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Software for Family Practice: A Decade of Development

SUMMARY

The University of Ottawa's Department of Family Medicine has been developing software for family practice for ten years. The system started with remote keyboard data entry and has evolved through use of optical mark/sense reading to the use of two IBM personal computers for system maintenance. Programs have been developed for billing procedures in two provinces, filing and chart organization, administrative statistics, educational profiles of individual practices, data for research, patient reminders, and appointment booking. Programs for CME, X-ray and blood test reports, and cross checks for drug interreactions are currently being developed. (Can Fam Physician 1984; 30:2567-2571).

SOMMAIRE

Le Département de médecine familiale de l'Université d'Ottawa développe depuis dix ans déjà des logiciels pour les médecins de famille. Le tout a débuté avec des entrées de données sur des claviers à distance et a évolué de l'utilisation de lecteurs optiques à l'utilisation de deux ordinateurs personnels IBM pour le maintien du système. Des programmes ont été développés pour les procédures de facturation dans deux provinces, pour le classement et l'organisation des dossiers, les statistiques administratives, les profils éducationnels de pratiques individuelles, les données pour fins de recherche, les rappels de patients, et la prise de rendez-vous. Des programmes sont en cours de développement dans le domaine de l'ÉMC, des rapports de radiographies, des analyses sanguines, et de vérifications pour les interactions médicamenteuses.

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CANADA IS ON the threshold of very widespread use of computers in every aspect of our lives, including clinical practice. We felt our experience might benefit many physicians who may be considering computerization now or in the next few years.

In January 1973, registration of patients on a typewriter-style computer terminal began at the Ottawa General Hospital Family Medicine Centre. This marked the beginning of ten years of cooperation between clinicians in the University of Ottawa Department of Family Medicine and the Computer Applications Branch of the University of Ottawa. This cooperative venture resulted in the development of a computerized data storage and retrieval system that assists the family physician and his staff in improving the efficiency of health care delivery.

Our system was developed in a university- and hospital-supported teaching centre and was heavily subsidized by both the Computer Applications Branch of the University of Ottawa and the Ottawa General and Ottawa Civic Hospitals. These subsidies were based on cost-effectiveness studies that showed adequate savings in clerical time and staff to justify the costs of equipment rental. However, physicians in private practice must calculate costs of such a system very carefully; the impact on office function will be different in each practice setting. The teaching and research needs and objectives of a family medicine teaching centre usually exceed those of most private practices.

Evolution Of The Computer System

In 1973, $6,000 of grant money was used to begin the process of registering a practice of 8,000 patients using a printer terminal that relayed patient registration data to the University of Ottawa Computer Centre via a modem. The registration process took considerably longer than was expected and the grant money was depleted before registration was completed. Although this first attempt at computerizing medical records could be considered unsuccessful, we gained valuable knowledge about problems of patient registration. Registering all the patients in a practice is a tedious and expensive process. This problem can now be more efficiently dealt with in some provinces by obtaining a provincial billing agency's computer tape of registration data for all patients visit-

ing a practice in the preceeding two years.

The type of equipment used is important for efficient interaction with a remote central computer or micro computer. Telephone coupler linkage, using a modem and regular telephone lines, was unacceptable because of problems related to transmission and the slow speed of operation. The premature stopping of the registration process illustrated the importance of financial viability that would provide for continuous data collection. This realization forced a complete revision of the original priorities for designing and organizing the system. Our original priority list put research and teaching at the top; when it was revised, cost-effectiveness was the top priority (Table 1). Unless the system was practical and cost-effective, the research statistics would be of no value because continuity was fundamental. Also, accuracy in recording data was directly related to individuals' perceptions of benefits for them from the system. A system used for billing purposes stresses to users the importance of accurate recording every time a patient is seen.

From 1973 to 1976, when the initial registration program was in abeyance, work was continuing with the Interdepartmental Research and Records Group (IRRG) of Ontario universities. Within this group, the University of Western Ontario Department of Family Medicine, using a grant, had developed an extensive data recording system which resulted in several publications.[1-4] By cooperation and sharing experience, we were able to avoid many of the problems encountered in developing the Western system. This very innovative and large scale system ceased functioning in 1975 because grant money stopped, reinforcing our idea that a system must be cost-effective. IRRG agreed that the International Classification of Health Problems in Primary Care should be used to classify the problems of family practice[5] and developed criteria for minimum registration data that would be compatible between all Ontario family medicine centres.[6]

With the knowledge gained from both IRRG and the 1973 trial, a second attempt was made in 1976 to register the Ottawa Civic Hospital Family Medicine Centre practice using a system designed for billing purposes. This system consisted of three files: provider registration, patient registration and patient encounter. Each file was registered in the office on customized mark sense forms by clerical staff and then sent by courier to the university computing centre where they were batch processed through an optical scanner and transferred to computer tape. Practice registration required six months of fulltime clerical work by two individuals. It was completed in April 1976 and the computerized system for billing began to function on the assumption that it would be cost-effective by reducing clerical time required for billing. Modifications were made continuously, to improve the efficiency of information recording.

