FINAL REPORT

on

EVALUATION OF THE IMPLEMENTATION OF A MEDICAL INFORMATION SYSTEM IN A GENERAL COMMUNITY HOSPITAL

to

NATIONAL CENTER FOR HEALTH SERVICES RESEARCH
THE HEALTH RESOURCES ADMINISTRATION
DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

December 19, 1975

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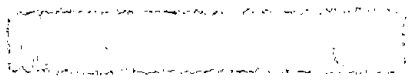

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ABSTRACT

TITLE: Evaluation of the Implementation of a Medical Information System in a General Community Hospital

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SUBJECT: Introduction
Conclusions and Recommendations
Summary of Results
Analysis of Changes in Staffing Levels
Nursing Activity Analysis
Nursing and Other Hospital, Staff Attitudes and Acceptance of MIS
Physicians Use of Hospital Services
Physicians Attitudes and Acceptance of MIS
Comparative Analysis of Medical Orders for Accuracy and Completeness
Selected Performance Indications
Qualitative Assessment of MIS in the Ancillary and Support Areas

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ABSTRACT: Presents the results of the evaluation of the impact of a medical information system (MIS) on the operation and organization of El Camino Hospital, Mountain View, California

FOREWORD

This final report presents results of a four year evaluative study of Technicon's Medical Information System (MIS) implemented at the El Camino Hospital, Mountain View, California. It supercedes the Battelle Interim Report released on September 30, 1973. In our opinion the conclusions reached in this report accurately represent the impact of this hospital information system at this hospital. Some of the studies undertaken had to be done less rigorously than was previously planned. We feel, however, that the overall evaluation effort is the most comprehensive study of its kind completed thus far and represents a benchmark for future evaluations of this technology.

The reader will find but little coverage of the cost benefits implication of this system at the El Camino Hospital and what is present is of an indirect nature. This omission was not an oversight in the evaluation plan; operational constraints made it necessary to delay this portion of the study. A detailed look at the cost implications of the Technicon MIS system at the El Camino Hospital is in progress and the final report of this study should be available in mid 1976.

Finally, the results of this report are not intended as an endorsement of this specific hospital information system. The purpose of this evaluation is to provide objective information to all interested parties on how this technology has affected a general community hospital. We feel that this report and future studies at different sites will provide the support for the evolution of increasingly productive and effective information systems for use in the health services community.

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EVALUATION OF THE IMPLEMENTATION OF A MEDICAL INFORMATION SYSTEM IN A GENERAL COMMUNITY HOSPITAL

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1.0 INTRODUCTION

This final report presents the findings of the evaluation of the impact of the Technicon Medical Information System (MIS) on El Camino Hospital (ECH) in Mountain View, California, 1971-75.[1] The system has been fully operational at ECH for 3 years. This report provides a comprehensive documentation of the evaluation effort from July 1, 1971, through June, 1975, covering system development, implementation, and operational periods of MIS. (See Figure 1-1.) This report does not cover the economic impact of MIS. However, the results of an indirect study related to staffing levels analyzed by Battelle is discussed in this report. In July, 1975, Battelle initiated a study on the cost-benefits of the system which will examine the full economic impact of MIS on ECH. The report on this study will be completed in June, 1976.

The major objective of the research was to evaluate the impact of the Technicon MIS on the organization and administration of health care delivery at ECH. The Technicon MIS is a real time, computer based system that nurses, physicians, other health care professionals, and the hospital administration interact with in the delivery of health care to patients. The system affects all facets of the highly complex hospital environment. In order to attain the major objective of this research project, several subobjectives were pursued including determining changes in the organization of staff and their activities, attitudes and acceptance of MIS, the effectiveness of the performance of MIS and changes in accuracy and completeness of information.

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(1) The Battelle interim report "Evaluation of the Implementation of a Medical Information System in a Community Hospital" to The National Center for Health Services Research and Development, September 30, 1973, presents findings for the first two years of research (1971 to 1973). Vol. I PB232784, Vol. II PB232785, NTIS.

This report is organized according to the studies performed. Analysis of staffing patterns is presented first followed by nursing activity analysis, and studies on the direct use of the system by the medical staff. Finally, special studies consider the performance of MIS and its impact on ancillary and support services.

Appendix A presents a chart showing the time span for major components of the evaluation. Appendix B presents a discussion of the background and a description of the implementation process. Appendices C through E contain the 1974 questionnaires and tabulations of responses. Appendix F presents the MIS input and retrieval capabilities by class. Appendix G presents the forms used in data collection for comparative analysis of medical records. A description of the Technicon Medical Information System at ECH is provided in Appendix H.

1.1 Background on HEW Study

The rapidly increasing costs of hospital care have been of major concern at the national level. One of the primary factors in increasing hospital costs is the cost associated with the transfer and handling of information about patients and their care. Another major concern is the rapid and accurate handling of information to assure a high quality of patient care including completeness of medical orders, reduction of medication errors and minimizing turn-around-time of orders to ancillary and support services. In early 1971, the Health Care Technology Division of the National Center for Health Services Research and Development (Department of Health, Education, and Welfare--HEW) undertook a program to demonstrate and evaluate the effectiveness of hospital information systems in meeting the needs of hospitals for rapid and accurate processing of patient care information.

The experiences in general with hospital information systems up to that point in time had not been encouraging. An attempt to place teletype terminals at the nursing stations in a large general hospital in 1963 had been unsuccessful. Two other hospital information system projects were not particularly successful at that time, and later would face serious retrench-

ment. However, by early 1971, there were several other full-scale information systems that had reached a demonstrable stage in a hospital.(2)

In June, 1971, El Camino Hospital using the Technicon Medical Information System was selected by the National Center for Health Services Research (NCHSR) to demonstrate and evaluate a total hospital information system. El Camino and Technicon were selected in competition with other hospitals using, or planning to use, nearly every other total hospital information system then operational, or near the implementation phase.

In late July, 1971, the Battelle Columbus Laboratories (BCL) were awarded a contract by NCHSR to assess the impact of MIS at the El Camino Hospital. The BCL project team had primary responsibility for areas other than the economic analysis.

Because of the unique contract arrangement between ECH and Technicon in 1971 which allowed the hospital to pay Technicon on the basis of savings documented by the hospital "cost bureau", ECH did not agree with preliminary plans which would allow BCL to conduct a cost benefits study at the hospital. Consequently, the systems engineering staff of El Camino Hospital had primary responsibility for evaluating the impact of MIS on hospital costs. As a result of a new contract arrangement which eliminated the measurement of economic benefits as a contractual issue between the hospital and Technicon, NCHSR initiated a comprehensive cost-benefit analysis of MIS at El Camino in July, 1975. The report of this study will be completed in June, 1976.

The scope of this report does not include analysis of the system hardware, configuration, etc., or the software operating system.

The admissions department of ECH began to use MIS in December, 1971. In early January, 1972, implementation of MIS on the first nursing station occurred, with the phased implementation in the service areas to support the nursing stations. Complete implementation of MIS in all the hospital areas was completed in October, 1972.

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(2) U.S. Public Health Service, National Center for Health Services Research and Development, Comprehensive Hospital Computer Applications Program, (National Technical Information Service, PB-211690), Volume II, April, 1972, pp. 255-269.

1.2 Background on ECH and the Technicon MIS

El Camino Hospital is a 464 bed, 52 bassinet, nonprofit, tax-supported (district), short-term, general community hospital serving patients under the care of their own personal physicians. Opened in 1961, the hospital primarily serves the California suburban communities of Mountain View, Sunnyvale, Los Altos, Los Altos Hills, and Cupertino, and certain unincorporated areas adjacent to these cities. Employment in the area is concentrated in the aerospace and electronics industry particularly the manufacture of semiconductors.

Patient days for 1975 totalled 119,924, and there were 25,229 admissions including newborns in the same period. The average length of patient stay was 4.75 days for adults and children.

Table 1-1 presents selected ECH activity statistics for the time period before implementation through full operation of the system.

ECH has 307 physicians on the active medical staff, 59 associate staff members and an additional 154 have courtesy staff privileges. All of the recognized medical specialties and many of the subspecialties are represented on the medical staff. ECH does not have an internship or residency program.

TABLE 1-1. EL CAMINO HOSPITAL STATISTICS FY 1970-FY 1975

	1970	1971	1972	1973	1974	1975
Number of Admissions	22,349	22,726	22,918	23,792	24,663	25,229
Number of Patient Days	124,169	121,028	120,362	121,553	122,736	119,924
Number of Emergency Room Visits	24,827	25,448	26,974	31,947	34,836	34,771
Number of Laboratory Procedures (excludes Blood Bank)	181,085	198,774	206,900	210,907	216,827	225,450
Number of Radiology Procedures (excludes Nuclear Medicine)	50,250	54,655	58,834	59,814	66,217	71,101

In 1974, total hospital staffing averaged 995 full-time-equivalents (FTE), or 2.14 FTE per bed. The nursing department represents the largest segment of employees with 455 FTE.

Included in the services of the hospital are acute cardiac and intensive care, psychiatric facilities, renal dialysis, and the latest inpatient and outpatient ancillary services. Diagnostic, surgical, and nursing facilities are also available for open-heart surgery patients. Area physicians also use the hospital for such diagnostic procedures as heart catheterization, electromyographic analysis of nerve function, blood gases, and radioactive isotope studies of various body organs. Since 1972, ambulatory surgery services have been added, total joint replacement surgery is available and the artificial kidney unit (AKU) has been expanded. Many of these services were initiated or expanded during the course of this study, thus the favorable impact of MIS is probably understated as it has occurred concurrently with increasing patient dependency due to the increased complexity of services rendered.

El Camino Hospital is currently completing an expansion program. A new, expanded emergency department and the relocation and expansion of the intensive care unit was completed in February, 1975. Construction will be completed for expansion of the Radiology Department in November, 1975. In addition, the OB-GYN nursing units have been redesigned and expanded to provide flexible utilization depending on the fluctuating needs for maternity and GYN patients.

