Medical data processing in the United States

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In the past few years, there has been a sharp rise in the demand for health care services of all types by a larger and increasingly more well-informed public. At the same time, the cost of delivering high quality care is becoming formidable for hospital and patient alike. The introduction of the computer and information management techniques is considered by many informed health professionals and knowledgeable leaders in the medical computer field to be a solution to some of the major health management problems we are confronted with today.

Such systems should not be expected to magically solve all health care delivery problems; computerized systems can, however, alleviate much of the congestion in the medical communications network. It has been stated that the lack of an effective means of communication between health care professionals is one of the most serious drawbacks to improved patient care today.

Increased use of medical computerization upgrades this communication. Additionally, it assists the physician to carry out duties which he does not like involving documentation and clerical functions. It effects a reduction in personnel workload by taking over much of this paper work.

Computerization also reduces errors. It is imperative to good health care that the possibility of error be minimized. To ensure accuracy in the transmission and storage of data for subsequent use, a computerized medical information system can establish consistent standards and continuously monitor all transactions. All entries that require verification can be immediately printed at the entry terminal and verified by the user, thereby providing positive confirmation of the data. A printed record of the transaction is then available for future reference.

The computerized medical information system also promotes an important organization and accessibility of valuable medical information. The physician can have direct access to all stored information through the use of remotely located terminals. A timely patient summary report provides accurate and convenient information supporting on-going medical care as well as enabling the implementation of a more exact system of capturing charges and giving provider credits. Of course, legibility is most certainly a positive benefit as well.

This type of system also improves physician communication with the community medical facility through incorporation of a so-called hospital information system. Through this system, an improvement of overall hospital organization and procedures is effected. Control is obtained by supplying the staff with concise information concerning events as they are occurring. The system can, therefore, serve as a tool in making day-to-day as well as long-range operating decisions. A major advantage of computerization is in the improvement effected by the systematic organization of medical functions and patient information in an accessible data bank. An information system establishes specialized files containing data on various functional activities and on patients. This data is distributed throughout the system for appropriate uses. The data base is constantly being updated during daily operation.

It is important to keep in mind that the principal advantages derived by physicians and patients from the installation of a computer system in the hospital occur after the physician has initially seen the patient. These include services subsequently executed after examination. Advantages affecting patient care include more rapid and accurate means of ordering tests and medication and of reporting, filing, and retrieving test results. While a computer system may not immediately reduce the time required to perform a specific test, the ordering and notification system will be speeded up.

There appears to be some confusion as to just what constitutes the medical information system. When used correctly, the term implies fully computerized management information as well as aspects of patient care. Although a comprehensive total system does not presently exist, the beginning of an ultimate system is being explored. In order to produce this type of system, an integrated flow of data processing will be necessary to cover:

1. the collection of source data
2. the transmission of information via terminals and other communication links to a central computer
3. the establishment of a large, immediate-access data bank
4. the development of computerized management information to be used for decision making
5. the unification of the physician and his staff with an on-line, real-time computer complex


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An all-inclusive system will facilitate communications between the activities of the various areas involved. To achieve acceptance of this system, the entire approach to our current methodology must get a face lifting. It is appropriate at this time to quote Machiavelli in reference to attempting this feat.

"It must be remembered that there is nothing more difficult to plan, more doubtful of success, nor more dangerous to manage, than the creation of a new system, for the initiator has the enmity of all who would profit by the preservation of the old institutions and merely lukewarm defenders in those who would gain by the new one."

Before beginning to consider the field of Computer Medicine which involves the study of the various computer assisted medical applications making up the potential community medical information system, one needs a frame of reference within which to consider the current status of its development. The following diagram offers such a taxonomy.

Some of the applications mentioned in the diagram are discussed below.*

1. **Admissions and Bed Control:** Prepare current census report. Monthly periodic statistical reports. Bed status and accounting. Generation of lists of current patient locations and condition for use by physicians, clergy, telephone operators, etc. Message transmission to and from other pertinent areas (admissions, nursing, etc.). Assistance in patient admission interview. (For a small hospital—too costly.)

2. **Billing and Accounts Receivable:** More than 1,000 hospitals have one form or another of data processing. The biggest problem is capturing the charge information and entering the charge against the right patient. Most use batch processing. General ledger and budgeting usually are computerized after billing, accounts receivable, payroll/personnel, and accounts payable. These are most useful to management and planning.

3. **Payroll/Personnel:** This can be considered by the 100-300 bed hospital. These vary in sophistication, i.e., FICA and federal income tax deductions, to more complex problems with bonds, insurance savings, etc. The more sophisticated the more the cost; you get what you pay for.

4. **Accounts Payable:** This is a very early and justifiable computer application. Again, as in the foregoing areas, the repetitive nature of the task and the use of the same data to produce numerous reports makes this function a natural for the computer. As a result, it is usually automated early along with patient billing, accounts receivable, and payroll.

5. **Purchasing:** This is justified if combined effort is made with pharmacy, food service, maintenance, and central purchasing. If each is considered alone, it is not cost justified. Because of a lack of cooperation, coordination, and control in most institutions, this area is not one of the first to computerize.

6. **Inventory Control:** This can reduce the physical inventory if combined with a computerized purchasing system.

7. **Maintenance/Engineering Department:** Programs that can be considered in this area area: (1) preventive maintenance scheduling, (2) work order request control and costing, and (3) personnel scheduling. These programs can be undertaken on a variety of systems and have no bearing on the type of HIS or computer facility your hospital has.

