Enroute Toward A Computer Based Patient Record: The ACIS Project

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The clinical arm of the University of Utah operates a 400 bed general hospital and 30 specialty and subspecialty clinics and with the advent of managed care will soon be linked to a much wider network of health care facilities throughout the state. Each of these patient care facilities maintains its own patient record. To provide common access to data on any patient needed to provide continuity to the care process where ever it occurs, the institution has embarked on the development of a completely electronic patient record. In this paper we will describe the route we have taken to achieve this goal in hopes of providing some sign posts along the way for others seeking the same destination.

ENVIRONMENT

Development of new projects at any institution is conditioned by the resources already available. In the hospital and medical school of the University of Utah we have 4400 work stations, most of which are PC's of varying vintage which operate in an environment using local and wide area networks throughout the institution and beyond. Commercial systems are in place for registration and financial functions, lab results reporting, radiology reporting, patient scheduling and billing, blood gas and respiratory function testing and reporting, disease and procedure coding for medical records and many other smaller special purpose departmental systems. A gateway is available for broadcasting registration information to these systems using unique patient identifier and physician identifiers.

THE ROUTE

System Architecture

The advanced clinical information system (ACIS) is a modular design based on client-server architecture using a relational database. It has the following characteristics: 1) integrated clinical database, 2) controlled vocabulary, 3) graphical user interface to facilitate direct coded data entry by physicians, and 4) open and scalable system. Figure 1 shows the ACIS system architecture.

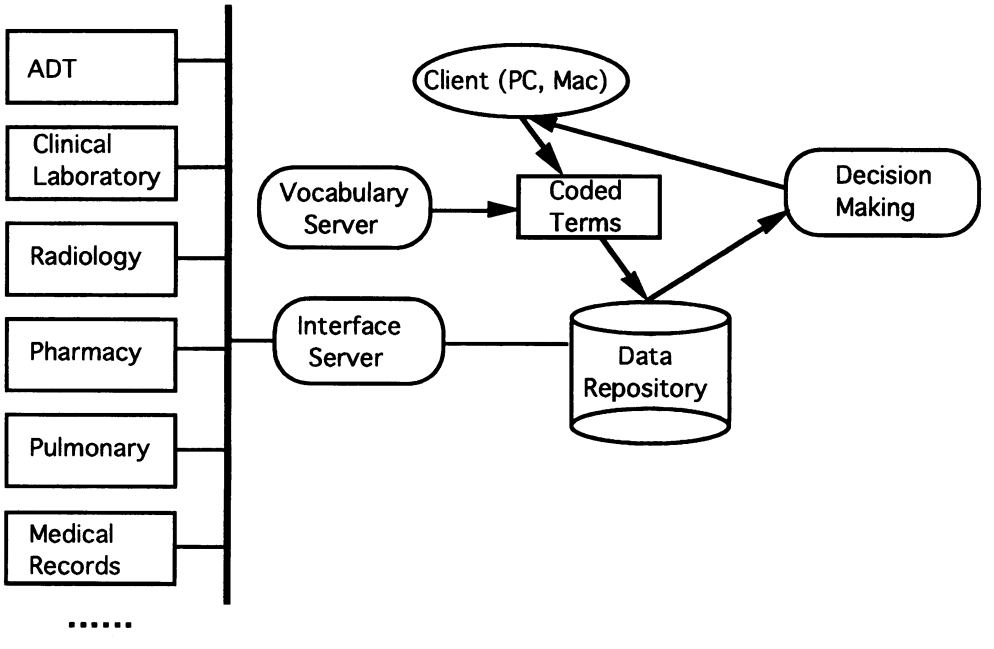

Figure 1. ACIS Architecture.

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Integrated Clinical Database. The heterogeneous nature of our hospital information system environment is a reality many hospitals are faced with today [1, 2, 3, 4, 5]. ACIS is designed to be a central data repository to provide a common data source for accessing, managing, and analyzing patient data effectively. ACIS will contain three basic types of data. The first is structured data that can be used to drive computer assisted decision making and from which reliable statistics can be obtained by searching across patients. The second is free text obtained by direct keyboard entry or by transcription of dictated information. The third is data entered into the computer record by scanning documents or images that are not otherwise available in coded or electronic text format.

