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Rochester Institute of Technology
School of Computer Science and Technology

A Study of Rochester-Area Hospital Information Systems

by

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A thesis submitted to
The Faculty of the School of Computer Science and Technology
in partial fulfillment of the requirements for the
degree of Master of Science in Computer Science

October 24, 1984

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Acknowledgements

I would like to express my sincere appreciation to Dr. R. Niemi for his interest, assistance, and guidance throughout this thesis project. Without his help, this thesis could not have been completed. Appreciation is also extended to Mr. G. Johnson and Dr. J. Ellis for their assistance. I would like to thank Dr. P. G. Anderson for giving me an opportunity to do this project and for guiding me throughout the program.

I would like to thank these hospital personnel who spend their time answering the questionnaire:

1. D. Zimmer Systems & Programmer Manager Genesee Hospital
2. Barbara Love D.P. Manager Highland Hospital
3. R. Nabewanice D.P. Manager Park-Ridge Hospital
4. W.G. Lachenauer Director of Information System

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Table of Contents.

1.	Introduction and Background	1
1.1.	History of Hospital Information system	4
1.2.	Theoretical and Conceptual Development	11
2.	An Ideal Hospital Information System	14
3.	Analysis of Design Methods	33
4.	Comparative Study of Hospital	38
5.	Benefits and Impact of Computer System on a Hospital	71
5.1	Impact on Departments	73
5.2	Economical Impact	78
6.	Summary	85
7.	Appendix	
7.1	Genesee Hospital	90
7.2	Highland Hospital	100
7.3	Park-Ridge Hospital	111
7.4	Rochester General Hospital	118
7.5	Strong Memorial Hospital	128
8.	Glossary	138
9.	Bibliography	140

1. INTRODUCTION AND BACKGROUND:

The computerization of a hospital has been a subject of intense discussion for the past several years due to the need for cost containment and efficiency. In recent years, hospital information system has exhibited a striking parallelism to the development of computer technology. Professionals in both fields of science, medicine and computer science, have been flooded with information concerning new methods, tools, technology, drugs and research that the patient care scenario has been changing at an even faster rate. Some of these changes have been beyond human capacity. The computer, therefore, has become a vital source for reliable and rapid information retrieval. It has also become a means for diagnoses and critical care.

The application of computers in health care, as the history of medicine points out, has grown tremendously in size and scope, thus making them complex both in design and implementation. Over the years, extensive and complex information processing systems have been developed to handle the data-related activities of medical care, such as writing and transcribing orders, creating requisition, patient charts, etc. Finally, the extraordinary computing power that the modern day computer holds, has now made possible the solutions to complex problems that were not even recognized in the 1950s.

The patient care within a hospital is a highly interactive process in which various health professionals contribute to the patient's care in a coordinated and time dependent manner. To coordinate the care, these professionals are required to transmit and receive a large volume of patient data. Because of the volume, size and nature of these data, the need for computers and data automation is very strong in hospitals. Furthermore, the computer system can provide an interactive communication link between all these professionals in a manner that would ensure speed, quality, accuracy and efficiency of patient care. Reliable information within a hospital depends on the soundness of the database of the patient information. Most of the medical information required to build this database is derived from the patients' records of illness, diagnostic investigations, treatments and results. This information is summarized and analyzed by computer application programs ranging from patient accounting systems to automated systems which retrieve and process data concerning the health of an individual patient.

In summary, the objectives of a computerized hospital system are:

- (1) communication among the departments.

- (2) To transmit individual patient data from doctors, nurses, pharmacists and lab technicians providing medical care, directly into patient's record, and from there to others who needs to act upon it.
- (3) To communicate patient data from laboratories, intensive care units, nursing charts, etc., into patients' medical records.
- (4) To establish admission, operating room schedules and booking files, and communicate such information to patient administrative and medical care services.
- (5) To communicate between clinical services such as medical, surgical, etc and ancillary services such as laboratory, ECG, pharmacy, etc.
- (6) To establish a sound database for administrative as well as health research functions.
- (7) To provide data necessary for projection of health needs and planing.
- (8) To communicate with insurance companies and statistical gathering agencies.
- (9) To provide the computing power necessary for research activity. (3).

1.1 HISTORY OF HOSPITAL INFORMATION SYSTEMS:

In the past, the development of information systems in hospitals has been a bit slower than in other industries. Computers were first used in hospitals as a part of administrative functions, in particular, financial applications. Later they moved into the area of clinical applications (18). This mode of operation facilitated record keeping and accounts receivables which insured the institution's survival. These systems were easy to install since the financial systems of hospitals are similar to that of other industries.

The decade of the 1960s saw a rapid development of the electronic computer as an aid to the information processing throughout the world. Consequently, hospitals increased the use of computer systems. During this period, batch processing was the hallmark of these systems. In this batch process, the data transactions for a given time period (i.e. one day or one week or one month) were collected at a central point, and appropriate coding was done on data forms. The coded data were keypunched and processed in a group or a batch (18).

The development of time-sharing systems in late 1960s and early 1970s allowed hospitals to pay for the the computer services for the time it shared or used the computer

system. (7). Hospitals used time-sharing services because of the following advantages:

- (1) Data processing was a new technology, particularly for hospitals. Buying an expensive computer system involved an element of risk. Reducing the risk was an advantage with shared system.
- (2) Sharing a computer system reduced cost because the user paid only for the time of system he used rather than for a complete computer system.
- (3) Computer equipment requires facilities such as air conditioners, humidifiers, independent power lines and backup power supply. These are not required in a shared system. Therefore, a shared system is more cost effective.
- (4) By sharing the computer system a hospital would save in personnel needed for running and maintaining the system and system development and equipment costs (8).

However, there were disadvantages in a shared system. Hospitals did not have control over the system. They could not get the reports when needed. In due course time, many hospitals believed that these drawbacks were enough to justify a stand-alone system

In late 1970s several computer manufactures were developing stand-alone mini-computer systems. A stand-alone computer system is limited in objective and scope. It addresses a single application area and it is dedicated to that application only. Hospitals installed stand-alone systems in the clinical laboratories, and in the business offices to do specific jobs. These systems were run for the benefit of the function providing the service rather than for the best interest of the organization as a whole. Soon it became apparent that there existed a need to tie in together these systems. These pioneer systems, therefore, paved the way for the development of integrated information systems, i.e. communication network among stand-alone system (6). This period also witnessed considerable drop in hardware costs, making computers more affordable for larger and complex tasks, and for handling of masses of information. A recent research study published by Electronic Computing Health Oriented (ECHO) organization stated:

"Predictions for improvements of 25% to 50% per year in cost performance, indicate that information technology will be so inexpensive that health care institutions will find a key means for survival in information technology innovation. Without such innovation in fact, costs for health industry are designed to continue their impossible spiral". (8).

The following table (1.1) shows the impact of technological advances on computer costs.

year	Instruction per Second	Computer Cost	Cost per Instruction per Second
1955	1,400	\$200,000	\$142.86
1960	3,000	\$125,000	\$41.67
1965	35,000	\$1.2 million	\$34.29
1972	300,000	\$1 million	\$3.33
1976	400,000	\$500,000	\$1.25
1978	5 million	\$3 million	\$0.60
1981	14 million	\$4 million	\$0.30

Speed and costs of representative computers from 1955 to 81 (The effects of inflation have not been factored into the cost figures. These effects make the real cost drop more dramatically) (19).

Another major revolution during late 1970s was in the hardware development which introduced directly accessible secondary storage in the form of disks in place of sequential tapes. These developments have encouraged the hospitals to install computer systems that can better deal with an enormous amount of data. This was followed by advances in the development of mini-computers. These mini computers were installed in various functional areas of a hospital to meet an organization's information processing requirements. These systems gradually crossed the departmental and specialty

boundaries. Their base was institutionally and administratively oriented, and had a superimposed communication network among them. On-line terminals were placed for order entry, for communications of orders and for charge capture. In addition to this, the system maintained some archival structure for retaining the patient medical records, results of tests, and progress notes as well as patient's demographic data for the duration of patient's stay in the hospital. The system also maintained databases for ancillary functions which were used to generate medical schedules, nursing care plans, and cumulative laboratory test results. The system also provided information about the patient, such as, all the active orders, medication profiles, uncompleted laboratory tests, etc (9).

The following table 1.2 shows the time period and over view of development of hospital information system.(18).

Time Period			
	1950-59	1960-69	1970-later.
Data Processing Equipment	Primarily manual system for information handling some mechanical aids such as bookkeeping machines and punch card equipment.	Initial use of of computers batch processing.	Increased computer on-line processing development of mini computers.
System Design Approaches	Individual departmental systems no integration of system.	Mostly batch processing focus on administrative Time-sharing approach attempts to tie related systems together.	Shift to on-line applications interested in fully integrated systems.
Focus of hospital administration	Insuring that individual departmental information needs were met.	Interest in computer systems to support operating departments of the hospital.	More attention to system plan and use of information for management control and medical quality assurance.

Hospital Information System an Overview (1.2).

Concurrently, major advances were made in operating programs that monitored the hardware, such as firmware programs embedded on a chip (microprogramming). This new technology not only enhanced the speed of computer but also made flexible the changes in architecture with insignificant cost encurrence. With the advent of more powerful computers, software designers developed the concept of integrated systems to manage the totality of an institution. All data were centralized in a single, comprehensive data base which was kept on-line, readily accessible to all users when needed. Data was entered only once in the database (19).

With the use of microprocessors, today's micro-computer has the reliability and sophistication of some of the very large machines of the recent past. This trend in all probability is likely to continue in the future. The EDP Analyzer in an article on effect of the new technology published in Sept. 1979, pointed out the following:

" The micros, with their associated hardware/software are making computer technology affordable by even very small organizations (say about 10 employees). Already they perform at about the same pace as the upper end of the mini-computers and soon they will be at the middle to upper range of today's main CPU's." (8).

One of the future areas of hope for the hospitals and physicians is the development of voice recognition computer program for data input. The computers having these features, have not reached the production stage yet, but they look promising and should have an obvious impact on data gathering techniques.

From broader perspective, as one projects where the computer technology is going, one may agree with Dr. Donald A. Lindberg:

" As to future of medical information system development, it will be strongly influenced by certain internal technical changes as well as by new concepts. The strongest internal effect will be micro processor, optical disk memories, artificial intelligence techniques and computer communication technology. The first three will generally have centrifugal effect, supporting even further decentralization of health care system. Communication technology could also potentially support direct computer access in remote areas but will more likely serve to centralize control over health care because of its potentiation of central file structure."(8).

1.2 Theoretical and Conceptual Development:

The concept that can strictly be called 'computer medicine' began in the immediate post-World-War-II years.

Lipkin utilized Marginal Punched cards for analysis of blood diseases (7). It was the research of Robert Steven Ledley and Lee B. Lusted that established the groundwork for a rational basis for computerized medicine. Their research brought forth two monographs, 1. "Use of computers in Biology and Medicine (1965)", by Ledley 2. " introduction to Medical Decision making(1968)" ,by Lusted. Ledley's practical experience in the then-existing generation of computers, provided mathematical background for data processing techniques. His writings on medical diagnosis and medical record processing as well as observations on special biomedical data processing methods, laid the groundwork for automated pattern recognition, which created an avalanche in all branches of medicine. Lusted in his writings explored the practical need of scientists to employ computers in diagnostic calculations. He provided new insights into the methods of computer medicine and particularly revealed to physicians how computers could serve them in many ways (7).

Since 1951, Morris F. Collen has carried out investigations of the Multiphasic Screening Program at the Kaiser Research Foundation Institute in Oakland, California. Since 1963 he has examined patients with modern electronic and automated laboratory equipment. This included 20 stations and facilities to record all the data on special punch cards. He was able to provide firm evidence with his metho-

dology and from his experience with computers that there was:

- (1) Saving of patient's time through the continuous series of investigations.
- (2) Saving of physician's time by providing numerous findings at the initial visit.
- (3) Improved reliability of diagnosis based on use of automatic laboratory investigations.
- (4) Considerable cost reduction due to the possibility that he could obtain four times as many observations at a faster rate and for the same cost.
- (5) Far-reaching understanding of many disease possibilities in a short time, which facilitates new diagnoses in shorter time at lower cost.(7).

The advent of automation and computers led to numerous other investigations and utilization of electronic data processing systems in other medical areas, for example EKG recording of heart beat data, automated evaluation of X-Ray, photography, etc [7].

2. An Ideal Hospital Information System:

A model hospital information system (HIS) is a computer based communication system capable of providing requisite data for every major medical and administrative services in the hospital. It must be able to gather, store and retrieve data pertinent to that service, and display data gathered at other services. It should interface with the hospital staff through the use of terminals located at various strategic places. As a result, administrative and medical personnel will have instantaneous access to the patient data. Its basic objective is to provide better patient care and more efficient hospital operation through an improved communication system. It substitutes manual data processing, thus gaining advantage in terms of speed, accuracy, legibility, completeness and consistency of data.(11,12).

The HIS which is documented in the thesis is hospital-wide system for patient care that uses a computer system to store data and to send it automatically or on request, to the personnel who needs to act upon this data.

This is the description of a model hospital information System.

2.1 ADMISSIONS:

The admission department is the first stop for any patient coming to a hospital. In this department, the critical and essential identification procedures required for patient services are carried out. The admission process is the one which compels the timely coordination of a number of hospital departments that handle the patients as they arrive. There are two kinds of admissions:

A. In-patient

B. Out-patient.

A. In-patient admission:

1. Pre-admissions:

Pre-admissions consist of a patient whose condition has a sufficiently long and predictable course that a time can be set for admission at the convenience of the doctor and patient.

For pre-admissions, a pre-admission record is created in the computer system prior to the admission by gathering information from the patient. The admission clerk enters this information into the computer system through a terminal. This patient data can be used by a physician as a basis for writing medical orders to be accomplished either before or at the of time admission.

When the patient is admitted, the pre-admission record is updated and the computer system automatically sends

printed admission notices to various departments as designated by hospital policy. This patient data is available for retrieval by any authorized personnel.

2. Emergency:

This kind of admission is unplanned nature and occurs because of an accident or natural disaster or a sudden onset of an illness. The patient may be treated as an in-patient or as an out-patient. When the emergency patient is admitted, an admission record is created which will contain some key information. In fact the documentation or medical record may follow the patient to the ward rather than accompany him. Medical orders for laboratory tests, X-rays, medications etc are recorded into the system which automatically codes all emergency room orders for stat processing. Stat processing is a type for a patient who needs immediate attention. Emergency room test results are entered through the terminals by the concerned departments and are printed in the emergency room.

3. The third type refers to an illness of sufficient severity to require immediate treatment but is not of emergency nature. These patients are usually referrals from a staff physician who has found serious problems in the course of an office visit that require hospitalization for proper diagnosis and treatment.

An admitting clerk uses a computer terminal to enter patient data, to generate or review patient admission record, to assign room or bed. Patient data is directly typed in to the computer.

B. Out-patient:

There are two kinds of outpatients.

1. One-time.
2. Recurring.

When patient is expected to have only one visit such as X-rays or laboratory test, a record is retained in the system for a limited time as per hospital policy. On the other hand, some patients are likely to have repeated visits. This type of record is maintained as long as the patient continue to visit. This eliminates registering the patient for each visit.

An out-patient record is created in the same manner as in-patient by out-patient department. The computer prints the requisitions for laboratory tests, X-rays etc at appropriate departments. Test results are entered into the system and printed at appropriate out-patient departments. The system will maintain for retrieval all patient data regardless of the time lapse since the patient's last visit. A typical admission record will have the following information:

Admission Record

-----		-----	
Date_____	Time_____	Type of patient I/O(in/out patient)	
Admitted by_____		Patient No._____	
Name_____		Date of Birth_____	
Age_____		Add_____	
City_____		Sex_____	
Phone_____		Marital Status_____	
		Religion_____	
Near Relative_____			
Name_____			
Address_____			
City_____			
Phone NO_____			
Room or floor no_____		Bed No_____	
Medical History_____			
Attending Physician_____			
Guarantor or Insurance_____			
Address_____			
City_____			
Phone NO_____			
Employed by_____			
Phone No_____			
Insurance No_____			

The following functions are part of admission department. The impact of computer system is as follows:

2.1.2 CASE NUMBER or PATIENT NUMBER ASSIGNMENT:

Computer can automatically assign a case number to in-patients or to out-patients with separate patient number as these numbers are maintained in the system for each category or an admitting clerk can assign the case number to the patient. The system will accept any type of alphanumeric number assigned by hospital.

2.1.3 BED NUMBER:

The admission department assigns the bed number to an in-patient. The computer system periodically prints the bed status report which shows all available beds. An admitting clerk can retrieve an updated list of available beds in the hospital. However, a separate department may also keep track of all information concerning rooms or beds in the hospital.

2.1.4 TRANSFER:

When patient is transferred from one room or from one bed to another, this information is entered into the system. The computer system automatically notifies the affected departments as per hospital policy. (usually laboratory, physician, dietary, X-ray etc)

2.1.5 DISCHARGE/EXPIRATION PROCESSING:

As physician writes a discharge authorization or an expiration statement, the nurse uses the physician's information and records the discharge time and notes, or expiration notes. The computer stores this information and notifies all affected hospital departments. Upon receipt of discharged or expiration date of a patient, the computer system takes the following actions:

- (1) Prints daily summaries for the patient;

- (2) Preparation of a completed test results summary for the hospital stay as well as tests that are to be performed,.
- (3) Preparation of a medical records abstract;
- (4) Preparation of the patient's bill or account closing;
- (5) Movement of patient data from active file to inactive storage file which is under the control of medical records department.

2.2 INFORMATION DESK:

The information desk clerk can use computer system only to retrieve patient condition and his location (bed or room or floor) information. These clerks can not update the patient data.

2.3 MEDICAL STAFF:

Computers can help medical staff(physicians) in many ways. However, major areas of physician/computer interface are:

2.3.1 PATIENT LIST:

Physician can retrieve his patient list by requesting the system. This patient list shows patient's name, case number, and bed location. In addition, the physician can

obtain the patient list of another physician whose patients he is attending.

2.3.2 PATIENT DATA RETRIEVAL:

Physicians can retrieve patient data at any terminal in the hospital. Physician can retrieve information about patient's data:

- (1) Admission data.
- (2) Laboratory test results.
- (3) X-ray reports.
- (4) Medication given.
- (5) Current orders.
- (6) All orders since admission.
- (7) Nursing notes.
- (8) Diagnoses
- (9) Allergies.
- (10) Diet.

This information shows all the data that has been entered from any point in the hospital up to the moment of retrieval request.

2.3.3 MEDICAL INFORMATION RETRIEVAL:

The computer system should have generalized storage and retrieval capability which can be used for wide variety of medical data. It should have abstracts of current articles from journals, antibiotic sensitivities and drug information, laboratory test results interpretation aids, and other subjects of interest to physicians.

2.3.4 MEDICAL ORDER WRITING:

The computer system automatically prints the physicians orders in the designated departments without need for manual transcriptions on requisition forms. This ensures that the orders go to the proper departments. As these order forms include the name of physician and his status which does not require his signature.

2.3.5 COMPUTER PRINTOUT DOCUMENTS:

The medical staff uses a variety of computer-produced printouts in analyzing and documenting the patient's status and care. The computer can produce patient data summaries showing new orders, x-ray reports, and nursing data. In addition, all STAT work is printed immediately after it is entered into the computer. The computer system also produces seven-day cumulative reports each day for test results, medications, etc which enable the physicians to spot trends

quickly.

2.4 NURSING STATION:

Nursing personnel use computer system extensively by using the terminal located at each nursing station. A unit clerk usually will do the data entry functions as they receive the data from the nurses.

The nursing functions impacted by the computer system are as follows:

- (1) Patient-care planning.
- (2) Medication, administration and reporting.
- (3) Requisitioning tests and supplies, including medicine.
- (4) Reporting of nursing data(chart).
- (5) Verbal and telephone orders.

2.4.1 PATIENT CARE PLANNING:

On daily or shift basis, computer prints the care plan for each patient. The care plan shows all current medical orders, nursing instructions, and general patient information that have been entered into the computers at various times by various personnel. The printout should include the following information:

- (1) Basic patient data (name, age, sex, attending physician, etc).
- (2) Diagnoses and surgical procedures.
- (3) Vital sign orders.
- (4) Diet and fluid balance orders and instructions.
- (5) Medication orders.
- (6) Other orders such as laboratory tests, x-rays, etc.

2.4.2 MEDICATION, ADMINISTRATION AND REPORTING:

The computer prints a list of medication to be given for each nursing station. After medications are given, they are reported at the terminal by selecting "given" or "not given" in conjunction with the each order. When a medication is reported as "not given" the system will display a list of reasons why the medication is not given, from which the nurse selects the proper choice or a nurse can enter the reason for not giving the medication. If a particular medication is not reported, a remainder notice is printed. Medication reporting generates both daily and weekly reports.

2.4.3 REQUISITION TESTS, SUPPLIES, and MEDICATION:

All medical orders entered into the terminal by physicians or by nurses are automatically transmitted to the

proper departments. Therefore, nursing personnel do not have to transcribe orders onto either requisition forms or charge slips. Both the initial and follow-on supplies of medications are sent to the nursing station by pharmacy, based on computer-produced printouts in the pharmacy. When central service supplies are required, the nurse uses the system to request the desired items which are printed in the central service department.