In 1980, we decided to convert from mark sense recording to an online system that allowed for both entry and access of data on terminal screens in the office. This step greatly enhanced our ability to edit and validate each entry. In March 1981, we modified our encounter form so that all prescriptions were duplicated, allowing direct entry of each prescription. The original "write in" record of prescribing data was error prone, because the physician had to rewrite each prescription. By copying the actual prescription, the error rate was reduced to less than 3%.

During 1982 and 1983, office staff and physicians were trained in simple programming so that easy access to useful information was possible. As computer hardware dramatically improved, all of the data storage and retrieval was moved to microcomputers, as of June 1984. This step puts software and hardware within the financial reach of solo or group family physicians.

TABLE 1
Revision of Priorities for the Ottawa Family Medicine Centre Computer System

Original Priority List	Current Priority List
1. Research	1. Billing
2. Teaching (students, residents, practicing physicians)	2. Clerical assistance
3. Patient care (patient profiles, patient recall)	3. Patient care (patient profiles, patient recall)
4. Record storage and retrieval	4. Administrative statistics
5. Billing	5. Teaching (students, residents, practicing physicians)
6. Administrative statistics	6. Research

Evolution Of Hardware And Software

The software design has remained relatively constant since 1973. The core components of this system are the ability to:

1. register patients
2. register doctors and residents
3. record encounter information.

Once these three components were in place, the information gathered permitted billing and remittance, patient profiling, practice profiling, and a statistical base for research. Although the software design has remained consistent, the hardware to run the system has undergone several changes.

In the pilot project a low speed terminal was used, but the software and system were inadequate. With the introduction of optical mark sense (OMR) forms, coding could be done with a lead pencil on preprinted forms which were passed through a scanner and picked up by the main computer.

This system was extremely cost-effective; however, there were lengthy delays between submission of OMR forms and receipt of outputs. Also, the Family Medicine Centre depended on the computing centre for all processing of computer runs. We finally went 'in-house' in 1980 with the installation of two remote terminals and a printer at the Family Medicine Centre, although a connection was still kept to the University's computer. The system became more and more stable; maintenance and upgrades were minimal.

The move to a complete in-house system became feasible as the cost of microsystems fell and their power and storage capacities grew to a level that met our needs. Three to four months of programming was required to convert current software for the microcomputer.

Current Status Of The System

Billing

By linking the physician and patient registration files with the daily patient

encounter data using a six digit patient number (four digit family number and a two digit individual number), Ontario or Quebec health insurance bills are generated on our printer. ICHPPC-2 Defined Classification is used to define all health problems seen. Unfortunately, Ontario and Quebec do not use the same classification, so the system has to translate into the numerical codes used for billing by each province. Since 10% of our patient population is from Quebec, there is a significant advantage in letting the computer programs translate into the appropriate billing format for each province. Another program produces accounts for patients with other provincial or foreign coverage, or no coverage. Both Ontario and Quebec now accept billings on computer tape or floppy disks. OHIP or QHIP cards are produced on continuous strip billing cards. Both agencies return remittance data on computer tape, so all accounting is machine processed. Only 30 minutes of manual work each month is required on the remittance information for 2,400 patient visits. Weekly or monthly profiles of billing, accounts outstanding etc. may be generated from account programs.

Clerical Assistance

The manual work involved in completing OHIP or QHIP cards is avoided by computerized printing. Up to 150 encounter sheets are computer printed daily, saving two or three hours of manual work. Computer printing encounter forms has reduced errors in obtaining charts for patient visits. All patient registration cards, which are necessary for chart number identification in a color coded filing system, are generated from the patient registration file by the computer. Once a patient is registered on the system, the basic demographic data (name, address, telephone number, insurance number etc.) can be used again for forms or any other use that requires demographic data. A computer is an excellent way of sorting and producing billing cards in alphabetical order, encounter sheets in the order of appointment, and other sorting functions.

A proposed application that will further reduce clerical work will be to generate embossed plastic cards for each patient so that imprinting can be used for X-ray and test requisitions.

The newest addition to the system is the function of booking. Patients requesting an appointment are first identified by chart number, using their name and birth date to search the files. Then a one week menu of their physician's time is flashed on the screen so that an appropriate time and day may be chosen. Once the appointment is made, office lists and encounter forms will be printed the day before the visit.

