Technique

Evolution of a Cardiovascular Information System

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ABSTRACT

The competitive nature of our evolving health care system mandates a concomitant increase in the level of sophistication of the cardiovascular information system. The new paradigms in health care also mandate a re-engineering of the process of data collection and analysis. This paper deals with a variety of hardware, software, and human issues encountered at our institution.

Topics covered include implementation of service line management, utilization of an interdisciplinary medical informatics model, database conversion, and application development. Special attention will be paid to the development of a system which is a comprehensive information system for clinical and financial management of the cardiovascular patient, not just a quality-of-care database.

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INTRODUCTION

New technology is both a blessing and a curse. The increase in power and sophistication of computer hardware and software provides many benefits to the provider and the consumer of health care. It has also provided insurers and third-party payers with a competitive advantage, as they have had sophisticated information systems in place for many years. Medicine, however, has traditionally lagged in the implementation and utilization of these tools. Whether we like it or not, this age of carve-out contracts, HMOs, and managed care dictates that we do business in a new way – as a business. Terms such as "outcomes," "value," and "quality" are permanent additions to the healthcare lexicon. The institution which does not become data-driven in this environment will certainly not thrive and probably will not survive. We will present some of the steps taken at our institution to deal with these issues.

Table 1: Information systems definitions

TERM	DEFINITION
Medical Informatics	Medical or biomedical computing with an emphasis on the nature of the field to which computations are applied. Implies interdisciplinary model with end-user involvement in information management and utilization.
Data	Observation or value of a parameter(s) at certain point or time.
Knowledge	Derived from formal or informal analysis or interpretation of data. Uses models, formal study, or heuristics (rule of thumb).
Information	Generic term which encompasses data and knowledge.
Field	Piece of data.
Record	Collection of related fields.
Database	Collection of related records.
RDMS	Relational Database Management System. Software system which allows storage, analysis, and manipulation of data.

DEFINITIONS

Table 1 provides definitions of some of the words germane to this discussion. The most significant term is medical informatics. The term implies a marriage of clinical expertise with computer science skills. Effective competition in the marketplace requires that clinical personnel become active participants in the development, implementation, and operation of the information system.

BACKGROUND

The cardiovascular surgery program was started at our institution in 1983. Simple patient demographic, surgery, and outcome data were collected and analyzed manually. The cardiovascular database system was initiated in 1988 with the donation of a computer and development of a DOS-based database developed for open-heart surgery. The first five years of manually collected data were also appended into this database. The cardiac catheterization lab developed their database within the next year. The purpose of these databases was primarily to provide necessary quality and statistical data to the physicians, surgeons, and to the institution.

Prospective collection of cardiovascular risk stratification was begun in March of 1991 using the Parsonnet method (1). Restrospective risk stratification data was calculated for the first full year of operation of the program (1984) and for the period from January 1989 through March 1991. Data collection became more extensive with time, and a postoperative module was added in 1983. The decision was made in 1994 to implement a comprehensive data collection system for the entire cardiovascular services department. Implementation of a cardiovascular local area network began in early 1995. The network is currently being expanded and upgraded to encompass the full spectrum of cardiovascular care.

CURRENT SYSTEM

The heart of the cardiovascular network is the APOLLO database system[a] utilizing Microsoft[b] (MS) DOS, an MS Windows graphical environment, and Novell[c] Netware. This database system has been developed using the MS Office suite of programs (Access, Excel, Word, Powerpoint) using Access as the database program. Additional data analysis is conducted using the Excel spreadsheet, and reports are generated with MS Word. The user interface has been developed by Seattle Systems using MS Visual Basic. Collected data can be analyzed either from within the APOLLO program or by using components of MS Office. The local area network is run on a Pentium class server with 486 or Pentium workstations. All are currently being upgraded to increase system efficiency and speed.

The core of the cardiovascular surgery module is based on the design of the Society of Thoracic Surgeons (STS) National Database plus a number of risk stratification algorithms (2). It was necessary for us to create additional outcomes modules in house for perfusion and postoperative data using MS Access. All surgery data collected prior to the introduction of this system has been converted to the Access database format. The goal is to eventually migrate all older data into our central database. Queries on collected information are run in Access. Selective

a Seattle Systems, Oakland, CA 94612
b Microsoft, Redmond, WA 98052-6399
c Novell, Provo, UT 84605

open-heart data is also exported monthly to the Excel spreadsheet for summary analysis. Excel allows data to be analyzed statistically as well as to be incorporated into a pivot table, which is a type of dynamic crosstab query. The data can be presented graphically in Excel or in Powerpoint presentation software. Final reports can be printed from the native application or exported to MS Word for futher refinement.