Although the hospital is not associated with a medical school, it does participate in several teaching programs. The nursing service department carries on a continuing in-service education program utilizing video tape equipment, classroom situations, and on-the-job training to keep abreast of medical progress. De Anza College uses the hospital for practical training of students in their school of nursing. Foothill College uses ECH for training inhalation therapists. San Jose City College rotates nursing students through the psychiatric department. There is a nurses assistant training program in cooperation with adult education programs of Los Altos/Mountain View, and Palo Alto school districts. The University of California at San Francisco has Master of Science in Nursing Practices with ECH. In addition, the hospital has an in-house 52 week school for medical technicians.

Figure 1-1 presents a chronology of major project events. The hospital and medical staffs at ECH began working in 1965 with personnel of Lockheed Missiles and Space Company (LMSC) to assist in defining the requirements for an automated hospital information system. The hospital served as the pilot for the actual demonstration and evaluation of the clinical and business office elements of the system. Operation of the business office system began at the hospital in November, 1967.

In 1967, development continued by LMSC on the clinical elements of the system. During this period, there was much active participation by the El Camino Hospital staff in the evolution of the system design. On-line display and printer terminals were first installed in the hospital in 1968 in the physicians' lounge and at a nursing station to make it possible for the hospital staff to have direct interaction with the system. These terminals were linked by wide-band communication lines to the dedicated medical computer facility located at Mountain View, California. As system development continued in 1969, terminals were installed in six service areas and at an additional nursing station. This led progressively to the following activities:

(1) Pilot parallel operations on a limited basis in the six service areas and two nursing stations in 1969 and 1970

(2) During April, 1970, four physicians were trained in the use of the system. Each of the physicians then used the system in parallel to enter all orders for one or two patients during their hospital stay.

(3) For a one-month period beginning in August, 1970, all portions of MIS except nurses notes were operated in parallel on one medical nursing station.

(4) In April-June, 1970, the hospital staff devoted approximately eighteen man-months of effort to evaluate the economic implications of the system for ECH, and a proposal from LMSC for full implementation of the system.

The hospital initially signed a contract with Technicon Medical Information Systems Corporation in May, 1971, under which the installation of the system was made.[3] This initial contract contained an important

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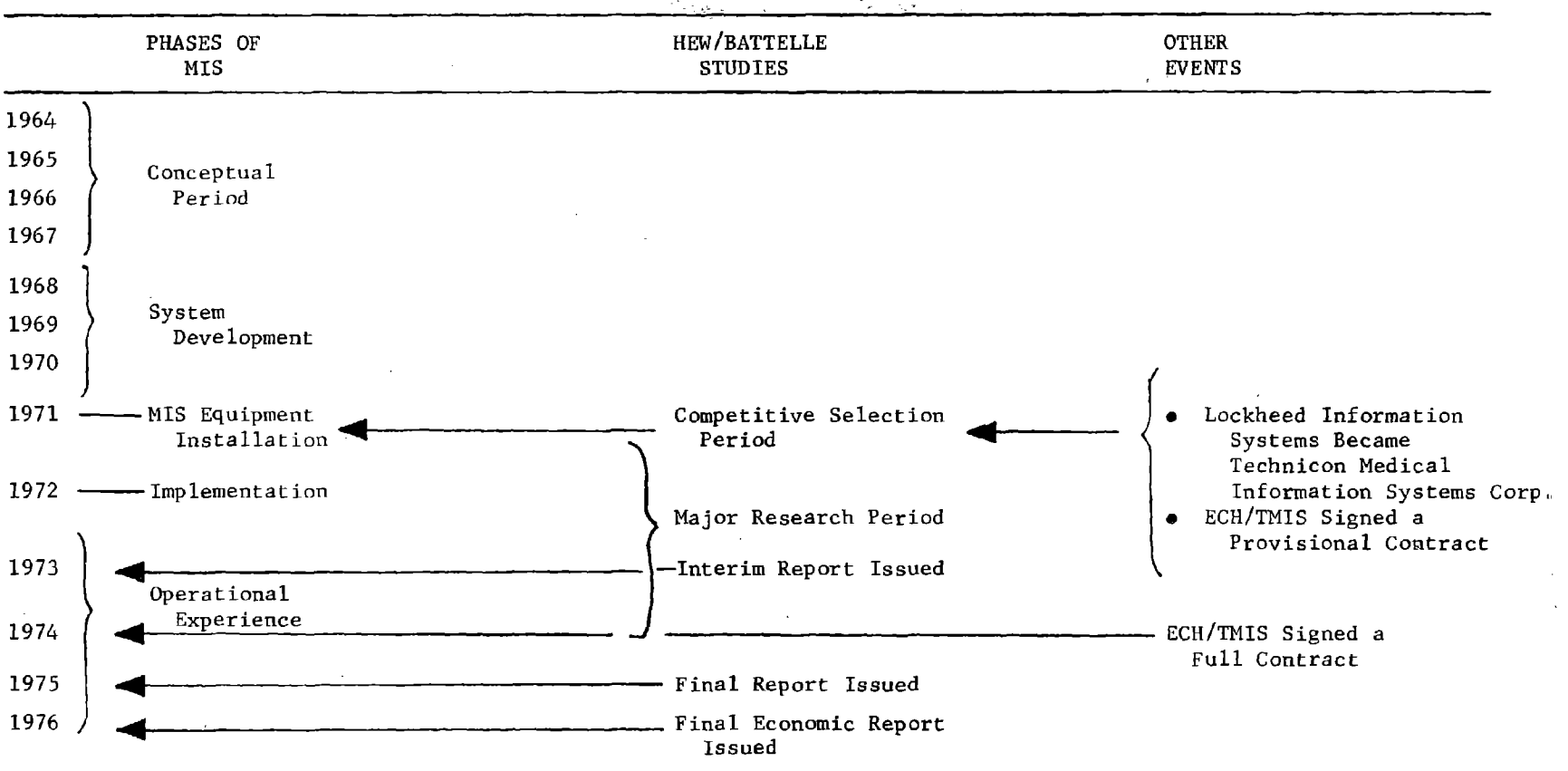
(3) The Lockheed Information Systems Division was acquired from the Lockheed Missiles and Space Company by Technicon Corporation and established as Technicon Medical Information Systems Corporation in May, 1971.

FIGURE 1-1. CHRONOLOGY OF MAJOR PROJECT EVENTS



provision permitting the hospital to defer any portion of Technicon's fee not matched by cost savings as measured by the hospital. In 1974, based on a cost study conducted by the hospital which indicated cost savings through the use of MIS, a new five-year, fixed-price contract was entered into with Technicon in August, 1974, replacing the earlier agreement. The HEW demonstration and evaluation projects at the hospital were initiated in July, 1971; the demonstration contract with ECH was completed in November, 1974; the Battelle evaluation contract (not including the cost-benefits study) was completed in July, 1975; and the cost-benefits study will be completed in June, 1976.

Subsequent to installation at El Camino Hospital, MIS has been selected for installation in a number of other hospitals, most recently the Clinical Center of the National Institutes of Health.

1.3 Factors Affecting the Study

The analysis of all study areas discussed in this report has been completed. However, as discussed earlier, Battelle initiated an independent cost-benefits analysis in July, 1975. This study will be completed in June, 1976.

The reader also should take into account that the evaluation is based on the first hospital implementation of the System. During the evaluation period, applications development of the system continued, and a number of changes at the 'user interface' were made to correct problems or to make improvements.

The environment of the evaluation has been affected, to some degree, by other factors. Various aspects of the hospital, even without MIS, are nonstationary over time. For example, the cost of ancillary services per patient day has had a continuing growth pattern due to changes in the number of services available, the complexity (and cost) of services, etc. Similarly, the average length of patient stay has had a decreasing pattern, and in addition to MIS, is influenced by the utilization review process, and other factors. These types of non-MIS related changes make it very difficult to interpret, and in many cases impossible to isolate, the effect of MIS.

Another factor affecting the evaluation effort was the initial 'lead time' available before phased implementation of the system was

scheduled to begin. In early August, 1971, when the evaluation effort was initiated, the first nursing station was scheduled for implementation in October, with concurrent incremental implementation in the ancillary service areas. The training of the nursing staff in the use of MIS had started, and the training of the medical staff was to begin soon. Consequently, the available time for obtaining some of the pre-implementation data was very short, and in certain areas pre-implementation samples or responses were not attainable with the projected lead time. For example, in the case of staff questionnaires a response to only the 'attitude' questionnaires was possible before implementation of MIS was scheduled to begin. Even in this area, it was necessary to obtain the first response after scheduled training was completed (but before implementation began) so nursing, medical, and other hospital staff, were at a common point with respect to average exposure and interaction with the system.

1.4 Time Span for Components of Evaluation

Figure A-1, Appendix A, is a chart showing the time span for the major components of the evaluation. The time chart is organized according to the several impact areas which comprise the research effort beginning in December, 1973.

Despite these complicating factors, Battelle feels that this report presents a definitive discussion of the results of the evaluation of the impact of a comprehensive medical information system used directly by nurses, physicians, and other professionals in the delivery of patient care in a short-term general hospital. These findings are not meaningful in evaluation of the impact of other types of hospital information systems, particularly those utilizing data terminal operators or those limited to business office procedures. Similarly, caution should be exercised in interpreting these findings for application of computers to hospitals in other environments.

2.0 CONCLUSIONS AND RECOMMENDATIONS

The objective of this research was to evaluate the impact of the Technicon Medical Information System (MIS) on the organization and administration of El Camino Hospital, a 464 bed suburban community hospital located in Mountain View, California. The Technicon MIS is a dynamic interactive computer information system which automates substantially all clinical and administrative information handling and interfaces with the nurse, the physician, the clinical laboratory, the pharmacy, radiology, and other medical services and with the administrative functions of the hospital, such as admissions, business office, and medical records.

The system has undergone major changes since installation in 1971 in response to both the needs of the hospital and the learning process associated with its initial implementation at this hospital. The hospital itself has experienced major changes over the same time period including the addition of transitional care and intensive care beds, ambulatory surgery service, and sophisticated new procedures such as cardiac surgery, total hip replacement, and kidney dialysis.

Battelle conducted a comparative evaluation of the effects of the system during the chronological phases of implementation of MIS; namely, (1) the pre-MIS hospital environment (baseline data), (2) early implementation of MIS (the transitional period), (3) full implementation of MIS, and (4) the post-MIS hospital environment. The impact of the system tends to affect all facets of the highly complex hospital environment. Thus, the studies pursued by Battelle are necessarily complex in their design, findings, and interpretation.

