HEALTH CARE SYSTEMS - AN INTEGRATED APPROACH

John W. Hamilton

Sisters of Saint Mary Data Center
Saint Louis, Missouri

The use of computer systems in health care institutions is increasing at a rapid pace. Computer systems can provide clinical services, meet record keeping requirements, manage patient scheduling, provide interactive screening and serve other needs within the health center. The Sisters of Saint Mary Data Center has implemented a second generation hospital information system in a 400 bed acute care institution; St. Francis Hospital, Blue Island, Illinois. The system is a micro-computer based system that provides an integrated system for clinical, financial, clerical and patient oriented activities. An earlier version of this system has been in operation at Saint Mary’s Health Center in Saint Louis, Missouri since May, 1972.

Summary

In 1969 Dr. Arthur Rappoport stated "Hospitals are under tremendous pressure by the communities they serve to provide better patient care in spite of rapidly increasing costs and the spiraling shortage of qualified personnel." The statement is also applicable in 1978. Delivery of care is more specialized and costs continue to increase. The Sisters of Saint Mary Data Center has developed and implemented a computerized hospital information system that is oriented to both of the mentioned areas; patient care and cost containment.

This paper provides the general objectives of the system, the philosophical premises inherent in the design effort and a general description of the system as it impacts patient oriented activities. Also, the computer equipment that is used is described. Lastly, future developments are examined and the conclusions are presented.

It is not feasible in a paper of this nature to examine in detail the impact of this system on all facets of the operation of the institution. What should be apparent is 1) the system can make a meaningful contribution to the operation of a health care institution 2) the benefits in both a qualitative and quantitative sense are greater than the cost and 3) that systems of this type offer significant potential to the medical community.

System Objectives

When the objectives of a system are being determined a major consideration should be the capability of the system to aid or assist in the primary function of the organization. One description of the hospitals primary function is provided by Dr. Conrad E. A. Herr. The description is very clear and concise. "The hospital exists to serve the sick, the injured, the disabled and some might add, those persons who stand in high risk of becoming sick, injured or disabled." The primary objective of the hospital is patient care. There are other objectives such as education, research and the operation of a complex financial institution. However, these subsidiary objectives are the means to fulfill the primary objective: service to the sick.

Improve the Delivery of Patient Care

The improvement of the delivery of care to the patient was and is the primary objective of the system. The system should assist in the improvement of care by supporting a wide array of activities. The admission process should be shortened, thereby allowing the diagnostic and treatment processes to be initiated more rapidly. Clerical duties of nursing personnel should be reduced to allow the highly trained, professional nursing staff more time for patient oriented activities. Orders for tests, treatments and supplies should be sent to ancillary support areas for expeditious action. Results from clinical tests should be sent to the
patient area for action by the clinician. The system should be capable of providing a common base of patient information that will facilitate the scheduling of services. When required, the system should notify all departments that are affected by a specific order.

The hospital information system should be a "tool" that is available to clerical, technical, professional and medical personnel to assist in the performance of the activities that are required to attain institutional objectives.

Personnel and Productivity

There are numerous occasions that the same information must be used in the hospital. The patient's social and demographic information must be entered on the history face sheet, registration form, insurance forms, the patient identification bracelet and the registration records that are required by regulatory and accrediting agencies. The repetitive uses of this basic information occur not only in the admitting of the patient, but are used in preparing census lists, dietary worksheets, departmental schedules and for other information requirements.

A manual system requires that requests for a service be delivered to the ancillary area before the service is initiated. An alternative method may be for a technician to make "rounds" and retrieve the service requests. An example may be an ECG technician commencing rounds "early in the morning" in order to obtain the requisitions for processing by the department.

The information system should provide a mechanism to eliminate the duplication of mundane and repetitious tasks. These tasks may be the typing of forms or other similar activity. Also, the requisition process should eliminate the need for "early morning rounds" that consume valuable technical or clerical resources.