2.4.4 REPORTING OF NURSING DATA:

There are two modes of entering nursing data. The first, functional reporting permits the nurse to enter routine vital signs or scheduled medications for all patients on the unit instead of calling each patient's record one at a time. The Second method, individual reporting, involves calling up a particular patient's record and entering one or series of data items for that patient. All nursing data entered into the system are printed on periodic patient data summaries.

2.4.5 VERBAL AND TELEPHONE ORDERS:

When nurses enter the medical orders that they have received verbally or by telephone these orders are printed by computer, showing both nurse's and physician's names.

2.5 LABORATORY SYSTEMS:

Laboratory information system constitutes one of the more common clinical computer applications in the hospitals. There are two phases to clinical laboratory systems.

1. Automation of the test.
2. Processing of laboratory data.

Automation of test processing involves linking of the laboratory instruments directly to the computer where as a laboratory data processing would include recording of test requisitions, scheduling of tests, preparing test reports, periodically test summary reports for a given patient, and statistical reports for administrative purposes. A complete computerized laboratory will include both automation and data processing.

2.5.1 ORDERING OF TESTS AND GENERATION OF REQUISITIONS AND WORKSHEETS:

The orders for laboratory tests to be performed in the hospital laboratories, and any other tests which can not be performed in the hospital, are given by the physicians. The laboratory personnel will tell the computer whether to batch the specimen for collection and whether the test will be run on an individual or batch basis or the system can decide itself. The batch coding permits the laboratory to control the flow of work, including both specimen pickup and

performance of tests. Nonbatched work flows into the laboratory immediately when it is ordered and is printed. Batched work flows in either at specified times or when requested by the laboratory. Stat tests receive special computer processing. They are clearly marked by the computer, and a light or bell is activated in the laboratory when Stat requisition prints. Tests ordered for future dates are held in the computer and released to the laboratory on the correct date.

2.5.2 SPECIMEN COLLECTION:

Specimen collection documents can be printed on any desired schedule or on demand. The computer prints the specimen pickup lists in bed number sequence, showing patient names, case number, test to be performed, type of specimen, and volume of blood required. For Stat tests and specimen to be collected at a specific time, the computer prints individual specimen sheets.

2.5.3 RECORDING AND ROUTING OF TEST RESULTS:

Laboratory test results are entered into the system by lab technicians while high volume test results are entered by linking automated laboratory instruments to the computer. When results are entered, they are available for retrieval to any authorized person at any terminal. The results are printed at the nursing station for insertion into the patient's chart. After the patient is discharged, a total

laboratory results report is printed in one document for insertion in the patient's medical record.

2.5.4 BILLING FOR LABORATORY WORK:

The charge for each laboratory test is stored in the system which is then added to the patient charges.

2.6 OPERATING ROOM:

Computer system will keep the patient list on whom operation is to be performed. The computer system will print a list of patient names who are having operation on specific day or date on demand or on a schedule time. The print out will have necessary instructions to patient, operating staff and will show what type of operation the patient will have.

2.7 PHARMACY:

Pharmacy systems integrated into a larger hospital information system will typically involve the entering the medication orders on the terminals at nursing stations. These orders are automatically routed to the pharmacy where worksheets are generated or prescription record is generated and labels are printed. These labels show patient name, bed location, attending physician and medical allergies. The system will automatically update the drug inventory as well as generate the patient charges for the medication which is being maintained by the hospital in the system. stat orders

are specially marked.

2.8 RADIOLOGY:

The installation of computer system significantly changes the data processing functions in Radiology department. Computerized treatment planning permits the preparation and evaluation of individual patient treatment plans, a complex mathematical problem whose solution was not feasible on an individual basis before the availability of computers.

A physician writes a request form to perform a particular diagnostic procedure which contains the standard terminology for all radiological procedures performed at the hospital for a particular patient. This information is printed in the department. After the tests the radiologist interprets the x-ray results and prepares a report summarizing his findings. This information is available to any authorized person and report is printed in at the nursing station. A complete summary of all radiology report is printed as a consolidated tests results summary after the patient is discharged. When the reports are entered, a procedure number is also entered which is being used by the system to look up for the charge and to post it to the patient's billing files.

2.9 DIETARY:

Dietary orders and special instructions are entered into the system by both physicians and nurses. Prior to each meal, the computer prints an up-to-minute diet orders listing in the dietary office. The printout shows the patient's name, bed number, current diet orders and any instructions.

2.10 MEDICAL RECORDS:

The medical record is central to all patient care activities in the hospital. This is the permanent documentation of the history and progress of a patient's illness or injury. It should be a complete and comprehensive compilation of observations, nursing notes, x-ray and lab results and findings from the time the patient is admitted until he is discharged. After the discharge of a patient, it becomes an archival record available for retrieval if patient is readmitted or requires further treatment as an outpatient. This medical record serves as a data base for research study.

After patient is discharged a complete listing of all the laboratory tests, radiology and other tests as well as nursing notes is printed at the records office. This also contains demographic information, a short medical history along with critical medical information such as drug sensitivities and allergies.

2.11 CENTRAL SERVICE:

Central service receives the requisition from the other departments. They place their orders by terminal indicating the patient for whom the item is needed. Billing for central service items is automatically and accurately processed by the computer system.

2.12 BUSINESS OFFICE:

The business office is integrated into the computer system. Each transaction in the hospital generates an appropriate charge, based on charge tables stored in the computer system. The computer system automatically produces the patient's bill, incorporating insurance prorations.

In addition to preparing patient bills and accounts receivable documents, the business office computer system will also have a full range of other financial and administration needs which are as follows:

- (1) Accounts payable.
- (2) General ledger.
- (3) Budgetary control.
- (4) Inventory control.

- (5) Employee payroll.
- (6) Labor distribution.
- (7) Workload statistics.

3. Analysis of Design methods:

Formulation of methods for software design have begun to take shape in the last decade. Several authors have proposed approaches and guide lines for software design that differ a great deal from each other.(14). Each author proposed a single approach to handle a specific software design problem rather than a standard approach for all. These authors have failed to distinguish the uniqueness in their approaches from others, established validity of their assumptions, and identify the areas where their approach will be ideal.(14). It is conceivable that these divers approaches resulted from the complexity that is inherent in software design, and lack of established theories for design approach. In a nutshell, these publications failed to produce a standard approach. However, they can be broadly divided into three categories, viz:

A. Data Structure-Oriented Methods.

B. Prescriptive Methods.

C. Data flow-Oriented methods. (14).

A data structure-oriented method ensures that for a given set of information there is only one best method of structuring the data, and therefore, the ultimate design of system would be the same irrespective of who designs it. It attempts to avoid reliance on one's experience, whims and fancies. This approach is based on identifying the data that

flows through the system and organizing their elements in accordance with their hierarchical relationships. Based on these relationship, the software designer produces a program by following a translation procedure.(14).

A prescriptive method dictates the procedures to be followed by a software designer for successful implementation. It does not possess an underlying rationale. It is primarily intended for the use by a limited community but offers opportunities as the system matures for expansion in the areas of application and number of users. It calls for intensive study and research prior to its adoption.(14).

Data flow-oriented methods, are the most widely used concept for software development in industries. It uses data flows as guides in the design approach. It is well suited for automating an existing manual system. The designer builds a model of the existing system in terms of data-flows and then identifies the areas for software application based upon economics.(14).

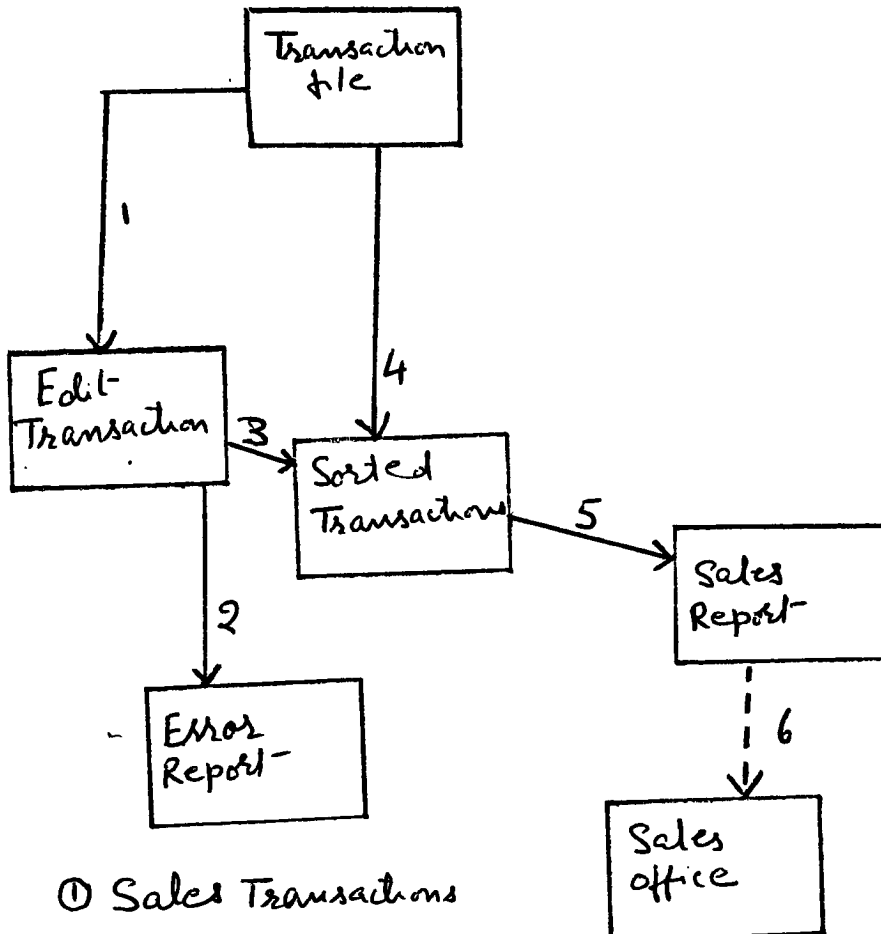
The drawbacks in this approach are that the software designer might merely automate the manual system without any consideration for further improvements that its application to a new system is unclear as there exist no data flows to guide the design. Further more, economic justification in a new system is difficult to back up with no bench marks for

comparison.

Systematic Activity Modeling Method (SAMM) was originated by Boeing Company and developed by Boeing Computer Services Company. SAMM is based upon the depiction of activities and data flows as primary means of understanding system design. The key element of a SAMM representation is the activity cell. This activity cell may contain several processes or may itself be a single process. The basis of an activity cell is a set of activities which function together. Several activity cells related by data flows together form an activity model. Individual activity cells can be expanded into other subordinate activity models, thus forming a hierarchy of activities and data flows. To complete the representation of data flow between the cells, each data item is given a reference number. (14,20).

The following figure shows the application of SAMM to a simple problem and shows how a table and other supportive notation enhance its use. The rectangular box indicates an activity cell where some processing will take place and from here it will be transmitted to another cell. The solid line represents the data flow is directly via computer system where as broken lines indicate that data is transmitted manually. The numbers are used to define the type and destination of data flow explicitly.

In the following example the sort transaction has direct input from edited transactions and sort keys from transaction file. It produces the sales report. This printed sales report is being sent to the sales offices manually.



- ① Sales Transactions
- ② Error Report
- ③ Valid Transactions
- ④ Sort keys
- ⑤ Sales Report
- ⑥ Printed Report
Sent Manually to
Sales office.

An attempt in the thesis will be made to analyze the Rochester-Area Hospital Information System from the perspective of Data Flow-Oriented Method, specifically SAMM(Systematic Activity Modeling Method). SAMM is an ideal for hospital information systems due to its inherent concept that distinct human-directed activities are interlated by means of data flows. SAMM is simple and can be easily understood by people with or without software design background.

The questionnaire is designed in a such a way to gather the information about the patient as they enter into the hospital until they are discharged from the hospital. How the patient data is transmitted within the hospital whether this patient data is transmitted via computer system or manually from department to department. The gathered information is shown in chart form as well as SAMM data flow diagrams for comparative study between the hospitals with that of model hospital information system, giving narrative explanation about each departments involved in the patient care.

4. Comparative Study of Hospitals:

4.1 General History and level of computerization within the hospitals surveyed:

The information presented within this section was obtained through written questionnaires completed by the information systems managers of each hospital. The distribution of the questionnaire was both preceded and followed by personal interviews with these managers. At the initial interview the purpose of the questionnaire was explained and at the second interview questionnaire responses were reviewed. The questionnaire and the answers are given in the appendix. This was done in the month of May of 1984.

Genesee Hospital appears to be the first of the Rochester area hospitals to introduce the computer as a means of information management. In 1968 Genesee hospital installed a computer system for its laboratory and in 1973 computers were used in billing as a part of a shared system with Rochester General and Highland Hospital managed by MEDICUS systems. Rochester General Hospital initiated the computer system in 1970, Park Ridge Hospital introduced the computer system in 1979, and Strong Hospital utilized the computer system in 1979. Highland Hospital began using computer system in the year 1969.

The location of printers in a hospital plays an important role like CRTs. If printers are centrally located there is delay in getting the reports or test results. The cost of printers is decreasing as the computer technology is growing. With the installation of printers at each department there is less chance of losing paper work and hospital staff need not wait for information which must move from department to department.

The hospitals varied widely in the location of printers. Genesee Hospitals has placed printers in centrally located areas for high volume printing and business office areas for specialized functions, thus attempting to best utilize the limited number of printers available. Rochester General Hospital has a total of 16 printers located in admissions, laboratory, Emergency, CCU, MICU, SICU, and in the data processing department. Strong Hospital has printers in all departments with CRTs. Park-Ridge and Highland Hospitals have printers located only in the data processing department.

Only Rochester General and Strong Hospitals have printers in all departments whereas Genesee Hospital has placed its printers in centrally located areas and in business offices. For high volume printing fast printers are located in the data processing department in these hospitals. Park-Ridge and Highland Hospitals have printers in the

data processing department and in the admissions department.

The location of CRTs is vital to a hospital's information processing function. CRTs should be located within close proximity of the staff generating data. The convenient location of CRTs is an important factor in reducing the duplication of data and promoting efficiency by eliminating the handwritten forms and manual information flow from department to department. CRTs which are readily accessible are vital to the utilization of a hospital's computer system. Genesee Hospital has the largest number of CRTs (90) located in Laboratory, Radiology, Business office, Finance, some Nursing stations and in the Emergency departments. Rochester General Hospital has 55 CRTs which are well distributed throughout the hospital covering most of the hospital. Strong Hospital has CRTs located in clinical areas and major hospital administrative offices. Park-Ridge Hospital has CRTs located in admissions, billing, medical records, payroll, inventory, accounting and in the data processing department. Highland Hospital has 14 CRTs located in admissions, personnel, business offices and with the cashiers.

On the basis of this general data, one can conclude that Rochester General, Genesee Hospital and Strong Hospital have well distributed CRTs for effective utilization of the computer system for information communication between the

departments. Park-Ridge and Highland Hospitals have a limited number of CRTs for patient information flow. Although the systems have the capability of networking communications, totally integrated communication between the departments has not yet been accomplished. The communication between the departments is handled manually using data from computer printed reports. In Genesee, Rochester General and Strong hospitals all emergency or STAT orders are communicated via the computer system. Reports are printed directly at the emergency room.

The tables which follow will show the degree of computerized communication within both the hospitals surveyed and the model hospital. These tables and SAMM diagrams will indicate whether the patient data flow between the departments is manual or computerized.

Key to responses on charts:

Yes = Communication is via computer system.

No = Communication is not via computer system.

Solid Line = Direct communication via computer system.

Dotted Lines = Communication is not via computer system(Manually).

4.2 Admissions:

In the model hospital information system, the pre-admission record is updated by the admitting clerk at the time of admission and this record is printed automatically in the departments as designated by hospital policy. Among the hospitals surveyed, only the Strong hospital has computerized this admission notification to billing and medical records offices. The model system permits physicians to access the pre-admission records for laboratory , X-ray and medication requests through the terminals located in their offices. Only Rochester General and Highland Hospitals provide physicians with access to pre-admission records.

In the model system bed numbers are assigned by an admitting clerk showing all available beds. Strong hospital is the only one which approaches the model system in the bed number assignment function. The system furnishes a list of unoccupied beds and the admission clerk selects one. In the other hospitals this function is completely manual. Only Strong and Genesee Hospitals are the only institutions in which patient number is assigned by computer system automatically.

Upon the discharge or expiration of a patient, the model hospital system automatically prepares a medical record abstract, an itemized bill, and a completed test

results summary and moves patient data from an active file to an inactive file which is under the control of the medical records department.

Strong, Genesee and Rochester General Hospitals all retain some patient information forever. Genesee Hospital retains demographic data and medical record information but purges other records after the billing is completed. Strong Hospital retains all patient data for 14 days past patient discharge and information which does not change is stored forever. Rochester General Hospital retains the medical record abstract for 18 months and saves all patient history on tapes permanently. Park-Ridge Hospital retains patient information for two years, while Highland Hospital purges this information when billing is completed.

The discharge or expiration function seems to be most thoroughly performed at Genesee Hospital where the computer system prepares various billing documents, insurance information, medical abstract information, patient history archive data and regulatory agency data. At Rochester General Hospital, the computer prepares bills, medical record abstract and summary statistics. At Strong Hospital the system prepares only billing and medical records information. At Highland Hospital the system prepares only medical record information while at Park-Ridge Hospital the computer system prepares a medical abstract and a total itemized bill.

Unlike the model system, none of the area hospitals print the admissions record directly at other departments. However at Strong Hospital the admission record is printed directly at the billing and medical records office from where it is sent to the nursing station. In other hospitals printed admission record is sent to physicians, billing and nursing station. Only at Rochester General and Highland Hospitals the physician can access the pre-admission patient record to request laboratory and any other requests.

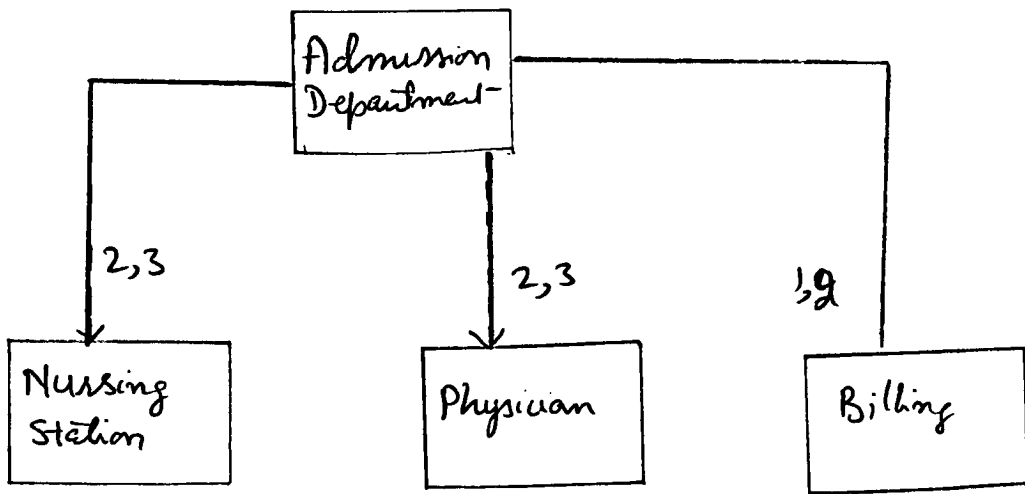
The following comparative table (4.1) and SAMM data flow diagrams will show the communication between admissions and other departments.

Comparative table for Admissions.