This section presents Battelle's major conclusions and recommendations to HEW, based on the findings of this study.

2.1 Conclusions

1. The Technicon Medical Information System (MIS) has had a demonstrably favorable impact on the organization and administration of El Camino Hospital. (Reference Sections 4, 5, 10, and 11.)

2. The results of this study indicate that the implementation of MIS has improved the ability of the El Camino Hospital staff to deliver patient

care as measured by more readily available, more complete, and more accurate information used for administering care and for monitoring patient progress. Moreover, the timeliness of the administration of tests and procedures has generally improved because of better communication and coordination made possible by MIS among nurses, doctors, and supporting hospital departments. (Reference Sections 9 and 10.)

3. Nurses, physicians, and other hospital staff have adjusted to MIS. While nurses and technologists adapted more quickly than physicians, MIS is now supported by a substantial majority of the medical staff and used directly by 78 percent of the physicians at the hospital. Moreover, attitude and use among all groups continue to improve with time. The fact that MIS is oriented toward direct use by nurses and physicians, rather than communicating through non-medical intermediaries, has been crucial to achieving the patient care and administrative improvements discussed in this report. (Reference Sections 6 and 8.)

4. MIS permitted the nursing staff to reduce the amount of time spent on clerical tasks, helped to improve communications among nurses and with ancillary departments and facilitated better planning of patient care by nurses. No consistent change in time spent in direct patient care was observed. In general the accuracy and timeliness of ancillary and supportive services have improved since implementation of MIS. No significant change in hospital patterns of practice by the medical staff was observed. (Reference Sections 5 and 7.)

5. In some instances MIS has produced changes in staffing patterns of the hospital. Most departments concerned with direct patient care have reduced their staffs or have been able to contain staff levels at a time of increased administrative burden resulting from hospital growth. In some cases the hospital has been forced to increase staff because of expansion of services or addition of new services, but additions to staff in most areas was unrelated to MIS. Several departments have yet to take full advantage of the potential labor-saving benefits of MIS. (Reference Section 4.)

6. Reliability ("up time" vs "down time"), both quantitatively and as perceived by nurses and physicians, permits reliance upon MIS in a clinical environment. (Reference Sections 6, 8, and 10.)

7. The confidentiality of patient data is kept within that prescribed by the California Business and Professions Code and the rules and regulations which pertain to that Code. A "trade off" between confidentiality and patient care was noted; reducing access in order to increase confidentiality further would tend to make patient care by authorized personnel more cumbersome and time consuming. (Reference Section 10.4.)

8. The future potential of MIS is widely recognized by experienced users at the Hospital, especially physicians. In particular, it is anticipated that MIS will become a significant aid to utilization review, audit of patient care, on-line intervention to prevent diagnostic and treatment errors (e.g., adverse drug interactions), and as a convenient source of current and relevant medical information concerning drugs, laboratory test interpretation, current medical literature abstracts, specialized diagnostic and therapeutic guides, etc. Accordingly, it is likely that the scope of MIS and its associated benefits will continue to expand in the future. (Reference Section 8.)

9. Studies conducted by the Hospital management engineering staff comparing El Camino costs trends with other comparable Northern California hospitals during the periods before and after MIS implementation have indicated cost savings at El Camino in excess of system costs. The independent verification of the cost effectiveness of MIS is the subject of a recently initiated study by Battelle for HEW scheduled for completion in 1976. That study will contain Battelle's conclusions regarding cost effectiveness of the system.

2.2 Recommendations

MIS has produced significant improvements in health care delivery at El Camino Hospital. The following Battelle recommendations to HEW are offered to promote use of comprehensive hospital information systems and for purposes of national health care planning and policy making.

1. The use of clinical research and hospital management data inherent in the computerized data base of comprehensive hospital information systems should be expanded. These systems should be recognized as an important vehicle to aid in the achievement of existing national health care objectives such as utilization review, medical audit, and continuing education.

2. Comprehensive hospital information systems should be demonstrated and evaluated in other types of hospitals, such as large urban hospitals and Federal hospitals, to determine the ease of technology transfer and the extent to which the benefits realized at El Camino Hospital may also be realized in other hospital environments.

3. The barriers to wide-scale adoption of this important new hospital advance should be identified. These may include inability to finance transitional and startup costs as the result of Federal and state prospective reimbursement programs for hospital patient care costs. Financial incentives for adoption of such systems may be justifiable in view of Government savings realized through reduced hospital costs. Dependent upon the results of the cost-benefits study, administrative and/or legislative programs should be developed to expand the use of computerized comprehensive hospital information systems.

3.0 SUMMARY OF FINDINGS

This section presents a brief overview of the findings of the studies discussed in this report. The summary of findings of each of the studies is presented in tabular form with references to detailed tables within the text.

3.1 Analysis of Changes in Staffing Levels

A summary of the results of the Analysis of Staffing Patterns is presented in Table 3-1. This table summarizes the changes in terms of reductions and increases in major hospital activity levels and staffing by category based on comparative analyses of changes between pre-MIS and post-MIS time periods.

Changes in the indicators of the levels of hospital activities since pre-MIS (1971) to post-MIS (1975) are impressive. There has been a gradual reduction in the average length of stay (5.33 days to 4.75 days) while admissions have increased and patient days have remained almost stable (-0.9%). In addition there has been a dramatic increase in emergency room visits, operating room procedures, renal dialysis treatments, and outpatient visits.

Although the level of hospital activities has increased, staff reductions were effected in nursing service areas--Medical and Surgical Units, Gynecology, Maternity, and Pediatrics. Increases in staff were experienced in other areas primarily due to expansion of services by Critical Care (ICU and TCU), Orthopedics, and Mental Health.

The ancillary services and support departments have been forced to expand staff primarily due to increased demand for services not related to MIS such as increases in tests, procedures, and therapy in Pulmonary Medicine, Respiratory Therapy, and EEG-EKG. Medical records increased staff because of new responsibilities brought about by utilization review and medical care audit programs. Staff decrease in the clinical laboratory were minimal because of the initial method of entering all test results through Video-Matrix-Terminals. Through recent computer interfacing of automated instruments and mark-sense card input of test results, staff reduction in

TABLE 3-1. SUMMARY OF STAFFING PATTERNS ANALYSIS

Category (Table Reference)	Reductions (Ordered by %)	Increases (Ordered by %)
Hospital Activity Levels (Table 4-1)[a]	Length of Stay (Average Days) Patient Days	Renal Dialysis Treatment Outpatient Visits Emergency Room Visits Radiology Charges Laboratory Tests Admissions Operating Room Procedures
Inpatient Nursing Service Departments in FTE's (Table 4-2)	Medical Units Pediatrics Maternity Care Gynecology Surgical Units	Critical Care Nursing Administration Mental Health Orthopedic
Case-Type Nursing Service Departments in FTE's (Table 4-3)		Renal Dialysis Unit Emergency Room Operating Room
Ancillary Service and Support Departments in FTE's (Table 4-4)	Admitting Central Service Clinical Laboratory	Pulmonary Medicine Respiratory Therapy Medical Records Pharmacy EEG-EKG Radiology Physical Medicine Food Service
Administrative and Service Departments in FTE's (Table 4-5)		Management Engineering Administration Purchasing, Stores, Print Shop Housekeeping Laundry Communications Personnel Business Office

(a) Numbers in parentheses refer to locations in the remainder of this report of detailed information.

this area could be further effected if the hospital would take full advantage of these improvements in entering test results. The Admitting Department did realize staff reductions as a direct result of MIS implementation.

The Administrative and Service Departments of ECH have experienced staff increases since implementation of MIS. Most of the increases in this area were due to expansion of facilities and services. Support personnel were added for the NCHSR demonstration and evaluation project in Management Engineering.

Case-Type Nursing areas had increases in staff since implementation of MIS primarily due to new services offered and increases in volume of services delivered.

3.2 Nursing Activity Analysis

A summary of the findings of the Nursing Activity Analysis is presented in Table 3-2. This table summarizes changes in nursing activities since implementation of MIS at ECH by category and activity for the inpatient nursing units.

It is impossible to consistently isolate the effects of MIS on nursing activities from other changes that have occurred in the hospital. However, the analysis indicates that MIS had a favorable influence on nursing activities. These favorable effects are most apparent in the clerical, communications, and other activities categories. There was no consistent change in direct patient care activities across the units observed.

The time and effort allocated to clerical activities, in most of the units observed, have been decreased with MIS. This decrease is probably greater than the analysis indicated because clerical workload increased in the post-MIS time period because of shorter length of patient stay (more patients are being admitted and discharged which increases clerical workload on the nursing units).

In the communications area, the availability and form of the information provided through MIS makes reporting activities easier to accomplish and less time consuming (shift change report).

In the other activities category, nursing personnel are now spending less time off the unit because better (more complete) information is readily available. Nursing personnel are now spending more time in

TABLE 3-2. CHANGES IN NURSING EFFORT - DAY SHIFT

Category & Activity	Hospital Units						Changes Aggregated Over All Units
	Medical	Surgical	Orthopedic	Pediatric	ICU	CCU	
Direct Patient Care	+	-	-	-	+	-	Inconsistent
Medications	+	-	+	-	+	+	
Attentive Activities	+	-	-	-	+	-	
Clerical (VMT, Printer)	-	-	+	-	-	+	-
Clerical	-	-	-	-	-	-	
VMT & Printer	+	+	+	+	+	+	
Communications	-	-	-	-	-	+	-
Communications	-	+	-	-	-	+	
Reports & Conferences	-	-	-	-	-	-	
Other Activities	-	-	-	-	-	+	-
Supply & Maintenance	-	-	+	+	-	+	
Planned Nursing Activities	+	+	-	+	-	+	
Nursing Station - Other	-	-	-	-	-	-	
Outside Unit	-	-	-	-	-	-	
Personal Time	+	-	+	-	-	+	
Total	-	-	-	-	-	+	-

+ = Increase in nursing personnel minutes per patient.

- = Decrease in nursing personnel minutes per patient.

planned nursing activities. The opportunity for better planning and management will evolve other changes to patient care in the nursing units.