System Philosophy

Evolutionary System

The hospital is a physical system consisting of a set of interrelated components which operate together to accomplish an objective. The objective is: service to the sick. One of the components of the hospital system encompasses the personnel who perform the activities required for the attainment of organizational objectives. A hierarchy exists in the division of labor 1) the physicians 2) medical and para-medical personnel who serve the patients directly or provide technical services 3) service staff who prepare food, maintain the physical facilities and other essential services and 4) clerical personnel who prepare, transmit and store the written communications of the institution. The efficacy of the interaction of the four groups is critical to the delivery of quality care to patients.

There are computer systems that dictate a rigid role for the physician in the clinical interaction with the information system. This requirement has been met with resistance by many of the practitioners. This antipathy on the part of the medical staff is not limited to the United States but is prevalent in Europe. The Sisters of Saint Mary system was designed to continue the use of the traditional order sheet. The negative impact of tying the physicians to the system is avoided by continuing the use of this ordering method. The information system can be structured to accommodate the entry of orders by physicians; however, the implementation of this procedure will occur when the medical staff and hospital administration deem it desirable, not because of an arbitrary system requirement.

The substitution of highly trained physicians or nursing personnel to perform essentially clerical functions (order entry) did not appear to be desirable. There are other activities that unit or ward clerks perform and order entry by professional personnel will not obviate the need for personnel in this category. The information system can and must achieve labor savings by increasing productivity or a reduction in personnel. Personnel savings may be attained when results are sent directly to patient care areas from the ancillary departments. Reductions such as this, the elimination of charters through attrition, can be achieved as the system expands and evolves into a comprehensive support system.

A Broad Based System

A cardinal rule: potential users must actively participate in the design and specification of the information system. The system should be integrated into hospital activities by participation of the medical staff, professional, clerical and administrative personnel in the system design. The ultimate users of the system are the hospital based
personnel and they must participate in decisions that will impact, possibly negatively or positively, the operational environment of the institution.

The medical staff should participate in decisions such as the presentation of clinical results. The result summary becomes a permanent element of the patient's medical record. The usefulness of the information for current and future needs is dependent upon clinician support of this activity. A nursing committee should be the mechanism that reviews activities that will impact the nursing area. The joint review of ordering procedures by the committee and the ancillary departments will minimize conflict and insure the implementation of effective procedures. The committee can also be the catalyst for change as the information system becomes capable of supporting nursing activities. Involvement of institutional personnel in decisions that impact their respective areas will assure an effective relationship between the system and their departments.

A Central Clinical System

The use of clinical data in the day to day operation of the institution requires real-time access to a common database. The database should be available to all departments and personnel who have a need to inquire into or retrieve from the clinical database. A single central source will eliminate the need to have replication of patient data in several computer systems. There are stand alone Pharmacy and Laboratory systems that are beneficial in the respective departments. These systems have a basic weakness when considering a comprehensive hospital wide system. They require information that resides in the central system. The duplication of information can be avoided and the needs of these departments provided for in a properly designed information system. An additional disadvantage of individual departmental systems is the inability of the departmental system to detect test contraindications. A patient enters the hospital to be served by the entire health care system in the institution. A centralized system can grow and meet hospital requirements more effectively than multiple independent entities.

The System Must Be Dynamic

A hospital is not a static system and the information system must be dynamic, it must adapt as institutional needs change. The instrument for change may be medical in nature, the implementation of a laboratory result reporting sub-system. Another catalyst for change may be the needs of administrative or departmental personnel, Blue Cross may require additional information on the patient notice of admission form. The regulatory bodies at the national and state level, as well as the Joint Commission on Accreditation of Hospitals require periodic adjustments in policy and practice. The implementation of Professional Standards Review Organizations is an example of change that is mandated by the external environment. The information system should be flexible in order to assist the hospital in responding to environmental (the health care environment) change.

System Overview

Admission Process

The admission process consists of two phases. The first phase is the reservation of the patient by the physician. The second phase is the arrival and admission of the patient into the institution.

Reservation Procedure. The procedure for admitting a patient to the institution begins with a telephone call from a patient's physician to the reservation department. Reservations enters patient information received from the physician's office into the computer system. This information includes: patient name, age, sex, address, telephone number, provisional diagnosis, expected date of admission and physician's name. This information is the basic data element in the common database. All information relating to the patient is incorporated into this basic set of data to create a record of the patient's stay in the health center.