Patient Care

The continuous patient profile (CPP) was originally developed at the University of Toronto after extensive review by many family physicians.[7] The basic concepts of the manual CPP have been incorporated into the computerized version: problems dealt with on previous visits, drugs prescribed, drug allergies, a longterm problem list, hospitalizations and smoking status (Table 2). The CPP includes the

TABLE 2
Sample Computer-Generated Patient Profile

CHART #0000000000 CUMULATIVE PATIENT PROFILE DEC 15/83 (VISIT DATE)
DDMMYY

JOHN Q PUBLIC MARRIED MALE DOB: 081235
13 ANY ST OHIP# 12345678 JQ PUBLIC
OTTAWA ONT SIN# 910111213
K1Z 000 HOME# 123-4567 WORK# 910-1112 EXT. 461

BLOOD PRESSURE

OCT 20/80	120/080
JAN 21/81	132/085
SEP 07/82	131/078
JUN 15/83	150/095
JUL 15/83	130/080
OCT 27/83	135/083

SMOKING

OCT 27/83 0-10 CIGARETS PER DAY

SCREENING PROCEDURES REMINDER SYSTEM

LAST REC	PROCEDURE	THIS VISIT	DONE
OCT 27/83	BL PRESSURE	NR	
OCT 20/80	STOOL OC BLD	YES	
OCT 20/80	NUTRITIONAL STATUS	YES	
NR	RETIREMENT STATUS	NR	
NR	INFLUENZA IMM.	NR	

PERMANENT PROBLEMS

JUN 15/83	DIABETES MELLITUS (250)

DIAGNOSIS

OCT 27/83	SEBACEOUS CYST (709)
JUL 15/83	DIABETES MELLITUS (250)
SEP 07/82 + 1	EYELID INFLAMMATION (361)
JAN 21/81	UPPER RESPIRATORY TRACT INFECT (460)
JAN 15/82 + 2	ACUTE BRONCHITIS (466)
NOV 19/80	DYSPNEA (780)
OCT 20/80	ANNUAL HEALTH EXAM (796)
OCT 02/80	RESPIRATORY TRACT ABNORMALITY (519)

DRUG ALLERGIES

OCT 02/80	PENICILLIN

DRUGS

OCT 15/83 + 1	INSULIN 24 UNITS QAM X 100 DAYS
JUL 15/83	OXAZEPAM 15 MG 1 QHS X 30 2 REPEATS

HOSPITAL VISITS

DATE IN	DATE OUT	HOSPITAL	ADMITTING DIAGNOSIS
JUN 15/83	JUN 24/83	OTTAWA CIVIC	DIABETES MELLITUS (250)

date on which the last screening procedure (e.g. Pap test) was performed. If the screening procedure has not been carried out in the recommended period of time (e.g. blood pressure annually) a reminder to the physician to conduct the procedure during the next visit will appear on the CPP. The desirability and effectiveness of such a reminder is presently unknown. Grant support has been received to assess the impact of reminders for the physician, the nurse or the patient, who would be sent a letter at the frequency with which screening procedures should be carried out. A randomized trial will be conducted to assess efficacy and cost-effectiveness of these reminder systems during the next two years.

Immediate access to the CPP on a terminal located in each nursing station enhances efficiency. If a pharmacist calls requesting a repeat prescription, the nurse can review the previous prescriptions and repeats. The nurse and physician may then approve or reject the request without pulling the chart. The repeat prescription is then recorded on an encounter sheet, which in turn is entered into the computer and will appear on the next CPP. This procedure saves the clerical time required to pull and refile 20-40 charts per day and consolidates all prescribing information in one place. The physician may access information about the patient from the CPP, some of which may not be recorded in the chart.

Administration

Statistics are frequently requested in a university and teaching hospital setting. Since all hospital admissions as well as all visits to the family medicine centre are recorded on the patient encounter system, we are able to generate statistics on age, sex, length of hospital stay, and rate of hospitalization for patients registered in the practice. These are only a few of the most frequently requested statistics. Now hospitals require a monthly list of all patients attending the practice with their age and OHIP or QHIP number to bill provincial health departments for subsidies. Accreditation surveys and other hospital administrative surveys often require this type of data. Developing these statistics manually required a full time employee and was often inaccurate. Now simple programs which can be used in the centre without requesting extra programming assistance allow generation of required data in minutes. The average length of stay for the 160 family medicine centre patients admitted to the Ottawa Civic in 1983 was 15.1 days, with a range of one to 231 days. These same patients made 11.8 office visits per patient per year, compared to 2.2 for all other family medicine centre patients. Tables 3-6 give some examples of administrative statistics generated on patients admitted.

