A Total Primary Care Medical Information System: DUCHESS

Stephen C. Lloyd, M.D., Ph.D.

University of South Carolina School of Medicine
Columbia, South Carolina

Nowhere is it more amply demonstrated that computers have an important role in health care delivery than at this symposium. However, it seems that to the population of users, that we have a situation akin to the Tower of Babel. There are many isolated projects which demonstrate the utility of the computer in a given aspect of health care delivery. Yet there is no one system which combines a sufficient complement of these capabilities to make a strong case for broad scale implementation of computers in primary care.

Duchess has made an effort to try to integrate many of the capabilities which have proven their usefulness in isolated pilot projects.

A key concept to the usefulness of computers in the real world of practicing physicians is modularity. We have designed the Duchess Medical Information Processing System to permit the practitioner to choose applications areas to be implemented in a selective and gradual fashion. Moreover, Duchess does not require the use of a totally paperless record. The most powerful capabilities of the system are available with the entry of only basic demographic data, problem list and medication summary. This permits the using physician to become familiar with the capabilities of the computer in a stepwise fashion, which reduces the confusion brought on by lack of understanding of the basic concepts of the data processing system.

Duchess was conceived in 1972 as a joint venture of the departments of Psychiatry and Community Health Science at Duke University in cooperation with the Department of Computer Science. There were two phases to the development. The first was the design and implementation of a CODASYL type database management system on a minicomputer (Digital PDP 11). After completion of this phase, the development of applications programs in a structured high level language was initiated.

The database management aspects were presented at the National Computer Conference in 1974. The essential requirements of a database management capable of supporting a medical record storage system are:

1. Potential for very large records.
2. Extensive base of potential variables.
   A. These variables are organized into natural groupings (i.e. demographics, insurance, diagnosis, treatment, lab results, etc.).
   B. Any individual record will possess only a small portion of this massive base of potential variables.
3. Repetitive structures (a definition of the data structure for describing a diagnosis would appear several times in an individual record).
4. Diverse data types (text, integers, decimals, codes, boolean, time, date, etc.) With the use of a CODASYL type relational hierarchical data structure with repetitive groups and sparse variables, we have available the necessary tools to implement a modular and large scale medical management system.

APPLICATIONS

The system is organized into two integrated sub-systems the administrative and the clinical. The administrative components perform the traditional business computer functions, including: demand billing (super bill), receipts, daily activity summaries, appointments, billing, aged accounts receivable, payroll, insurance claims processing (including the new paperless claims teleprocessing) and accounts payable.

The clinical sub system has four major components:

Drug interactions, Clinical databases, Algorithms, and patient education.
Administrative Applications

It is not the purpose of this paper to discuss the details of the administrative sub system. There exists hundreds of medical office computer systems which perform these roles in a very successful fashion. These systems have proven themselves to be of great utility in the administrative management of the medical practice.

Clinical Applications

When we embarked upon the Duchess project, we made an initial decision about the extent of computerization of the medical information which withstood the test of time. Rather than to promote a totally computerized medical record, it was felt that the majority of the benefits of the computer could be realized with the input of a very small subset of data. In fact, the most powerful features of the system result from the input of the simple problem list and medication summary.

From these data, the Duchess system:

1. Checks for drug interactions
2. Produces a "template" data sheet for each major problem which serves as a baseline for problem management.
3. Produces encounter forms at the time of each patient visit, which includes "reminders" of the subjective and objective (Weed POMR) data to maintain for each problem.
4. Prints brief summaries for the patients about their diagnoses and medications.
5. Generates a schedule of surveillance tests based on:
   A. The set of diagnoses that the patient has.
   B. The medications the patient is on.
   C. A preventative medicine schedule.
   D. Isolated individual tests, determined by the physician.
   E. Based on clinical algorithms.

These capabilities have been proven to be highly cost effective. This is in spite of the fact that the use of the system frequently causes an increase in office staff from 15 to 25%. However, this increase in staff has shown to assist in providing more comprehensive health care surveillance and much more personalized medical care.

The success of these clinical applications of the computer are predicated upon three assumptions.

