MICROCOMPUTER-BASED PEDIATRIC HEALTH MAINTENANCE SYSTEM

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Abstract

The Pediatric Evaluation, Research and Tracking System (PERTS) is an automated health maintenance and tracking system implemented on a microcomputer. This summary of significant medical information is used to support more effective patient care, operations research, training and program planning for a pediatric group practice in a suburban teaching hospital. The System's programs are designed to be convenient for use by health professionals and clerical staff. The system is implemented on a 64K microcomputer using MBASIC under MP/M and KSAM.*

Introduction

The Child and Adolescent Center (CAC) at Evanston Hospital is a medium size group practice limited to the primary and secondary health care of children and adolescents. It is a component of the outpatient services of a community and teaching hospital in a suburb north of Chicago.

As is appropriate in a practice which has been systematically integrated both economically and racially, the health assessment and health assurance of well children is the primary goal. In advancing this goal, the staff at the Center have developed, with the aid of consultants, a computerized system for improving performance in the screening and immunization of young children who are patients at the Center. This automated tracking system is called the Pediatric Evaluation, Research and Tracking System (PERTS).

PERTS uses many of the approaches taken by other ambulatory systems developers. It is designed primarily as an aid to quality-accountable patient care and to operational research. It is not a complete medical record and management system (like COSTAR); it is more like the system at Montreal Children’s Hospital since it supports patient care but not the financial functions such as billing and accounting. With its focus on epidemiology and quality of care, however, it is also an enhancement to the training mission inherent in a teaching hospital. Health maintenance activities for children, like follow-up activities for chronic diseases, are excellent candidates for automation since continuity and stability of care are demonstrably related to patient outcomes in both. It was within this context that PERTS was designed.**

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History

In 1970, two attending pediatricians at Evanston Hospital merged their private practices with the outpatient pediatric clinic at the hospital. This practice was, from the beginning, an experiment in community oriented primary care. Its goal was to foster the most advanced philosophy of practice:

- physician-pediatric nurse practitioner-nurse assistant teams were developed for efficiency;
- the most current professional standards for immunization, screening and follow-up were pursued;
- a systematic identification and treatment program for high risk community- or group-specific problems was undertaken.

During the next ten years of its existence, the Center tried several manual systems for tracking patients for preventive and health maintenance services. Periodic utilization and demographic reports were produced manually to enhance planning and teaching activities. There was a growing awareness among the providers of care that a more routine and efficient data collection method was necessary both to support the academic aspects of the practice and to assure adherence to the standards for screening, immunization and follow-up.

Interdisciplinary Development Team

As a result of a grant received in Winter of 1981, an interdisciplinary team was formed to design and implement an automated system. The team was composed of CAC staff and two consultants. This working team agreed to the following overall approach:

- purchase of a microcomputer capable of storing and analyzing records of up to 10,000 patients;
- design, development and testing of software to enter, store, retrieve and report data on one or all patients, on utilization of services, on demographic and diagnostic characteristics, and on immunization and screening status of the population.

**For full technical description or examples of data entry screens or reports, write the principal author, c/o Northwestern University Medical School, Dept. of Community Health and Preventive Medicine, Chicago, IL 60611, or call (312) 649-7933.
The advantages of this multidisciplinary team were soon apparent. The consultants were experienced in large production environments with high staff turnover and decentralized data entry. Thus, the philosophy of computing which they brought to the project was error forgiving and user oriented. The resulting system has many features found in larger systems, such as variable screen routing and error and correction prompts on each screen. There is little need to use manuals or remember codes, other than the major mnemonics for programs. The CAC clinical team were accessible and willing to spend time in scenario-building to ensure that the system matched the real needs of the small professional group while creating a practical, routine way to notify parents of children's health screening and immunization status. While standard development strategies (and documents) were used throughout, informal problem solving sessions greatly enhanced the final product.

System Overview

The detailed requirements for the system were defined interactively by members of the project team and documented in the external and detailed design documents.

PERTS was designed to store patient demographic and clinical data, to create a patient monitoring system based on a standard screening and immunization algorithm, and to produce individual patient and statistical reports from the stored records.

Data Entry

Two data entry programs were designed. One program creates the patient demographic record and summarizes all past data, such as immunizations, medical alert conditions, and screening visits. The second program enters subsequent visit data, such as height, weight, blood pressure, type of visit, physical exam results, diagnostic test results and additions to summary data, such as new immunizations and changes to medical alert status.

Correction Programs

The correction programs change data in the patient record—one changes the summary or "permanent" data, the other corrects the "temporary" or visit related information. There are two housekeeping or reference programs, one prints a list indexed by patient number, the other by patient name. Each includes all major tie breakers (hospital number, patient name, sex, date of birth and provider team).

Deficiency Program

The CAC staff conceived a three-stage follow-up for patients who were in need of screening, physical exams or immunizations. The first two contacts are by letter, the third by phone call, to parents.

The automated deficiency programs are designed to match these three phases and phase lengths are user defined. When the deficiency program is executed for the first phase, a file of all active patients with deficiencies is created. Two labels are printed for each patient in this file, one an address label for the heading of the first parent notification letter and the other a label listing the patient's deficiencies to be placed in the body of a preprinted letter. The phase two execution of the deficiency program prints labels for the second notification letter. The third phase execution prints a listing which includes the telephone number for all patients in the deficiency file. This listing is used to contact parents by telephone. A report can be generated at any time during the deficiency cycle which lists those patients currently in the deficiency file.