8. **Laboratory Medicine:** All subfunctions relating to the discipline of Pathology including clinical pathology, gross and microscopic specimen analysis (also cytology), and forensic pathology. Not only are the commonly automated areas of hematology and serum chemistry included but also urinalysis, histopathology, and microbiology. It also encompasses quality control, trend analysis, laboratory instrument monitoring, and all aspects of specimen control including intradepartmental file management techniques when applicable. Laboratory is quite successful; has small dedicated facilities. No reduction in cost but smaller increase of cost as rate of growth increases. Charges generated and reported on lab system which helps the business office. A lab doing over 300,000 tests a year should consider a lab system.

9. **Scheduling:** All subfunctions involved with the heavily transaction-oriented aspects of patient care concerned with bringing together certain resources (men, money, material), various facilities (including admissions and discharge functions), and patients in a logical manner most appropriate to completing the diagnostic work-up. Scheduling of inpatient and outpatient appointments is a part of this function.

10. **Administrative Management:** Within the hospital, this includes all subfunctions involved with cost accounting, patient accounting, bed availability, bed usage, medical staffing, medical material, budgeting,
programming (including preventive maintenance) and facility usage and planning. For the doctor's office, it also includes all management functions including the filling out of third party payment forms and patient billing. It also includes areas of health planning and the development of models.

11. Pharmacy: This must be considered in conjunction with other systems such as in-house accounting or shared hospital accounting for cost justification. The systems currently available do pricing, charging, inventory control, formulary listing, purchase order preparation, and other administrative type applications. All subfunctions relating to therapeutic agents and their usage. These include drug inventory control, prescription formulation, maintenance of a formulary, and appropriate aspects of clinical pharmacology such as usual dosage, orders checks and reminders (inpatient), contra-indications, and hypersensitivity reactions. In addition, appropriate aspects of clinical toxicology and acid-base (fluid) therapy are included as subfunctions.

12. Radiologic Diagnosis and Therapy: Work is being done in administrative applications, radiological information systems, and radiographic diagnostic systems. All subfunctions relating to Diagnostic Radiology including the conversion of requests into facility and technician schedules, patient preparation notices and reminders systems for reporting on individual roentgenograms, and maintenance of a film file locator. In addition, all subfunctions relating to therapeutic radiology are included such as the calculation of isodose curves, patient treatment schedules, and tabulation and maintenance of the results of treatment (Tumor Registries).

13. Multitesting and Health Screening: This is controversial and dependent on the decision of the professional staff. All subfunctions relating to history taking and physical examination separate from and included within areas making up multiphasic health screening functions. It also includes all outpatient methods of acquiring the basic data base on the patient alone or in conjunction with a physician's assistant.

14. Nursing Services: All subfunctions related to the scheduling and prompting of direct nursing care functions including shift-change summary reports on the patient's course and condition. In addition, a summary of all doctors' orders on demand and any additional nursing administrative functions not covered specifically in other areas is included. Computerization of the nurse's reporting (notes) system itself is also included. This is useful for visiting nurses as well as those based on the doctor's office or hospital.

15. Patient Support: All subfunctions involved with patient comfort including adjuncts to nursing care. It includes request processing, delivery of service, and inventory control in usually hospital based areas such as inhalation therapy, occupational therapy, and physical therapy as well as the central supply. It also includes the facility Food Service incorporating some or all of menu planning, nutritional accounting, and control of all foodstuffs through procurement, inventory, stockroom issue, food production, and daily cost accounting.

16. Patient Monitoring: All subfunctions involved with the integration and presentation of large amounts of physiometric data by sophisticated instrumentation frequently interfaced directly with the computer. Such efforts include those usually found in intensive care units (general, cardiac, burn), surgical recovery rooms, delivery rooms, and emergency rooms.

17. Medical Records: This is costly and difficult—not really a consideration for a 100-300 bed hospital. If 20 or more records per day are retrieved, strong consideration should be given to computerizing diagnostic and operative indices. This function refers primarily to advanced record management functions including prospective and retrospective statistical analysis. It is based on the patient record file system which is an intrinsic development of all the various functional areas themselves. It includes medical file folder inventory control procedures as well as individual reporting (summary) procedures. It also includes coding functions often associated with such documents, statistical compiler development, and other systems for on-going correlation of useful medical information based on such parameters as diagnoses, therapy, and tracking the clinical progress of disease (i.e., Epidemiology). Doctors' consultative reports (including summaries, operative reports, and correspondence) are also included under this category.

18. Electrocardiography (EKG): Here there is a possible cost reduction which the hospital administrator can investigate. When the computer is used correctly, the cardiologist can increase his work capacity at times tenfold by the use of computers. When one of the 27 EKG regional facilities is used, the average cost is three to four dollars per EKG, which includes the EKG equipment, terminals, communications, and computer time.

19. Electroencephalograpy (EEG): No general acceptance. It is hoped that when a new theory of statistical probability is acceptable, better than 75 to 80 percent accuracy will be available using computer interpretation, on abnormal versus normal readings leaving only 20 to 25 percent to be interpreted by the physician.

20. Respiratory Therapy: In most cases, part of an overall HIS and not a dedicated therapy system. Programs deal with the administrative function, physiological monitoring, and multiphasic screening, i.e., collecting and evaluating spirometry data, blood gas analyses, and some diagnostic programs. These programs are found in both time-shared systems and dedicated minicomputers, however, not in small community hospitals.