1. The proponderance of patient encounters are in one of three categories.
   A. Chronic disease surveillance
   B. Acute self limited illness
   C. Preventive health screening

2. The emphasis of the benefits of the computer system are on information management and not on "artificial intelligence", such as computer diagnosis

3. The physician is willing to establish standards of care making consistent decisions about what examinations and tests need to be performed on a regular basis for adequate patient surveillance.

Drug Interactions System

The details of the drug interaction system have been published elsewhere. To insure completeness of data, we encourage our users to have the computer print all prescriptions. This insures that all drug information is complete in the computer. As each medication is entered into the system, the computer checks for drug interactions with the medications the patient was previously taking.

The initial data base for the drug interaction system was obtained from the use of Hanstens 4th Edition. Interactions can be entered between individual drugs or between a drug and a class of other drugs or between two classes of drugs. When a new drug is entered into the patient's record, the system examines each other drug that the patient is already taking to see if there is an individual reaction or whether any of these drugs might be a member of a class of drugs for which the new drug may have an interaction.

If an interaction is encountered, the computer displays the mechanism of the suspected interaction. After this, the clinical significance is summarized.

Thirdly, the proposed patient management is displayed. The user has the option of cancelling the new prescription or making modifications based on the suggested management.
Drug interactions are classified into three categories: Major, Intermediate, Minor. The actual reference citation is also stored in the computer so that the physician can explore the problem further, if so desired.

It is easy for the physician or his staff to add additional interactions at any time. This is especially useful as new drugs come on the market. Often, the pharmaceutical manufacturer will send information on possible drug interactions with the literature on the new drugs and these may be entered into the system, giving very current, up to the minute drug interaction surveillance.

We have developed a users group to monitor the drug interaction data base and to share updates and modifications of the drug interaction data base.

The Initial Data Base

Associated with each diagnosis in the computer system are two data bases. The first is the "initial" and the other is the "follow up". The initial data base is a series of lines of text which are printed out each time a new diagnosis is entered into a patient's record. The text is organized into two categories: subjective and the objective. These lines of text summarize the pertinent variables which should be obtained as a baseline for substantiating the associated diagnosis.

In outpatient charts, we maintain one such sheet for each diagnosis. This page serves as the summary page for the long term management of that diagnosis. Initially it possesses historical information and baseline laboratory values. As time goes on, the critical variables for following this problem are added to the sheet.

The medical input for the development of these baseline "templates" are not readily available. It is disappointing and frustrating as a physician to recognize such critical information as suggested baseline line data sets are not in the medical literature.

As with the drug interactions, we have developed a consortium of users who supervise the creation, maintenance and update of the medical data bases.

The Encounter Form

We divide patient encounters into two types: Chronic surveillance and Acute care. For our chronic surveillance patients, when they present for their scheduled visits, the appointment system will print, on the morning of their visit, a computer print out which we call the encounter form. The encounter has four sections. The top of the form has basic demographic data, including name, age, race, sex, and occupation. The second section summarizes their active diagnoses and medications. The diagnoses are classified as to whether they are M-major, m-minor, T-temporary, S-status post, H-history of, or R-rule out. The date of onset is printed beside each diagnosis, the medications prescribed for that diagnosis are summarized. Included is the dosage and frequency of the medication and the date last filled.

The third section of the encounter form is a unique contribution of the Duchess system. For each major diagnosis, the computer retrieves a follow up data base of subjective and objective information which is to be obtained at each visit. Use of these reminders has stimulated several changes in the nature of practice. We are able to use our nursing staff more fully to help patients identify any problems with their chronic diseases. A much more thorough and disease specific history is obtained and the physician has an opportunity to hone in on more relevant features of the patient's problems.

The fourth portion of the encounter form reviews the standing orders. Each examination or test has the diagnosis for which this order was entered, the frequency it is to be performed and the date next due.

Summary

We have presented the highlights of a comprehensive medical practice management information system. We believe it provides the broadest range of capabilities yet available on a single system. The software runs on the PDP-11 series of Digital computers. With the advent of the Micro-11, the basic hardware to support this system will cost less than $15,000. Duchess's success is based on the concept of modularity. Each of the sub-systems have been developed and are maintained independently, coordinated through the data structure of the associated data-bases.