Individual Patient Reports

PERTS provides for two individual patient reports. The first report program prints a date-specified visit report (the default is to last visit). The second prints all visits for a patient. Both reports print demographic, immunization and medical alert information. (See Figure 1.)

Statistical Reports

PERTS is also designed to provide a number of statistical reports, both demographic and clinical, which assist the CAC in planning and educational programs, and which assist in measuring patient health status and improving provider performance.

Figure 1: Example of a Patient Summary Report
Most of the reports are useful in quality assurance activities as well.

Because PERTS is intended to be used by health care personnel unfamiliar with computers, extra care was taken during the design and coding of the programs to ensure that the system is as simple to use as possible.

Examples of these features in the data entry programs are:

- A check digit is added to the patient number to ensure that data entry on this key is correct;
- The data entry program will test previously entered data and based on the values entered, determine which subsequent data entry screens are to be bypassed and which are to be displayed;
- Since the data entry program utilizes several screens to enter all the information for one patient, each screen displays the patient name and, where appropriate, the visit date, so that the possibility of entering data from the wrong patient record is minimized.

In the correction programs, additional features are:

- When correcting visit information, the patient number and visit date are requested first. These data are then verified against the files to eliminate wasted data entry time if either of these data items is incorrect;
- Before any changes can be made to either patient data or visit data, all the demographics for a patient are displayed for verification;
- The formats of the screens used to update or correct patient or visit data are identical to the screens used to enter the data, which minimizes learning time.

In the patient summary program, the features are:

- The command to print a specific patient visit defaults to last visit; in this way, the latest information for a patient can be obtained without knowing the exact date;
- Patient identifiers are printed at the top of each page of every report; each visit starts printing on a new page, which minimizes misapplying clinical information.

The reporting programs include the following:

- Menu screens are utilized to choose the report parameters; this saves data entry time for experienced users while prompting correct action by casual users;
- Age and clinical result ranges can be selected for all reports. (See Figure 3.)

**Human Factors in Design**

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**Technical Description**

The system was programmed in MBASIC on an Altos 64K ACS8000-12 microcomputer running under NP/M, using KSAM, a file handling package.

Modular programming techniques were utilized in the implementation of the system for three reasons: first, functions common to more than one program would be coded only once and then reused; second, due to the complexity of some of the programs, the code would have exceeded the memory capability of the microcomputer if it were not broken up into separate modules; and last, by breaking up the code into manageable modules, any modifications required in the future could be implemented more easily.

Due to the amount of medical data that the system was designed to accommodate for each patient, it was necessary to store the data in six different,
logically related files. All the files were designed with approximately five to ten percent of free space to accommodate future expansion. (See Figure 4 for Report and File Relationships.)

Data Collection Forms
1. Summary Form
2. Encounter Form

Data Collection Forms
1. Patient Summary -- One encounter or all encounters
2. Deficiency Labels
3. Deficiency Telephone List
4. Listing of Deficient Patients
5. Patient Name Cross Reference
6. Patient Number Cross Reference
7. Patient Demographic Report
8. Patient Alert Report
9. Patient Visit Report
10. Patient Test Report
11. Patient Height Report
12. Patient Weight Report

Reports

Figure 4: System Overview

Since these files are fixed format, there was a need to economize on file space in the visit records. This forced the team to analyze pre-existing manual records. See Figure 5. The results allowed the storage of one byte flags to represent the "tests not performed" and "physical exam all normal" branches of the model, saving space and data entry time.

Registration
(100,000 records)

Patient Visits
(120,000 records)

Tests
Not performed
65%
(43,000 records)
Performed
35%

Physical Exam

Figure 5: Manual Records Analysis

The PERTS software is hardware independent except in its communication with the CRT where codes specific to the terminal were used. With modifications to these codes, PERTS can be used on most microprocessors with 64K, which have BASIC and KSAM running under either CP/M or MP/M.

System Impacts

Since January of 1983, the system has been used daily for entry of encounter records on patients already on file and for adding new patients to the files. Patient summary records are printed to forward to a new provider when patients move from the community; computer generated patient visit summaries, which were designed and approved to meet the requirements of state and local school and health districts, are regularly sent in place of school health forms. Time savings, as a result, have been calculated at more than one day of nurse assistant time per week.

Although statistical evidence is still slight, preliminary analysis suggests an improvement of about ten percent in the screening status of the patient population since the implementation of the system. No significant change has been detected in immunization status.

Parent response to the deficiency follow-up mailings has been moderately good. After six months of operations (two full follow-up cycles), 126 appointments are directly attributable to the computerized follow-up. During the first cycle, 21 percent of parents receiving deficiency letters responded and 57 percent of the respondents made appointments. During the second cycle, 12 percent responded and 42 percent of the respondents made appointments. In addition, as parents called the Center in response to deficiency letters, the CAC staff were able to schedule visits in open appointment times, thus smoothing the appointment schedule. The demographic and clinical reports on patients with abnormal test results or high risk conditions have promoted a great deal of discussion between and within the health care teams at the CAC. These reports have stimulated healthy questioning of the current standards of practice, of the relationship between compliance or classification and economic factors and about how to design new programs to change provider and parent behavior.

References