HENRY FORD HOSPITAL NEPHROLOGY INFORMATION SYSTEM

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Abstract

Henry Ford Hospital is a large tertiary care teaching and research hospital in the city of Detroit, Michigan, USA. The hospital contains several ambulatory clinics in the suburbs which contribute to its clinic workload of 1.3 million clinic visits/year. It had a total staff of 7,000 in 1981. Its revenues were $320 million. The Division of Nephrology and Hypertension operates five clinics providing 10,200 clinic visits/year and performs about 40,000 dialysis treatments a year. This paper describes the experiences gained in developing a Nephrology Information System and a technical overview of the system.

Background and Experience

Over the last eight years, the Nephrology Division at Henry Ford Hospital has been developing a computerized data base for the management of the large volume of information stemming from patient visits, peritoneal and hemodialyses, kidney transplants, and inpatient care. After ten man-years of work and a complete change in systems specification, vendor, and machine just one year ago, the system is proving itself to be of significant value to the division. There are several features directly relating to the purpose of this project (that of managing Nephrology and Hypertension information) which contain important and not generally appreciated lessons for future developers of such projects and of any large data processing project.

The first part of this presentation will concern itself with problems relating generally to large data base management systems and then to problems specific to our implementation (which is that of a clinical information data base) and will be followed by a technical overview.

The first general lesson we learned was that of assuring the competence and ability of the vendor to produce our required system. We initially contracted with a minor firm which had devised a system in the field of dialysis data management. After approximately four years, and efforts of several physicians on our part, the firm went bankrupt and we were left with pieces of a system which did not perform as originally contracted. The lesson from this was that although we had thought the vendor could produce a product that we specified, it was partially our fault and partially their fault that neither party could see the eventual requirements in such a system, in terms of both analysis and programming time.

As a consequence, a great deal of underestimation took place. In addition, there was an emotional loss in terms of morale relating to the predicted effectiveness of such a project, which obviously was diminished when the initial attempt failed.

In 1980, when the vendor was declared bankrupt after completing only 30% of the system, it was decided to replace the system. The initial stages of feasibility, requirements and system design were completed by mid-1981. The implementation of the system was divided into four phases:

a. Phase 1 - Patient Care Subsystem
b. Phase 2 - Lab Result Processing
c. Phase 3 - Ad Hoc Analysis and Reporting
d. Phase 4 - Technical Management Subsystem

Phase 1 of the system was implemented on an operational basis in August, 1982; Phase 2 in August, 1983; and Phase 3 at the end of 1983. Phase 4, which is a technical management subsystem, has marginal cost benefits and its implementation may be delayed.

The new system provides a total capability to meet the clinic and research needs of the Division of Nephrology and Hypertension and is working well in the medical environment. This has been a very close, cooperative venture between the physician staff and the data processing staff, and has demonstrated that good systems can only be provided when the physician staff is intimately involved.

During the lifetime of the project, communication was again a problem. It turned out that there were two factors which led to this development: (1) the systems analyst worked in partial isolation from the user, and (2) the physicians and administrators who communicated with the data processing staff were not in contact with the end user. Although we had recognized in advance the consequences of the first type of mistake (that of poor user-programmer/analyst communication) we were not as well aware of the second difficulty. This was due to the difference in perspective and knowledge that a person designing input, output, and process procedures would require versus that of a user such...
as a nurse or technician who would actually inter-

A second general lesson derived for this system
turns out to be an advantage. We are beginning to
find that the availability of so many dimensions
of patient information not only improves the quality
of patient care in terms of monitoring clinical and
laboratory variables, catching therapeutic errors,
and increasing the timeliness of data, but also
optimizes human and machine resource location, mak-
ing scheduling decisions, and benefiting finances.

A third general lesson learned is that this
kind of project is very difficult to achieve, espe-
cially when large amounts of manpower resources,
many difficult decisions, and the need to go back
and make changes (when there is opposition to those
changes) is involved. A corollary of this, which
is very important for computer systems which are
used clinically, is that the production mode should
not be entered until all personnel associated with
the system are satisfied with its performance in
the testing mode.

The three lessons listed above, although very
important and as new to us as the lessons that
follow, were not as revealing as those which de-
pended on the fact that we were implementing a
clinical information system for Nephrology
and Hypertension patients. We did not expect that
the subject matter of the implementation would
effect so greatly the course of development of the
system. It is these lessons which we feel are
different and important enough to convey to other
potential or current developers of similar systems.

Specifically:

1. Although a project steering committee, was put
   in place consisting of Administrative, Medical
   and Data Processing staff, effective communic-
   nation was not always achieved and this tended
to stretch timescales.