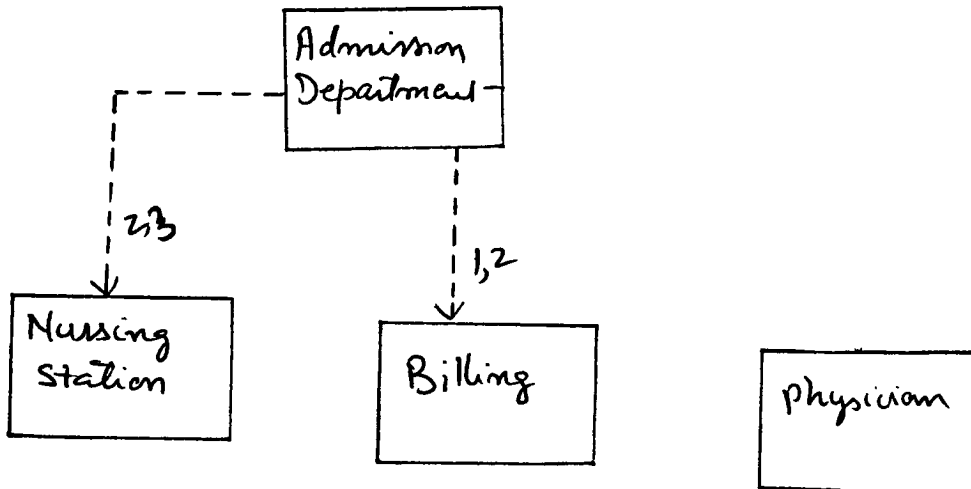
Name of Hospital	Nursing station	Physician	Billing
Model hospital	Yes	Yes	Yes
Genesee Hospital	No	No	No
Highland Hospital	No	No	No
Park-Ridge Hospital	No	No	No
Rochester General	No	No	No
Strong Hospital	No	No	Yes

Table 4.1

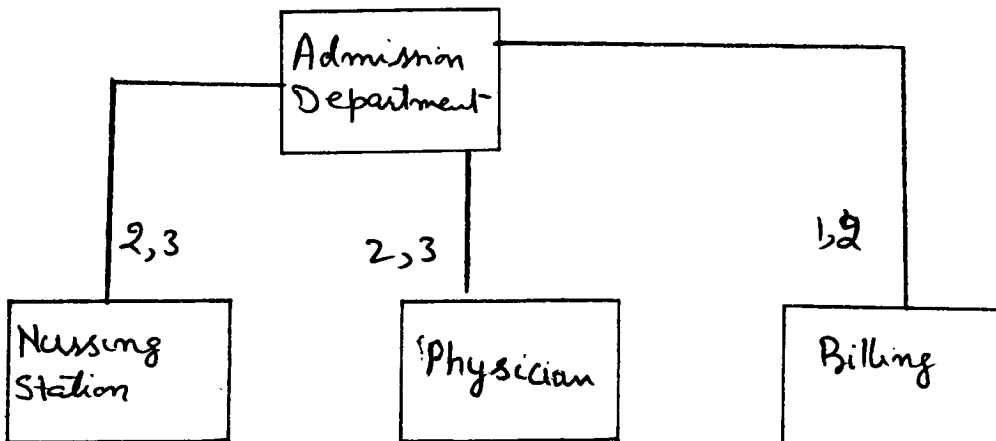
MODEL SYSTEM



GENESEE HOSPITAL

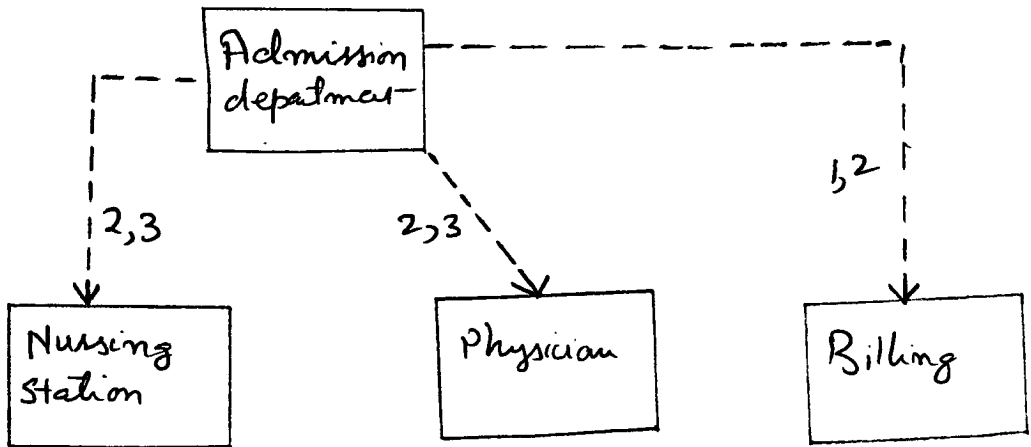


HIGHLAND HOSPITAL

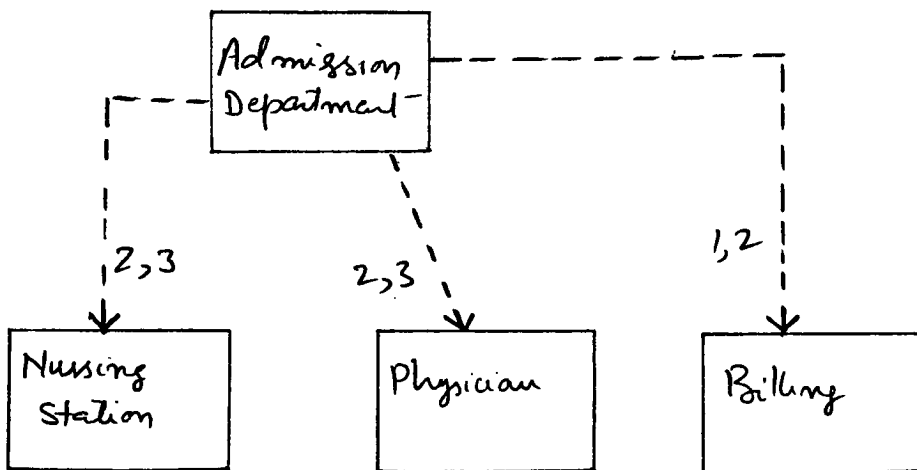


- ① Demographic data
Insurance Information ③ Medical History
- ② Patient Name
ID#, Bed#, Floor#

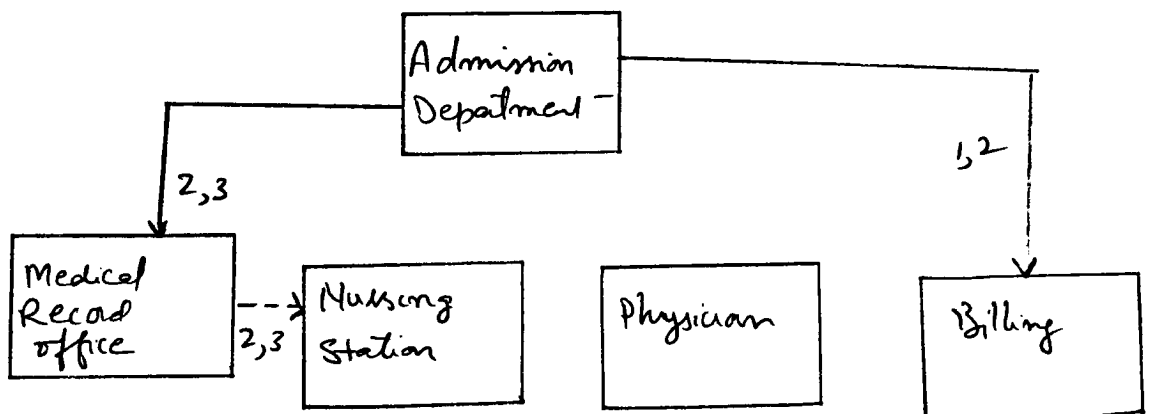
PARK-RIDGE HOSPITAL



ROCHESTER GENERAL HOSPITAL



STRONG HOSPITAL



- ① Demographic data, Insurance information
- ② Patient Name, ID#, Bed#, Floor#
- ③ Medical History

From above SAMM data flow diagram, it seems that unlike the model system, in none of these area hospitals the admissions record is directly printed at nursing stations nor at physicians office. Only at Strong Hospital the admission record is directly printed at the billing office and at the medical records office which is different from that of model system. The medical records office will send the patient record if the patient has any previous medical record to the nursing floor. Physicians at Strong and Genesee Hospital will not get the printed admission record like that of model system.

4.3 Laboratory:

The model hospital information system provides the mechanism for the control of work flow within the laboratory. The system alerts the laboratory staff to STAT requests and provides a means for immediately communicating the results of the STAT test. Laboratory test results are entered into the system by laboratory technicians or by automated laboratory instruments linked to the computer system. The results are printed at the nursing station, physician's office, out-patient department and at the emergency room depending on the type of patient. The charges for the laboratory tests are automatically added to the patient's bill.

Within the Rochester-area hospitals Genesee Hospital, Strong Hospital, Highland Hospital, and Rochester General Hospital provide a degree of direct communication between the laboratory and Emergency or for STAT orders. Park-Ridge Hospital has manual communication between laboratory and emergency services. In addition Rochester General has computerized patient billing. None of the hospitals has direct computer communication between the laboratory and nursing stations and physicians.

Highland and Strong Hospitals have stand-alone systems while Rochester General has a system which is integrated

with the main frame. Genesee Hospital has integrated system with the main system but operates largely in a stand alone mode. STAT orders are flagged and have priority. The STAT results are printed directly on the printers located in the Emergency room and Intensive care units in Strong, Genesee, Rochester General and Highland Hospital. At Strong hospital STAT or Emergency orders are sent manually.

None of these hospitals has developed a computerized means of relaying non-STAT test results to physicians and nursing stations nor have they developed a computerized mechanism for sending the out-patient department results. The computer printed results are communicated manually.

In the surveyed hospitals only Rochester General, Strong, Genesee and Highland Hospitals have direct communication between the laboratory and STAT orders or the emergency room to send the test results. But for non-STAT orders the printed laboratory test results are sent to departments manually. At Genesee and Strong Hospital charges are spooled on the tape and then sent to billing department. At Park-Ridge and Highland hospitals billing is done manually.

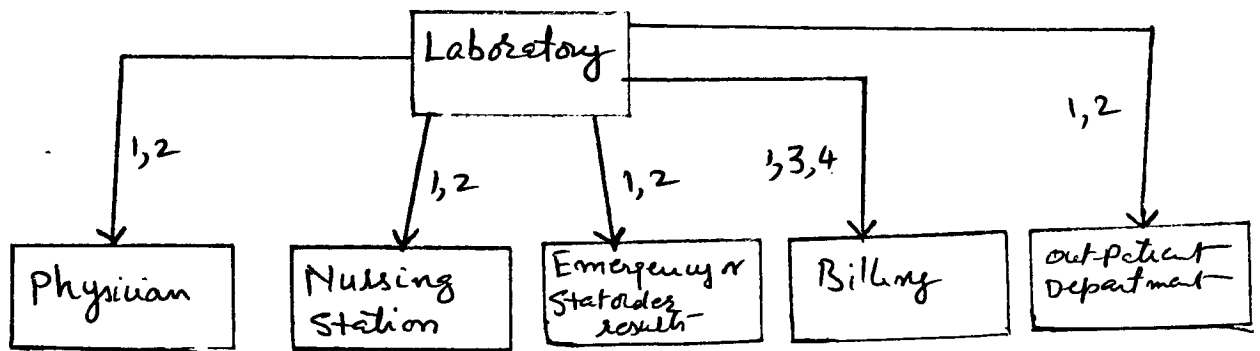
The following comparative table (4.2) and SAMM diagram will show the computerized the patient data flow between laboratory and other departments.

Comparative table for Laboratory.

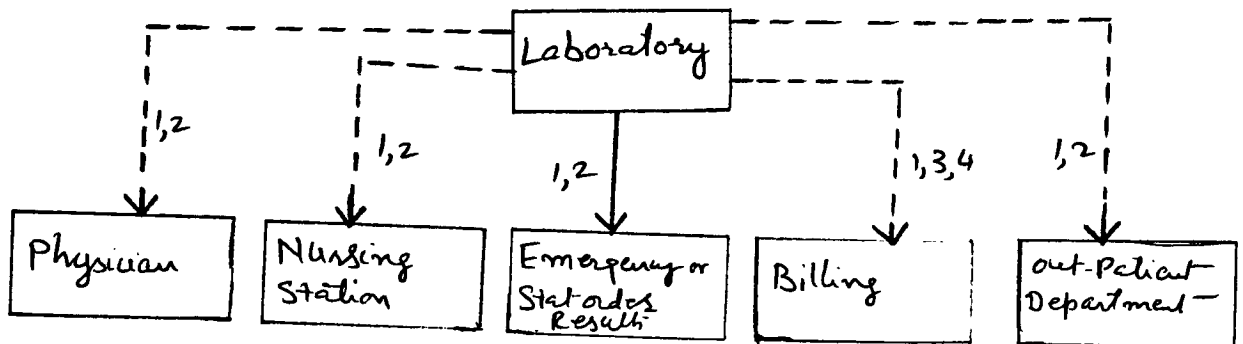
Name of Hospital	Nursing Station	Physician or STAT Orders	Emergency Orders	Out-patient Department	Billing Department
<hr/>					
Model Hospital	Yes	Yes	Yes	Yes	Yes
Genesee Hospital	No	No	Yes	No	No
Highland Hospital	No	No	Yes	No	No
Park-Ridge Hospital	No	No	No	No	No
Rochester General	No	No	Yes	No	Yes
Strong Hospital	No	No	Yes	No	No

Table 4.2

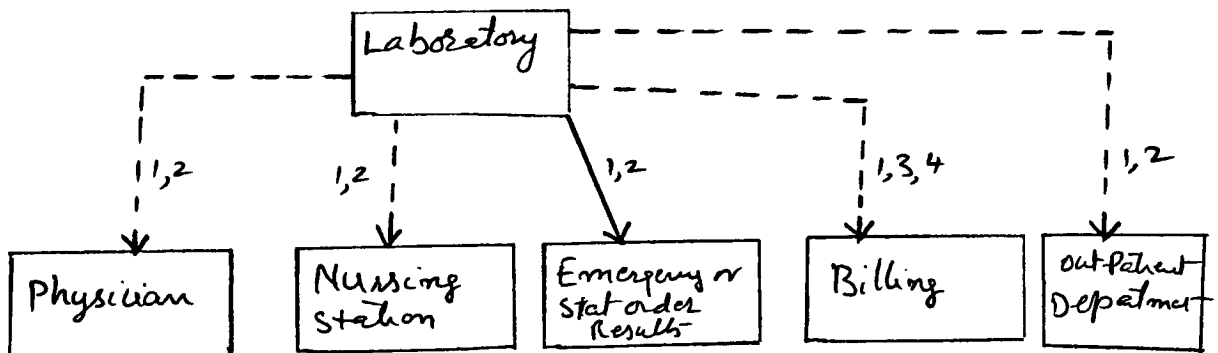
MODEL SYSTEM



GENESEE HOSPITAL

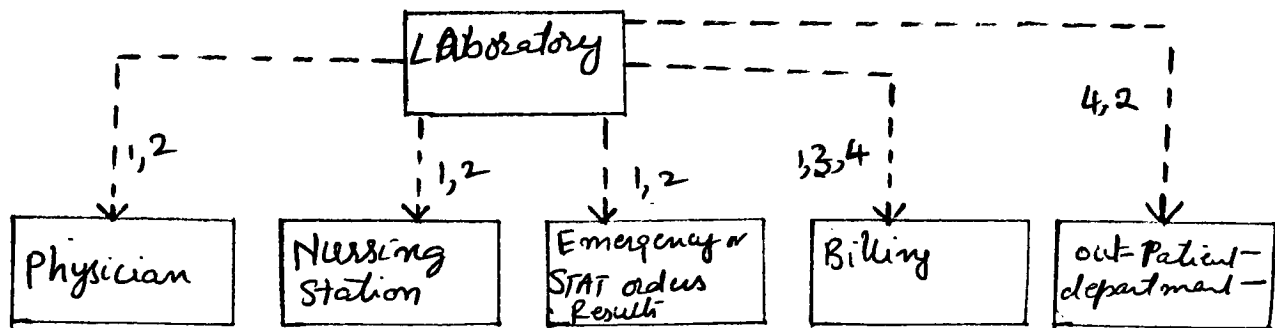


HIGHLAND HOSPITAL

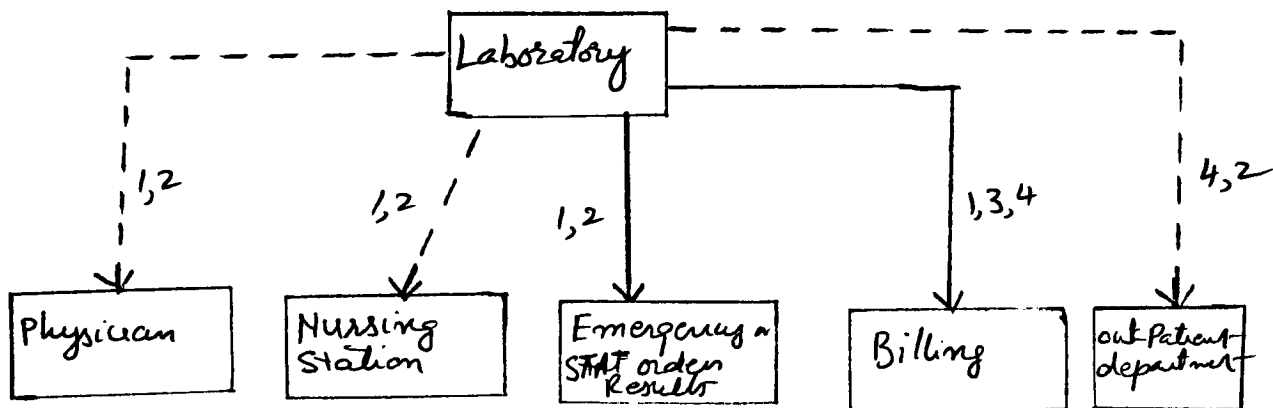


- ① Patient Name
ID#, Bed#, Floor#
- ② Test Results
- ③ Charges
- ④ Out-Patient Name
ID#,

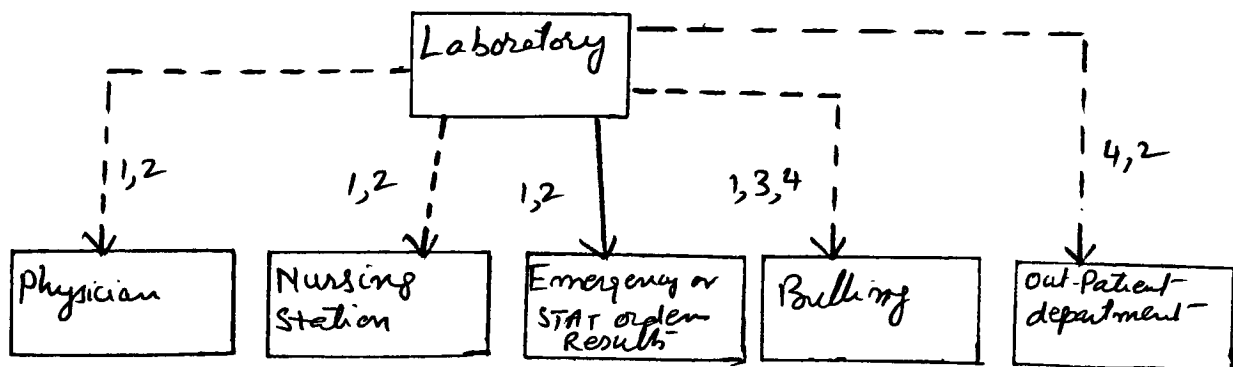
FAIR-KIDDE HOSPITAL



ROCHESTER GENERAL HOSPITAL



STRONG HOSPITAL



- ① Patient Name
ID#, Bed#, Floor#
- ② Test Results
- ③ Charges
- ④ Out-Patient Name
ID#

The SAMM data flow diagram shows that the patient data flow i.e. laboratory test results from laboratory to other departments is not totally computerized in the Rochester area hospitals like that of the model system. However, there is direct communication between laboratory and the emergency room and STAT results at Rochester General, Highland, Strong and Genesee Hospitals. The charges for the laboratory test are added to the patient's billing directly at Rochester General whereas at Genesee and Strong hospital charges are spooled on computer tape which is sent to the billing department.

4.4 Physicians:

The model computer system permits the physician instant retrieval of his patient list as well as patient data on laboratory, X-ray, medication, current and past orders, nursing notes, diagnosis and diet. The system automatically prints physician's orders in the proper departments, thus eliminating the need for manual transcriptions. The model system facilitates physicians diagnostic functions by furnishing computer printouts at his desk showing seven day cumulative reports. These reports allow physicians to more easily sight patient trends. The system stores abstracts of journal articles and information on antibiotic sensitivities and the interpretation of laboratory test results, thus functioning as an on-going training tool.

Within Rochester area hospitals there is no computerized communication between physicians and other departments like that of the model system. Only at Rochester General Hospital do few physicians have terminal in their offices. However, these are not used for any communication purposes. The physician can retrieve their patient information, condition, location and laboratory results. In all of these hospitals, communication between physician and nursing stations is completely manual. Communication between the emergency room and physician is manual. In each hospital X-rays, laboratory tests and medication are requested through

written orders, but at Rochester General Hospital all written orders for the laboratory are collected nursing at floor and then entered into the computer system. In none of the hospitals surveyed does the computer system provide information about articles from the journals nor can the system provide information on antibiotic sensitivities or interpretation of laboratory or X-ray results like that of model system.

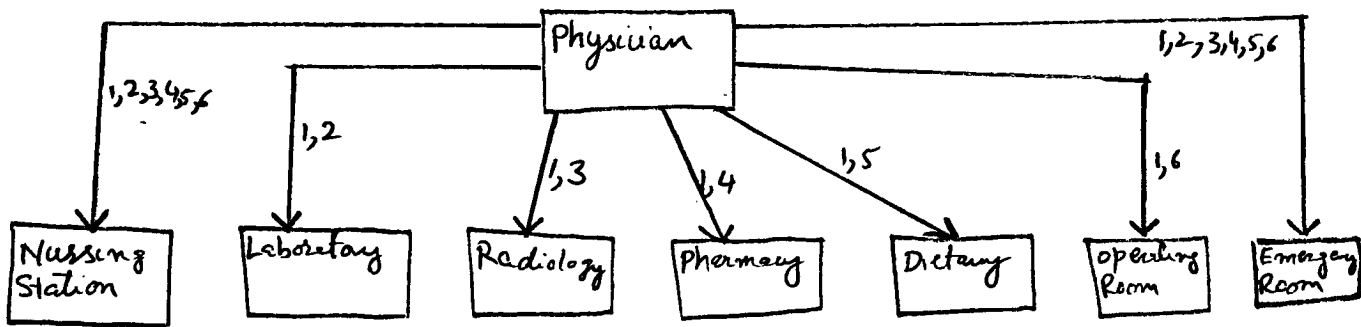
The following comparative table (4.3) and data flow diagram will show how the computer system is used by both Rochester area physicians and physicians in the model system.

Comparative table for Physicians.