A bi-directional interface with the hospital mainframe system will be implemented in the near future. Until that is in place, we are manually downloading summary demographic, billing, insurance, procedure, and diagnostic coding information from the hospital system. This occurs monthly, with reimbursement information being provided on a quarterly basis. We are also exploring methodology for collection of patient outcome data for the post-hospital period and on an ongoing long-term basis.

The cardiac catheterization and cath inventory modules are in the final preparatory phases for implementation. In addition to collecting new data, all the previously collected cath data will be migrated to the Apollo system. Non-Invasive Cardiology will be introduced once Invasive Cardiology is fully implemented. This will include Stress, Echo, Holter, and interface with ECG. Cardiac Rehabilitation and Electrophysiology modules will be added at a later time.

Other programs that are in preliminary stages of execution include an interface with physician offices and collection of preoperative data such as history and physical. The goal is to provide an on-line medical record of all cardiac patients at our institution. Methods of remote access to these records are currently being explored. Our objective is to create a mechanism by which the cardiac patient record can be accessed throughout our vertically integrated healthcare system.

DISCUSSION

Denton et al have identified five categories of information that must be available in a cardiovascular information system in order to compete in the managed care arena. These categories are: patient satisfaction, medical outcomes, methods to assess quality of medical decisions, systems for continuous quality improvement, and financial outcomes (3, 4). Williams and colleagues further explored the elements required for a cardiovascular surgery quality assurance program (5). Several recent publications focus on the limitations of outcomes measurement and data analysis, as well as the increasing need for clinician involvement in information management (6, 7). The caregiver must be an active participant in the data collection process in order to ensure that data elements collected and analyzed are relevant and correct. A recent publication addresses in depth the consequences and financial disincentives of a system where hospital net income decreases as patient risk increases (8). The implications for a cardiac surgery program are great, particularly in a capitated environment. Our institution has adopted a certain philosophy and taken eight steps to facilitate implementation of a comprehesive information system which tracks clinical and financial information. Our goal is not only to respond to RFPs, but to actively market our services and recruit them.

Table 2: Components of cardiovascular service line

Invasive Cardiology
Non-Invasive Cardiology
Perfusion Services
Post Open-Heart/CCU
Cardiovascular Stepdown Unit
Post-Cath Unit
Cardiac Rehabilitation

EIGHT-STEP PLAN

1. Service line management: Restructuring into an "organization within the organization." This places all participants in the care of the cardiac patient under one service line leader. It promotes the overall organizational goals as opposed to individual work unit or personal objectives. This also helps facilitate communication and resolution of interdisciplinary issues. Table 2 lists the basic units comprising our service line.
2. Utilization of the STS Cardiac Surgery Database as the core of the clinical system. This has become the de facto standard for surgery programs and insurers alike.
3. Development of an information system which is a tool for comprehensive clinical and financial management of the cardiovascular patient, not just a quality-of-care database. Once collected, the data must be accessible and functional and the proper data analysis tools must be available. These should permit statistical analysis, graphing, and data manipulation. Data which is hard to access, hard to enter or retrieve, or difficult to analyze or manipulate has very limited value.
4. Software utilized has excellent import and export facilities, so that older data can be imported and data can be shared or exported to other programs for analysis or presentation.
5. Use of a graphical interface and proper form design which promotes point of service data entry by the clinician. Retrospective data abstraction is very costly, time-consuming, and prone to error. Applications (whether purchased or developed) should limit free text on data entry screens. Use of yes/no fields or pull-down lists keeps data consistent, is quicker to enter, and limits the errors inherent in free-text entry. It should take a minimum of time to enter a maximum amount of data.
6. The overall focus should be on creation of data analysis tools and methods which place the institution in a competitive position when dealing with payers and insurers. These organizations have vast amounts of hardware, software, and personnel dedicated to data analysis. Health care organiza-

tions, however, traditionally lag in the implementation of computers and information processing. Cardiovascular programs which are not prepared to confront these issues should prepare to wither and die.

7. Re-engineering of human thought processes regarding the role of an information system is usually a larger hurdle than the implementation of hardware or software. Clinical roles in health care are changing, with an increased involvement in the area of information management. The clinician must recognize and adapt to this functional change.
8. Maintenance of the information system is a dynamic, evolutionary process. Upgrades in hardware and software, and changes in methodology are to be anticipated as the system matures. The hospital or health care organization must commit to providing the necessary support for a comprehensive medical informatics program.

An information system which functions at a minimally effective level is already obsolete. The volume of data collected and its manipulation require that hardware be both current and optimized. In order to stay competitive in the business of health care, it is also necessary to plan for the future and act prospectively. Emerging technologies such as digital imaging have great ramifications for network operations. Sophisticated software such as neural networks, fuzzy logic, and expert systems may soon be commonplace in cardiovascular data analysis. Clinical personnel must understand the importance of their role in the proper operation of the information system. Proper hardware and software are vital, but there is no information system without the proper personnel and policy to manage it.

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