysis* generates three reports. This series first describes for each practice the number and percentage of all services, patient visits, and charges provided by each physician. The second section lists for each physician the number and percentages of services in each of several categories: office visits, hospital visits, laboratory services, surgical procedures, consultations, radiology services, and other medical services. The third section provides a detailed list of each service in the category shown in the previous section. The services are ranked by frequency of occurrence for the provider, his/her practice, and for all practices.

There is a special part of the practice analysis module that allows documentation and analysis of a resident's experience during his training. The basic FMIS collects information for services performed for which the practice charges, but not all residents' services are charged. Residents carry a 3×5 card for recording services performed that are not charged. These data are added to charged services in the FMIS files to produce a residency experience file. Thus, the entire experience of the resident can be reported during and at the completion of training. These reports allow curriculum modification to optimize training experience and documentation of the residents' skills, useful in requesting hospital privileges.

Applications

Much of the literature referring to automated medical record systems has been presented from

an academic view. Sometimes, reference is made to use by practicing family physicians, but this applicability is mainly in fiscal management. In addition to this important function, the FMIS gives the family physician the ability: (1) to escape the false stereotype of the nonresearch-oriented keeper of the URI turnstyle, and (2) to participate in the invigorating exercise of studying his own work. This section presents specific examples of how the FMIS was used this past year in a Colorado family medicine residency and in a practice begun in September 1977, served by a residency-trained family physician working in a community of 3,000 people. The examples were selected not to be exhaustive, but to indicate the flexibility of the FMIS in the hands of its users. Six categories helped organize the examples.

1. Teaching/Learning

A. The physician in the practice has selected continuing education courses to further understanding of the problems he most frequently encounters. Since his nurse has a provider number, her morbidity index and service reports also indicate her continuing education needs.

B. The weekly conferences in the residency were designed to include management of most frequent diagnoses; for example, during one report period, 379 prenatal visits were performed involving 95 patients producing the second most common diagnosis. Therefore, at the beginning of the academic year, the first series of conferences offered were in prenatal care and the management of third trimester complications.

C. The morbidity report from the last quarter of 1977 indicated lacerations were the tenth most common diagnosis in the entire system, but were 31st in the residency. Bruises and contusions were 20th in the system, but 61st in the residency. The conclusion was that residents received an inadequate exposure to trauma and one that differed from that of practicing physicians in Colorado. Therefore, there has been a revision of the Emergency Room curriculum and the addition of a rural practice experience which, the information system has indicated, will include more exposure to trauma.

D. Especially important is the feedback to individual physicians concerning their performances. When one physician recognized that his most frequent laboratory procedure was a protime while the remainder of the system ranked that tenth, he immediately inquired about the age of his patient population and some specific diagnostic categories. This prompted the use of the age/sex registry and the morbidity index. Thus, the inquisitive posture was promoted.

2. Evaluation

A. The residency wants individual residents to experience an appropriate sample of family practice. No corrective actions were judged necessary for Dr. A when her experience was reviewed as follows. Doctor A, during the last quarter of 1977, conducted 156 encounters involving 82 patients and made 200 diagnoses. Her top ten diagnoses were prenatal care, general health maintenance, diarrhea, postnatal care, pain in a limb, upper respiratory tract infection, depressive neurosis, menometrorrhagia, perinatal problems, and abdominal pain. Of Dr. A's services, 32 percent were rendered as office visits, 28 percent involved the laboratory, 16 percent were surgical, three percent were provided in the Emergency Room, and seven percent involved hospital visits. Doctor A's average charge for an office visit was \$15.80. Her most common laboratory procedure was a urinalysis, which was the second most common laboratory procedure in the entire system as well as in the practice. Doctor A sees many more boys under the age of five, men between the ages of 25 and 30, and women between the ages of 20 and 25 than does the rest of the practice or the entire system. Doctor A inserted two IUDs during the report period, did one sigmoidoscopy, and had nine patients admitted to the hospital. On similar review, another physician, however, was discovered to have seen no patients with otitis media. Therefore, a physician who had otitis media as his second most common diagnosis was notified and was able to demonstrate the disease readily to the physician not having otitis in his practice.

B. A pediatric (age 12 to 24 months) immunization status audit of the practice was conducted in January 1978, and showed only 33 percent com-

pliance. Names and telephone numbers of inadequately immunized patients were produced, and these patients were contacted and immunized. Re-audit six weeks later found over 95 percent of these children receiving appropriate immunization.