3.3 Evaluation of MIS Impact By the Nursing Staff and Medical Staff

A summary of the results of the Evaluation of MIS Impact By the Nursing Staff and Medical Staff at ECH is presented in Table 3-3. This table summarizes only the responses to the 1974 questionnaire and excludes neutral responses and no opinions. The discussion of these evaluations and changes in attitudes and acceptance over time are presented in Sections 6.0 and 8.0 of this report.

In the comparative evaluations there was a dramatic change in attitudes and acceptance of MIS between the pre-MIS and post-MIS time periods. Attitudes toward MIS became much more positive over time and acceptance dramatically increased amongst the nursing staff and other hospital personnel. The medical staff also became more positive and acceptance of the system increased but to a lesser degree.

As indicated in Table 3-3 the results of the 1974 survey show a significantly greater number of positive responses than negative responses to all categories for evaluation of MIS. Nurses have overwhelmingly accepted MIS, they are satisfied with most aspects of the system, and the vast majority advocate use of the system. The majority of physicians have accepted MIS. However, some physicians interviewed indicated dissatisfaction with the medical chart and post discharge aspects in spite of overall favorable response to these categories in the questionnaire. The majority of other hospital staff personnel have a positive attitude toward MIS.

3.4 Physicians' Use of Hospital Services

A summary of the major findings on the analysis of Physicians' Use of Hospital Services is presented in Table 3-4. This analysis consisted of two independent studies: Use of the Video-Matrix-Terminal, and Medical Order Sets/Progress Notes by day of patient stay. These studies were conducted to determine the extent of physicians' use of the system

TABLE 3-3. EVALUATION OF MIS IMPACT BY THE NURSING STAFF AND THE MEDICAL STAFF EXCLUDING ALL NEUTRAL RESPONSES

Category For Evaluation of MIS	Percent of Positive Responses		Percent of Negative Responses	
	Nursing Staff	Medical Staff	Nursing Staff	Medical Staff
Training	88	90	12	10
Mechanical	97	89	3	11
Medical Chart	87	63	13	37
Nursing Care	94	-	6	-
Provision of Medication	99	-	1	-
Information Transfer	93	-	7	-
Attitude Toward MIS[a]	78	61	22	39
Interdepartmental Aspects	95	-	5	-
Placing Medical Orders	-	66	-	34
Impact on Patient Care and Rounds	-	62	-	38
Satisfaction with MIS Procedures	-	91	-	9
Research and Information Aspects	-	94	-	6
Post Discharge Aspects	-	66	-	34
Total	88%	69%	12%	31%

(Reference Tables 6-1, 6-11, and 8-1)

(a) Other hospital staff also responded to this portion of the evaluation with 71% positive responses and 29% negative responses, excluding neutrals.

TABLE 3-4. SUMMARY OF PHYSICIAN USE OF HOSPITAL SERVICES

- Use of Video-Matrix-Terminal (Tables 7-1 through 7-5)
  - proportion of physicians using VMT increased during 1974 over that during 1972
  - proportion of order sets entered by physicians increased initially then stabilized
- Medical Order Sets/Progress Notes
  - no significant change in average number of progress notes per patient day pre- and post-MIS (as expected since MIS did not impact procedure or format)
  - statistically significant increase in average number of medical order sets per patient day, primarily due to increase in first day of patient stay

and the impact of physicians' use of the system on hospital services. The detailed discussion of these studies is presented in Section 7.0 of this report.

3.5 Comparative Analysis of Medical Records for Accuracy and Completeness

A summary of the major findings of the study on Comparative Analysis of Medical Records for Accuracy and Completeness is presented in Table 3-5.

This study represents the first quantitative, statistical analysis of medical orders for errors to determine the impact of a medical information system on accuracy, completeness, interpretation, and reporting results of medical orders.

As indicated in Table 3-5 the system had a positive impact expressed in overall decrease in variances in medical orders and reporting results after implementation of MIS. This improvement in accuracy and completeness of medical orders has a direct effect on raising the level of the quality of care delivered at ECH. Improvements in reporting results assists the medical

TABLE 3-5. SUMMARY OF COMPARATIVE ANALYSIS OF MEDICAL RECORDS FOR ACCURACY AND COMPLETENESS

- Omissions in Medical Orders (Table 9-1)
  - decrease in omission of site and route of administration for pharmacy
  - increase in omission of reason for prn medications for pharmacy
  - decrease in omissions in schedule aggregated over all areas
  - no significant changes in areas other than pharmacy
- Clarity and Completeness in Writing Medical Orders (Table 9-2)
  - elimination of hard to read orders in pharmacy
  - increase in pharmacy orders requiring clarifications of prescriptions
  - increase in dietary orders requiring clarification
  - no significant changes outside of pharmacy, dietary areas
- Changes in Presenting Clinical Data in Writing Medical Orders (Table 9-3)
  - increase in presenting clinical indications for EKG and X-Ray (since VMT prompted such responses)
  - increase in presenting medication indications for EKG
- Variances in Reporting Results (Table 9-4)
  - major reduction in variances in reporting site and route of administration for medications
  - increase in variances in charting of schedule
  - generally, reduction or stabilization in variances after MIS in all other areas
- Clarity-Interpretation Errors in Reporting Scheduling (Table 9-5)
  - increase in errors of charting schedules (medications, treatments, etc.)
  - decrease in errors in reporting laboratory and radiology results

staff in caring for patients and altering care plans based on readily available, more complete and accurate information on the patient's progress.

These findings are indicative of the benefits of the system (based on quantitative data) in caring for patients that are not directly measurable as an economic value to the hospital and/or patient. Similar to many areas of quality of care, it is difficult to assign a dollar value to these benefits although the value to patients may outweigh many of the direct economic benefits of the system.

The detailed discussion of this study is presented in Section 9.0 of this report.

3.6 MIS Impact on Hospital Performance

A summary of the major findings of the study on MIS Impact on Hospital Performance is presented in Table 3-6.

This table presents the major findings of selected studies completed prior to June, 1973, and described in Battelle's interim report, September 30, 1973. These studies include Analysis of Turn-Around-Time for Tests and Procedures, Percentage of High Priority Requisitions, Scheduled and Unscheduled Down-Time, and Confidentiality of Medical Records.

Further discussion of these studies is presented in Section 10.0 of this report.

3.7 Qualitative Assessment of MIS Impact on Ancillary and Support Services

This section presents a description of changes that have occurred in the departments of the hospital as a result of MIS and cannot be effectively summarized.

TABLE 3-6. SUMMARY OF MIS IMPACT ON HOSPITAL PERFORMANCE

- Turn-Around-Time (TAT) For Tests and Procedures (Tables 10-1 and 10-2)
  - decreases in turn-around-time for tests and procedures in some areas of clinical laboratory, radiology, electrocardiography, and other ancillary areas, urinalyses, hematology/serology, and in certain priority categories (Stat, today, or routine; 1971 vs. 1972)
  - increase in turn-around-time for microbiology test group, routine priority (1971 vs. 1972)
  - no significant changes except for increase in TAT for urinalysis - today and slight decrease, although not significant, for biochemistry test group - routine (1971 vs. 1975)
- MIS Scheduled and Unscheduled Down-Time (Tables 10-3 and 10-4)
  - average monthly reliability was 99.2% for 1972-1973 and 99.4% for 1974-1975
  - average monthly availability was 96.3% for 1972-1973 and 96.7% for 1974-1975
- Confidentiality of Medical Records
  - trend in usage where physician and nurse are being assisted by alternate health manpower resources which, though practical, do not enhance confidentiality
  - recommendations for further enhancement of confidentiality include statement of use of system in admission conditions, and user agreement to confidentiality conditions.

4.0 ANALYSIS OF CHANGES IN STAFFING LEVELS

The purpose of this study is to identify changes in staffing levels which have occurred at ECH between a time period prior to the implementation of MIS, and a second time period after the full implementation of the system, and after primary adjustments in staffing and in methods and procedures have been accomplished. The source of the data for this study is the El Camino Hospital biweekly labor analysis report.

Initially this study was to compare staffing levels in FY 71 and FY 74. However, there were still changes taking place within the hospital during FY 75 as a result of MIS implementation. Therefore, in order to provide a stable post-MIS period for comparison, this portion of the report was delayed until the staffing level data could be extended through FY 75.

4.1 Conclusions

In keeping with the purpose of this study and based upon the results presented throughout this section, the comments and findings presented below are appropriate.

This study was delayed to the extent possible and part of the data base was extended through FY 75, to permit further adjustments in staffing and in methods and procedures related to the MIS implementation. In addition, several services have been expanded and new services added concurrent with the implementation of MIS. Consequently, the results of this task present a composite of the productive hours used at ECH during FY 71, FY 74, and FY 75. The results of this study present a comparison of the staffing used during the three time periods. The reasons for changes observed which are related to the implementation of MIS are explained to the extent feasible.

Of the four service areas studied, Inpatient Nursing Services are the most favorably impacted during the comparison periods. After the influences of added and expanded services, increased administrative activities, and suspected increases in patient dependency are considered, the productive hours-per-patient day have increased slightly and the nursing hours per admittance has been substantially reduced. Based upon the activities

and events that occurred throughout the periods studied, it is believed that MIS contributed significantly to the favorable impact on Inpatient Nursing Services.

MIS had less impact upon the staffing in Case-Type Nursing Services, Ancillary Services, and Administrative Services. It is believed that the increases in staffing in these areas are due to increased workload and new and expanded services and are not attributable to MIS. However, the following observations are appropriate:

- The FTE's in Pathology (Clinical Laboratory) initially increased because of the implementation of MIS and at the end of FY 75 returned to nearly the same level as FY 71. Three FTE clerical positions were added to enter test results into MIS. These positions are currently filled although the need for them has been eliminated through putting the SMA-18/60 (automated clinical chemistry analyzer) on line and utilizing mark-sense input of test results by technologists in other areas of the Clinical Laboratory.
- Medical Records has increased staff by eleven FTE's. However, only three FTE's were added because of the implementation of MIS. These three FTE's are still in Medical Records but the positions are now being used to accomplish increased workload that is not MIS related.
- Although by the end of FY 75 one FTE had been added in the Business Office due to increased workload, a net reduction of two positions was accomplsihed because of MIS.
- One secretarial position in the Radiology Department was eliminated because of MIS.
- The Management Engineering Staff increased significantly during the implementation of MIS to assist in the implementation and in the evaluations of the system. In addition, staff from other Departments were permitted to charge to this Department's account

when they were involved in the implementation of MIS. This practice will be ended. In addition, some of the increased positions were eliminated by 1975. It is believed that the remaining additional positions are temporary and will eventually be eliminated.