21. Physiological Monitoring: These systems are comprised
of on-line instruments and patient monitoring equipment with warning signals should the conditions exceed pre-defined set bounds. Careful record of the patient’s progress is kept. Monitoring is seen in intensive care units, coronary care units, operating rooms, delivery rooms, surgical recovery rooms, nursery areas, pulmonary care units, and catheterization laboratories.

22. Food Service: Food service personnel and menu planning computerization. Dietician and cooking staff is largely manual, although new equipment has made automation more efficient and cut costs. Computer Assisted Menu Planning (CAMP) is a package to plan a series of varied menus with predetermined nutritional requirements at minimal costs. This then leads to the planning for purchase of raw food, and control over inventory. Disadvantage is that initiating CAMP is very expensive and can offset the benefits gained. In most installations, one year of the dietician’s time was required to set up the system.

23. Diagnostic Support: All subfunctions in direct support of the physician’s diagnostic work-up. This includes request processing, delivery of service, recording results (sometimes automatically), allocation of resources for such elements as electrocardiography, pulmonary functions, and nuclear medicine, and computer-assisted diagnostic consultation.

24. Medical Library: All subfunctions involved with bibliographic referencing, the maintenance and updating of computer displays on important parameters, and other appropriate medical library functions.

Hospital communication systems have been deemed to tie many of the above functions together. A brief description of each of the most popular approaches is discussed below:

1. The Nursing Station Approach, one of the most widely represented views, maintains that activity at the Nursing Station is most directly related to patient care.

2. The Medical Record Approach can serve as a total, uniform, fiscal, historical, and medical data base. A standardized system of recordkeeping must be instituted in order to computerize effectively.

3. The Fiscal Approach to computerized Hospital Information Systems is to establish a data base at the admitting office.

4. The Multiphasic Screening Approach is based on the theory that taking a patient through an extensive series of pertinent examinations before he is admitted to the hospital makes it possible to establish a data base for subsequent use.

5. The Research-Oriented Approach is the least represented, and hopefully, in the future, the medical industry will devote additional efforts in this area. Here the emphasis is on Epidemiological information rather than on current hospitalization data.

6. The Modular Approach is becoming more and more popular due to the emphasis on dedicated turn-key systems such as in the laboratory, pharmacy, business office, etc. The concept here is to establish a well-planned linkage to a central depository out of which the communication system evolves and grows.

7. Distributive Systems Approach centers around the development of a network of integrated stand-alone systems which interact.

Several computer companies have entered into the field of computer-based health care systems; some of the major ones are discussed below and on the following pages.

BURROUGHS/MEDI-DATA, INC.

Functions: Clinical Laboratory, Patient Support, Diagnostic Support, Medical Records, Scheduling, Pharmacy, Administration and Management.

Burroughs Corporation offers Medi-Data Hospital Information System in support of a stand-alone system (complete) for a single hospital or a group as a service from the Charlotte Data Center, Charlotte, North Carolina.

Medi-Data, Inc., has developed a hospital information system in which the nursing station is the nucleus of activity. The system provides information processing and message-switching capabilities in the following three areas: (1) patient care, (2) administrative accounting, and (3) research and statistics. On-line data terminals, consisting of a CRT unit, keyboard, and card reader, can be connected to the central computer by means of leased telephone lines or hard wired as appropriate, i.e., can be hospital's own system or remote. Duke University, North Carolina, has just installed this system.

The Burroughs/Medi-Data system now automates many hospital routines including: (1) complete census, pre-admissions, admissions; (2) transmitting doctors' requests and communications to the appropriate ancillary departments; (3) nurses' clerical-service functions; (4) hourly departmental scheduling, e.g., operating room, X-ray, hospital maintenance and housekeeping, etc.; (5) transmitting test results and/or diagnoses to the proper location; (6) recording and updating data on the patient’s medical record; (7) floor stock resupply; and (8) all fiscally-oriented procedures.

Action is initiated via the physician's hand-written orders. The ward secretary, located at the terminal, then enters through the keyboard all patient-related information. This data is displayed on the CRT screen, and a hard-copy is also produced for verification. Upon its confirmation, the data is sent to the central processing unit for permanent storage. The central processing unit generates all care and medication schedules for each nursing station, pharmacy, laboratory, department, etc.

Test results from ancillary departments are entered directly into the computer, and they are automatically printed out at corresponding nursing stations to be included in the patient's chart. All entries are validated by the
computer to confirm the contents by patient number and by doctor's identification number. Laboratory results are summarized daily (on new activity) and printed in descending date order by patient by procedure for the chart.

Outpatients can be entered into the system through an outpatient registration system similar to that of inpatients. Medical orders can be entered in the same manner as inpatients' data. Requisitions are then generated to applicable departments, and charges are posted. Results may be sent to the requesting clinic or department. Outpatients may stay on the system for a predetermined period of time or as scheduled for repeat visits.

Burroughs hardware and support has facilitated Medi-data (non-profit) Hospital Information System. At present, Burroughs themselves are entering the hospital information systems field on their own corporate level with different terminals (plasma terminals) and a somewhat different approach than taken by Medi-data. Such a system can be seen at Wesley Hospital in Wichita, Kansas.

CONTROL DATA CORPORATION

*Functions:* Clinical Laboratory, Patient Support, Diagnostic Support, Scheduling, Medical Records, Patient Monitoring, Pharmacy, Administrative Management.