2. The immense volume of data generated by patients
   with chronic renal disease treated with hemo-
dialysis are exceptional in the quantity of data
   and its importance in quality care. A typical
   patient may visit a clinic 150 times a year and
   generate 27 items of data at each visit. Look-
   ing at a few patients on hemodialysis re-
   quires quite an effort. Looking after one hun-
   dred requires a good data base management system.
   Any deficiencies in the design of such a system
   clearly shows itself in its applications to
   such an immense volume of data. We have found
   this in our own project since all along special
   attention had to be paid to the large amount of
   data elements generated for the care of our
   patients.

3. We are only now seeing as a distinct advantage
   the value of combining a large mainframe com-
   puter, with its ability to manage and massage a
   large data base, with a small minicomputer to
   do interactive graphic analyses of data trans-
   mitted from the mainframe. By using the tal-
   ents of the data processing staff which has
   experience with programming IBM systems and the
talents of an outside firm, which developed the
package specifically keyed into graphic analysis
with a minicomputer (Clinical Computing Ltd., UK),
we have made possible a system for looking at
patient data using state-of-the-art graphics, while
retaining the statistical analysis and storage ca-
pabilities of a mainframe. Although we clearly run
the risk of a change in the interface specification
of one of the two computers affecting the other, we
have the advantage of allowing possible modifica-
tions to graphics packages without affecting the
workings of the data base package and vice versa.
It also allows independent use of the data to en-
hance the clinical management of the patient.

To summarize, we have discovered during the
implementation that there are problems and advan-
tages that arise, both stemming from the fact that
it is a large computerized system and that its
application is in the field of clinical information
processing. We have grouped what we have learned
into lessons general and specific to the subject
are of Nephrology/Hypertension.

Objectives of the System

From the experience gained in using and opera-
ting the minicomputer system, the following objec-
tives were established for the development of a new
system:

Provide information...

1. to assist staff member to plan/monitor/control
   individual patient therapy programs,
2. to assist staff members to avoid/react to
   patient problems,
3. to assist staff members to predict and evaluate
   the effectiveness of various treatments and
   treatment programs,
4. to review patient progress,
5. to assist in the preparation of bills,
6. to assist staff members to evaluate and improve
   the overall effectiveness of division operations,
7. through ad hoc analysis and reporting capabili-
   ties to support division research activities,
8. through user friendly operator/system inter-
   vention.

From a data processing point of view, the
overall objectives of such a system is to facilitate
record keeping and communication of data. Specifi-
cally it should:

1. provide information that is timely, up-to-date,
   accurate, and consistent,
2. allow for local input and output,
3. allow for timely response and data entry
   turnaround,
4. provide standard reports on request as well as
   on a regularly scheduled basis,
5. provide for high resolution graphics as well
   as textual output,
6. provide statistic capabilities for ad hoc,
7. have sufficient capacity expansion potential.
As a result of the feasibility and requirements studies, it was decided to develop an on-line system using the hospital's mainframe computer. The philosophy of our approach was to use on-line data base techniques and incorporate, wherever possible, standard software tools to facilitate the development process. It was envisaged that by using these standard software packages, the system could be designed to ensure ease of maintenance and support.

In response to this philosophical approach, a system has been designed and implemented using IBM's Application Development System (ADS-PCH/Patient Care System as it is commonly known), CICS is the telecommunications handler and DL/1 is the data base management system. All the software operates under the MVS Operating System on a 303X machine.

A number of software packages were used for ad hoc and batch reporting, statistics and graphics.

a. Answer/2 - a batch report generator,
   b. FOCUS - An on-line ad hoc report generator,
   c. SAS/SAS Graph - A statistics and graphics package.

This system supports a number of CRT terminals (equipped with light pens) and printers in the clinics for entry and correction of data and for information retrieval (see Figure 1).

The system supports the above functional activities through:

a. four major data bases (see Figure 2)
   b. sixteen on-line input subsystems,
   c. five batch input subsystems,
      - dialysis medications
      - patient problems
      - dialysis lab results log
      - hemodialysis treatments
      - peritoneal dialysis treatments

Conclusion

The development of the Nephrology and Hypertension Information System at Henry Ford Hospital has been a long and protracted process. However, much experience has been gained and several useful lessons learned. The system, which is now successfully implemented, is working well and serving the needs of a large Nephrology and Hypertension Clinic at Henry Ford Hospital.

This has been achieved through good user/data processing liaison, the use of modern software techniques and effective project management.