C. The standard morbidity reports indicated, in the last quarter of 1977, that the average pregnant woman in the residency had 12 prenatal visits. This was interpreted as an acceptable performance. On the other hand, the average number of visits for a person who had acute otitis media was 1.6, which implied inadequate follow-up.

3. Administration

A. One of the first needs of the practice was determination of malpractice insurance rates. In addition to filling out the usual questionnaire, it was possible to provide the insurance carrier with data on diagnoses and procedures done in the practice. This resulted in a 50 percent reduction in malpractice insurance rates over what was previously projected. Annual review is available at insurance renewal time.

B. A local prepaid insurance group is attracting a large number of patients, many of whom are residency patients. It became increasingly important for the Family Medicine Center to be a participant in the prepaid program. The program, however, was concerned about laboratory utilization by physicians in training. Information generated by standard reports documented that the amount of the patient's dollar spent on laboratory services averaged 19 cents for the physicians in the residency. This assured the administration of the prepaid group that these resident physicians do not overspend on laboratory services.

C. Since the system automatically prepares claims for Medicare, Medicaid, Blue Shield, prepaid groups, and commercial insurance, physician and staff involvement in the insurance claim process is minimized. The FMIS also assists in the collection of fees by providing a modified aged accounts receivable report which includes the address and telephone number of families with delinquent accounts. Furthermore, it offers the ability to assign a collection message to the monthly statement, either automatically or manually.

4. Service

A. The FMIS facilitated on-site evaluation of a group of patients by a specialist. All female patients between 35 and 50 years of age with irregular menses were identified and evaluated by a gynecologist at the practice site. Not only was this more convenient for the patients, but it promoted the continuity of their care and furthered the education of their physician.

B. In the fall of 1977, the faculty and residents determined the population which they wished to have receive an immunization against influenza. The patients meeting the criteria were readily identified. Simultaneously, mailing labels were produced and those patients were notified of the office schedule designed to facilitate their receiving the immunization.

5. Patient Education

A. An item of intense public health concern in the community was streptococcal infection. At the conclusion of the last quarter of 1977, it was possible to demonstrate that the incidence of streptococcal pharyngitis was lower in the practice than the average in the rest of the FMIS system. Newspaper articles aimed at public education on streptococcal infection were published using data generated by the system.

B. The residency's head nurse teaches classes on breastfeeding. The FMIS assists her by identifying all of the pregnant women in the practice and notifying these expectant families of the availability of these classes.

6. Practice Planning

A. The FMIS assisted the practice in the determination of the appropriate time to bring on a new partner. The growth projections suggest that a new partner might be necessary 15 to 18 months after the practice opened.

B. When the opportunity to hire a full-time pediatrician for the residency arose, the FMIS indicated that 45 percent of the visiting patients were under the age of 20 and over one third of the

hospital admissions were newborn babies, suggesting that a pediatrician would be a timely addition to the residency faculty.

Cost

One of the stated goals of the development of the Family Medicine Information System was to create a cost effective, automated billing and data system applicable to both training centers and actual family medicine practice sites. The system must take the place of staff time and/or improve the quality of the tasks performed. While the FMIS may not replace an insurance clerk, it allows more effective utilization of staff time and an expanded and improved level of working knowledge about the practice, the providers, the patients, and the management systems. The ten practices using the FMIS are in various stages of development and growth and utilization of components of the Family Medicine Information System. As a result of this development and growth, it was necessary to examine utilization and cost of the system by each individual practice. The compilation of the information provided enough data and cost information to develop two illustrative models.

The first is a one-physician practice with an average patient load of 35 encounters per day, a registered family population of 1,600, with a growth rate of approximately 50 families per month. This model includes figures for a practice in close proximity to the computer center and also a practice using long distance leased lines. The second model is a two-physician practice seeing an average of 70 patients per day, with a registered family population of 2,800 and an average growth rate of 75 families per month. This, too, reflects both an in-town and long distance relationship to the computer center. The assessment of staff time needed for registering new families and putting them into the data system, and making receipt and adjustment entries was calculated by observing staff at practices using the FMIS. The cost of staff time was calculated using average 1978 salaries.