Control Data Corporation's concept of an integrated medical information system is to coordinate all health related activities—patient care, administration, education, and research—via the MEDICOM System. MEDICOM, now in the design state, is a communication and patient-file management system which will form the basis for the integrated system. St. Louis University Hospital in Missouri is involved in this project.

In a typical system, it is planned that the computer will process selected patient-data which are entered on-line from remote terminals. The central processing unit will store the data on active mass storage devices while the patient is in the hospital. Patient files will be organized into active and passive files. The active files will hold all the information available on a patient when he is receiving health services. When the patient is released from the hospital, the active file will be summarized, added to the passive file, and released to an inactive storage portion of the system.

Reports and requests to the computer center may be entered by conversion to card input, page readers, or directly through on-line entry/display terminals. CDC has developed and utilized the MEDISCOPE system to handle all hospital communications.

MEDISCOPE is a data acquisition and information retrieval system that is based on the CDC 1700 computer with optional links to the CDC 3000 and/or 6000/7000 computers. The specially designed CRT terminal is called the "Digiscriber" and includes 20 transport strips on the entry/display screen. By touching one of the 20 strips, the user can manipulate pre-programmed subject matter and/or enter unprogrammed material via the attached keyboard.

To assure patient privacy and security, the mode of identification for entry into the system is a combination code consisting of a number, color, and animal (e.g., 6, green, fox) to be keyed in at the terminal.

Currently, the dedicated systems pertaining to medical computer applications that are offered by CDC include: (1) MEDLAB, an intensive-care system; (2) CARDIOTEST, and EKG system; and (3) CLINLAB, a clinical laboratory management and automation system. Several of these applications can be seen at Latter Day Saints Hospital in Salt Lake City, Utah. The MEDISHARP business system includes the SHARP (Shared Hospital Administrative Report Processing) system.

Although all of the above systems have the capability of being stand-alone systems, when they are combined with MEDICOM, they will form Control Data's concept of an integrated medical information system. However, no such complete system is in operation at this time.

**DIVERSIFIED NUMERIC APPLICATIONS**

*Planned Functions:* Clinical Laboratory, Patient Support, Medical Records, Scheduling, Pharmacy, Radiologic Diagnosis and Therapy, Administrative Management.

Diversified Numeric Applications is developing HOSPITROL, a computer controlled data handling and communications system which will consist of centrally located computers (MED/16). HOSPITROL is being designed specifically to utilize multiple computers for effectiveness and reliability; the computer was designed to be used in multiple computer configurations through the use of partitioned, shared core memory.

For example, in a typical 400 bed hospital, DNA's HOSPITROL system will employ three MED/16 processors in a minimum configuration (software is designed to obtain maximum utilization from this redundancy). Four processors if total clinical laboratory automation (UNI-LAB) is included, or possibly five processors if complete accounting capability is desired. Six types of communication consoles will be combined in various ways to provide the appropriate terminal(s) at every ancillary department. Each of the units is described below: (1) Plasma/600 is a CRT unit for nursing station communications. The unit includes an alphanumeric keyboard for names and variable data, an "action" keyboard for initiation of various functions, and selection buttons for medical order information. The console also contains a badge reader for positive identification of the user. Plasma/610 and Plasma/620, modified versions of the Plasma/600, can be used in the departments of pharmacy and radiology, respectively. (2) Plasma/500 is a keyboard/display console with less display area than the Plasma/600. This console is designed for use in those ancillary areas where high-speed display and keyboard entry are essential, e.g., surgery, the delivery room, laboratories, etc. (3) Video/400 is a large CRT display console developed for use in admissions, the business office, medical records, information desk, and administrative departments. The unit contains a simplified keyboard for functions similar to that of a typewriter and
also includes administrative function control keys. (4) Format/300 is a hard-copy printer that contains a specially formatted keyboard for the individualized input requirements of each department it serves. The printer provides a continuous audit trail of all transactions, prints reports, etc. The Format/300 can be used in dietary, central supply, radiology, etc. (5) Labeler/200 is a printer designed specifically for printing labels which can be used in pharmacy, laboratory, etc. (6) Reporter/100, a printer designed for location in the emergency room, business office, nursing station, etc., will provide all hard-copy printout.

In addition to ordering, storage, routing, and checking data, HOSPITROL is being designed to provide patient treatment schedules; patient/departamental supplies ordering; patient charge handling; pre-admission and admission functions; access to medical records, billing data, and statistical data; etc. The prototype is being installed at North Memorial Hospital, Minneapolis.

EXECUTIVE DATA SYSTEMS, INC.

Functions: Clinical Laboratory, Scheduling, Nursing Services, Pharmacy, Administrative Management.

Hospital computer systems offered include both on-line and off-line types and cover the hospital areas of financial/administrative management systems, clinical systems, and systems' coordination. Among the system concepts followed are modularity and flexibility. Equipment used at the hospital varies depending upon the systems employed and the size of facilities. Some EDS hospital clients have no in-house computer equipment, while others have one or more pieces of computing equipment such as keyboards and keyboard-printers, card readers, magnetic tape units, line printers, cathode ray tubes, minicomputers, and even large-scale computers.

Of the operational systems, accounts payable, payroll, personnel, and physical plant are available without the hospital needing any in-house equipment. Hospitals choose from a range of in-house equipment including nursing station and departmental terminals when utilizing the other operational systems.