4.2 Summary of Results

4.2.1 Presentation of the Summary of Results

This task compares the staffing patterns of El Camino Hospital during Fiscal Year 1971 (FY 71) with FY 74 and FY 75. Table 4-1 presents the changes in activities levels at the hospital for these time periods. As can be seen in Table 4-1, with the exception of patient-days which was higher in FY 74 and then decreased in FY 75 to below the FY 71 level, all activity levels for both FY 74 and FY 75 experienced an increase compared with FY 71. The length of stay has been significantly reduced.

TABLE 4-1. CHANGES IN ACTIVITY LEVELS

Activity	FY 71	FY 74	% Change 71-74	FY 75	% Change 71-75
Patient Days	121,028	122,735	+ 1.4	119,924	- 0.9
Admissions	22,726	24,663	+ 8.5	25,229	+ 11.0
Length of Stay in Days	5.33	4.98	- 6.6	4.75	- 10.9
Emergency Room Visits	25,448	34,836	+ 36.9	34,771	+ 36.6
Operating Room Procedures	11,196	12,533	+ 11.9	12,264	+ 9.5
Renal Dialysis Treatments	755	2,972	+293.6	4,882	+546.6
Outpatient Visits	35,686	54,202	+ 51.9	54,607	+ 53.0
Lab Tests	198,774	216,827	+ 9.1	225,450	+ 13.4
Radiology Charges	54,655	66,217	+ 21.2	71,101	+ 30.1

TABLE 4-2. STAFFING CHANGES IN INPATIENT NURSING SERVICE DEPARTMENTS

	Productive FTE					Hours/Patient Day					% FY 71 Patient Days	Adjusted FY 75 Productive FTE[h]	FTE Change 71-74
	FY 71	FY 74	% Change 71-74	FY 75	% Change 71-75	FY 71	FY 74	% Change 71-74	FY 75	% Change 71-75			
Medical	78.7	80.4[e]	+ 2.2	54.4[e]	-30.8	5.43	5.57	+ 2.6	5.26	- 3.1	24.9	74.2	- 4.5
Surgical	76.3	59.0[e]	-22.7	70.4[e]	- 7.7	5.65	5.05	-10.6	4.88	-13.7	23.2	64.1	-12.2
Orthopedic	31.5	37.2	+18.1	33.8	+ 7.3	5.04	5.65	+12.1	5.41	+ 7.3	10.7	32.8	+ 1.3
Gynecology	24.5	21.8	-11.0	19.3	-21.2	5.56	4.97	-10.7	4.66	-16.2	7.6	20.1	- 4.4
(Total MSO/Gyn)	211.0	198.4	- 6.0	177.9	-15.7	5.45	5.35	- 1.8	5.06	- 7.2	66.4	191.2[g]	-19.8[g]
Critical Care[a]	34.3	57.4	+67.3	71.5	+108.5	16.21	13.84	-14.6	12.58	-22.4	3.6	25.7	- 8.6
Maternity Care[b]	58.1	47.4	-18.4	44.3	-23.8	6.50	5.83	-10.3	5.52	-15.1	15.4	48.2	- 9.9
Pediatrics	23.9	22.7	- 5.0	18.1	-24.3	6.52	6.25	- 4.1	6.00	- 8.0	6.3	21.4	- 2.5
Nursing Administration	20.2	30.9	+53.0	34.1	+68.8	0.38	0.57	+52.4	0.66	+75.1	91.7	34.3	+14.1
Total Nursing Service Areas[c]	347.5	360.3	+ 3.7	348.5	+ 0.3	6.44	6.67	+ 3.6	6.58	+ 2.2	92.7	320.8[g]	-26.7[g]
Mental Health	22.8	26.0	+14.0	25.2	+10.5	5.36	5.18	- 3.4	5.32	- 0.8	7.3	22.0	- 0.8
All Inpatient Nursing Services[d,f]	370.3	386.3	+ 4.3	373.7	+ 0.9	6.36	6.55	+ 2.9	6.48	+ 1.9	100.0	342.8[g]	-27.5[g]

(a) Critical Care includes Intensive Care (ICU), Coronary Care (CCU), and Transitional Care (TCU). The growth in the Critical Care area has been largely in TCU which grew from 12 beds to 28 beds from '71 to '75, with some growth from 8 to 13 beds in ICU.

(b) Maternity Care includes Labor and Delivery, Nursery, and Maternity Units.

(c) Nursing Service Areas include all the units shown above it in the Table and the total for FY 74 and FY 75 include Ambulatory Surgical Care (3.5 FTE in FY 74 and 2.6 FTE in FY 75). The FY 71 total does not include Ambulatory Surgical Care which did not exist at that time, but it does include AKU (Artificial Kidney Unit) which has since been incorporated into outpatient services.

(d) Inpatient areas include Nursing Service Areas and Mental Health. Excluded from this category are Emergency Room, Renal Dialysis Unit, and Operating Room.

(e) In FY 74 Unit 6E was included in the Medical area although some Surgical patients were cared for in the Unit. In FY 75 Unit 5W was included in the Surgical area although some Medical patients were cared for in the Unit. Hence comparisons of changes in Productive FTE's are more meaningful for the Total MSO/Gyn.

(f) The changes in hours per admission for all inpatient nursing services went from 33.89 for FY 71 to 32.58 for FY 74 (a decrease of 3.9%) and to 30.81 for FY 75 (a decrease of 9.1%).

(g) These totals were not calculated using the adjustment formula; rather they are summed.

(h) These figures do not include 2105 patient days recorded for ambulatory surgical patients.

TABLE 4-3. STAFFING CHANGES IN CASE-TYPE NURSING SERVICE DEPARTMENTS

Case Type Service Department	Productive FTE FY 71	FY 74	% Change 71-74	FY 75	% Change 71-75
Operating Room	49.1	61.4	+ 25.0	62.0	+ 26.2
Emergency Room	16.0	22.4	+ 40.0	24.1	+ 50.6
Renal Dialysis Unit	6.1	13.4	+120.7	18.8	+208.2
TOTAL	71.2	97.2	+ 36.5	104.9	+ 47.3

Table 4-2 identifies the specific changes in staffing between FY 71 and FY 74 and FY 75 for the units assigned to the Inpatient Nursing Services Departments. In Table 4-2, staffing at the unit level is presented in terms of productive full-time equivalents and in hours-per-patient day. The number of admissions at each nursing unit was not readily available. Thus staffing in terms of hours per admittance for each unit could not be calculated. Admittance data were available for the total of all units and the hours per admittance is shown for the total Inpatient Nursing Services. In addition to actual changes shown, Table 4-2 includes an adjustment of FY 75 FTE assuming a FY 75 distribution of patient days identical to FY 71. The adjusted numbers were calculated for each unit as

$$\left(\begin{array}{l}\text{Percent of}\\ \text{FY 71 Patient}\\ \text{Days for}\\ \text{the Unit}\end{array}\right) \times \left(\begin{array}{l}\text{Total}\\ \text{FY 75}\\ \text{Patient Days}\end{array}\right) \times \left(\begin{array}{l}\text{FY 75 Hours}\\ \text{Per Patient}\\ \text{Day For the}\\ \text{Unit}\end{array}\right) \div \left(\begin{array}{l}\text{2080 Hours}\\ \text{Per FTE}\end{array}\right) .$$

The adjustment permits a comparison of change in FTE by nursing units with adjustments for expansions and changes in the units since FY 71.

The staffing data for the Case-Type Service Department category are given in Table 4-3. Tables 4-4 and 4-5 present the specific changes in staffing for the Ancillary Service Departments and the Administrative Service Departments, respectively.

TABLE 4-4. STAFFING CHANGES IN ANCILLARY SERVICE DEPARTMENTS

Ancillary Service Department	Productive FTE FY 71	FY 74	% Change 71-74	FY 75	% Change 71-75
Admitting	10.6	9.3	- 12.3	9.5	- 10.4
Central Service	17.1	17.4	+ 1.6	16.8	- 1.8
Food Service	58.5	62.0	+ 6.0	60.7	+ 3.8
Radiology	32.3	34.3	+ 6.5	38.1	+ 18.0
Pathology (Clinical Laboratory)	58.3	65.3	+ 12.0	57.7	- 1.0
Physical Medicine	4.7	5.4	+ 14.9	5.0	+ 6.4
EEG-EKG	6.0	7.5	+ 25.0	7.5	+ 25.0
Pharmacy	10.8	13.9	+ 28.7	14.2	+ 31.5
Medical Records	17.9	23.4	+ 30.7	29.0	+ 62.0
Respiratory Therapy	7.2	14.5	+101.4	16.4	+127.8
Pulmonary Medicine	0.9	1.9	+111.1	2.2	+144.4
TOTAL	224.3	254.9	+ 13.6	257.1	+ 14.6

[ ] See below

TABLE 4-5. STAFFING CHANGES IN ADMINISTRATIVE SERVICE DEPARTMENTS

Administrative Service Department	Productive FTE FY 71	FY 74	% Change 71-74	FY 75	% Change 71-75
Business Office	34.2	33.2	- 2.9	35.2	+ 2.9
Plant Engineering & Maintenance	23.4	23.9	+ 2.1	23.4	0
Personnel	5.9	6.2	+ 5.1	6.4	+ 8.5
Communications	9.4	10.3	+ 9.6	10.3	+ 9.6
Laundry	21.2	23.3	+ 9.9	23.5	+ 10.8
Purchasing, Stores & Print Shop	7.6	8.9	+ 17.1	11.6	+ 52.6
Housekeeping	45.5	54.3	+ 19.3	62.2	+ 36.7
Administration	4.9	9.4	+ 91.8	7.7	+ 57.1
Management Engineering	3.6	12.3	+241.7	10.3	+186.1
TOTAL	155.7	181.8	+ 16.8	190.6	+ 22.4

[ ] Departments whose operations were significantly impacted by MIS. See discussions in Sections 4.6 and 4.7.