Admission Phase. Prior to the arrival of the patient for admission, information that relates to the insurance and other required information necessary to admit the patient is entered into the database. Upon completion of the entry of required information the preparation of necessary admission forms may be accomplished. Some of the forms that are printed are the registration sheet, the history face sheet, insurance forms, and chart labels.

When the patient arrives to be admitted to the hospital, the forms are reviewed with the patient and when this process is complete the patient is admitted to the institution.
When the patient is entered into the nursing unit census the computer system automatically prepares admission requisitions. Additionally, all concerned departments are automatically notified of the admission by the printing of an admission notice in the appropriate area. This admission process requires several minutes of the patient's time.

Patient Service Ordering

Patient orders are initiated at a nursing unit. Nursing units enter requests for patients in the unit census. Areas such as the emergency room access patients alphabetically in order to enter requests.

Information required for service requests is entered into the system by a selection process. Each ancillary area has different requirements that must be met therefore the selection process must vary accordingly. The basic order consists of selecting the patient, the ancillary department, the service to be performed, special requirements and the date and time the service is required. If an order impacts multiple departments the information system notifies the individual departments.

The orders that have been entered into the system may be recalled and displayed upon the computer terminal on demand. This eliminates the need to file paper copies of service requests at the nursing unit.

The terminal also prepares identification labels for the patient chart and specimen labels for laboratory specimens. The need for a plastic or metal plate imprinted with patient information has been removed.

Reporting of Results

After a service request has been received and the test has been completed, the result may be reported to the nursing unit or patient care area. To enter a result the requisition number is entered into the computer system and the result requirement for the particular test will appear on the computer terminal. The result values are entered into the terminal and transmitted to the appropriate area. The result information is stored in the computer system and may be retrieved by the medical staff and other personnel that require access to this information.

If a request does not require a result to be reported the service area must acknowledge the request. The acknowledgement procedure insures that the request is performed.

The information system provides a nightly summary which contains cumulative results for the patient's length of stay in the hospital. The results provided are from areas such as, the laboratory, nuclear medicine, and respiratory therapy.

Discharge

The discharge procedure consists of a preliminary and a final discharge. The preliminary discharge notifies bed control that a bed will be available at some point during the day. The business office also receives a preliminary notice in order to allow a review of the patient's account before the discharge process is completed. If the account is in order the patient is discharged from the nursing unit and need not stop at the business office.

When the patient physically has left the institution a final discharge is entered into the system. All departments that require notification of the patient discharge are informed. A service request to clean the patient's room is automatically entered into the housekeeping service system.

Computer Hardware

The computer hardware operates in a distributed environment. There are three levels in this environment. The first level consists of a microprocessor computer terminal. The second level is a dual minicomputer system. The last level is a large scale general computer system.

Features of the System

Security. An integral part of the terminal is a badge reader. The badge reader in conjunction with the employee badge provides positive identification of individuals. The identification provides a control mechanism to insure confidentiality of patient information is maintained.

Reliability. A real-time system in the hospital becomes an integral element of the day to day operation of the institution. Critical areas must be duplicated. The essential elements in the system are the minicomputer, the database and the terminals. The system provides for the duplication of these elements.

Ease of Operation. The terminals
used in the system are specifically designed for personnel without data processing training. In most instances the system may be used by simply pointing a finger and touching a selection button.

Response Time. One of the most significant features in any computer system that interfaces with humans is the delay time between human input and a computer response. The system developed has the capacity to transmit data to and from the terminal at the rate of up to five hundred thousand characters per second. This data rate insures a minimum of delay to a request.

Cost. A major feature of this system is the low cost. The system with approximately fifty terminals will cost less than one dollar and fifty cents per patient day. This cost is for a four hundred bed institution.

Microcomputer Terminal

Each terminal in the system contains one of the latest technological microcomputers available. The terminals are installed in all nursing areas, ancillary departments and where required in the hospital. A major advantage of an "intelligent" terminal is the ability of the terminal to share the computational load of the total system. Many of the activities performed by the system are executed within the terminal.