The interface server has three components: communication, parsing and monitoring. The communication component sends and receives messages from a host using various protocols (TCP/IP, SPX/IPX, FTP, etc.). The parsing component is designed to support parsing of patient data messages originating in various protocols such as HL-7, ASTM, or word processing templates [6]. Once the messages are parsed they are stored as formatted records in the ACIS database. The third component is used for operator monitoring of the system interfaces. The monitoring software also allows messages to be sent to the various interface components telling them to raise or lower their priorities, to pause, shutdown or re-start. This architecture allows the components to be located anywhere in the hospital and be monitored at a single location. The interface system is written in Microsoft Visual C++ and runs on a Microsoft Windows NT server.

Controlled Vocabulary. A clinical information system without a controlled data dictionary can not achieve its full potential. Representing patient data in coded form makes it possible for a clinical information system to have knowledge driven processes, accurate population based queries, and exchange of patient data and knowledge [7].

The vocabulary server (VOSER) was developed to maintain the integrity of data vocabulary from different sources such as UMLS Metathesaurus, SNOMED-3, CPT-4, PTXT [1], ILIAD [8], Drug Formulary at University of Utah Hospital Pharmacy. Each term in the VOSER has a unique expression identifier and a concept identifier [9]. Figure 2 shows the structure of the VOSER. There are three components within the VOSER - concept mapping, multiple hierarchical structure, and pick lists. Concept mapping allows medical concepts from different coding systems to be mapped by the concept identifier. A multiple hierarchical structure reflects the multiple hierarchical nature of medical concepts in medicine. Pick lists are built for each physician based on specialty. Uncoded terms in ACIS are periodically reviewed and incorporated into the VOSER as needed.

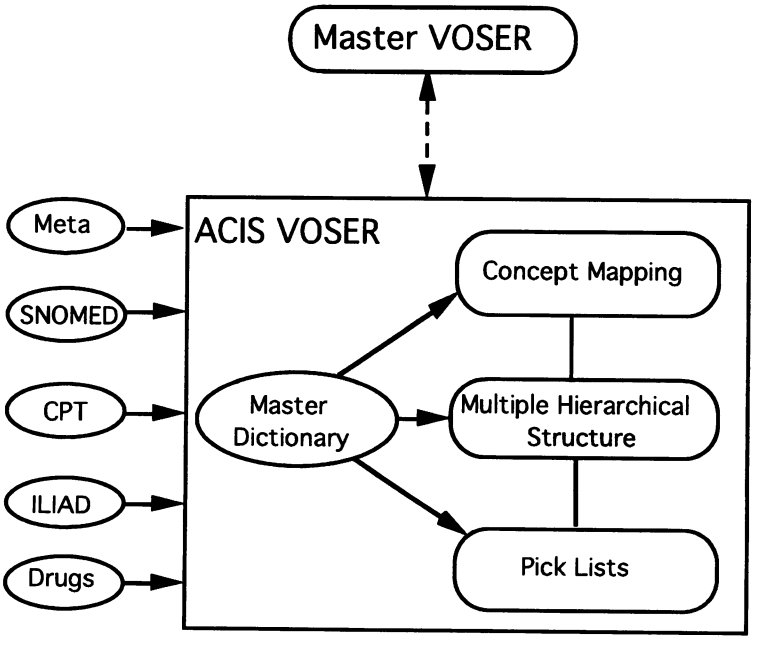

Figure 2. ACIS Vocabulary Server Structure.

3M Corporation, Intermountain Health Care, and the University of Utah are cooperating to build a common standard clinical vocabulary system to support the exchange of patient data and medical decision logic. ACIS VOSER will have a replicated subset of the Master VOSER.