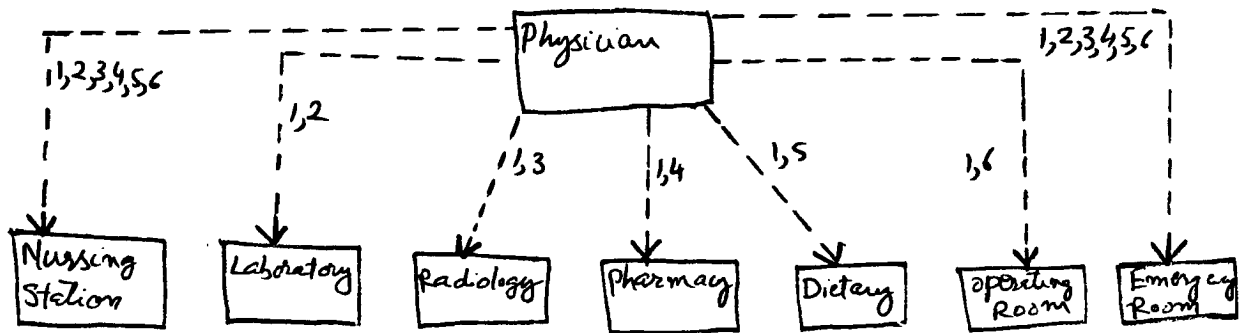
Name of Hospital	Nursing Station	Dietary Dept.	Laboratory	Radiology	Pharmacy	Operating Room.
Model System	Yes	Yes	Yes	Yes	Yes	Yes
Genesee	No	No	No	No	No	No
Highland	No	No	No	No	No	No
Park-Ridge	No	No	No	No	No	No
Rochester	No	No	Yes	No	No	No
General						
Strong	No	No	No	No	No	No
Hospital						

table 4.3

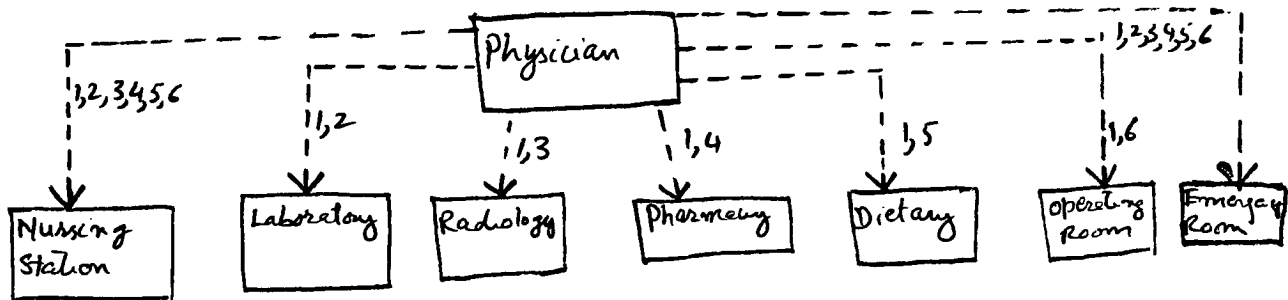
MODEL SYSTEM



GENESEE HOSPITAL

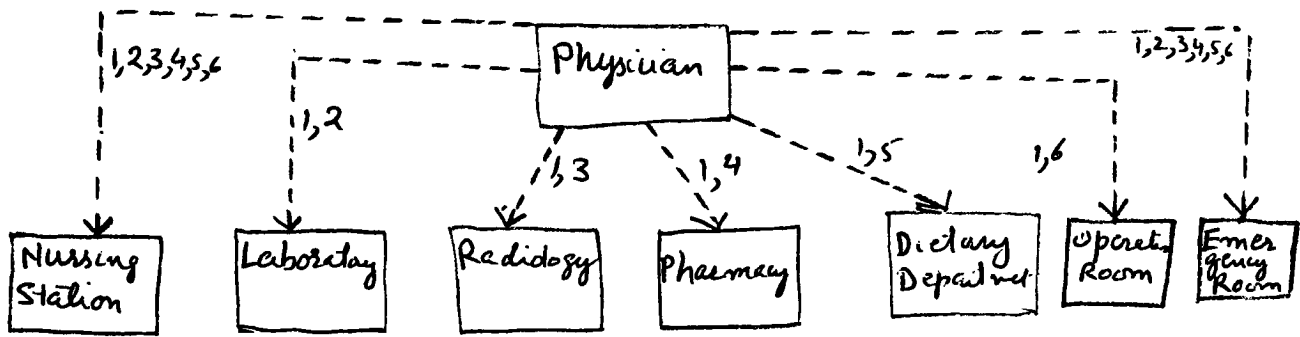


HIGHLAND HOSPITAL

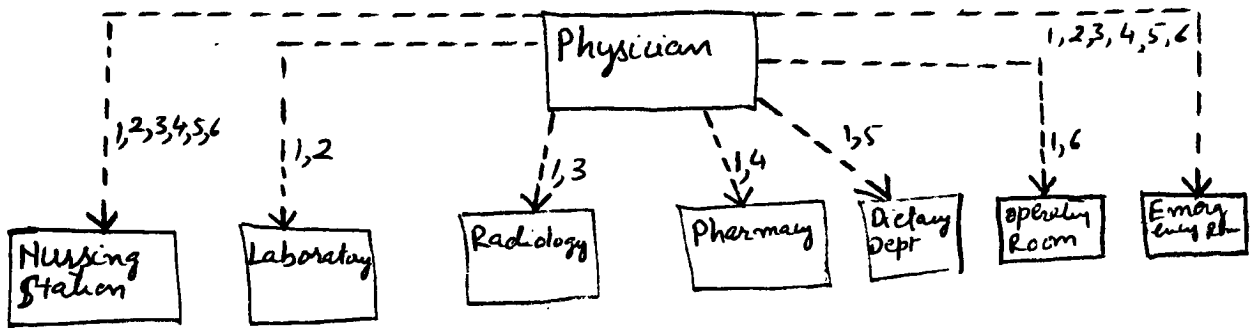


- ① Patient Name
ID#, Bed#, Floor#
- ② Laboratory Request-
- ③ X-ray Request-
- ④ Medication Request-
- ⑤ Diet Request-
- ⑥ Operating Schedule
Information

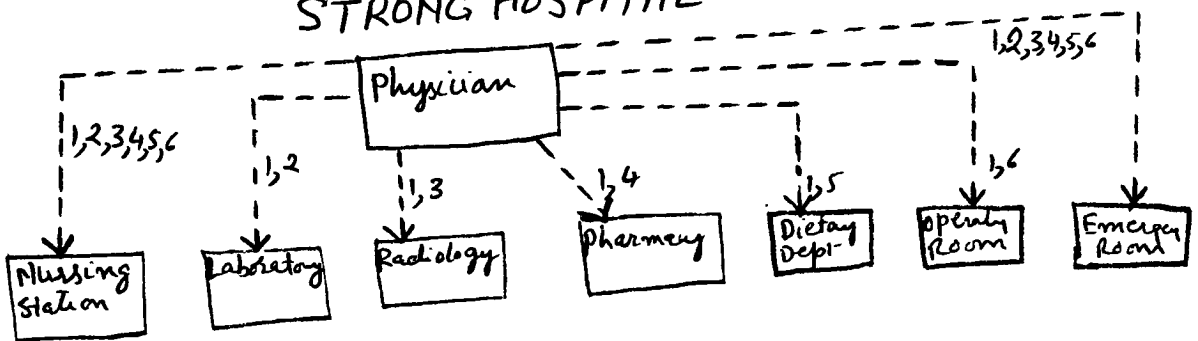
PARK-RIDGE HOSPITAL



ROCHESTER GENERAL HOSPITAL



STRONG HOSPITAL



① Patient Name
ID#, Bed #, Floor #

② Laboratory test-
Request

③ X-ray Request-

④ Medication Request-

⑤ Diet Request-

⑥ operating schedule
information

The SAMM data flow diagram shows that in all these area hospitals communication between physicians and other department is not computerized. Only at Rochester General Hospital few physicians have terminals in their offices. They can use the system to retrieve their patient information, condition and laboratory test results. However for laboratory test request, the request form is collected at nursing station and entered into the system by data entry staff and sent to laboratory via computer system.

4.5 Nursing Station:

In the model Hospital Information System nursing personnel use the terminals located at each nursing station for patient care planning, requesting the laboratory tests, X-rays and medication supplies and reporting nursing data. The computer system prints the care planning showing all current medical orders, nursing instructions and general patient data. This data includes diagnosis, vital signs, orders, diet. The model system prints a list of medication due list for each nursing station. Furthermore, the need for manual transcriptions and requisition is eliminated. All medical orders are entered into the terminal and automatically transmitted to the proper department.

Within Rochester area hospitals nursing procedures and functions, like those of physicians are overwhelmingly manual. In none of the hospitals surveyed is there computerized communication comparable to that of the model system. Only at Rochester General Hospital nursing stations have terminals for data entry and requesting laboratory tests. In the other area hospitals nurses request X-rays, laboratory, medication and diet through written orders. In no hospital surveyed is there a computer generated medication schedule or patient care planning. At Genesee and Rochester General Hospitals the emergency department has terminals to order STAT requests. Park-Ridge, Highland and

Strong Hospitals do not have any computer system usage in their nursing department. All activities are manually performed.

The following comparative table (4.4) and the data flow diagrams will show the communication between the nursing station and other departments.

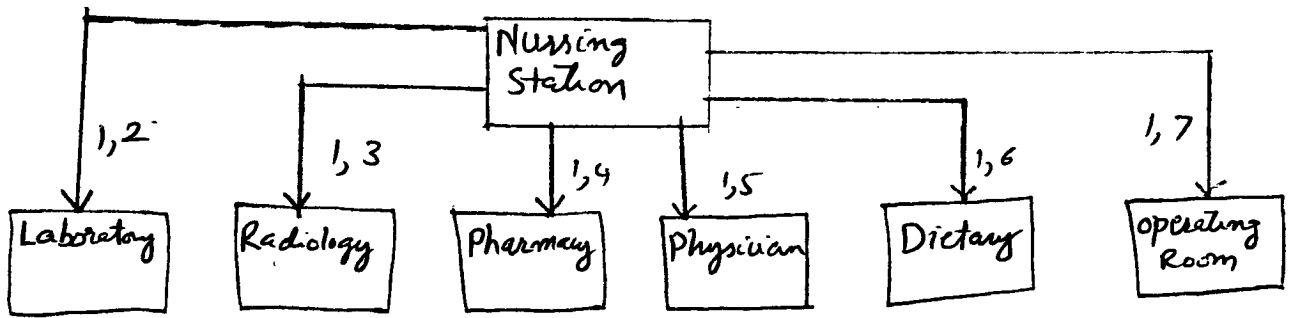
Comparative table for Nursing Station.

Name of Hospital	Laboratory	Radiology	Pharmacy	Physician	Dietary	Operating Room

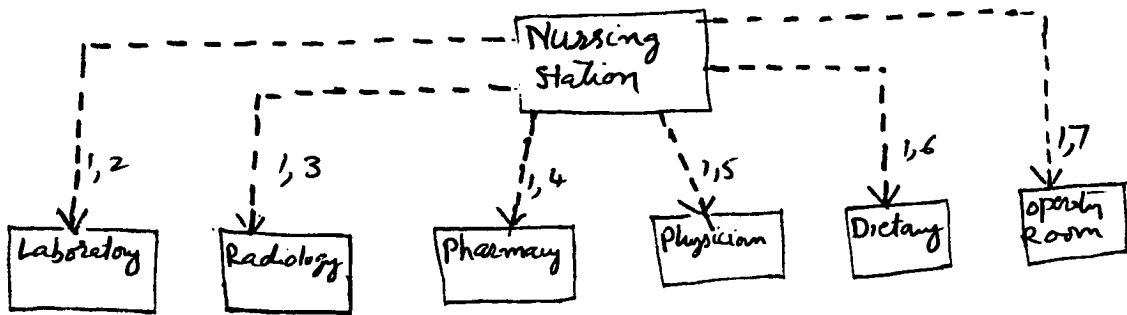
Model System	Yes	Yes	Yes	Yes	Yes	Yes
Genesee	No	No	No	No	No	NO
Highland	No	No	No	No	No	No
Park-Ridge	No	No	No	No	No	No
Rochester	Yes	No	No	No	No	No
General						
Strong	No	No	No	No	No	No
Memorial						

Table 4.4

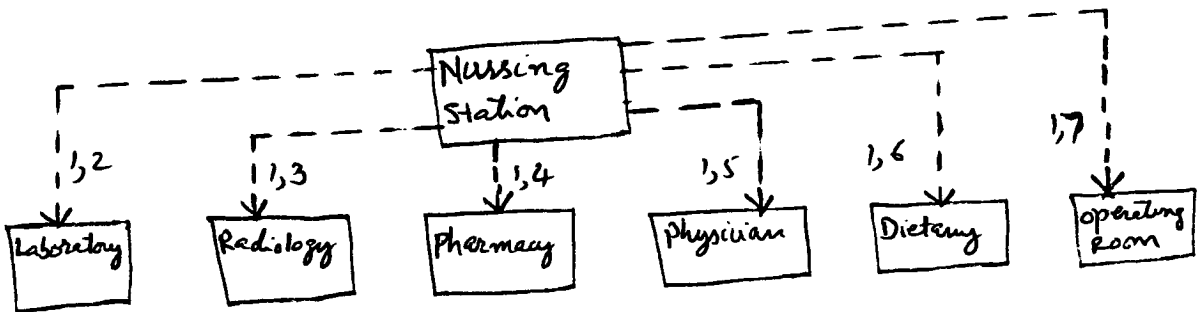
MODEL SYSTEM



GENESEE HOSPITAL

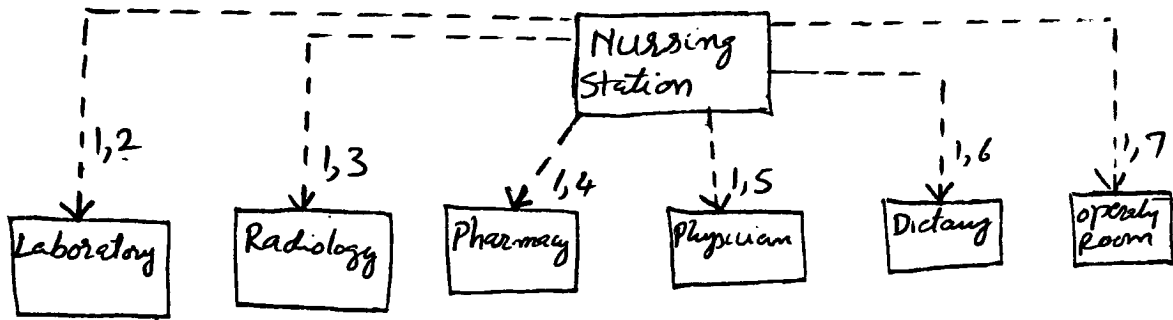


HIGHLAND HOSPITAL

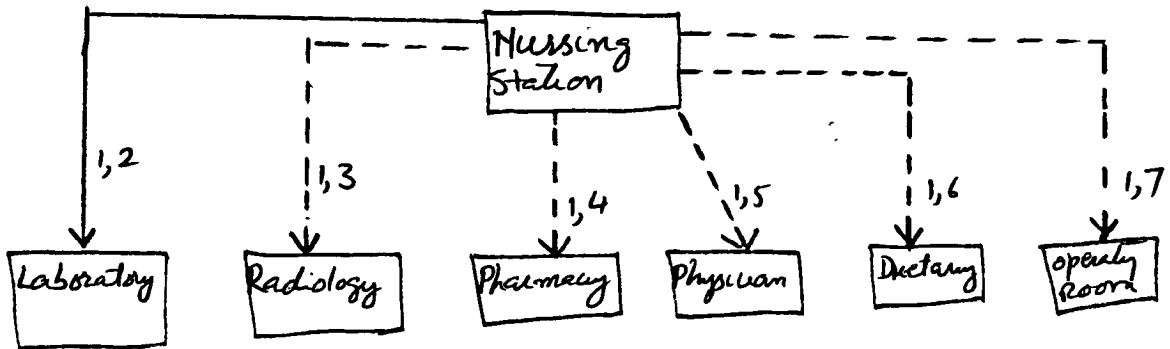


- ① Patient Name
ID#, Bed#, Floor#
- ② Laboratory test Request
- ③ X-ray Request-
- ④ Medication Request-
- ⑤ Patient Information
- ⑥ Diet Request-
- ⑦ operating schedule information.

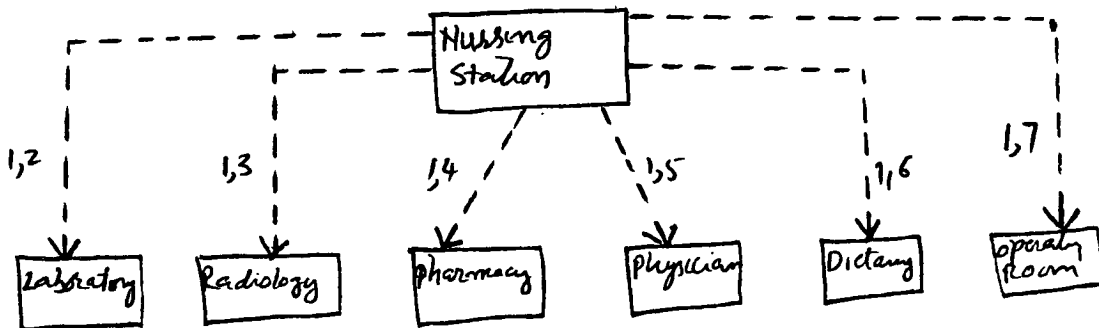
PARK-RIDGE HOSPITAL



ROCHESTER GENERAL HOSPITAL



STRONG HOSPITAL



- ① Patient Name
ID#, Bed#, Floor #
- ② Laboratory Request-
- ③ X-ray Request-
- ④ Medication Request-
- ⑤ Patient Information
- ⑥ Diet Request-
- ⑦ operating Schedule
Information.

The above data flow diagram illustrates that communication between nursing stations and other departments is manually. At Rochester General Hospitals nursing station can communicate via computer system to laboratory only like that of model system.

4.6 Pharmacy:

Within the model system the pharmacy is integrated into the larger hospital information system. Medication orders are requested by physicians and nursing stations via computer terminals. The computer system routes these orders to the pharmacy where worksheets, inventory and prescription record is generated by computer system. The system prints for each prescription patient labels indicating patient name, bed number, attending physician and medical allergy. Charges for the medication will be automatically added to the patient's bill by the computer system.

At Rochester General Hospital the pharmacy department is computerized only for billing functions. The pharmacy technicians enter the patient charges through terminals located in the pharmacy. At Strong Hospital the pharmacy department is integrated with the main computer system. The pharmacy department can only retrieve information on patient location. The only computerized function is billing. At Genesee Hospital manually prepared patient charges are entered into the computer system by data entry department. The pharmacy is notified of patient discharge and transfer via computer printers located in the pharmacy department at Genesee Hospital. At Highland Hospital patient labels are printed by computer system. Park-Ridge Hospital pharmacy does not use computer system. In the area Hospitals drug

inventories are kept manually by pharmacy departments.

Among Rochester area hospitals billing is the only function which approaches the level of computerization of the model system. The systematic computerization is absent in all of these area hospitals and the system handles only a small number of pharmacy functions, necessitating time consuming manual performance of inventory maintenance.

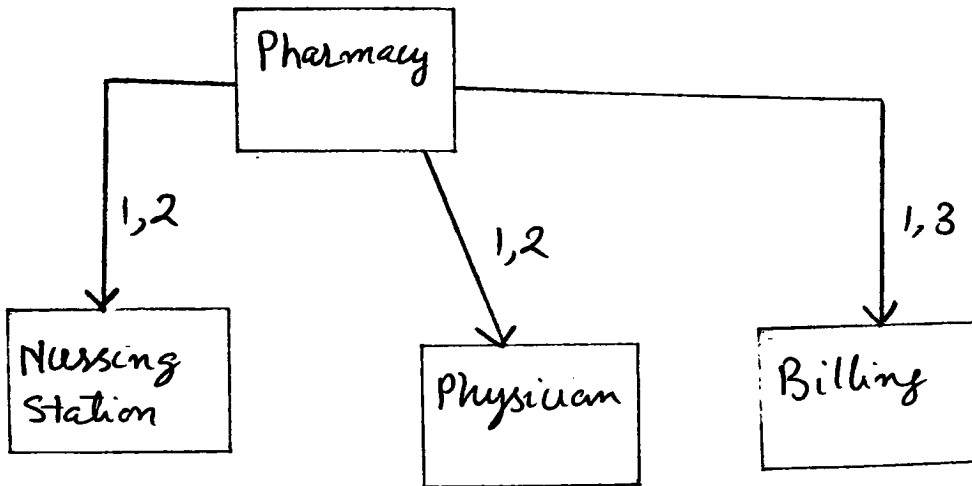
The following comparative table (4.5) and data flow diagram will illustrate the level of computerization communication within both the model system and the hospitals surveyed.

Comparative table for Pharmacy.