Education:

The *educational* role of a computer in our centre has grown substantially. Students and residents can receive a profile of the activities they participated in while working in the centre. This includes the age and sex of the patients they saw, the new or chronic problems they dealt with, the drugs they prescribed and the procedures they performed. These profiles can then be compared with the average of all physicians in the practice so that if there is a significant deviation, explanations for the differences can be sought. By reviewing age-sex distribution of patients who visit residents, imbalances such as too many male or female patients, or unusually high or low load of elderly patients may be detected and changes in booking procedures can be implemented to overcome the problem. Using simple programs, residents have surveyed the practice to determine the number of patients with a specific problem seen during the past one or two years, the drugs prescribed for the problem and other similar information that enhances the relevance of seminars and teaching rounds. A significant role in education is the ability to audit the number of procedures each resident performs. The capacity to audit drug prescribing has led to several audits and publications on the subject.[8, 9]

Research

Computerization of a practice is essential if efficient research programs are to be conducted. One of the major problems in primary care practice is to develop proper incidence or prevalence rates. The problem in mobile North American primary care practices is to compute as accurately as possible, the population at risk. Much thought has been given to this subject by researchers and statisticians; no simple solutions have been found.[10, 11] About 18% of the patients at the Ot-

TABLE 3
Hospital Stays For 160 Family Medicine Centre Patients Admitted to Ottawa Civic Hospital in 1983

Age	No. of Bed Days		No. of Pts.		Average Stay	
	M	F	M	F	M	F
<15	2	11	1	2	2	5.5
15-44	57	96	6	17	9.5	5.6
45-64	219	82	14	13	15.6	6.3
>65	1056	897	55	52	19.2	15.3

TABLE 4
Ten Most Common Diagnoses for 160 Family Medicine Centre Patients Admitted to Ottawa Civic Hospital in 1983

No. of Pts.	ICHPPC	Diagnosis
11	4280	Heart failure
9	4150	CVA
9	4920	COPD
7	5780	Gastrointestinal hemorrhage
7	2500	Diabetes mellitus
7	4120	Chronic ischemic heart disease
5	4100	Myocardial infarction
5	4350	Transient cerebral ischemia
4	4290	Unstable angina
4	1622	Ca of lung

tawa Civic Hospital Family Medicine Centre leave the practice each year. These patients are replaced, so that after six years of continuous registration, 24,000 patients have been registered yet there are only 14,000 active patients in the practice. Inactive patients' files are stored on tape for possible future reference. Active patients are defined as having visited the practice once during the previous 18 months. Any patient with no visit recorded in 18 months is sent a letter asking if they still consider a physician in the practice as their primary care physician. The response or lack of it to this letter allows maintenance of chart files as accurately as possible. The full potential of this system for research will take many more years to realize, but papers dealing with immunization, prescribing patterns, smoking, and the content of family practice have already been published.[12-16] The only limitation is the time and energy required for careful assessment of the data which is available.

Record Storage

Computer storage of medical records has great potential, but is presently an expensive and somewhat impractical way to store information. A much needed addition to the system is the storage for and retrieval of results of X-rays and laboratory investigations. Since most of these results are currently collated on hospital-based computers, an interactive system that actually reports results in a summary fashion and which could be easily accessed on video terminals would reduce phone calls for results, reducing the volume of paper on most charts. Such linkages are possible with the IBM personal computer and will be developed over the next two years.

TABLE 5
Pattern of Admissions by Month for 160 Family Medicine Centre Patients Admitted to Ottawa Civic Hospital in 1983

Month	No. of Admissions
Jan	6
Feb	9
Mar	12
Apr	8
May	21
Jun	18
Jul	19
Aug	14
Sep	24
Oct	18
Nov	4
Dec	7

The Future

The potential for computer systems in the next two decades make it difficut to foresee what the future will bring. All of the applications currently used in the University of Ottawa system are simple and not particularly innovative in comparison to present levels of hardware or software.

Future developments in monitoring patients at high risk, complete file storage, voice interactive recording systems, interactive continuing medical education programs, and drug interactive programs are only a few of the potential systems that will emerge in the next decade. All of these developments will allow family physicians to better describe our daily work, and to better deliver new therapies and preventive programs to our patients.

Conclusions

Although individual physicians may not need all of the components of this system, they can perhaps appreciate from our experience both the limitations and the potential of office based computers. Electronic technology will rapidly change many aspects of daily living, including the delivery of primary care. If the technology is carefully adapted to practice needs, it will enhance our ability to care for our patients. Probably our present system will be so overwhelmed by developments in the next one or two decades that it will be more archaic than the typewriter-style terminal we first used ten years ago. ◉

TABLE 6
Number of Admissions per 1000 Registered Practice Population for 160 Family Medicine Centre Patients Admitted to Ottawa Civic Hospital in 1983

Age	M	F	Total
<15	1.2	2.5	1.9
15-44	1.8	4.2	3.1
45-64	11.3	9.1	10.1
>65	87.6	61.0	72.2

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