4.2.2 Discussion of the Results

In Table 4-2, the FY 74 and FY 75 full-time equivalent count for the Inpatient Nursing Services category includes service areas that have been expanded since FY 71. For example, in the Critical Care area, the Transitional Care Unit (TCU) and the Intensive Care Unit (ICU) have been expanded. The number of full-time equivalents, as may be seen in Table 4-2, for Critical Care have been increased from 34.3 to 71.5 in FY 75, or an increase of 37.2 full-time equivalents, which is a 108.5 percent increase. Also, as indicated in the hours-per-patient day column of Table 4-2, patient-days in the Critical Care Units increased more rapidly than the staffing and a 22.4 percent reduction was achieved in the productive hours-per-patient day in FY 75.

Staffing in the Orthopedic Unit increased 18 percent in FY 74 while the patient census only increased 5.6 percent. The 18 percent increase is believed to be due to an increase in the number of more complex orthopedic surgical procedures such as total hip replacements during FY 74 compared to FY 71. This percent increase was subsequently reduced in '75 down to 7.3 percent.

Nursing Administration increased (see Table 4-2) in full-time equivalents largely because of increased activities in new employee training, in continuing education, and in committee and project work. Also, there were changes in the accounting procedures for recording productive hours to Nursing Administration. This is discussed in more detail in this section of the report.

In Table 4-2 the FY 74 and FY 75 entries for the Total Nursing Service Areas include 3.5 and 2.6 full-time equivalents respectively for Ambulatory Surgery Nursing Services. The Ambulatory Surgery full-time equivalents are not included in any of the service units shown above the Total Nursing Service areas, i.e., for FY 75 the sum of the column excluding Ambulatory Surgery FTE is 345.9. The 2.6 FTE are added to 345.9 to give the 348.5 entry shown. The Ambulatory Surgery Nursing Service has been added since FY 71.

In summary, the Inpatient Nursing Service Department totals shown for FY 74 and FY 75 in Table 4-2 include full-time equivalents that have been added through the expansion of Critical Care Units, the FTE that have

been added through providing Ambulatory Surgery Services, and nurses that have been added because of increased Nursing Administration activities and because of increased complexity of orthopedic surgery procedures. Other changes which have occurred in the Inpatient Nursing Services Department are discussed in Section 4.4 of this report.

When the 37 FTE added to the Critical Care Unit plus the 3 FTE added for Ambulatory Surgery are subtracted from the 374 FTE shown in Table 4-2 for FY 75, the result is 334 FTE in FY 75 as compared with 370 FTE in FY 71. This is a reduction of 36 FTE or 9.7 percent. However, because some of the FY 75 patients in Critical Care Units (including TCU) would have been cared for in MSO/GYN under the FY 71 arrangement, the entire additional 37 FTE for Critical Care should not be subtracted in computing total FTE reductions. The adjusted FY 75 FTE's shown in Table 4-2 compensate for this consideration, and comparison of these with FY 71 FTE shows a net reduction of 27.5 FTE or 7.4 percent.

Productive full-time equivalents for the Inpatient Nursing Service Departments are translated to hours-per-patient day and hours per admit, in Table 4-2, to measure staffing based on patient workload. The productive hours per admit decreased from FY 71 to FY 75 by 9.1 percent. However, the productive hours-per-patient day increased by 1.9 percent for all inpatient nursing services. The largest contributors to this increase were Nursing Administration and Orthopedics. Also, the productive hours used in calculating the hours-per-patient day, for the All Inpatient Nursing Services entry, include the productive hours spent in Ambulatory Surgery. Staffing in nursing education increased from two full-time and two part-time employees prior to MIS to eight full-time employees following MIS. Of the total increase in educational staffing, MIS training only accounts for the equivalent of one-half of an employee. Consequently, it must be concluded that educational activities have increased significantly and should be reflected in better patient care. Both training of new employees and continuing education increased since FY 71. Increased planning and work improvement activities which were evidenced in the nursing activity analysis should also be reflected in better patient care.

Because of the increase in the percentage of patient days in the Critical Care area, the hours per patient day required should have increased by about 6 percent between FY 71 and FY 75 based on constant engineering

standards. The actual hours-per-patient day increased by only 2.2 percent in the Nursing Services area. This represents a slight increase in productivity in this area.

The increase in full-time equivalents experienced in the Case-Type Services Departments presented in Table 4-3 is believed to be a result of increased activities as shown in Table 4-1, such as the expansion of the Renal Dialysis Unit.

The entries for the Ancillary Service Departments shown in Table 4-4 include additional employees in the Pharmacy Department that have been added because of the implementation of the unit dose system. Pathology (Clinical Laboratory) initially added 3 FTE clerks because of MIS and although the requirement for these clerks has been eliminated, the positions still exist. Medical Records each added about 3 full-time equivalents because of the implementation of MIS, and these employees were included in the FY 74 and FY 75 figures. It is believed that the remainder of the Ancillary Service Departments experienced increases in staffing because of increased workload in the procedures accomplished. Respiratory Therapy was a new department when the study was initiated and MIS has had some impact in improving the information on orders and in the charting treatments. The increase in 9 FTE's since 1971 can be attributed to natural growth of the department and increased workload. Changes in Ancillary Service Departments are discussed further in Section 4.6.

The entries for the Administrative Services Departments shown in Table 4-5 show an increase of about 35 full-time equivalents from FY 71 to FY 75. Most of this increase is unrelated to the introduction of MIS. Of the total increase, about 7 of the FTE were added to the Management Engineering Department to accomplish projects related to the HEW evaluation and other special studies. Approximately 3 full-time equivalents were added to the Administrative Departments because of the addition of new services and functions such as audio-visual services, utilization review, infection control, and health planning. The Housekeeping Department added about 17 full-time equivalents primarily due to changes in the physical plant. Changes in Administrative Service Departments are discussed further in Section 4.7.

4.3 Study Approach

The data for this study were obtained from the hospital's Labor Analysis Report, which is a biweekly report generated by the payroll system. It lists paid hours in two major categories, productive and nonproductive hours, for each department, work station, shift, and position. Productive hours include the time spent within the hospital and are charged to the unit to which the employee was assigned. Nonproductive hours include time not spent within the hospital such as sick leave and vacation time and have been excluded from this analysis.

Data consisting of productive hours from the biweekly Labor Analysis Report were grouped into four categories:

- Inpatient Nursing Services - nursing units that care for inpatients and Nursing Administration
- Case-Type Nursing Services - nursing units that do not provide bedside care to patients: Emergency Room, Renal Dialysis Unit, and Operating Room
- Ancillary Services - departments that provide support services to patients
- Administrative Services - departments that provide services to hospital employees, administration, and care of the physical plant.

The productive-hours data were grouped for each department or service area within each of the categories identified above.

The productive hours for each category and department were converted to full-time equivalents (FTE) by dividing the productive hours by 2,080 hours per year.

For the Inpatient Nursing Service Departments additional calculations were made to convert the productive hours into hours-per-patient day and hours per admit. These productive hours were calculated as follows:

- Hours-per-patient day - productive hours divided by patient days yield hours-per-patient day
- Hours per admit - productive hours divided by the number of admissions yield hours per admit.

The "hours per admit" for the individual nursing departments were not calculated because the admissions for individual units were not readily available due to interunit transfers.

The percentages of change for categories and departments between FY 71 and FY 74 and FY 75 were calculated:

$$\text{Percent of Change}_{71\text{-}74} = \left(\frac{\text{FY 74 value - FY 71 value}}{\text{FY 71 value}}\right) \times 100$$

$$\text{Percent of Change}_{71\text{-}75} = \left(\frac{\text{FY 75 value - FY 71 value}}{\text{FY 71 value}}\right) \times 100$$

The data for Inpatient Nursing Service Departments are further analyzed by examining the distribution of productive hours by skill classification and by shift. Data for these departments were grouped in the following five job classification skill categories:

- Supervisory - classifications having supervisory responsibility
- Professional - classifications requiring licensing or college education, except Licensed Vocational Nurse (LVN)
- Licensed Vocational Nurse
- Clerical - clerical and secretarial classifications
- Technical - classifications including nursing assistant and a number of technicians.

4.4 Changes in Inpatient Nursing Service Departments

4.4.1 Changes in Staffing Techniques

The staffing planning process has gone through a cycle from decentralized to centralized and back to a decentralized process during the MIS implementation and operational periods. Prior to MIS, staff requirements were determined by each head nurse or assistant head nurse for the respective shift and submitted to the nursing supervisor. The nursing supervisor made final adjustments at the beginning of her shift to balance the staff.

During implementation, one supervisor was appointed to the position of staffing coordinator. A dependence system for rating patient care requirements was established. Efforts were made to forecast patient census and staffing requirements. Based upon these forecasts, the staffing coordinator balanced the day-to-day requirements over units and also determined hiring needs over the long term.

As organization studies progressed, however, Nursing Administration placed greater responsibility for staffing planning at the head nurse level, and staffing responsibility was eventually returned to the head nurse. However, the tools used by the staffing coordinator (rating patient care requirements and patient forecasting) were continued after being modified to fit the needs of the head nurse.

4.4.2 Changes in Staffing Levels

Table 4-2 presents the staffing changes in the Inpatient Nursing Service Departments expressed in productive full-time equivalents between FY 71 and FY 74 and FY 75.

The largest increase in productive FTE's occurred in the Critical Care Units. The major portion of the increase resulted from the expansion of the Transitional Care Unit (TCU) since 1973 when a Medical Unit was converted into the TCU. TCU moved and expanded from 12 beds in the east wing to 28 beds in the west wing of the fourth floor. In the east wing, when TCU moved, the open heart surgery beds were left for the Intensive Care Unit (ICU). The area that TCU vacated was divided for expansion of both the Intensive Care unit and the Renal Dialysis Unit. The increase in the number of available beds in the Critical Care area resulted in an increase in productive FTE's at a lower rate than the increase in patient days.

Nursing Administration increased its productive FTE's by 69 percent in FY 75 over FY 71. The increase was caused primarily by three changes:

- Increases in nursing education (see paragraph 4.4.3.3 below)
- Changes in time-charging procedures (see paragraph 4.4.3.7 below)
- Increased committee and project work (see paragraph 4.4.3.5 below).