Table 1 reflects comparative costs for an on-line 35-patient per day practice and a 70-patient per day practice, also on-line. The doubling of volume illustrates the economies of scale experienced by

Table 1. Comparative Costs

	35-Patients/Day*		70-Patients/Day*	
Staff Time				
New Families	50/month × \$1.00=	50.00	75/month × \$1.00=	75.00
Encounters	770/month × .20=	154.00	1,500/month × .20=	300.00
Receipt and Adjustments	350/month × .05=	17.50	700/month × .05=	35.00
Subtotal		\$221.50		\$410.00
Forms				
Encounter Forms	770/month × \$.10=	77.00	1,500/month × \$.10=	150.00
FIS	50/month × .12=	6.00	75/month × .12=	90.00
Statements	800/month × .25=	200.00	1,300/month × .25=	325.00
Insurance	260/month × .10=	26.00	500/month × .10=	50.00
Aged Accounts	1,600/month × .01=	16.00	2,500/month × .01=	28.00
Master Patient List	1,600/month × .01=	16.00	2,500/month × .01=	28.00
Subtotal		\$341.00		\$671.00
Computer				
Computer Charge	\$350/month	350.00	\$350/month	350.00
Terminal and Printer	\$105/month	105.00	\$105/month	105.00
Leased Line	\$ 35/month	35.00	\$ 35/month	35.00
Subtotal		\$490.00		\$490.00
Total (in-town site)		\$1,052.50		\$1,571.00
Registered Family/Month (in-town site)		\$.66		\$.56
Each Encounter (in-town site)		1.36		1.05
Rural Site Additional Leased Line Cost	\$190/month	190.00	\$190/month	190.00
Total (rural site)		\$1,242.50		\$1,761.00
Registered Family/Month (rural site)		\$.78		\$.63
Each Encounter (rural site)		1.61		1.17
* Average				

greater utilization of fixed cost categories such as: computer charge, terminal and printer rental, and the leased line charge. A 35-patient per day practice using batch processing on the FMIS would cost \$692 per month, 90 cents per encounter per month, and 43 cents per registered family per month. The 70-patient per day practice would cost \$1324.25 per month, 88 cents per patient encounter, and 47 cents per registered family per month.

At this time, the FMIS is competitive in cost with commercial systems in the region, while offering increments in: access to information on the part of the practice (23 hours per day); family

orientation; flexibility in cross relating patients, services, providers, diseases, and costs; and ready comparisons across teaching, nonteaching, urban, and rural settings.

Comment

Kerr White³ described a renaissance of clinical research in which research is "conducted with the cooperation of ambulatory patients in the doctor's office, the health center, the clinic, the outpatient department and in the home." As articles by

Table 2. Patient Accounts Module

Patient/Family Statement
 Insurance Claims Forms
 Blue Shield
 Medicare
 Medicaid
 AMA Universal
 Prepaid
 Commercial
 Workman's Compensation*
 Ledgers
 Aged Accounts Receivable Reports
 Complete
 Modified (patient's address
 and telephone number
 for delinquent accounts)
 Monthly Summary of Accounts Receivable
 Daily Charge and Receipt List
 Special Reports

* Still developmental

Table 3. Practice Analysis Module

Master Patient List (monthly)
 Family Registration and Activity Report
 (quarterly)*
 Age/Sex Registry (quarterly)
 Age/Sex Distribution of Visiting Patients
 (quarterly)
 Morbidity Report (quarterly)
 Service Reports (quarterly)
 Practice Service Summary
 Provider Service Summary
 Provider Service Detail
 Fubar's Opinion*
 Special Report

* Still developmental

Table 4. Patient Management Module

Family Profile*
 Patient Profile*
 Problem Surveillance and Follow-Up*
 Patient Education Assistance Package*
 Special Reports

* Still developmental

Smith,⁴ Braunstein,⁵ and Rodnick⁶ confirm, the FMIS is but one of several innovative systems assisting such investigation. However, the implementation of the FMIS into practices: (1) in diverse settings, (2) without disrupting the practice of family medicine, and (3) at affordable cost, may be particularly useful in the further development of family medicine. Already, physicians using the system express their pleasure at having an effective tool to review their own behavior. They also emphasize the importance of being part of a larger system that helps them avoid a sense of professional isolation and encourages a sense of belonging to family medicine as an important, growing discipline.

Tables 2, 3, and 4 summarize the reports produced by the FMIS. Those marked with an asterisk are still developmental and are not yet functional. The listings imply where the system has been and where the system will go. Initially, the assurance of cash flow was paramount, but future developments will be toward: (1) additional practices using the FMIS, (2) more intelligent automated analysis (for example, Fubar's opinion), (3) applications directly into the physician/patient encounter, (4) the exercise of its research potential, and (5) learning to maintain the data bank.

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