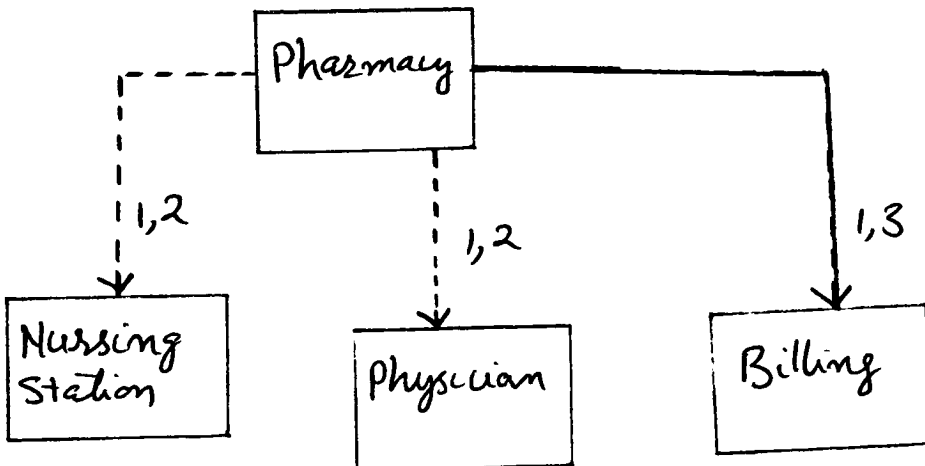
Name of Hospital	Nursing Station	Physicians	Billing Dept
Model System	Yes	Yes	Yes
Genesee	No	No	Yes
Highland	No	No	No
Park-Ridge	No	No	No
Rochester General	No	No	Yes
Strong Memorial	No	No	Yes

table 4.5

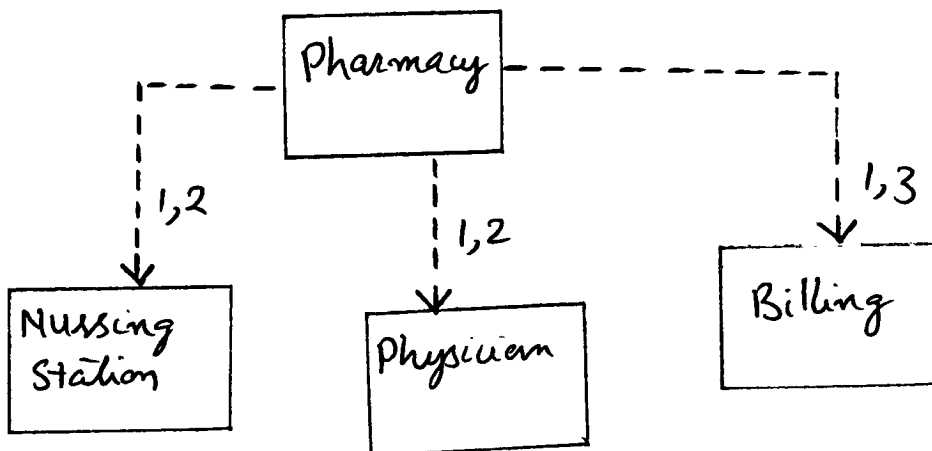
MODEL SYSTEM



GENESEE HOSPITAL

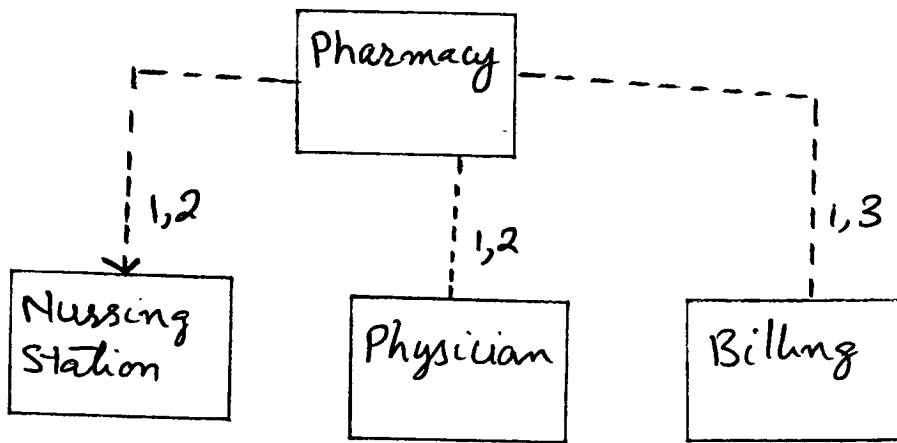


HIGHLAND HOSPITAL

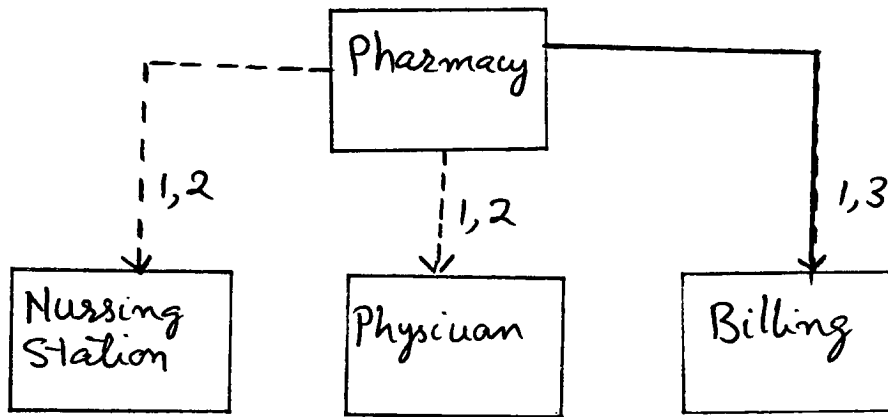


- ① Patient Name
ID #, Bed #, Floor #
- ② Medication Information
- ③ Charges

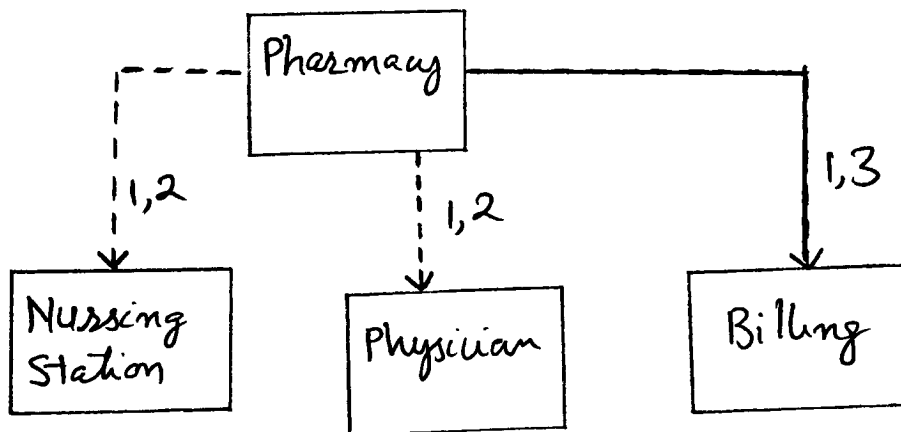
PARK-RIDGE HOSPITAL



ROCHESTER GENERAL HOSPITAL



STRONG HOSPITAL



- ① Patient Name
ID#, Bed#, Floor#
- ② Medication Information
- ③ charges

The SAMM data flow diagram indicates that none of the Rochester area hospitals have direct communication between pharmacy and nursing station and physicians. Only at Rochester General and at Strong Hospital there is direct communication between billing and the pharmacy like that of the model system.

4.7 Dietary:

In the model system dietary orders and special instructions are entered into the system by both physicians and nurses. Prior to each meal the computer system prints updated diet orders in the dietary office.

Among the Rochester area hospitals, only at Rochester General Hospital has computerized dietary department functions of any significant degree. However, the involvement of computers is limited to preparing diet order sheets and making inquiries into the patient files. All other dietary activities are performed manually. Strong Hospital does utilize its computer system to print diet order list which contains patient names within the each nursing station units. The dietician completes the order list manually. At Genesee Hospital diet charges are keyed into patient charges by data entry staff. Park-Ridge and Highland Hospital dietary departments do not have the computer system at all. None of the hospitals surveyed has direct communication between the dietary department and the other departments. At Rochester General Hospital dietary charges are included in the room charges. This differs from the billing procedure of the model system.

The following comparative table (4.5) and data flow diagram will show the computerized communication of dietary

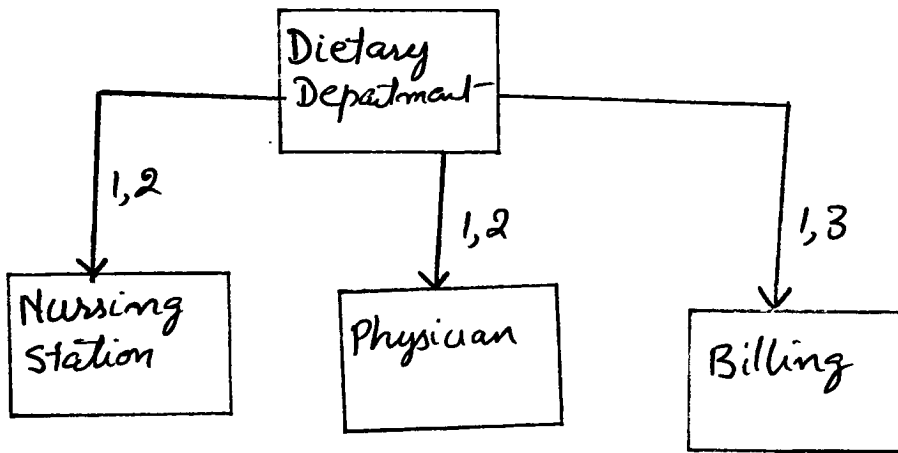
department within both area hospitals and the model system.

Comparative table for Dietary.

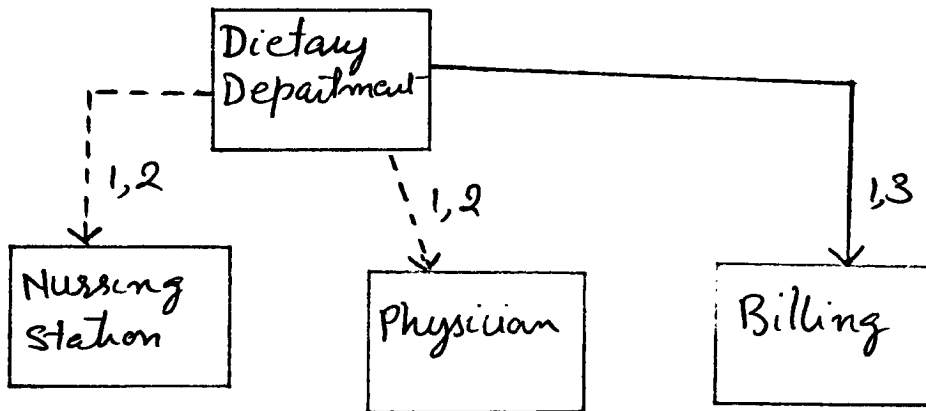
Name of Hospital	Nursing Station	Physician	Billing
Model System	Yes	Yes	Yes
Genesee	No	No	Yes
Highland	No	No	No
Park-Ridge	No	No	No
Rochester General	No	No	No
Strong Memorial	No	No	No

Table 4.6

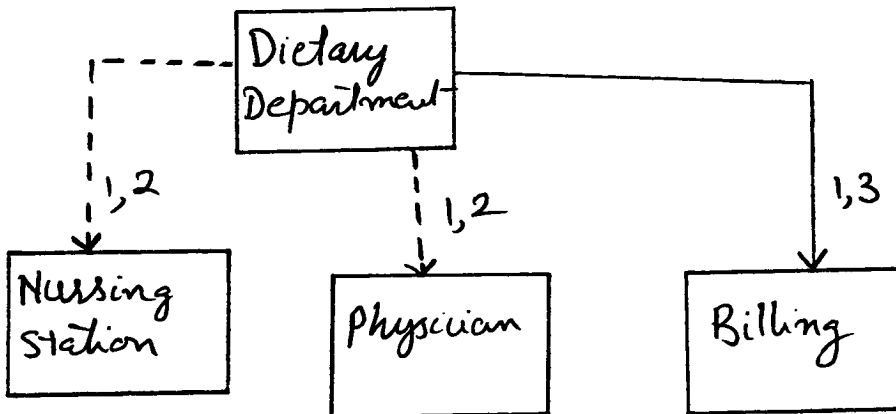
MODEL SYSTEM



GENESEE HOSPITAL



HIGHLAND HOSPITAL



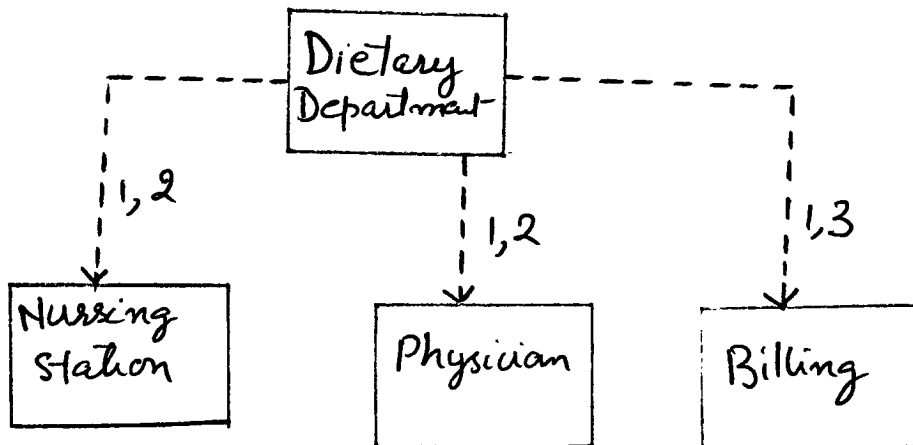
① Patient Name

ID #, Bed #, Floor #

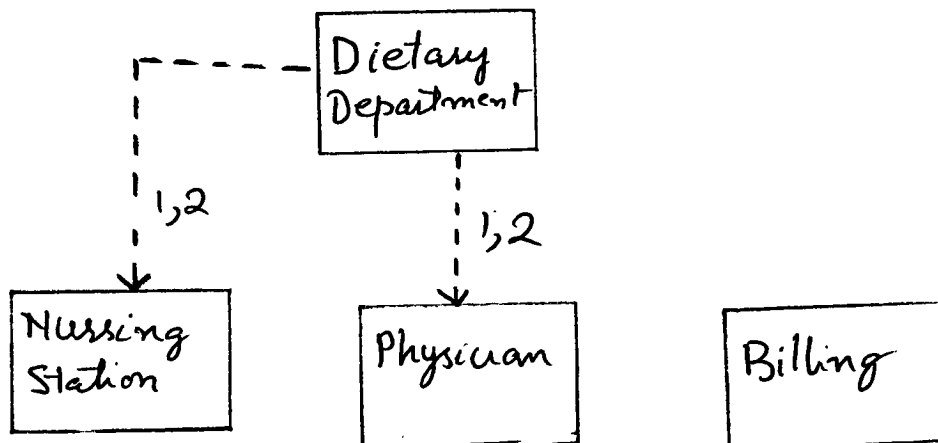
② Diet Information

③ charges

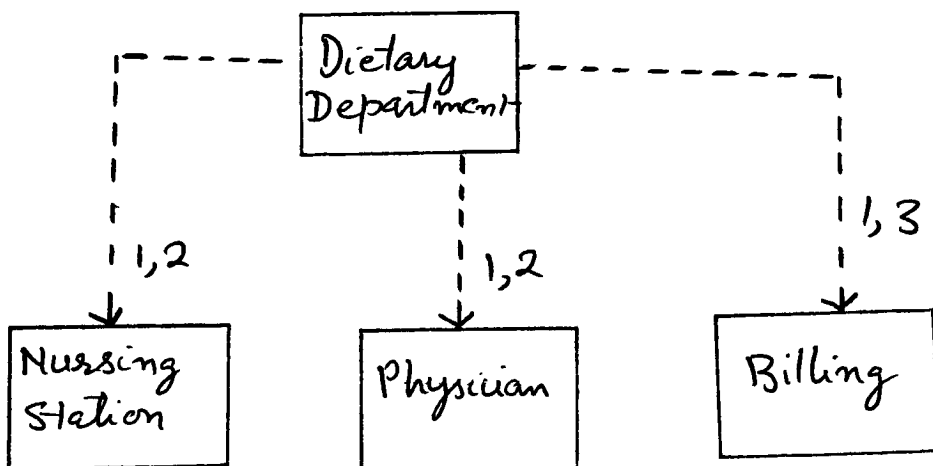
PARR-KIDGE HOSPITAL



ROCHESTER GENERAL HOSPITAL



STRONG HOSPITAL



- ① Patient Name
ID#, Bed#, Floor#
- ② Diet Information
- ③ Charges

The above data flow diagram shows that there is no computerized communication between dietary department and physicians, nursing stations and billing department like that of model system. However, there is no communication between dietary and billing department at Rochester General Hospital because dietary charges are included in to the patient room charges which is different from that of the model system.

4.8 Operating Room:

Within the model hospital information system the computer will retain a list of all patients on which surgery is to be performed. The system will print the list of patients scheduled for operations on any specific day and will include any necessary information or instructions to the patient and operating room staff.

Among the Rochester area hospitals surveyed only Rochester General Hospital has truly computerized the operating room functions. At this hospital operating schedules are printed and computer generated reports are sent to nursing stations and physicians. The operating room system is integrated with the main system. Billing for the operating room charges is also fully handled by computer system. At Strong and Genesee Hospitals billing is the only computerized function of the operating room activities. At Highland and Park-Ridge Hospitals all operating room activities are done manually.

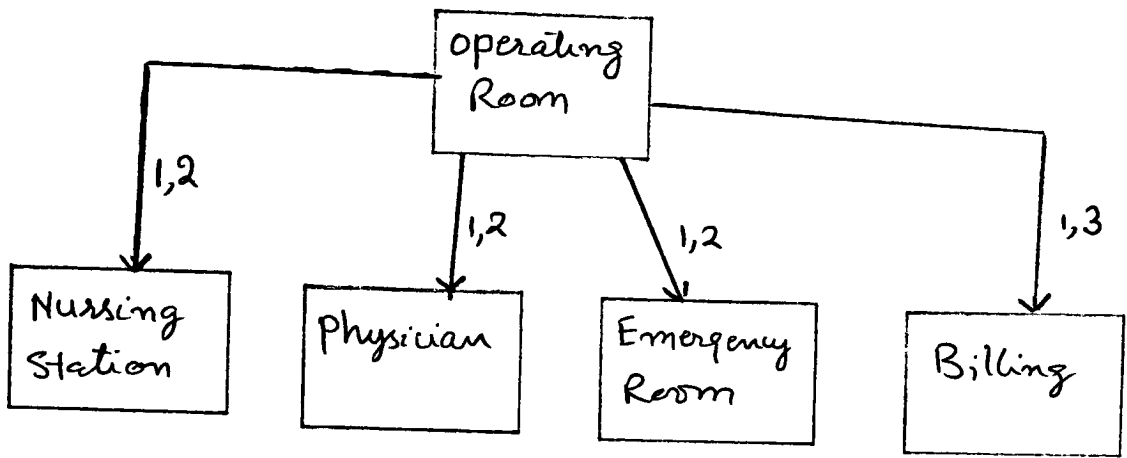
The following comparative table (4.7) and data flow diagram will compare area hospitals with that the model system.

Comparative table for Operating Room.