The terminal software has an operating system that provides for multi-programming and supports a high level language designed specifically for the hospital information system.

The terminal is controlled by a Zilog 2-80 microcomputer operating at approximately a 2.5 megacycle clock frequency. The terminal has 32K bytes of random access memory. Also there is a 1K read only memory which is used to bootstrap load. The cathode ray tube provides for display of 1,600 characters of information. The information display is enhanced through the use of attributes which provide character or field blinking, high intensity and reverse video. A keyboard is provided with the terminal and is similar to a typewriter keyboard. A significant feature of the terminal is the "select" switch adjacent to each row on the display. These switches are activated by a capacitive coupling. The magnetic badge reader was previously mentioned under security. There are various printers that may be connected to the terminal in order to obtain hard copy output.

A microcomputer terminal

The terminal is also designed to interface with automated equipment.

Database Control System

There are dual minicomputers that provide for database control and communication with the terminal microcomputers. The minicomputer has clinical information in the database and also information that is periodically forwarded to the general computer system. The general computer system performs financial and historical activities.

Each minicomputer is multi-programmable. The computer memory size is 128K bytes each. The mass storage capacity for each system is 135 million bytes of information. Additionally the systems have tape drives to "save" the database. Also the system has a line printer for audit reports and a card reader for job control information.

Future Capabilities

The hospital information system that cannot continue to meet the expanding needs of health care will soon atrophy. Those hospitals that are able to streamline operations will depend on electronic data processing efforts to generate data and to improve patient care. Thus, the future of hospitals will in large measure depend upon data processing.
The Sisters of Saint Mary Data Center has several enhancements to the hospital information system under development or in the evaluation stage.

Interaction System

The initial stage of the interaction system will screen drug orders for possible allergic reaction or contraindication. The interaction system is designed to expand into a comprehensive order screening system.

Automated Interfacing

The microcomputer terminal is capable of interfacing with automated instruments and systems. The initial area of instrumentation will be in the laboratory.

On-Line Medical Record

The ability of the system to support text processing will greatly benefit areas such as medical records. The preparation of admission and discharge summaries on the terminal will also provide the capability to store this information in the database. The system may be structured to provide an on-line medical record as additional clinical information is incorporated into the database.

Physicians Office System

The ability to have a computer terminal in the physician's office should greatly benefit the patient, the hospital and the physician. The physician could have patient information entered into the system by his office staff. Orders for patient tests and services could be ordered by the physician. The physician would also have the ability to retrieve the results and other clinical information pertinent to the treatment of the patient. This would reduce the clerical requirements in the hospital and allow for patient treatment and diagnostic activities to be initiated more rapidly than current manual systems.

Conclusions

The Sisters of Saint Mary Data Center has performed several internal studies concerning the attainment of the system objectives. The studies indicate that the general objectives of the system were attained.

Patient Care

The admission process in many cases takes less than five minutes. The patient need not spend a lengthy period of time for clerical activities related to the admission process to be performed. Orders for tests and services are instantly communicated to the service areas. Under the manual messenger system a request may take several hours before being delivered to the ancillary department. Laboratory results are instantly reported to the patient care area and are also available for inquiry and display on the computer terminal by the physician. These activities can contribute to a reduction in the average length of stay.

Productivity

Through the use of the common database information may be repeatedly used. The information need not be entered one time and then it is available for a multiplicity of uses. Blood collection lists, radiotherapy logs and radiology services to be performed are byproducts of information that has been entered into the system. Requisitions for departments that do not operate twenty-four hours are available upon arrival of personnel in the department each day. The departmental activities can commence immediately. The ability for medical records to perform diagnostic and operative coding has contributed to a reduction in employees in the medical record department.

The Sisters of Saint Mary Data Center concludes the hospital information system was a factor in an improvement in patient care and the system assisted in increasing the productivity of personnel within the institution. Lastly the system has been a valuable tool in hospital operation and will be even more valuable in the coming years.

References


6. Ibid., p. 8.


John W. Hamilton
Assistant Director
Sisters of Saint Mary Data Center
1100 Bellevue Avenue
Saint Louis, Missouri 63117