Hours-per-patient day increased by 7 percent in the Orthopedic Unit. Patient-care requirements have been increasing because of a growing number of more complex orthopedic surgical procedures such as total hip replacement. Also, this unit was the pilot unit for developing and using standard care plans.

In the medical areas productive FTE's are inconsistent due to classification changes of nursing units during the 5-year period. First, the conversion of the unit on the fourth floor from a Medical Unit to the Transitional Care Unit occurred over this period of time. As the conversion occurred, the staff was increased, but the reporting in the Labor Analysis Report was not switched to TCU until the conversion was nearly complete; this resulted in additional hours being added to the medical areas since 1973. Second, in FY 75, one of the units classified as a surgical unit consistently handled overflow medical patients.

In the Surgical Units staffing was reduced. One cause identified was the staffing planning system which was implemented during implementation of MIS.

Implementation of the staffing planning system also influenced staff reductions in the Maternity Care Units, Pediatric Unit, and Gynecology Unit.

Increases in productive full-time equivalents in the Mental Health Unit were due to several factors:

- Increase in number of outpatients treated
- Addition of a social worker
- Addition of an occupational therapist.

A new service, Ambulatory Surgical Care, is included in the "Total Nursing Service Areas" values. This service was initiated in April, 1974, and added about 2.6 FTE to FY 75 values.

4.4.3 Organization Changes in Nursing Services

MIS was designed with the nurse and the physician as the primary users of the system. As a consequence, it was expected that the Nursing Service Department would undergo the most significant staffing pattern and organization changes as a result of the adoption of MIS.

The patient care process being carried out at El Camino Hospital was reviewed by examining departmental objectives, responsibility, and authority. This led to modification of patient care planning, nursing education, physical location of units, and the organization structure.

4.4.3.1 Patient-Care Process. At the beginning of implementation (1972), team nursing was the predominant form of nursing process used in all

but the Critical Care Units. Subsequently, various alternatives were utilized from three- or four-person teams to an individual nurse attending to several patients. As of FY 1975, primary nursing is being utilized on one nursing care unit on a trial basis.

4.4.3.2 Patient-Care Planning. A nursing consultant was engaged to assist in a study of the care planning process. As a result of this study, standard patient care plans have been established for over 200 diagnoses. These care plans have been published by El Camino Hospital. Some standard care plans have been programmed into MIS with the Orthopedic Unit serving as the pilot unit. This project is continuing and effort is being made to relate staffing requirements to patient care requirements determined through care planning.

4.4.3.3 Nursing Education. The staffing for nursing education has increased from two full-time plus two part-time persons prior to MIS, to eight full-time including a secretary at the end of 1974. MIS training accounts for the equivalent of one-half of a person. The major increase resulted from the implementation of a more thorough training program for new employees. This program assesses existing skills and provides needed additional skills in use of MIS and the complex equipment, such as used in the Critical Care area. The length of training has increased from 1 week in FY 71 to 2 weeks for all new staff and 3 weeks for those to be assigned to Critical Care. In addition there has been a trend toward replacing full-time staff with 2 part-time people. This permits every other weekend off for every staff member, but it doubles the new employee training load. The balance of the persons are involved in developing and presenting decentralized education programs to meet specific needs of different units. Prior to MIS, programs were more general in nature and aimed at the overall needs of the Nursing Service Department. In addition to technical nursing programs, emphasis is also being placed on developing the nursing process skills of patient assessment, care planning, and care evaluation. Nurses are learning how to bring hospital and community resources to bear on the patient's health condition.

4.4.3.4 Physical Location of Nursing Units. A number of nursing units were physically relocated in mid-1974 with the objective of locating

like services in proximity to each other. These relocations played an important role in the successful accomplishment of organizational changes.

The Medical Care Units were consolidated into 2 units on the sixth floor; previously one Medical Unit was on the third floor, one on the fourth floor, and one on the sixth floor. The Gynecology Specialty Unit was moved to the second floor adjacent to the Maternity Unit. The third major move was to expand the Transitional Care Unit and the Intensive Care Unit on the fourth floor.

4.4.3.5 Organization Structure. Figure 4-1 presents the organization of El Camino Hospital nursing service as of FY 74 and FY 75. The Nursing Service Department developed a vertical organization similar to most other hospitals with much of the authority and decision making held in the top position. During implementation, organizational studies were made, data were collected, and ideas were solicited from the nursing staff. The nursing staff voiced the desire and need to have more authority and responsibility at the unit level. In order to facilitate an atmosphere conducive to creative and professional practice within the hospital, it was decided to work toward a horizontal organization structure as opposed to the traditional vertical structure.

The outcome was to phase out the Assistant Director and Supervisory positions and redesign the head nurse position to include total authority and responsibility for her individual unit. The head nurse position became the pivotal position to link nursing management with nursing care and to realize the potential benefits of MIS. This makes the head nurse link accountable to the Director of Nursing Service for all facets of nursing care and for the administration of her personnel and the unit. This action eliminated two levels of organizational hierarchy.

A key component of the decentralization process has been the creation of three major clinical management groups:

- Maternal-Child Care Complex
- Medical-Surgical-Orthopedics Complex
- Critical Care Complex.

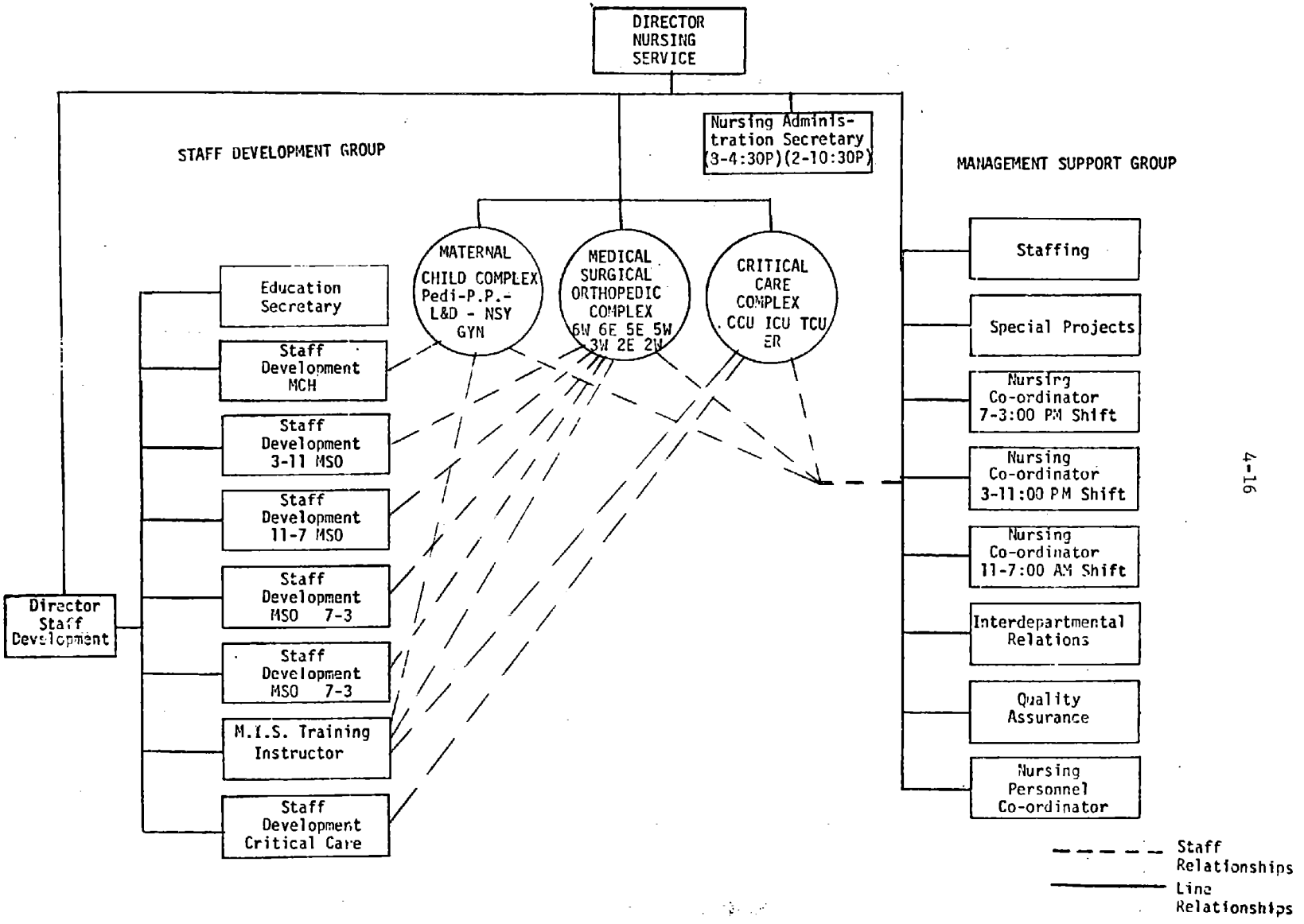


FIGURE 4-1. NEW NURSING ORGANIZATIONAL STRUCTURE

Each complex is administratively independent but designed in such a way as to encourage cooperative and necessary patient care interactions. For each complex there is a complex captain, a position that is rotated monthly among the head nurses in the complex. The responsibilities of the Complex Captain include day-to-day balancing of staffing, assigning the complex's staffing pool, and standardization of both technical and administrative practices.

The Assistant Directors and Supervisors took positions as Head Nurses or as Nursing Coordinators. Nursing Administration established the Nursing Coordinators in staff positions to provide round-the-clock coverage as staff support resource persons to the complex groups, head nurses, nursing staff, and other departments. The Nursing Coordinators are accountable for the implementation of special projects. These persons provide input, resource, and recommendations as necessary and would make decisions only in emergency or crisis-type situations. Their primary function is to support decision making at the unit level. The following roles emerged:

- Interdepartmental Coordinator - a part-time position responsible for developing and maintaining relationships between the Nursing Service Department and the Ancillary Departments.
- Quality Care Coordinator - responsible for developing audit criteria and measuring effectiveness of the patient care planning and care delivery processes on the unit including charting, reporting, clinical practice, and development of outcome criteria.
- Primary Nursing Project Coordinator - responsible for developing, evaluating, and implementing the primary nursing care process. This person also is available to assist head nurses with special problems associated with the group process and to facilitate communication between head nurse and her unit and the director of nursing.
- Project Coordinator-HPD - responsible for determining current and long-range staffing requirements and assisting head nurse to attain staffing goals.