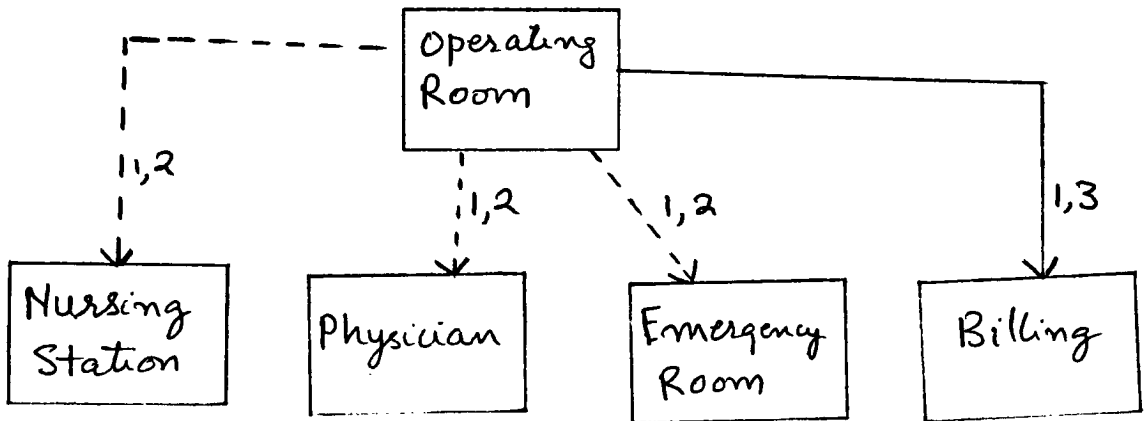
Name of hospital	Nursing Station	Physicians	Billing Dept.
<hr/>			
Model System	Yes	Yes	Yes
Genesee	No	No	Yes
Highland	No	No	No
Park-Ridge	No	No	No
Rochester General	No	No	Yes
Strong	No	No	Yes

Table 4.7

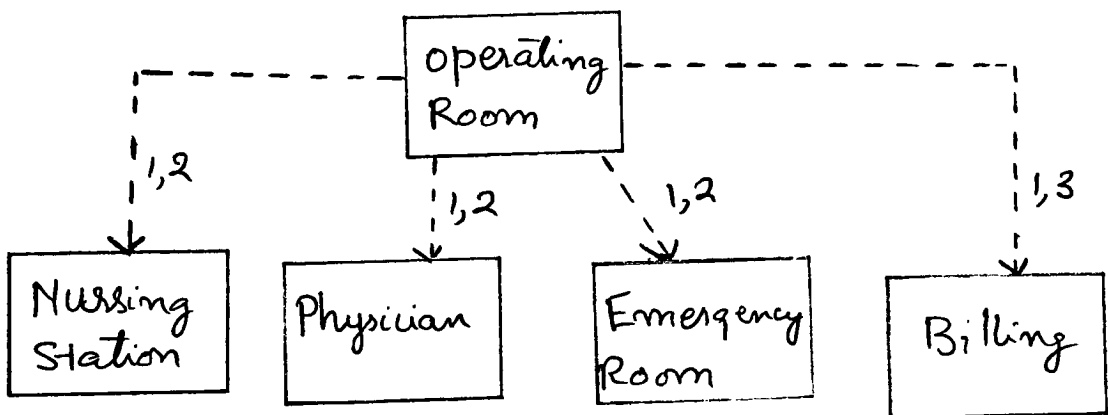
MODEL SYSTEM



GENESEE HOSPITAL



HIGHLAND HOSPITAL



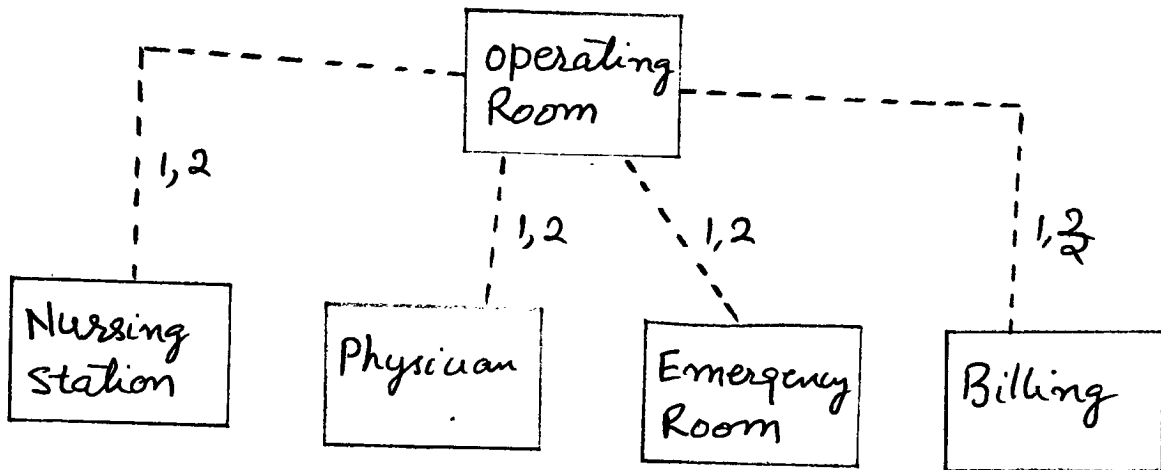
① Patient Name

ID#, Bed #, Floor #

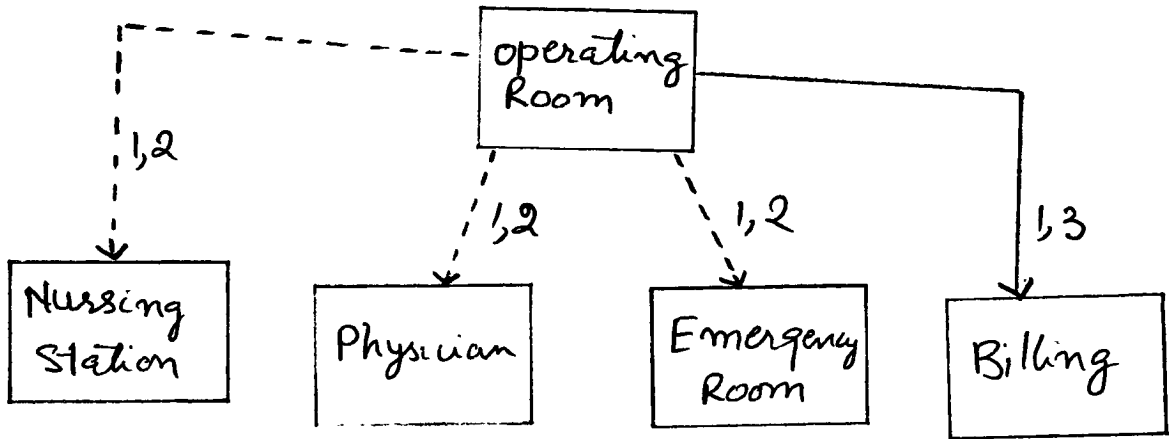
② operating schedule
& information

③ charges

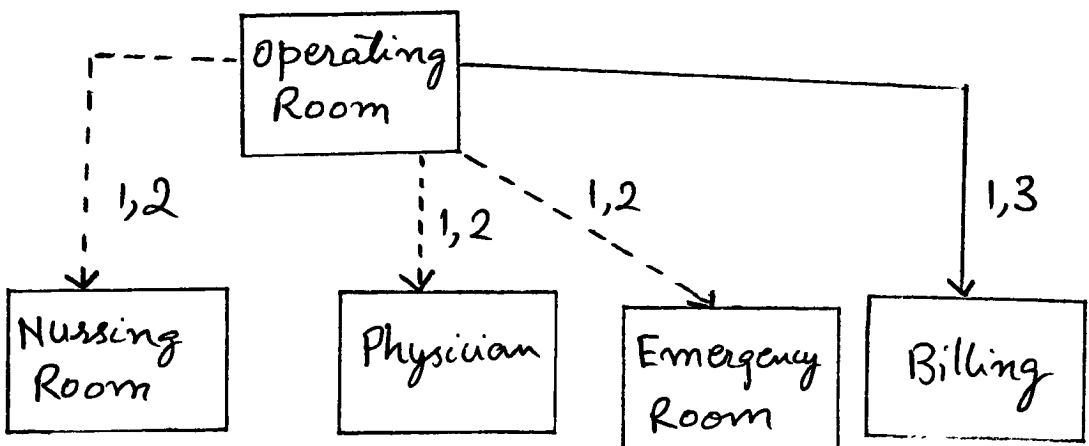
PARK-RIDGE HOSPITAL



ROCHESTER GENERAL HOSPITAL



STRONG HOSPITAL



- ① Patient Name
ID#, Bed #, Floor #
- ② operating Schedule
& information
- ③ charges

The SAMM diagram shows that there is computerized communication between operating room and the billing department at Strong, Rochester General and Genesee Hospital like that of the model system. There is no direct communication between operating room and other departments.

-4.9 Radiology:

In the model hospital information system the introduction of computers creates computerized treatment planning which permits the preparation and evaluation of individual patient plans. After a physician requests a diagnostic procedure, the request is printed in the radiology department. The radiologist performs the procedure and sends results via the computer system to the nursing station, physicians or accessible to any authorized person. A complete summary of all radiology reports is printed as a consolidated tests results summary after the patient is discharged.

Of the hospital surveyed, Strong, Rochester General and Genesee hospitals do use their computers for some radiology tasks. Strong Hospital uses its computer system for billing and retrieval of patient data only. Genesee Hospital's radiology department uses the hospital's main frame for communicating with the patient index system which allows the radiology department to enter patient data into the system and retrieve the patient information. The data entry staff enters the patient charges at Genesee Hospital. Rochester General's radiology department has its own computer system for printing test results but uses the hospital's main frame for billing.

The most revolutionary computer development in radiology is computer interpretation of test results. None of the Rochester area hospitals use the computer system for interpreting the results or sending test results.

Rochester General Hospital uses the computer system for calculating the amount of radiation needed for patient. At Park-Ridge and Highland Hospitals do not use the computer system in their radiology department.

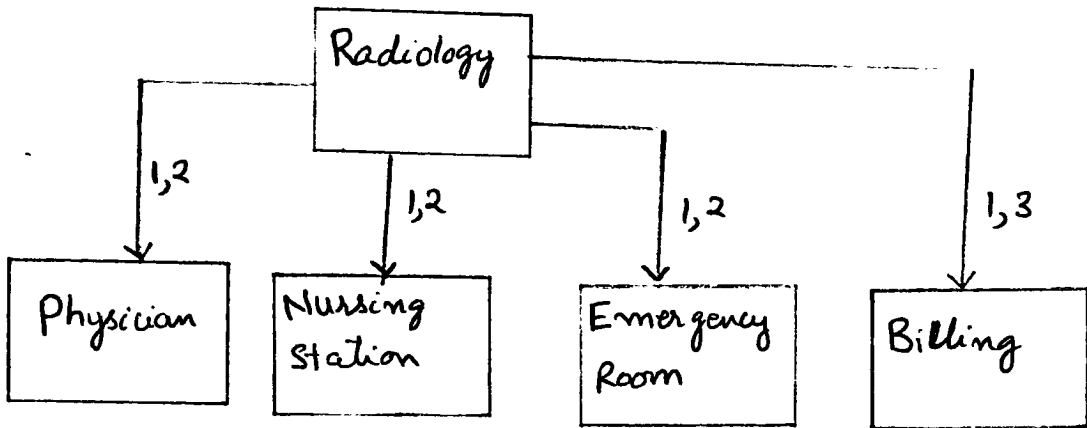
The following comparative table(4.8) and data flow diagrams will show the integration of computer system in the radiology department in area hospitals.

Comparative table for Radiology.

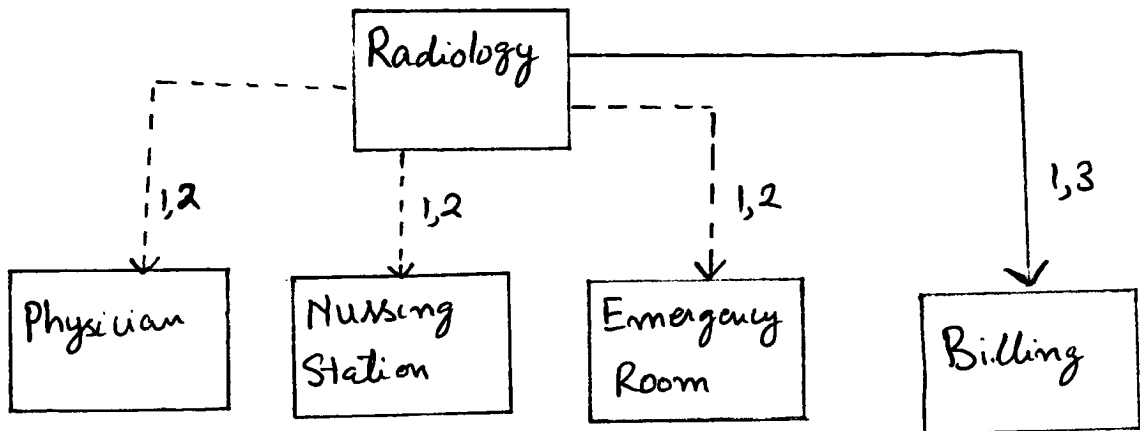
Name of Hospital	Nursing Station	Physician	Out-patient Dept.	Emergency Room	Billing Dept.
<hr/>					
Model System	Yes	Yes	Yes	Yes	Yes
Genesee	No	No	No	No	Yes
Highland	No	No	No	No	No
Park-Ridge	No	No	No	No	No
Rochester	No	No	No	No	Yes
general					
Strong	No	No	No	No	Yes

Table 4.8

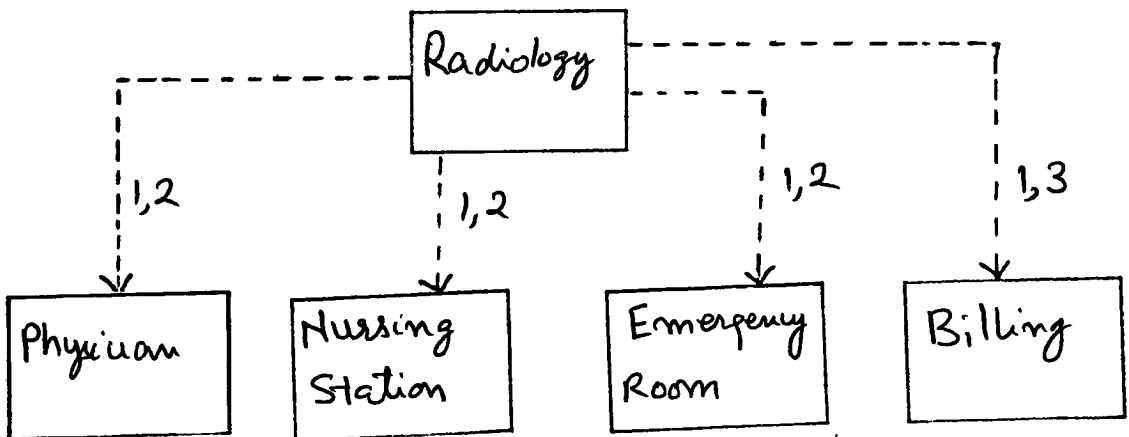
MODEL SYSTEM



GENESEE HOSPITAL

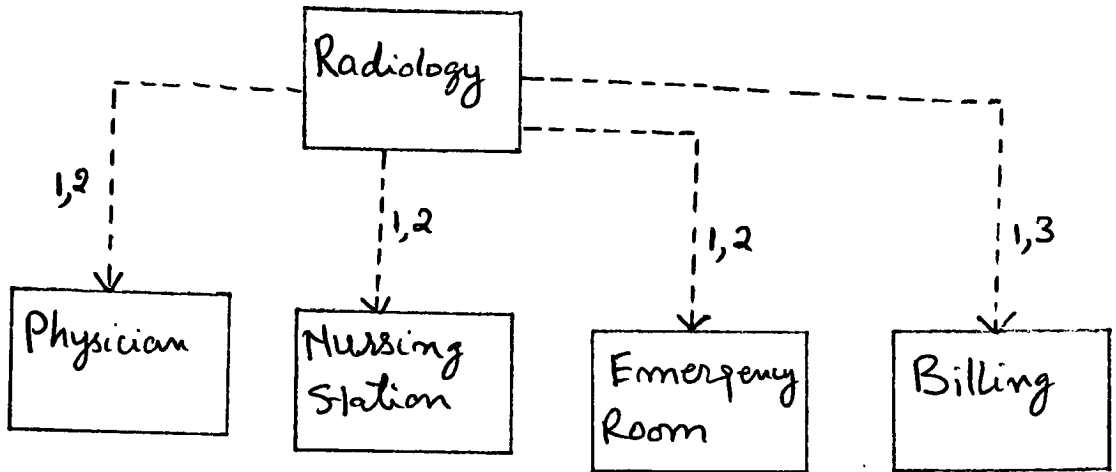


HIGHLAND HOSPITAL

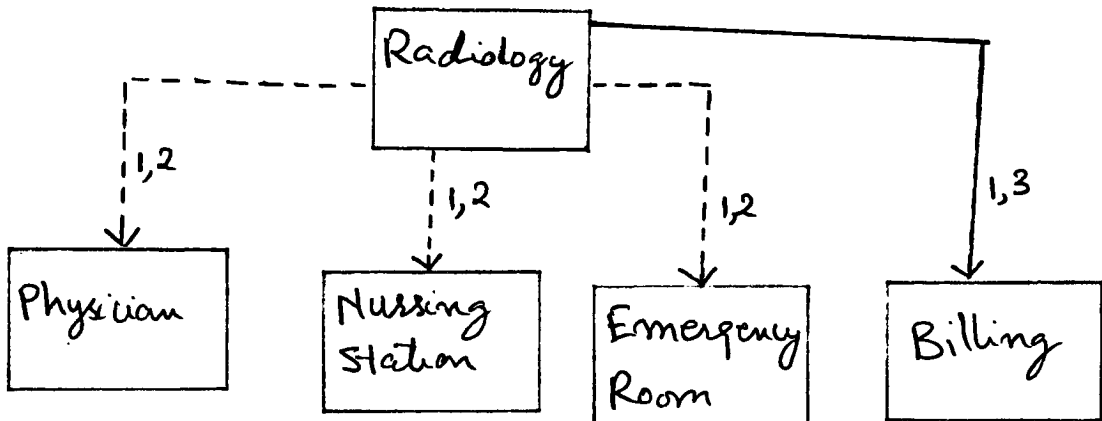


- ① Patient Name, ID#, Bed#, Floor #
- ② X-ray Results
- ③ Charges

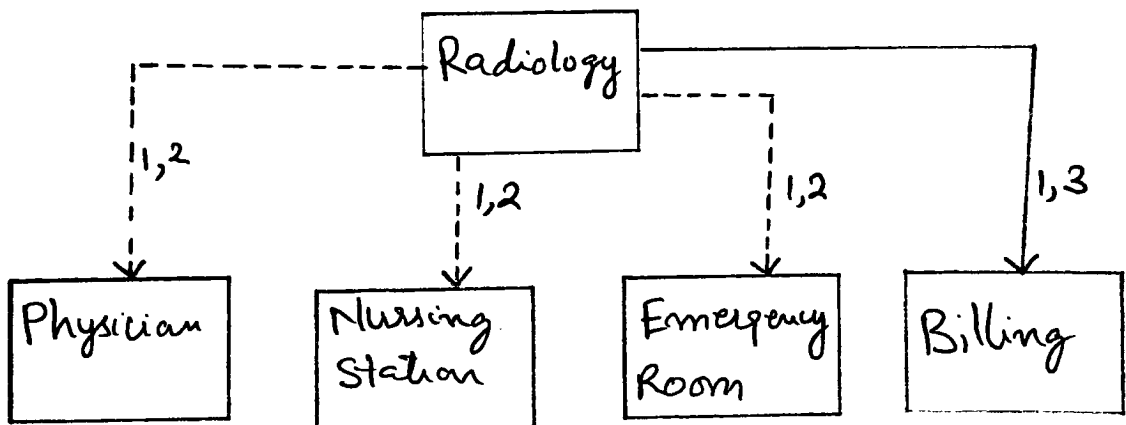
PARK-RIDGE HOSPITAL



ROCHESTER GENERAL HOSPITAL



STRONG HOSPITAL



- ① Patient Name, ID#, Bed#, Floor #
- ② X-ray Results
- ③ Charges

The SAMM data flow diagram shows that only at Rochester General, Strong and Genesee Hospitals have computerized direct communication between radiology department and billing department which is similar to that of model system.

5. Benefits and Economic impact of Computer system on a hospital

Increasing costs of hospital care have been one of the major concerns at the national level. Two of the primary factors responsible for increasing hospital costs are the cost associated with the transfer and handling of patient information and the labor necessary to provide the assuring the high quality of patient care which requires the completeness of medical orders, reduction of errors and minimization of the turn-around-time of orders to ancillary and support services. As patient status changes quickly, these changes affect the decisions and services provided by number of people in different areas of a hospital. In all hospitals, the data-related activities of patient care involve an extensive and complex information flow from one place to another. The hospital personnel spend considerable time recording information, finding, reading and interpreting the data recorded by others. The computer technology will not eliminate these information processing activities, but it will offer the potential for extraordinary changes in how these actions are carried out. Several information technologies now exist that can be applied individually or in combination to refine and streamline health care operations and thereby reduce hospital costs and upgrade the quality of patient care.

In the past numerous writers have stated confidently that medical information systems would cut hospital cost and improve the handling of information. (24). This was not fully documented until 1975 when there was retrospective examination of a fully functioning system, for the purpose of demonstrating that these benefits could be achieved. These data came from two reports, both based on extensive studies of a comprehensive medical information system installed at El Camino Hospital (ECH), Mountain View California, which has 464 beds. ECH is a general acute care facility. It began to use the computer system in the admission department in December of 1971. The complete implementation of the computer system in all the hospital areas was completed in October of 1972. The first study was carried by Battelle Columbus Laboratories for the National Center for Health Service Research of the Department of Health, Education and Welfare. This report is titled "Evaluation of the Implementation of a Medical System in General Community Hospital". The report, which is the first long-term evaluative study, presents the systems development, implementation and operation from 1971 to 1975 a period which includes three years of full operation from 1973 to 1975. The study evaluated the impact of the computer system on the organization and administration of health care delivery at ECH. The second study under the above sponsorship, evaluated the economic impact of the system and was carried out by

Battelle with the hospital's management and engineering department.(23). The results of these study were encouraging. This study has shown that the technology can yield significant improvement in productivity and facilitate more effective use of personnel as well as enhancing the ability of the institution to influence the quality of patient care. At the time of this study the Technicon company was developing the system as an experiment. This system was being developed and at the same time installed and tested. The hospital did not pay for the cost of computer system and for its development.(21). The economic impact of the system on the hospital will be described in the section 5.2.

5.1 Impact on Departments:

5.1.1. Admitting:

The operation of the admitting department did improve considerably as a result of more efficient procedures initiated through the implementation of the computer system. Physicians are able to order tests up to 14 days prior to the admission for pre-admitted patients. Business office is able to process financial and insurance information very easily. Verification of patient information is done through the system without printing the pre-admission record. The admission record is printed in appropriate departments throughout the hospital at the time of admission which

helped avoid lost or misplaced the admission records. The system prints adhesive labels for each patient in admission department and these labels are used throughout the hospital wherever manual patient identification was required. These labels reduce the transcription errors when recording the patient information. The Admission department can locate a bed more rapidly as result of accurate and current bed availability data through the system. There has been a reduction in the number of forms and time spend on typing. Updating of information on pre-admission is easier and less time consuming. The ECH has closed night-time operation of the admission department due to the system. The nursing station admits the patient by using the system. The Emergency Room uses the system for all patient information. The system has provided more efficient procedures for order entry and retrieval of medical and administrative patient information. The system automatically prints the out-patient record at the appropriate service area for the out-patients. Test results are printed in the service area and are mailed to the physician. If an out patient goes directly to the service area or other department personnel in that place can register the out-patient through the system.