Basically, each hospital designates the applications which it wishes to use and how it wants to use them. Master files and specific system-design requirements are then defined, and the applications made operational. Typical processing units with related peripherals include: Burroughs 3500, BMR 6135, IBM 370/145, and IBM 1800. Auxiliary units include Burroughs N and Mohawk 2501. Terminals include IBM 1050, IBM 1092, Burroughs N, and minicomputers with CRTs (Datapoint 2200s). This hardware is used for a shared fiscal as well as a H.I.S. at St. Barnabas Hospital in Livingston, New Jersey.

System options which a hospital can follow are to choose to computerize payroll with no in-house equipment performing financial/administrative functions through the use of a shared computer network with in-hospital terminals or mini-computers or to include clinical subsystems with one or more in-hospital computers and multiple terminals located throughout the hospital.

The medical message-switching occurs through data entries at the terminals located at various areas in the hospital. Security codes allow for appropriate data entries and information retrievals. After editing, the data are processed according to their types and needs with message forwarding, file updating, and system interfacing occurring as appropriate. Currently, the departments operationally affected include admissions, business office, pharmacy, nursing, and laboratory.

HONEYWELL, INC.

Functions: Clinical Laboratory, Scheduling, Patient Monitoring, Pharmacy, Radiologic Diagnosis and Therapy, Administrative Management.

A typical intra-hospital message-switching system can consist of a Honeywell H-1015 with 131K of core memory, three disks, two tapes, a printer, a 35 G.E. Terminent, 300 R.O. terminals, and five Bunker Ramo CRTs with keyboards. It runs in 65K foreground of an operation system. This is implemented at Parkview Hospital in Ft. Wayne, Indiana.

The receive-only printers are located at the nursing stations, ancillary departments, admissions, P.B.X., kitchen, central supply, and pharmacy. One CRT is located in admissions, and the other four are situated in the data center. Patients are admitted on-line, and the ward, P.B.X., and other appropriate departments receive messages giving the patient's room, bed number, and physician's name. Admissions can query the system at any time for available bed census.

Nurses, doctors, emergency room, operating room, and other departments access the system by dialing "3" on a telephone. A CRT operator in the data center answers and is given the patient's name. The name is keyed into the CRT which displays the patient's name, account number, ward, room and bed number, and physician's name. This information is verbally verified with the caller. Services are ordered verbally, and CRT operators key in service codes. The service codes will bring up the service description so that the operator can verify the service ordered. When all orders are completed for each patient, the messages are released to the departments, and an audit message is printed at the nursing station for inclusion in the patient's chart. Where an order would involve several departments, for example, a G.I. series, all departments (i.e., X-ray, kitchen, pharmacy) would receive orders pertaining to it from the single transaction code for a G.I. series.

Upon a patient's discharge, finance, P.B.X., and housekeeping are notified from the single discharge code. Housekeeping dials "3" when bed and room are ready for occupancy. This notifies admissions of bed and room availability.
Presently, all transactions are spooled from a disk each night to the patient account system. It is planned to do patient accounting on-line. The system can produce a census on demand.

INTERNATIONAL BUSINESS MACHINES CORP.

Functions: Clinical Laboratory, Patient Support, Diagnostic Support, Medical Records, Scheduling, Patient Monitoring, Pharmacy, Radiologic Diagnosis and Therapy, Administrative Management.

IBM Corporation's concept of an integrated medical information system utilizes the System/360 or System/370 processor(s) to form the foundation for: (1) a communication system that centrally controls the flow of source data to ancillary locations throughout the hospital; (2) a central information system that electronically receives, transmits, and stores data for immediate access; and (3) a real-time system that processes and provides data in a desirable format.

IBM's medical systems are designed to assist many different service areas in the hospital. These include: nursing stations, admissions, pharmacy, clinical laboratories, X-ray, dietary, electrodiagnostics, operating room, central supply, medical records, business office, etc.

Doctors' requests for patient treatment, laboratory analysis, laboratory results, and other information are entered at terminals located at nursing stations and ancillary departments or by calling a central terminal pool. This information is stored in the central file of the computer, which uses random access disk storage for rapid reporting and large capacity. The data obtained from the central processing unit provides the basis for the preparation and printout of schedules, patient data, messages, and reports. This system can be seen at Layola and Little Company of Mary Hospitals in Chicago and at Monmouth Hospital in New Jersey.

Basic terminal configuration includes combinations of 2260 CRTs and 1030/1092s. The 1092 terminal is composed of an entry keyboard and printer connected to the central processing unit via communication links. It uses plastic overlays placed over the 16 columns of keys to identify the data being entered.

Each patient can be identified by the depression of a single key in the first four columns. This key is assigned to the patient upon his admission, and the patient's name is written on the overlay by the nurse. This patient overlay remains on the keyboard for all entries. The remaining 12 columns are used for entering specific orders for requests and are identified by a larger overlay. The terminals automatically sense the specific overlay being used, thus identifying the type of entry into the system. Groups of these 12 column overlays are kept at each terminal. In addition, the CRT terminal device, the IBM 3270, may be used in combination with the above-mentioned terminals. It includes a light-pen and badge reader.

McDONNELL DOUGLAS AUTOMATION COMPANY

Functions: Clinical Laboratory, Diagnostic Support, Scheduling, Pharmacy, Radiologic Diagnosis and Therapy, Administrative Management.