Graphical User Interface. One major ACIS design goal is to facilitate direct data entry by physicians and other providers. An optimized graphical user interface is a key to achieving the goal. A tabbed-chart forms metaphor and predefined data templates and pick lists enhance this process. The visual components development tools allow us to respond to user's needs quickly and deliver timely modifications with limited resources.

Open and Scalable System. ACIS is designed to take advantage of emerging standards and tools to optimize development productivity and system scalability. Figure 3 shows the modular components of ACIS.

The user interface layer specifies how patient data is presented and entered. The applications are developed in Visual Basic for PCs, and HyperCard for Macintoshes. We are developing ways of using HTML browsers such as NetScape to review patient data.

The data access layer provides an interface to the server for client applications. Industry standards (SQL, ODBC, and OLE) are being used. The data access layer allows researchers, administrators and other users to access ACIS data through not only ACIS client applications but also other user-friendly tools such as Microsoft Excel and Microsoft Access.

The central data repository is a relational database management system (ORACLE). Data can be easily ported to other relational database systems. This portability across server platforms allows scaling of server capacity as needed with little or no modifications of the client applications.

The system Interfaces provide the communications to other systems in the hospital or systems in other institutions. HL-7, ASTM, and email are used as standards for patient data transfer among systems.

IMPLEMENTATION AND DEVELOPMENT

We began with the structured information which at the time of initial installation consisted of demographic information (organized and displayed by visit), a list of problems, allergies, procedures and medications. Current information regarding the status of active elements from these lists are displayed on the cover sheet when the patient's record is retrieved.

Coded diagnoses and procedures already existing in electronic form in files in the medical records department are transferred directly so that data may exist in ACIS even before a patient is first seen in any clinic. New problems, medications and requests for procedures can be entered directly by physicians by selecting from pick lists on an ACIS workstation.

In pursuing our goal of a completely electronic patient record, we are advancing in two directions simultaneously, onward and upward. Onward consists of installing ACIS in new sites each of which requires special adaptations of the program to accommodate the special needs and interests of those working at the new site, and the upward consists of adding new features such as additional sources of information, modes of display or decision support.

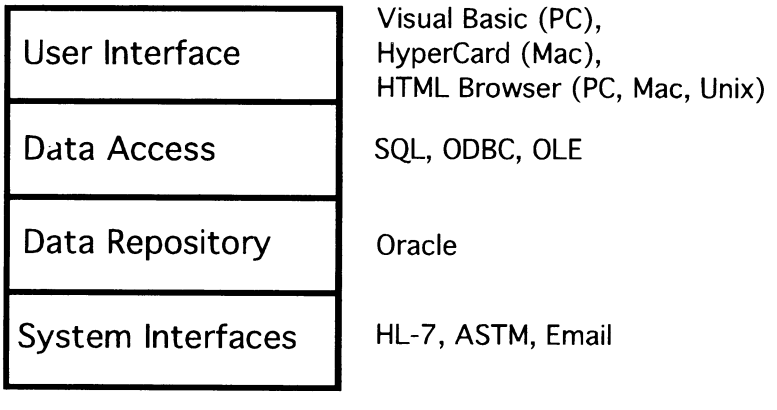

Figure 3. Modular Components of ACIS.

Onward

The ACIS project began in July of 1993 with the hiring of one programmer. The staff has now grown to six programmers and a number of other people who act as consultants, trainers, operators and promoters of the system within the institution. In the Spring of 1994 we had the first version of the system ready to bring up in the dermatology clinic. We had chosen this clinic because of interest on the part of several dermatologists who were already experienced with computers. However, this installation did not take place because the large volume of patients seen and the short time involved in each patient encounter. Any system that required more than a minute over the existing manual system for each encounter was unacceptable. As a result of this we moved to another specialty for our first installation.

In July of 1994, workstations were placed in each of the six examination rooms used by the rheumatology clinic. Three of the four rheumatologists use ACIS with each patient encounter. Right from the start they had suggestions for improving the program. They wanted the program to print prescriptions certain ways and to accept free text progress notes and other visit oriented comments. We have made both additions and modifications to the pick lists.