5.1.2 Physicians:

The physicians can retrieve current medical orders from any of the terminals. They can request laboratory tests, X-

rays and medication through the system. The system provides information on antibiotic agents and patient treatment, antibiotic ordering information, laboratory interpretation aids and surgical abstracts. The patient information is available sooner to the physician which allows changes in the patient treatment to be made earlier.

5.1.3 Nursing Department:

The Battelle study indicated that the computer system at ECH had a favorable influence on nursing activities. The impacts were most apparent in clerical activities, communications and greater availability of patient data. There was no consistent change in the direct patient care activities. The time and effort allocated to the clerical activities in the most of the units was decreased. In the communications area, the availability and form of information provided through the system made reporting activities less time consuming and easier to accomplish. Nursing personnel were spending less time off the unit as information was readily available. Nurses did not need to use the Kardex in order to transcribe orders or check medication. In addition the nurse's notes were in legible format.

5.1.4 Laboratory:

The computer system did not impact on the operation of the laboratory, since the development and implementation of

the interface between the system and the automated laboratory instrumentation was incomplete. The Technicon Computer Company was developing programs to allow the laboratory to interface with the total system at the time of this study. The system has assisted the laboratory with specimen collection, preparation and scheduling the work flow. The laboratory receives batch blood specimen pickup lists from the system. This list is sorted in bed-number sequence for each floor and indicates the patient's name, test ordered, type of specimen required and amount of specimen. The computer system prints individual pickup sheets for stat orders. The system holds tests for future dates and prints them on the proper dates. The charges are entered into the patient's account directly. The test results are entered into the system and are available to any authorized personnel.

5.1.5: Pharmacy:

The computer system has improved the efficiency of all the areas within the department including ordering, billing and dispensing of medications which has resulted in a significant improvement in the service. The system has provided a means of implementing unit-dose dispensing of medications with minor changes in the staff. The pharmacy maintains the medication price list in the system. As each medication is administered the nurse's charting entry causes the appropriate charges to be added to the patient's billing. The

radical changes made by pharmacy has improved its operations prints the labels. The Pharmacy is able to deliver faster service with less errors.

5.1.6 Radiology:

The system has made a major impact on secretaries in the areas that transcribe the reports. The keyboard in combination with the report header and the information provided by the system has significantly reduced the typing time required to enter the reports. Packaged reports for normal chest examinations have been developed. The format of the report has also improved. The technologists are pleased with the completeness of the patient information available to them.

5.1.7 Dietary:

The dietary department receives a printed diet list with patient name, room number, diet changes, transfers and discharges. Prior to the system, this was done manually and sent to the dietary department via pneumatic tubes. This was an inconvenience to the department. There is a very good chance of losing the paper work. The dieticians feel that errors resulting from manually transcribing orders have been totally eliminated. Another advantage of the system to physicians is display of most frequently used diets for selection by physicians. Prior to the system physicians had to

refer to a diet manual.

5.2 Economic Impact:

The economic impact created by the introduction of a total hospital information system into a hospital environment is highly complex and not yet fully understood. This phenomenon embraces not only a variety of economic efforts (direct labor, indirect labor, changes in the volume of service units, cost avoidance, cash flow, material cost changes) but also encompasses the broad spectrum of physical impact points including all nursing stations, ancillary services and supporting services.(22).

There were numerous changes that occurred during the Battelle's study period among the hospitals participating in this study. These changes compound the difficulty in isolating and identifying the economic impact on ECH. The cost of ancillary services per patient day has had a continuing growth pattern due to changes in the services available, application of new technology and the resulting sets of new services. However there has been a reduction in the length of patient stay (4.7%) due to availability of timely patient data, reductions in errors of patient orders and faster turn-around time in tests and treatments due to shortening the time between orders and their executions, the improved communication at all levels of ECH facilitates the

physician's to delivery of improved quality care. (21). As there is a reduction in patient stay there is a reduction of cost per patient day which is an important indicator of both the resource cost of treating patients and the cost of hospital care to the individual. There was a statistically significant 5% reduction in the cost of nursing services per patient during the time when the information system was operational. The system reduced the amount of time nurses spent on paper work which lessened the clerical workload and ultimately reduced the nursing staff thus reducing the departmental costs. Results in the other departments were less encouraging. The ancillary department showed a small insignificant decrease in the operating cost per patient day. The table 5.2.1 shows the economical impact of the system (excluding the cost of the system) on three measures of cost at ECH by department and by system phase relative to pre, post system implementation period.

Department	Cost per patient		Cost per patient day		Cost per Month	
	TMIS Impl Pre	TMIS Impl Post	TMIS Impl Pre	TMIS Impl Post	TIMS Impl Pre	TMIS Impl Post
(Percentage change) ¹						
Nursing	3.3	-5.0*	3.0	-2.0	6.4**	5.3*
Ancillary	1.1	-2.4	-0.32	1.1	4.3	7.7**
Support	5.7	4.5	5.5	7.5**	8.4**	14.3**
All Depts	3.4	-0.65	3.3	2.3	6.2**	9.2**
Medical care	2.1	-5.0*	1.8	-2.4	5.2*	5.9**

Table 5.2.1

¹ Positive values represents cost increase due to TMIS. Negative values represent cost savings due to TMIS.

The estimates were produced by multivariable

regression analysis which held constant other factors that affect the hospital cost and should be interpreted as the percentage in cost during the specified TMIS phase relative to the pre-TMIS period.

* Estimate was statistically different from 0 at a .5 % level of significance or better

** Estimate was statistically different from 0 to .5% level of significance or better.(23).

There are many papers describing the computer based systems and claimed benefits without substantiating them in detail. Few hospitals which have used the computer system claim that they have reduced over all cost of the hospital. But very few indicate what system cost and almost no quantitative discussions of the benefits achieved.

1. Deaconess hospital in Evansville Indiana reduced its personnel increased operating revenues by \$180,000 and reduced its account receivable turnaround time by 16 days.

2. Canyon General Hospital in Anaheim California which has used a multiple mini computer system since it opened, claims to use 40 fewer full time people than other proprietary hospitals of similar size in southern California.

3. Texas Institute of Rehabilitation and Research a small 56 bed hospital found that both users and administrators are satisfied with the system and has resulted in more rapid patient recovery combined with a decrease in service costs.
(24).

The Good Samaritan Hospital has consulted three respected studies throughout the country to validate cost savings due to the total information system. These studies show that hospitals can save more money and reduce the cost of patient care through the use of computerized information processing. One of them is Battelle institute's study of ECH. The other study done by Richard Nolan in the year 1977

relative to hardware and that a hospital is willing to spend \$ one million on patient care systems development, could recover approximately \$ two millions in quantifiable benefits. A Canadian hospital study of a similar hospital using the industrial engineers and accountants projected that a yearly \$ 1.3 million savings from a \$ 27 million budget. (25).

The management systems department at ST. Vincent Hospital Massachusetts has done a study which utilizes an Industrial Engineering (Methods Time Measurement) methodology to evaluate four alternative solutions to of improving clerical efficiency to determine the one which most likely to succeed on a cost effective basis in laboratory.

The four alternatives are:

1. Addition of clerical positions.
2. Automation through existing data processing system.
3. Automate through Time-sharing system.
4. Automate through dedicated computer system.

The study has shown that the 4th alternative has greatest impact on clerical efficiency, cost reduction and patient care. (29).

The implementation of the comprehensive medical system may produce different results from that of ECH, because the system was a development al system. The system was being developed at the same time it was being installed and

tested. The findings of this Battelle study are best applied to the hospitals that are of comparable to ECH. Installation of the system now will be at a lower cost as a result of what was learned at the ECH and the decrease in the cost of computer systems since the analysis of the ECH. (22). The computer technology is a valuable too; in the present environment where hospitals are charged with maintaining their quality and service level in the face of increasingly limited resources. This computer technology addresses the issue of quality services level and cost containment in varying degrees. The significant component of a total health care cost is related to recording and processing of information. A well design computerized information system can cut significantly into this cost and at the same time enhance the value of the information supplied. The primary justification of the computer system should lie in improving the quality of patient care and services render by the hospital. The computer system promotes quality mainly by improving timeliness and accuracy of treatment. The timeliness is a critical variable in the patient's treatment in many cases and accuracy is the prerequisite for the good care in all cases to which it is very hard to assign the dollar value. More over system will reduce the errors in transcribing and communicating orders , reduce failures in carrying out physician's orders and reduce nursing staff's administrative time which can be utilized in direct patient care. Whether

or not these goals are worth the costs remains a matter of judgement. The cost reductions are simply the means for obtaining the necessary tools for better patient care. In short the benefits of the computer system are far reaching. Those we can identify include:

1. Reduction in personnel.
2. Reduction in clerical work.
3. Reduction in lost charges. The computer can provide more accurate record keeping which will improve billing and collection. Lost charges are practically non existent with an on-line system since services and supplies are chargeable at the time of orders and all orders are on-line.
4. Minimize errors.
5. Improve work flow.
6. Instantaneous input and retrieval of patient data from numerous remote sites is available.
7. Centralized patient care data.
8. Reduction in patient forms.
9. Reduction in length of patient stay.
10. Improved patient care because of readily available, more complete, more accurate information and better communication and coordination among the nurses, doctors and ancillary services.
11. Better statistics for administrative planning education and research.

SUMMARY:

From gathered information, it appears that hospitals surveyed in the Rochester area do not approach the high degree of computerization characteristic of a model hospital information system. In all of the Rochester Area hospitals a great number of routinized labor intensive tasks (writing and transcribing orders, completing dietary requests, charting patient data) are performed manually. The institutional cost of unnecessary labor must surely be substantial and the cost of the inefficiency and lack of speed consequent to the manual performance of such work functions must surely impact on patient care and increase the risk of human error.

Rochester General Hospital has achieved the greatest degree of computerization, while Highland and Park-Ridge hospitals have very low degree of computerization. However, most of the Rochester area hospitals surveyed, have heavily computerized their billing activities. Nursing and physician duties still remain largely outside the computer system of each hospitals. Utilization of computers for time consuming nursing tasks could substantially relieve the acute nursing shortages which hospitals are now encountering.

Whenever hospital has computerized some functions ,there is little computerized communication between hospital departments. Thus identical patient information is entered on the patient

charts or records by different departments. Certainly, direct computer communication between the departments would eliminate errors and release staff time which could be utilized for research and planning. Furthermore, computers would allow better coordination of tasks thereby promoting an overall improvement in patient care.

In surveyed area hospitals, Genesee Hospital was the first one to use the computer system for its laboratory purposes in the year 1968. In the year 1973 Genesee, Rochester General and Highland Hospitals used shared computer system for their billing functions.

The Rochester General and Strong Hospital has printers in all departments. Genesee Hospital has printers centrally located and in their business offices. Park-Ridge and Highland Hospitals have printers and CRTs in their data processing and admission department. Rochester General, Strong and Genesee Hospitals have well distributed CRTs for effective order entry only.

The Emergency or STAT orders are communicated via computer system through CRTs located in emergency rooms. The test results for STAT are directly printed in the emergency rooms. None of these hospitals have a computerized means to communicate non STAT test results to physicians and nursing stations nor for out-patient departments. The computer printed reports are sent manually.

A few physicians at Rochester General hospital do have terminals in their offices to retrieve patient information and test results only but can not be used for communication purposes. At Rochester General hospital all laboratory test requests from physicians are collected at the nursing floor and then entered into the system by the data entry staff. All other area hospitals physicians orders are sent manually to other departments.

Nursing procedures and clerical functions are overwhelmingly manual. Only at Rochester General Hospital few nursing stations have terminals for data entry and requesting laboratory test requests. None of these hospitals has computer generated schedules or patient care plans.

The Pharmacy Department at Rochester General Strong and Genesee Hospitals have computerized the billing function. At Genesee hospital patient discharge and transfer is printed directly in pharmacy department. At Highland Hospital patient labels are printed by computer system.

The charges for operating and for X-rays (radiology) is done by the computer system at Rochester General, Strong and Genesee hospitals. Only Rochester General has truly computerized the operating room functions like that of model system. The operating schedules are printed and sent to nursing stations and to physicians. The operating room system is integrated with the main system.

The study done by Battelle institute in early 1970's about El Camino (ECH) hospital has shown that the computer technology is available for total a hospital information system. The Techni-con System was being developed at the same time as it was being installed and tested at ECh. Since the computer technology was new in the medical field, the hospital did not pay for the computer system, due to the developmental nature of the system. The payments by the hospital for services would be made only as cost benefits were actually realized.

Since the Battelle's study was made, computer technology has increased in its capacity to encompass complex organizational settings at affordable prices. The technology market is flooded with many information systems and it is very difficult for a hospital to choose the best system. It is better to have a comparative analysis of these systems and include investigation some or all of the following elements for each system:

1. System philosophy.
2. Installations and Progress.
3. Input/Output devices.
4. Hardware configurations.
5. Departments and functions covered.
6. System output.
7. Cost per patient day.
8. Business functions.

Hospital information systems are no longer a new technology which has, therefore, reduced the financial risk of installing the system. The hospitals, which have installed computer system for cost-effectiveness and for better patient care, are pleased with the results. An integrated, health care information system provides an opportunity for achieving significant improvement in the quality of patient care and in productivity. Like other hospitals in the nation, Rochester area hospitals are also installing and developing their information systems department by department. In near future, say with in 3-5 years in my opinion at least two area hospitals will have a total information system for better patient care.

GENESEE HOSPITAL:

Admission:

- (1) How does the admission department communicate or send the admission record to the physician, nursing station and billing department? Is it computerized or manual?

Admission form is printed on-line after on-line admission process. Copies are sent to nursing station and Billing department

- (2) How long do you keep data in the system for admission record?

Basic demographic data and medical record information is kept forever. Complete admission record is purged approximately after 60 days after billing is complete.

- (3) Can a physician access pre-admission record for requesting laboratory test and medication request?

The laboratory maintains a separate master file in which pre-admission test can be requested.

- (4) How is bed number assigned to a patient? Is the bed number assigned automatically by computer system or manual by admission clerk?

Bed is selected by admission clerk based on patient

and or hospital needs and then entered into admission screen.

- (5) How is case number assigned to a patient? Is it given by computer system or by admitting clerk?

Case number is assigned by computer system.

- (6) Who transfers patient and how is information transmitted to other departments?

Admission department is notified of transfer. Clerk then enters into the computer system and notices are printed and distributed.

- (7) What type of information does the computer system prepare after the discharge or expiration of a patient?

Various billing documents UBF, Insurance bills etc. Medical abstract system information. Patient history archive data. Regulatory agency data.

Information desk:

- (1) Does the information desk uses the computer system?

Not at present. Information desk system is under development

- (2) What type of information can the information desk retrieve from the system?

Currently information desk uses census reports only.

Physicians:

- (1) Do the physicians have terminals in their offices?

No.

- (2) How does the physician communicate with the nursing station? Is it computerized or manual?

Manual.

- (3) How does the physician request laboratory tests? Is it computerized manual?

Physician enters request in patient's record at nursing station. nursing station STAFF prepares requisition for laboratory.

- (4) How does the physician request X-rays? Is it computerized or manual?

Physician enters request in patient's record at nursing station nursing station STAFF prepares requisitions for X-Rays.

- (5) How does the physician request medication from pharmacy? Is it computerized or manual?

Physicians enters request in patient's record at nursing station

- (6) How does the physician communicate with operating room? Is it computerized or manual?

Telephone and Manual.

- (7) How does the physician communicate with dietary department? Is it computerized or manual?

Usually dietary orders are handled the same as laboratory orders.

- (8) Is communication between emergency room and the physician computerized or manual?

Manual.

- (9) Does system have information about current articles from journals, antibiotic sensitivities or any other information?

In-house systems does not have such information.

Medical library has access to these types of system.

nursing Station:

- (1) Do the nursing stations have terminals?

Only selected nursing stations currently have terminals. For example ICU, CCU, Ed.

- (2) Is the communication between nursing station and laboratory computerized or not? (requesting lab tests and results)

Generally communication is via phone or delivery of computer generated reports. Selected nursing stations

receive "STAT" reports via computerized system.

- (3) How does the nurse request the X-rays? Is it computerized or manual?

Same as laboratory tests.

- (4) How does the nurse request medication from pharmacy? Is it computerized or manual?

Manual. Nurse calls orders to pharmacy or sends requisition

- (5) How does the nurse communicate with physician? Is it computerized or manual?

Telephone.

- (6) How does the nurse communicate with dietary department? Is it computerized or manual?

Telephone or manual.

- (7) How does the nurse communicate with operating room? Is it computerized or manual?

Telephone.

- (8) Does system print patient care planning? When it is printed?

No.

- (9) Does system print medication schedule at nursing station? When it is printed?

No.

Laboratory:

- (1) Do you have a stand alone laboratory computer system or integrated with the main frame?

System is on hospital main frame but operates largely in a stand alone mode.

- (2) Does system print a list of patients for specimen collection?

No.

- (3) How are stat orders recognized and processed?

Stat orders are flagged and given priority treatment.

- (4) How are Stat results sent? Is it computerized?

For ICU and ED stat results are sent via computer system. all others are called by phone.

- (5) How are lab results communicated to physicians and nursing stations? Is it computerized or manual?

Sent by phone and computer print outs.

- (6) How are patient charges sent to the billing department?

Patient charges are spooled to a magnetic type for entry into billing system.

- (7) How are the outpatient results sent? Is it computerized or manual?

Computer generated reports are usually mailed to physicians.

Pharmacy:

- (1) Does the pharmacy department use the computer system?
Is it stand alone or integrated with main frame?

Pharmacy is notified of discharges and transfers via computer printers.

- (2) How does the pharmacy communicate with doctors and nurses? Is it computerized or manual?

Manual.

- (3) Does system print patient labels?

Not at this time.

- (4) Does system update the drug inventory?

No.

- (5) How are the patient charges sent to the billing department?

Via manually prepared requisitions which are keyed into the system by data entry department.

Radiology:

- (1) Does the radiology department use the computer system?
Is it stand alone or integrated with main frame?

Radiology uses main frame system for patient index

system.

- (2) Are X-rays interpreted by computer or by technicians?

Technicians.

- (3) How are results verified and sent to nurses, physicians or other departments? Is it computerized or manual?

Manual.

- (4) How are outpatient X-ray results are sent?

Manual.

- (5) How are the patient charges are sent to the billing department?

Manually prepared requisitions are keyed by data entry staff.

Operating Room:

- (1) Does the operating room use the computer system? Is it stand alone or integrated with the main system?

Does not presently use system.

- (2) Does the system prints operating schedules?

No.

- (3) How does operating room communicate with physicians and nurses? Is it computerized?

Manual.

- (4) How are patient charges sent to the billing department?
Charges are keyed by data entry staff.

Dietary department:

- (1) Is dietary department computerized?
No.
- (2) Does system print diet requests and when it is printed?
No.
- (3) How are the patient charges sent to billing department?
Charges are keyed by data entry staff.

General questions

- (1) What is the make and model of the system?
IMB 4341. Model 12.
- (2) When did your hospital begin using a computer system?
1973 for hospital Billing as a part of shared system
1968 for laboratory system.
- (3) Are the printers centrally located or in the departments? list departments?
System has centrally located printers for high volume printing and business office areas for specialized functions.

- (4) Are the CRTs centrally located or in the departments?
List the departments?

Approximately 90 CRTs are distributed through out the hospital. Laboratory, X-ray, Business office, Finance and some nursing stations.

- (5) Who can access any patient data?

Laboratory, medical and business staff can access appropriate patient data.

- (6) Do different users have different passwords?

Selected functions are protected by unique passwords.

- (7) What is the response time to access the patient data?

Response time varies depending on data being accessed and the system load. Generally, response time is 1-5 seconds.

Highland Hospital:

Admission:

- (1) How does the admission department communicate or send the admission record to the physician, nursing station and billing department? Is it computerized or manual?

Manual.

- (2) How long do you keep data in the system for admission record?

Till the patient bill is produced which is triggered by the final diagnosis of medical abstract.

- (3) Can a physician access pre-admission record for requesting laboratory test and medication request?

Yes.

- (4) How is bed number assigned to a patient? Is the bed number assigned automatically by computer system or manual by admission clerk?

Manually by type of service needed.

- (5) How is case number assigned to a patient? Is it given by computer system or by admitting clerk?

Admitting clerk.

- (6) Who transfers patient and how is information transmitted to other departments?

Doctors and nursing staff. Manually.

- (7) What type of information does the computer system prepare after the discharge or expiration of a patient?

Total itemized bill, medical abstract.

Information desk:

- (1) Does the information desk uses the computer system?

No.

- (2) What type of information can the information desk retrieve from the system?

None.

Physicians:

- (1) Do the physicians have terminals in their offices?

No.

- (2) How does the physician communicate with the nursing station? Is it computerized or manual?

Manual.

- (3) How does the physician request laboratory tests? Is it computerized manual?

Manual.

(4) How does the physician request X-rays? Is it computerized or manual?

Manual.

(5) How does the physician request medication from pharmacy? Is it computerized or manual?

Manual.

(6) How does the physician communicate with operating room? Is it computerized or manual?

Manual.

(7) How does the physician communicate with dietary department? Is it computerized or manual?

Manual.

(8) Is communication between emergency room and the physician computerized or manual?

Manual.