The McDonnell Douglas Hospital Patient Care (HPC) System is an on-line, real-time system designed to service the ordering, results reporting, and basic scheduling needs of the hospital. Originally installed in October, 1969, the HPC System currently services three hospitals located remotely to the data center, utilizing the shared computer concept. Original application areas installed were admissions, clinical laboratory, radiology, and nursing (ordering and patient information retrieval). Since the original installations, pharmacy and laboratory instrumentation modules have been installed and are currently operational.

The system is designed for ordering to be done from the nursing station with the clerical people on the station having the primary responsibility for order entry. Should the day arrive when physician order entry is required, the network, as currently installed, will require only a change in the input device to accomplish this. Utilizing cathode ray tubes as the ancillary entry devices, results reporting from laboratory and radiology are operational. Laboratory tests being done on SMA 12/60 and 6/60 are automatically retrieved through an on-line System 7 in one of the hospitals.

Currently, all ancillary departments and admitting use CRTs for entry devices with a push button keyboard at each nursing station. Development is presently underway to incorporate advanced terminals at the nursing stations. This system can be seen at St. Francis Hospital in Peoria, Illinois.

MEDELCO

Functions: Scheduling, Clinical Laboratory, Patient Support, Pharmacy, Radiologic Diagnosis and Therapy, Administrative Management.

The Medelco Total Hospital Information System (THIS) handles patient, room, and bed information on a real-time basis in addition to message-switching and storing financial transactions; it transmits orders and requests to and from nursing stations, automatically updates changes, updates inventory records by department, prints medication requests at the pharmacy terminal in label form, and handles all radiology, special diets, housekeeping, laboratory, and outpatient requests. Terminals can also be used as time clocks to collect payroll information. Terminals, consisting of a file of edge-punched cards; an optical card reader for input of data into the system; and a teleprinter for hard-copy output are located at each nursing station and every ancillary department.

Pre-punched cards for each order, service, or product available in the hospital are in the card files as are cards for patients. Since the central processing unit is a hard-wired machine with only a small amount of computing capability,
these cards form the software. Desired cards are selected from the file to initiate a request. These cards are dropped through the card reader, and the combined data from the two cards is stored in the central processor and then transmitted to the appropriate department. The data is also printed out at the originating nursing station providing an accuracy check and a printed entry for the patient's chart. Other "stand-alone" computers such as on-line laboratory equipment, etc., can interface into the system.

The patient card is typed and punched when the patient is admitted into the hospital. This card goes with the patient to the nursing station and replaces the embossed identification plate. The order information cards are prepared by the manufacturer when the system is installed. They are kept at the nursing station in numbered pages in a visible file in open-book form. Pages are color-coded by department and alphabetized within the department. Each card is also numbered to correspond with its slot on the "page." This system can be seen at Deaconess Hospital in St. Louis, Missouri.

MEDAC*-Medical Electronic Data Acquisition and Control System designed and marketed by Metric Systems Corporation.

Functions: Patient Registration, Physician and Religion Lists, Bed Control, Housekeeping List, Census, Requisition Handling, Pricing, Timekeeping, Payment on Accounts, Current Charges, Inventory Control Information, Department Activity.

MEDAC allows for automatic input to the computer. This system is built according to the following distinct processing activities: (1) servicing of remote on-line terminals sending requisitions/messages to the system in a real-time mode; (2) communication with the central work station in a real-time mode and processing of basic system functions such as new admissions, bed status, and current charges; (3) execution of batch-mode programs such as census, daily charge activities, and department activity lists.

The system is designed in a manner that will allow expansion of the system functions without making change necessary to the basic functions. The following systems are independent subsystems, therefore, any combination of the functions may be included in the desired configuration: (1) bed control; (2) admitting and census; (3) printed requisitions delivered electronically; (4) automatic, uniform pricing; (5) computer input; (6) inventory control information; (7) timekeeping by work center; and (8) pharmacy package. This is the foundation of a modular approach.

Other features of the system are: automatic security check on all entries; instant validation of all entries; automatic message routing of all "Need-to-Know" locations; catalogues and print lab requisitions by unit and type test; automatic generation of secondary messages such as "Hold Tray"; procedure and service summaries available by department; all transactions recorded on magnetic tape; allows plastic card or keyboard input at terminals; and all messages reflect date, time, and employee identification. This system is currently operational at Central Kansas Medical Center in Great Bend, Kansas.

REACH** (VITAL)

Functions: Blood Bank, Central Supply, Clinical Laboratory, Dietary, EKG, Scheduling, Medical Records, On-line Admissions, Pharmacy, Radiology, General Business Office Functions, and Overall On-Line Data Collection, Storage and Retrieval.

The REACH System (Real Time Electronic Access Communications for Hospitals) is a clinically-oriented medical information system. The CRT display terminals and associated printers are located at the nursing stations, in ancillary departments, and in the business areas. This affords hospital personnel the capability of acquiring both fiscal and medical information on a patient.

At the same time that the doctor or nurse enters a service request for laboratory work, X-ray, etc., a charge is automatically made on the fiscal record of the patient's bill and is recorded on the patient's medical record. In addition, as a by-product of ordering through the system, inventories are updated, and volume and statistical reports are automatically maintained for each department. Laboratory tests can be both ordered and scheduled from the nursing stations in order to make optimum use of the staff and facilities. Upon discharge of the patient, the medical record is stored on magnetic tape or hard-copy, and a complete bill is created for the patient.