As pick lists and training was completed for other specialties, workstations were installed and ACIS was implemented in these clinics. By July 1995 we have ACIS workstations in 64 clinic exam rooms covering 19 specialties and the Emergency Department. We are also installing ACIS in physician's offices in the School of Medicine so the record will be more widely available to review or record clinical information.

A full time person with nursing background carries a laptop computer to different clinics introducing ACIS to potential users. 70 physicians and nurses have been trained to use ACIS (1 hr training). By November of 1995 we will have ACIS workstations installed in 150 clinic exam rooms and in many of the wards of the hospital.

Upward

In September of 1994, a program for entering outcomes information was implemented in the sports medicine clinic. This data is acquired directly from the patient using a touch screen workstation in the patient examination room and includes information regarding the functional status of a patient and patient satisfaction with the care process. Similar terminals are now being installed in several other clinics.

In December of 1994 an interface was implemented which allows lab data to be transferred from the laboratory system to ACIS as soon as results are available. This transaction takes place whether or not the patient has ever had a visit to a physician in a clinic with an ACIS workstation.

In April of 1995, programs were added to ACIS which allow the user to see a display of trends in any of the numerical data coming from the laboratory. This provides a feature to the user that was in demand but not available on the existing laboratory data retrieval system (STATLAN).

We have done a study of dictation and transcription processes used in our institution and found that this varies from transcription done by personal secretary on a word processor which is then printed out but not saved in an electronic form to the use of a highly structured dictation procedure which is saved in a database which can be downloaded directly to ACIS. In July of 1995, our first text reporting interface was added to a commercial transcription service that has dictated discharge summaries and surgical reports. This will be followed by radiology reports in August of 1995. We are working on interfaces to allow departmental secretaries to enter dictated notes directly into ACIS.

Programs are being tested for entry of history and physical exam data in structured form using several template-based alternatives for displaying clinical findings. This will be implemented first in our ambulatory surgery unit during the summer of 1995. Communication of orders entered by physicians to appropriate destinations such as the laboratory is not yet under development, but is felt to be a high priority for the institution.

Interfacing an expert system such as ILIAD with ACIS can be useful for problem oriented patient care documentation and on-line consultation of diagnosis and patient management. Development efforts are underway to use ILIAD's knowledge frames as templates to facilitate data entry in ACIS and use ILIAD's inference engine to drive decision making with patient data in ACIS.

EXPERIENCE WITH THE SYSTEM

Many of the challenges we have encountered in implementing ACIS have been people problems. First, it is difficult to get many physicians to take an interest in the patient electronic record at this stage since the primary benefits will not be realized until ACIS is fully installed in all clinics and has been operational long enough that the database is well populated. Until then, many physicians see the electronic record as an additional burden which only slows them down in getting their clinical tasks

performed. The exam rooms in our clinics were not designed to accommodate a workstation between the doctor and the patient, and can require some adjustment to work patterns.

Early in its history, the ACIS project was looked on by some of the hospital and medical school staff as an experiment not likely to succeed. Over time however, this project has become the center piece of our attempt to solve the information needs of the institution and a key element in our efforts to meet many of the information management requirements of our upcoming review for hospital reaccreditation. The support from hospital administration has been a key factor in keeping the project on track. The medical director of the hospital now heads a committee charged with facilitating ACIS implementation throughout the institution and monitoring its progress upward and onward. Although there are technological challenges in such a project, current software and hardware tools have made this doable even with limited resources. The real unknowns in a project such as this is the behavioral issue: "Can we build a system and create an environment in which health care providers will embrace a new electronic approach to keeping the record that documents and supports his/her interaction with a patient?"

CONCLUSION

The ACIS project is still moving onward and upward. Even at this stage we have evidence that a computer based medical record will soon make patient data available when and wherever it is needed at the University of Utah Health Sciences Center. Having the structured component of this data entered directly by physicians should improve its accuracy, eliminate delays and errors inherent in after-the-fact coding and provide the data needed for driving decision assistance and other clinical pathway tools for improving the care process.

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