(9) Does system have information about current articles from journals, antibiotic sensitivities or any other information?

No.

Nursing Station:

(1) Do the nursing stations have terminals?

No.

(2) Is the communication between nursing station and laboratory computerized or not? (requesting lab tests and results)

Manual.

(3) How does the nurse request the X-rays? Is it computerized or manual?

Manual.

(4) How does the nurse request medication from pharmacy? Is it computerized or manual?

Manual.

(5) How does the nurse communicate with physician? Is it computerized or manual?

Manual.

(6) How does the nurse communicate with dietary department? Is it computerized or manual?

Manual.

(7) How does the nurse communicate with operating room? Is it computerized or manual?

Manual.

(8) Does system print patient care planning? When it is printed?

No.

- (9) Does system print medication schedule at nursing station? When it is printed?

No.

Laboratory:

- (1) Do you have a stand alone laboratory computer system or integrated with the main frame?

Stand alone.

- (2) Does system print a list of patients for specimen collection?

Yes.

- (3) How are stat orders recognized and processed?

Stat orders are processed first system.

- (4) How are stat results sent? Is it computerized or manual?

It is sent via system.

- (5) How are lab results communicated to physicians and nursing stations? Is it computerized or manual?

Manual.

- (6) How are patient charges sent to the billing department?

Manually.

- (7) How are the outpatient results sent? Is it computerized or manual?

Manually.

Pharmacy:

- (1) Does pharmacy department use the computer system? Is it stand alone or integrated with main frame?

Manual system.

- (2) How does the pharmacy communicate with doctors and nurses? Is it computerized or manual?

Manual.

- (3) Does system print patient labels?

Yes (from main system).

- (4) Does system update the drug inventory?

No.

- (5) How are the patient charges sent to the billing department?

Manually.

Radiology:

- (1) Does the radiology department use the computer system? Is it stand alone or integrated with main frame?

Manual.

- (2) Are X-rays interpreted by computer or by technicians?

Technicians.

- (3) How are results verified and sent to nurses, physicians or other departments? Is it computerized or manual?

Manual.

- (4) How are outpatient X-ray results are sent?

Manual.

- (5) How are the patient charges are sent to the billing department?

Manual.

Operating Room:

- (1) Does the operating room use the computer system? Is it stand alone or integrated with the main system?

Manual.

- (2) Does the system prints operating schedules?

No. (Manual distribution of schedule.)

- (3) How does operating room communicate with physicians and nurses? Is it computerized or not?

Manual.

- (4) How are patient charges sent to the billing department?

Manually.

Dietary department:

(1) Is your dietary department computerized?

No.

(2) Does system print diet requests and when it is printed?

No.

(3) How are the patient charges sent to billing department?

Manually.

General questions.

(1) What is the make and model of the system?

IBM 4341.

(2) When did your hospital begin using a computer system?

1969.

(3) Are the printers centrally located or in the departments? List departments?

14 terminals. Billing, admitting, accounts payable, payroll, personnel, Medical records and cashiers.

(4) Are the CRTs centrally located or in the departments? List the departments?

Same as 3.

(5) Who can access any patient data?

Billing, admitting, medical records, cashiers.(pertinent data)

(6) Do different users have different passwords?

Yes.

(7) What is the response time to access the patient data?

Few seconds.

PARK-RIDGE HOSPITAL:

Admission:

- (1) How does the admission department communicate or send the admission record to the physician, nursing station and billing department? Is it computerized or manual?

It communicates manually. (but not computerized)

- (2) How long do you keep data in the system for admission record?

2 Years.

- (3) Can a physician access pre-admission record for requesting laboratory test and medication request?

No.

- (4) How is bed number assigned to a patient? Is the bed number assigned automatically by computer system or manual by admission clerk?

Seq. manually by admission clerk.

- (5) How is case number assigned to a patient? Is it given by computer system or by admitting clerk?

By medical record manually.

- (6) Who transfers patient and how is information transmitted to other departments?

By admitting department manually.

- (7) What type of information does the computer system prepare after the discharge or expiration of a patient?

All medical record information.

Information desk:

- (1) Does the information desk uses the computer system?

No.

- (2) What type of information can the information desk retrieve from the system?

None.

Physicians:

- (1) Do the physicians have terminals in their offices?

No.

- (2) How does the physician communicate with the nursing station? Is it computerized or manual?

Manual.

- (3) How does the physician request laboratory tests? Is it computerized or manual?

Manual.

- (4) How does the physician request X-rays? Is it computerized or manual?

Manual.

- (5) How does the physician request medication form pharmacy? Is it computerized or manual?

Manual.

- (6) How does the physician communicate with operating room? Is it computerized or manual?

Manual.

- (7) How does the physician communicate with dietary department? Is it computerized or manual?

Manual.

- (8) IS communication between emergency room and the physician computerized or manual?

Manual.

- (9) Does system have information about current articles from journals, antibiotic sensitivities or any other information?

No.

Nursing Station:

- (1) Do the nursing stations have terminals?

No.

- (2) Is the communication between nursing station and laboratory computerized or not? (requesting lab tests

and results)

Not.

- (3) How does the nurse request the X-rays? Is it computerized or manual?

Manual.

- (4) How does the nurse request medication from pharmacy? Is it computerized or manual?

Manual.

- (5) How does the nurse communicate with physician? Is it computerized or manual?

Manual.

- (6) How does the nurse communicate with dietary department? Is it computerized or manual?

Manual.

- (7) How does the nurse communicate with operating room? Is it computerized or manual?

Manual.

- (8) Does system print patient care planning? When it is printed?

No.

- (9) Does system print medication schedule at nursing station? When it is printed?

No.

Laboratory:

- (1) Do you have a stand alone laboratory computer system or integrated with the main frame?

None.

- (2) Does system print a list of patients for specimen collection?

No.

- (3) How are stat orders recognized and processed?

N/A.

- (4) How are stat results are sent? Is it computerized?

No. Manually.

- (5) How are lab results communicated to physicians and nursing stations? Is it computerized or manual?

Manually.

- (6) How are patient charges sent to the billing department?

On charge cards.

- (7) How are the outpatient results sent? Is it computerized or manual?

Manually.

Pharmacy:

- (1) Does pharmacy department use the computer system? Is it stand alone or integrated with main frame?

None.

- (2) How does the pharmacy communicate with doctors and nurses? Is it computerized or manual?

Manually.

- (3) Does system print patient labels?

N/A.

- (4) Does system update the drug inventory?

N/A.

- (5) How are the patient charges sent to the billing department?

Manually.

Radiology:

- (1) Does the radiology department use the computer system? Is it stand alone or integrated with main frame?

None.

- (2) Are X-rays interpreted by computer or by technicians?

N/A. (technicians)

- (3) How are results verified and sent to nurses, physicians or other departments? Is it computerized or manual?

Manually.

- (4) How are outpatient X-ray results are sent?

N/A.

- (5) How are the patient charges are sent to the billing department

On charge cards.

Operating Room:

- (1) Does the operating room use the computer system? Is it stand alone or integrated with the main system?

None.

- (2) Does the system prints operating schedules?

N/A.

- (3) How does operating room communicate with physicians and nurses? Is it computerized or not?

Manual.

- (4) How are patient charges sent to the billing department?

On charge cards.

Dietary department:

(1) Is your dietary department computerized?

No.

(2) Does system print diet requests and when it is printed?

None.

(3) How are the patient charges sent to billing department?

On charge cards.

General questions.

(1) What is the make and model of the system?

Four phase IV-90.

(2) When did your hospital begin using a computer system?

1978.

(3) Are the printers centrally located or in the departments? List departments?

Data processing department only.

(4) Are the CRTs centrally located or in the departments? List the departments?

Departments Admission, billing, Medical record, payroll, inventory, accounting and data processing.

(5) Who can access any patient data?

Admissions. Medical record.

(6) Do different users have different passwords?

Yes.

(7) What is the response time to access the patient data?

15 seconds.

ROCHESTER GENERAL HOSPITAL.

Admission:

- (1) How does the admission department communicate or send the admission record to the physician, nursing station and billing department? Is it computerized or manual?

Computerized reports are printed. Copies are sent to physicians and nursing stations billing and other departments manually.

- (2) How long do you keep data in the system for admission record?

Until 10 days after discharge for some data. Medical records keeps abstract data on the system for 18 months. All patient history is saved on tapes permanently.

- (3) Can a physician access pre-admission record for requesting laboratory test and medication request?

Yes.

- (4) How is bed number assigned to a patient? Is the bed number assigned automatically by computer system or manual by admission clerk?

Admission clerk.

- (5) How is case number assigned to a patient? Is it given by computer system or by admitting clerk?

Admission clerk.

- (6) Who transfers patient and how is information transmitted to other departments?

Nursing stations notify the admitting department which makes the changes in the system. User departments (Lab, Dietary, Pharmacy, X-ray etc) have access to the patient record with the new location.

- (7) What type of information does the computer system prepare after the discharge or expiration of a patient?

Bills, medical record abstracts, summary statistics.

Information desk:

- (1) Does the information desk uses the computer system?

Yes.

- (2) What type of information can the information desk retrieve from the system?

Patient's demographic data, location, condition, next of kin, diagnosis, surgical schedule, religion etc.

Physicians:

- (1) Do the physicians have terminals in their offices?

Very few.

- (2) How does the physician communicate with the nursing station? Is it computerized or manual?

Manually.

- (3) How does the physician request laboratory tests? Is it computerized or manual?

Lab tests are requested automatically through a data collection terminal on the floor.

- (4) How does the physician request X-rays? Is it computerized or manual?

Manually.

- (5) How does the physician request medication from pharmacy? Is it computerized or manual?

Manually.

- (6) How does the physician communicate with operating room? Is it computerized or manual?

Manually.

- (7) How does the physician communicate with dietary department? Is it computerized or manual?

Manually.

- (8) Is communication between emergency room and the physician computerized or manual?

Manually.

- (9) Does system have information about current articles from journals, antibiotic sensitivities or any other information?

No.

Nursing Station:

- (1) Do the nursing stations have terminals?

Yes. They are used only for data input at present time.

- (2) Is the communication between nursing station and laboratory computerized?

Lab tests are requested by the computer system.

- (3) How does the nurse request the X-rays? Is it computerized or manual?

Manually.

- (4) How does the nurse request medication from pharmacy? Is it computerized or manual?

Manually.

- (5) How does the nurse communicate with physician? Is it computerized or manual?

Manually.

- (6) How does the nurse communicate with dietary department? Is it computerized or manual?

Manually.

- (7) How does the nurse communicate with operating room? Is it computerized or manual?

Manually.

- (8) Does system print patient care planning? When it is printed?

No.

- (9) Does system print medication schedule at nursing station? When it is printed?

No.

Laboratory:

- (1) Do you have a stand alone laboratory computer system or integrated with the main frame?

Integrated with main fram.

- (2) Does system print list a of patients for specimen collection?

Yes.

- (3) How are stat orders recognized and processed?

Stat orders are coded and processed as soon as received in the lab. When the results are ready, they are sent directly to printers located in the departments that have printers.(Emergency room, Critical care

unit, Medical intensive care unit, Surgical intensive care unit, ECU).

(4) How are the stat results sent? Is it computerized?

Yes.

(5) How are lab results communicated to physicians and nursing stations? Is it computerized or manual?

Non stat results are manually sent to physicians and nursing station.

(6) How are the outpatient results sent?

Manually.

(7) How are patient charges sent to the billing department?

Charges are automatically generated when the results are put in the system.

Pharmacy:

(1) Does pharmacy department use the computer system? Is it stand alone or integrated with main frame?

No pharmacy order system. System is used for billing.

(2) How does the pharmacy communicate with doctors and nurses? Is it computerized or manual?

Manually.

(3) Does system print patient labels?

No.

(4) Does system update the drug inventory?

No.

(5) How are the patient charges sent to the billing department?

Entry of charge data done by pharmacy technician on terminals located in the pharmacy.

Radiology:

(1) Does the radiology department use the computer system?
Is it stand alone or integrated with main frame?

Radiology does have a computer system. Main system is used for billing purposes.

(2) Are X-rays interpreted by computer or by technicians?

Technicians interpret the results.

(3) How are results verified and sent to nurses, physicians or other departments? Is it computerized or manual?

Manual.

(4) How do you send out-patient X-ray results? Is it computerized or manual?

Printed results are sent manually.

- (5) How are the patient charges are sent to the billing department?

Charges are entered by technician on the terminals located in the department.

Operating Room:

- (1) Does the operating room use the computer system? Is it stand alone or integrated with the main system?

Integrated with main system.

- (2) Does the system prints operating schedules?

Yes.

- (3) How does operating room communicate with physicians and nurses? Is it computerized or not?

Computer printed reports are sent. Reports are printed in data processing departments.

- (4) How are patient charges sent to the billing department?

Charges are sent on line entry.

Dietary department:

- (1) Is your dietary department computerized?

Limited to diet order sheets and inquiry into patient files.

- (2) Does system print diet requests?

Yes.

- (3) How does dietary department receives diet orders from nurses and physicians? Is it computerized or manual?

Computerized reports are printed daily which is completed by the patients and sent manually to dietary department from data processing department.

- (4) How are the patient charges sent to billing department?

Dietary charges are included in the room charges.

General questions.

- (1) What is the make and model of the main system?

Digital equipment corp. DEC system KL 1091-E.

- (2) When did your hospital begin using a computer system?

In the year 1970.

- (3) Are the printers centrally located or in departments?
list the departments?

16 printers. Lab, Admitting, Emergency, CCU, MICU, ECU, SICU, and Data processing department.

- (4) Are the CRTs centrally located or in the departments?
List the departments?

55 CRTs. Lab, Admitting, Emergency, Operating Room, X-rays, Dietary, Accounting, Business office, Telephone office, Data processing, Medical library, Public safety, Information desk, Medical Records, Pharmacy, Radiation therapy, Personnel, Engineering, Material

handling.

(5) Who can access any patient data?

Users with proper authorization and account numbers and passwords can access the data.

(6) Do different users have different passwords?

Yes.

(7) What is the response time to access the patient data?

2 to 4 Seconds.

STRONG MEMORIAL HOSPITAL:

Admission:

- (1) How does the admission department communicate or send the admission record to the physician, nursing station and billing department? Is it computerized or manual?

A copy of each admission document prints automatically in billing department and 3 copies in medical records. One of these copies is sent by pneumatic tube to the nursing station and one is placed in patient chart.

- (2) How long do you keep data in the system for admission record?

All data remains on-line 14 days past patient discharge and most of it (patient address, insurance data etc) remains accessible (by ISAM retrieval) for 2 yrs. Data that does not tend to change (patient name, birth date, social security number and parent's name) is never deleted.

- (3) Can a physician access pre-admission record for requesting laboratory test and medication request?

Not at this time. With system capabilities we currently have operational.

- (4) How is bed number assigned to a patient? Is the bed number assigned automatically by computer system or manual by admission clerk?

A current list of all unoccupied beds on each nursing station is retrieved at admission time from which the admission clerk selects the bed which the patient will occupy.

- (5) How is case number assigned to a patient? Is it given by computer system or by admitting clerk?

If the patient has been seen at the hospital at any time prior to this admission, he will receive a unique medical record number.(7 Digits). This number is retrieved and a visit modifier is added to it.(6 digit julian date). If it is a first visit the computer assigns the next sequential 7 digit number and adds the julian date to it.

- (6) Who transfers patient and how is information transmitted to other departments?

The patients are transferred from bed to bed within the nursing unit or from unit to unit and the unit secretary notifies the admission office. The transfers are input to the computer system and transfer notices print out is forwarded to nursing unit.

- (7) What type of information does the computer system prepare after the discharge or expiration of a patient?

A discharge notice prints showing date and time of discharge or expiration which prints in the medical records and billing offices.

Information desk:

- (1) Does the information desk uses the computer system?

Yes.

- (2) What type of information can the information desk retrieve from the system?

Patient name, location in hospital house address, condition date of surgery, phone in room indicator, visitor indicator, admission date and time, attending physician.

Physicians:

- (1) Do the physicians have terminals in their offices?

No.

- (2) How does the physician communicate with the nursing station? Is it computerized or manual?

Manual.

- (3) How does the physician request laboratory tests? Is it computerized or manual?

Manual.

- (4) How does the physician request X-rays? Is it computerized or manual?

Manual.

- (5) How does the physician request medication from pharmacy? Is it computerized or manual?

Manual.

- (6) How does the physician communicate with operating room? Is it computerized or manual?

Manual.

- (7) How does the physician communicate with dietary department? Is it computerized or manual?

Manual.

- (8) Is communication between emergency room and the physician computerized or manual?

Manual.

- (9) Does system have information about current articles from journals, antibiotic sensitivities or any other information?

No.

Nursing Station:

(1) Do the nursing stations have terminals?

No.

(2) Is the communication between nursing station and laboratory computerized or not? (requesting lab tests and results)

No.

(3) How does the nurse request the X-rays? Is it computerized or manual?

Manual.

(4) How does the nurse request medication from pharmacy? Is it computerized or manual?

Manual.

(5) How does the nurse communicate with physician? Is it computerized manual?

Manual.

(6) How does the nurse communicate with dietary department? Is it computerized or manual?

Manual.

(7) How does the nurse communicate with operating room? Is it computerized or manual?

Manual.

(8) Does system print patient care planning? When it is printed?

No.

(9) Does system print medication schedule at nursing station? When it is printed?

No.

Laboratory:

(1) Do you have a stand alone laboratory computer system or integrated with the main frame?

Stand alone.

(2) Does system print a list of patients for specimen collection?

Yes.

(3) How are stat orders recognized and processed?

Requisition of stat orders are sent manually to lab than it is processed.

(4) How are stat results sent? Is it computerized or manual?

On a special printers located at ICU and emergency rooms.

(5) How are lab results communicated to physicians and nursing stations? Is it computerized or manual?

Manual.

(6) How are patient charges sent to the billing department?

On-line tapes are created and are sent to billing department.

(7) How are the outpatient results sent? Is it computerized or manual?

Print outs are sent manually.

Pharmacy:

(1) Does pharmacy department use the computer system? Is it stand alone or integrated with main frame?

Integrated though at this time they only retrieve data on patient location.

(2) How does the pharmacy communicate with doctors and nurses? Is it computerized or manual?

Manual.

(3) Does system print patient labels?

No.

(4) Does system update the drug inventory?

No.

(5) How are the patient charges sent to the billing department?

In most areas they are input on-line but charge

clerks in clinics and ancillary areas.

Radiology:

- (1) Does the radiology department use the computer system?
Is it stand alone or integrated with main frame?

To retrieve patient data only.

- (2) Are X-rays interpreted by computer or by technicians?
Technicians.

- (3) How are results verified and sent to nurses, physicians
or other departments? Is it computerized or manual?
Manual.

- (4) How are outpatient X-ray results are sent?
Manual.

- (5) How are the patient charges are sent to the billing
department?
On-line charge entry.

Operating Room:

- (1) Does the operating room use the computer system? Is it
stand alone or integrated with the main system?

For charging patient data only.

- (2) Does the system print operating schedules?
No.

- (3) How does operating room communicate with physicians and nurses? Is it computerized or not?

Manually.

- (4) How are patient charges sent to the billing department?

On-line charge entry.

Dietary department:

- (1) Is your dietary department computerized?

No.

- (2) Does system print diet requests and when it is printed?

The system prints a diet order list which only contains patients within each nursing unit. The dieticians fill it in manually.

- (3) How are the patient charges sent to billing department?

Manually.

General questions.

- (1) What is the make and model of the system?

We have a Techicon Medical Information system which runs on a NAS AS-5 machine.

- (2) When did your hospital begin using a computer system?

January 1979.

- (3) Are the printers centrally located or in the departments? List departments?

Departments. Admissions, Billing offices, Medical records, Emergency, Out-patient registration, Clinical areas, Ancillary areas, Pharmacy(In and out patients) Directors office.

- (4) Are the CRTs centrally located or in the departments? List the departments?

They are located in the same departments as the printers.

- (5) Who can access any patient data?

Currently the registration clerk can access admission data. Charge entry clerk can access patient name, location and prior charges.

- (6) Do different users have different passwords?

Each user has a unique password.

- (7) What is the response time to access the patient data?

Present response time (during peak hrs) is 5-6 seconds.

GLOSSARY:

Access time: The time required for a device to receive or transmit data after receiving the associated command.

Batch processing: The organization of the work of a computer in such a way that the work is collected and fed into the system in batches, for processing as a single unit. Common areas of a hospital applications are payroll, billing, accounts receivable & payable.

Communication: The process of transferring information among people, devices or locations.

Disk storage: A storage device with magnetic recording on a flat rotating disk.

Data flow: A pipe line along which information of known composition is passed.

Data flow diagram: A graphic tool that represents data flow and transforms in a process. A network of related functions showing all interfaces between components parts.

Information: A meaningful aggregation of data or knowledge which can be evaluated for a specific use or set of uses.

Mini-computers: A small data processing unit that contains an internal memory and can accept other peripheral devices such as disk storage, line printers, magnetic tap units etc.

Operating System: A set of intergrated subroutines and programs which control th operation of a computer carrying out such functions as execution of computer programs, input/output control, job scheduling and language

translation.

Sequential access: Access to any section of memory is not possible without having to pass through all the sections physically intervening between the required section and the present position of the read or write head.

Stand-alone: A mini-computer system, address a single application area and is dedicated to that application only.

Time-sharing: A system of allocating certain hard-ware devices in sequenc to concurrently running programs, receives a similar short period of access.

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