The CRT display terminal includes 20 select buttons adjacent to the screen to indicate selection of data and an attached keyboard. These three sections—select buttons, CRT, and keyboard—comprise the input unit. Output is created by these same three sections plus a hard-copy printer.

The system identifies the user by a machine-readable badge, the size of a credit card, which is inserted into a slot on the upper right-hand side of the terminal. Upon insertion of the coded badge, the program will make available only the information which that particular badge entitles its holder to see.

The REACH System utilizes two NDC (National Data Communications), 1695 central processing units located in the hospital. The system offers the hospital service and back-up by using one processor on-line and one off-line in a batch processing mode.

National Data Communications, Inc., offers an off-line system called Fiscal Management Information System (FMIS) at a low cost in addition to the above complete system.

There are two real-time, front-end systems. The first is the Source Data Communications & Retrieval System (SDC&LR) which can be implemented by application. An example is ADT (Admissions, Discharge, and Transfer).

* Purchased by B-D Spear on November 1, 1973.

** On October 1, 1973 Honeywell took over REACH, such that NDC's software will be licensed to the purchasing hospital.
This can front-end any present off-line the Hospital may have because all data is brought off on tape in ASCII.

At such time as the hospital wishes, it can add the Patient Medical Information System (PMIS). The REACH System can be seen at Deaconess Hospital in Evansville, Indiana.

SANDERS ASSOCIATES, INC.

*Functions:* Scheduling, Clinical Laboratory, Patient Support, Pharmacy, Radiologic Diagnosis and Therapy, Administrative Management.

Sanders Associates has developed the CLINI-CALL System, a computer-controlled, high-speed data system. It can extend to any area of the hospital-admissions, wards, surgery, pharmacy, dietary, laboratories, accounting, admissions, etc. In addition to storing, retrieving, sorting, and checking data, the system is designed to provide patient medical histories, current medical records, statistical summaries, and legal records. It will schedule medical tests, maintain inventories of beds, and maintain the current status of meal orders, accounting/billing records, etc.

All data entries and requests are made from data terminals located at strategic points throughout the hospital. The data terminal used consists of five modular units: (1) display unit, (2) data printer, (3) Photopen sensor, (4) keyboard, and (5) card reader.

The CRT unit includes an electronic Photopen device which is the size of a fountain pen. It is used as a pointer to select data and/or "action words" from the display screen. The operator at the terminal touches the indexed items he wishes to see on the base of the display screen with the Photopen unit. When the action word "execute" is activated by the pen, the index is immediately replaced with newly selected information. This information can then be studied, updated, modified, or erased by using the pen or a touch command at the terminal keyboard. The keyboard may also be used to enter new patient data and/or instructions in the central processing unit, call up selected stored records, and request special communications with other terminals in the system. The hard-copy printer produces paper records and labels on command from the central processing unit.

Personnel wishing to access the system are identified by inserting a small identification card in the card reader at the terminal. The reader determines the level of a user's authority and unlocks the system for his use. The system is also programmed to withhold specific data items from individuals who do not have specific authorization on their identification cards.

The central processor is the focal point of the CLINI-CALL System through which all data inputs, requests, and communications from the terminals must pass. System operating software is FOPS (File Oriented Programming System); it is designed by Sanders and allows for the writing of application programs in logical English Statements. This system can be seen at Kaiser San Francisco Hospital in San Francisco, California.

SEARLE MEDIDATA, INC.

*Functions:* Clinical Laboratory, Diagnostic Support, Scheduling, Patient Support, Medical Records, Multitest and Health Screening, Pharmacy, Administrative Management.

The Searle Medidata Network 320 Hospital Information System is a modularly-expandable communications and applications computer system. It is designed to route orders, collect charges and other financial information, and return results directly to a nursing station. It is expandable through additional modules to meet specific applications: Lab 320 in the clinical laboratory, Pharmacy 320 in the pharmacy, and Financial 320 for financial data processing.

The heart of the system is a unique "Touch-Terminal." The terminal presents 320 patient order choices at one time to the operator on a single overlay sheet. A few such overlay sheets can hold all the orders for a particular station. An order is entered by touching the phrase (or phrases) describing the order on the "Touch-Terminal." The computer prints the order immediately at every "need-to-know" terminal including a confirming printout at the originating station. The printer operates at 30 characters per second.

A completely backed-up computer configuration is used with two identical computer systems installed at each site. All data are retained on two separate disks and are further logged on a magnetic tape for a third level of data security.

In addition to the "Touch-Terminal," other terminals may be attached to the system. Cathode ray tubes are used to input textual and extensive numeric data in the admitting office and the financial areas. A receive-only version of the "Touch-Terminal" is available for installation in areas where it is not necessary to enter orders; maintenance, housekeeping and dietary are typical sites. A low cost "Check-In" terminal is available for locations requiring only the capability for an employee to check-in or out for time-keeping purposes.

The availability of a back-up computer makes it feasible to implement some systems without adding an additional computer. For example, the back-up computer can run Multitest 320 (Automated Multiphasic Health Testing) during the day, and a complete package of financial programs (Financial 320) can be run at night.

The Network 320 system can also be shared among several hospitals. In order to add a hospital to an existing group, terminals and a controller are added to the hospital, and a set of look-up tables are prepared to meet the hospital's specific requirements. This system is being installed at Baptist Memorial Hospital in Jacksonville, Florida.

SPECTRA MEDICAL SYSTEMS

*Functions:* Scheduling, Clinical Laboratory, Patient Support, Diagnostic Support, Medical Records, Pharmacy, Administrative Management.

The Spectra-2000 System is an on-line, real-time data
system which utilizes a dedicated computer and a large hospital patient data base. The facility is centrally located in the hospital and can be simultaneously accessed from any of the remote terminal stations in key areas of the hospital. Examples of these key areas include patient care areas, pharmacy, various laboratories, and administrative locations. Terminals located at remote stations include a multicolor video display for data entry and display, a light-pen and keyboard for data entry, and a printer for hard-copy output.

The system processes the following types of data: (1) admission information, (2) medical orders, (3) test results and narrative reports, (4) nurse-generated orders and comments, and (5) captured charges for services performed. Information is processed for patients from the time of pre-admission or admission through two days after discharge.

The information processing impacts patient care and hospital operations in the following ways: (1) medical orders are incorporated into reports on patient status showing active orders, test results, medications given, and results/reports outstanding; (2) requisitions are transmitted to the laborotary, pharmacy, diet kitchen, and other ancillary services; (3) scheduling capability is provided for medication administration and performance of laboratory tests; (4) various reports are produced to facilitate hospital operations, e.g., laboratory work sheets, specimen pick-up lists, specimen and medication labels, scheduled admissions list, beds available list, census and activity reports, etc.; and (5) control is provided for pharmacy inventory, automatic refill of medication orders, time-out of non-renewed medical orders, and clinical lab patient-specimen test result integrity.

The system may be accessed through entry of an appropriate identification code. The code is a unique six-character password, and only a valid password gains access to the system.

Entry of the physician's password causes the system to display his list of patients. The physician selects the desired patient by pointing the light-pen to the appropriate name and depressing the button on the shaft of the light-pen. Using the same technique, the physician then may review active orders or enter new medical orders for that patient by simply pointing the light-pen at key phrases and data that are assembled to create the orders. Only in exceptional situations will the physician use the keyboard. However, other users, such as the medical secretary, will use the keyboard primarily as the input device. At present, this system is being installed at Mary's Help Hospital, Daly City, California.

TECHNICON MEDICAL INFORMATION SYSTEMS CORP.

Functions: Scheduling, Clinical Laboratory, Patient Support, Medical Records, Pharmacy, Administrative Management.

Technicon (formerly Lockheed Information Systems) has developed MIS-1, a regional medical information system in which the nursing station is the center of activity. Using special I/O terminals at each nursing station, physicians and nurses initiate the data base.

Admission data are entered to MIS-1 through the Video Matrix Terminal (VMT), thus initiating the collection and processing of data. Once a patient's file is created, the data entered are available for automatic compiling and rapid retrieval by the physicians, nursing staff, and other authorized personnel.

Physicians enter orders and review the patient's chart directly through the VMT at the nursing station or by telephone to the nursing station. Orders are transmitted automatically to the appropriate departments creating a printout of requisitions and instructions in all ancillary areas. Orders are also easily recalled through the VMT for review by nurses and the physicians.

The VMT display terminal consists of three basic parts: the display screen, a light-sensing pen, and a keyboard. The user can enter, extract, or manipulate information primarily by using the light-pen and secondarily by using the keyboard.

While Technicon's business office system can function independently of MIS-1, it is designed to be an integral part of the total system. Upon entry of patient information, a computer record file is established for the purpose of accumulating billable transactions. This data is obtained directly from the original record of information by a hospital staff member.

Users can gain access to MIS-1 by entering a valid identification number through the keyboard. MIS-1 allows access to stored information only in accordance with the predetermined rules applying to each type of user.

Technicon recommends the use of a regional data processing center where several hospitals can utilize the IBM 370/145 central processing unit. The Technicon central processor stores all patient data, processes inputs, directs all VMT terminal and printer operators, and prepares reports for the various hospitals using the MIS-1 system. El Camino Hospital in Mt. View, California, has installed this system.

OTHER SYSTEMS AVAILABLE

There are many other companies either entering into or already committed to marketing hospital or medical information systems. Several companies have been marketing dedicated systems in various areas of the hospital, e.g., laboratory admitting, radiology, EKG analysis, pharmacy, etc.; and, having been successful in these specific areas, some companies are planning to integrate dedicated systems through a message-switching system, to create a unified, centralized hospital information system. Companies falling into this category include Digital Equipment Corporation, Medical Data Systems Corporation, General Electric's Medinet Systems, and Biometric Computer Service, Inc. (BCSI).

Companies involved in various phases of hospital information systems not discussed above are ITT, Medical Scientific International, Univac, Medical Information Technology
(MEDITECH), Shared Medical Systems, Medlab, Inc., Automated Systems Corp., Datacore, Inc., Medilogic Corp., National Cash Register and Standard Register. Many consulting organizations are entering into this field and will be making additional contributions in the years to come.

SUMMARY
In order to employ advanced communication's concepts in the various areas discussed in this presentation, the scope and nature of each task must be carefully defined. Choice and implementation of a computer system must be preceded by a thorough analysis of the present manual operation. The administrator and his colleagues must familiarize themselves with basic data processing principles. Without sufficient knowledge of how a computer system works, they are poorly equipped to compare available alternatives.

Other important considerations include realistic cost assessments and the quality of the hospital's in-house educational program. The dedication of the medical staff and the cooperation of the administration are essential.

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