- Nursing Personnel Coordinator - a part-time position responsible for screening applications and matching them to current and projected staffing requirements. This person also is responsible for establishing a nurse recruitment program and developing personnel policies.

4.4.3.6 Unit Secretary. During implementation, Unit Clerks were given the responsibility to enter written and standing medical orders into MIS as agents for physicians. This change reduced the clerical activities for Registered Nurses. The additional time made available to the Unit Clerk as a result of MIS permitted the Unit Clerk to assume a much larger role in the communication process. The Unit Clerks provide a communication channel for other hospital departments, physicians, nurses, and visitors. This freed the RN's to devote more time to patient care duties. As a reflection of this increased responsibility, the job title was changed from Unit Clerk to Unit Secretary.

4.4.3.7 Time-Charging Procedures. A change in time-recording procedures was implemented in 1973. Emphasis was placed on charging productive hours on a "where-worked" basis. The result was to increase the productive hours charged to Nursing Administration and to In-Service Training and to reduce the hours charged to the nursing unit for these functions. The practice in 1971 was to charge training and meeting time to the nursing unit.

4.5 Changes in Case-Type Nursing Service Departments

Table 4-3 shows the staffing changes in the Operating Room, Emergency Room, and the Renal Dialysis Unit. The staffing in these units is principally dependent upon the number of activities including procedures, visits, and treatments required in these areas. Table 4-1 presents the changes in the activity levels for these departments.

4.6 Changes in Ancillary Service Departments

The staffing changes in some of the Ancillary Service Departments presented in Table 4-4 and organization changes in these departments are discussed below. Only those Ancillary Service Departments whose operations were significantly impacted by MIS are included in the discussion.

4.6.1 Admitting Department

During the implementation of MIS, the Outpatient Registration Department was transferred from the Business Office to the Admitting Department for the purpose of consolidating registration activities functionally. The increase in activity for the outpatient registration function resulted in an additional personnel requirement of 3.5 FTE's as determined by engineering labor standards developed by the Commission for Administrative Services in Hospitals (CASH). However, the actual average staffing change from FY 71 to FY 74 and 75 was a reduction of 1.2 FTE. This yielded a productivity improvement of 56 percent. Productivity was determined by dividing required labor hours by actual expended labor hours. This change in productivity was due primarily to use of MIS in the hospital.

4.6.2 Medical Records Department

During early 1974 the Medical Records Department was divided into two departments:

- Medical Records Department - responsible for reviewing, abstracting, and storing patient records (charts), and transcribing dictation
- Medical Staff Support Department - responsible for providing secretarial and administrative support for medical staff activities.

A physical rearrangement of the department was also made to facilitate chart handling problems.

During implementation, three temporary persons were added to the staff to review charts. The Medical Records people invested additional effort in reviewing charts to ensure that no information was lost in MIS. A number of system deficiencies were discovered and eliminated. Format changes in MIS chart documents were made to provide a shorter and quicker audit trail. Medical Records personnel recommended other format changes in the printed MIS output that reduced the bulk of the permanent patient chart.

There are no reliable engineering standards currently available for Medical Records which permit comparison of productivity between FY 71 and FY 74 and 75.

4.6.3 Radiology Department

MIS had reduced the typing load for the Medical Secretaries resulting in a staff reduction of one person. There has been an increase in workload in radiology from FY 71 to FY 74 and 75 as determined from engineered standards. However, the change in workload was matched by a change in actual FTE's so that productivity changed less than 1 percent. Thus based on reliable measures of productivity, the effect of MIS was not apparent in the Radiology Department.

4.6.4 Pharmacy

The operating procedures in the Pharmacy changed almost totally as a result of adopting the unit dose drug distribution system. Technicians were added to fill the drug cart cassettes. A packaging operation was established for unit dose packaging. The opportunity to screen drug orders was enhanced by the MIS printout "Medications Supply List".

There are no reliable engineering standards currently available for Pharmacy having a common data base for comparing FY 71 with FY 74 and 75 productivity.

4.6.5 Clinical Laboratory

Prior to full implementation, three clerical persons were added to the Clinical Laboratory to enter test results into the video-matrix-

terminal. In mid-1974, the interface module was implemented. The interface module provides for direct input from the blood chemistry analyzer (Technicon SMA 18/60) and mark-sense input from other test areas. The interface module is expected to significantly reduce the clerical requirements but reductions had not been realized by the end of 1975. At that time, procedural and organizational studies were in progress.

Productivity for the Clinical Laboratory cannot be compared for FY 71 and FY 74 and 75 because of the absence of engineering standards using a common data base.

4.6.6 Respiratory Therapy

Respiratory therapy was a new service at the time the study was initiated and has experienced an increase in staff primarily due to increase in workload. Although MIS has had a favorable impact on the department in terms of improved format of orders and charting procedures, changes in productivity could not be measured because of the lack of reliable engineering standards.

4.7 Changes in Administrative Service Departments

Staffing changes in the Administrative Service Departments, presented in Table 4-5, and organization changes in these departments are discussed below. Only those Administrative Service Departments which were impacted by MIS are included in the discussion.

4.7.1 Business Office

MIS eliminated the requirement for three persons to perform keypunch operations. A data entry clerk was added to enter cash receipts, adjustments, and other data into the video-matrix-terminal. MIS interfaces directly with the billing system to eliminate keypunching the charges from requisition slips as previously done in the manual system. The increase of FTE's (FY 71-FY 75 shown in Table 4-5) is not due to MIS.

The department was divided into two separate departments, Business Services (Patient Accounts and Collections) and Accounting. This change was independent of MIS.

The Business Office had operated using the Technicon Business Office System (BOS) since 1969. Therefore only the additional impact of MIS implementation is considered in this discussion.

The workload in the Business Office has not changed between FY 71 and FY 75 as indicated by the required hours determined by applying the engineering standards for Business Services and Accounting. The outpatient registration function was removed from the Business Service area but other work has increased to compensate. The productivity for the area changed in the same proportion as the productive FTE's shown in Table 4-5.

4.7.2 Management Engineering

The Management Engineering Department played the key role in implementing MIS. Personnel from the department were assigned to all hospital departments to provide implementation support. In effect, the head of each department had a staff assistant in the person of the management engineering representative who supported the department head to attain the best possible operation from MIS through

- Development of MIS methods that modify or replace manual methods
- Auditing MIS operations to ensure that information is accurate and complete
- Coordinating interdepartmental MIS operations attributable to MIS implementation
- Promoting changes to MIS that improved departmental operations
- Identifying systems problems and transmitting them to Technicon
- Implementing changes to MIS as they occurred
- Assisting in reviewing departmental objectives, responsibilities, and authority
- Performing special studies to obtain cost savings realization and quality improvement.

Prior to the implementation of MIS, the Management Engineering Department included three industrial engineers. To provide technical support for implementation, a Registered Nurse was added to the staff.

In 1972, after the evaluation contract was signed with HEW, four additional people were added to the staff: two industrial engineers, a data analyst, and a departmental secretary. Also, a health economist consultant was retained to perform the economic impact analysis for the HEW contract. During the 3-year period of implementation, operation, and evaluation, the staff varied as a result of changing evaluation requirements. For example, two nursing consultants and a management engineering consultant were retained for 5 months in early 1973 to participate in a special cost-saving realization study.

At the end of 1974, the staff consisted of five industrial engineers, one registered nurse, and two clerical personnel, but staff reductions are expected to occur upon completion of the HEW contract.

4.8 Distribution of Productive Hours to Skill Classifications and Shifts

Data were collected and analyzed for Inpatient Nursing Service Departments relative to the productive hours contributed by skill categories and by shifts. The results of these analyses are presented in the following paragraphs.

4.8.1 Changes in the Distribution of Productive Hours to Skill Classification

The distribution of productive hours to skill classifications was derived for Inpatient Nursing Services Departments for both FY 71 and FY 74. Table 4-6 presents a comparison of the results for the two years. The data presented in Table 4-6 considers the productive hours for all three shifts combined. The distribution of hours was obtained by dividing the productive hours for each skill classification by the total productive hours for the appropriate fiscal year.

TABLE 4-6. INPATIENT NURSING SERVICES: DISTRIBUTION OF PRODUCTIVE HOURS BY SKILL CLASSIFICATION

Skill Classification[a]	Medical		Surgical		Orthopedic		Total M-S-O		Critical Care[b]		Maternity Care[c]	
	FY 71 (%)	FY 74 (%)	FY 71 (%)	FY 74 (%)	FY 71 (%)	FY 74 (%)	FY 71 (%)	FY 74 (%)	FY 71 (%)	FY 74 (%)	FY 71 (%)	FY 74 (%)
Supervisory	13.5	9.8	13.5	14.0	10.6	7.4	13.0	10.7	23.6	17.5	15.9	18.7
Professional	39.0	39.9	38.5	39.5	34.3	35.4	38.0	38.8	63.6	62.9	45.8	42.4
LVN	6.5	5.9	5.4	6.9	10.2	9.7	6.7	7.0	4.0	7.4	1.4	0.6
(Prof & LVN)	(45.5)	(45.8)	(43.9)	(46.4)	(44.5)	(45.0)	(44.7)	(45.8)	(67.6)	(70.3)	(47.3)	(43.0)
Clerical	6.6	6.2	4.4	6.7	5.0	4.8	5.4	6.1	3.2	4.7	4.6	5.7
Technical	34.4	38.2	38.1	32.9	39.8	42.7	36.8	37.4	5.5	7.4	32.3	32.7

Classification	Pediatrics		Gynecology		Nursing Admin.		Nursing Service Areas[d]		Mental Health		All Inpatient Areas[e]	
	FY 71 (%)	FY 74 (%)	FY 71 (%)	FY 74 (%)	FY 71 (%)	FY 74 (%)	FY 71 (%)	FY 74 (%)	FY 71 (%)	FY 74 (%)	FY 71 (%)	FY 74 (%)
Supervisory	13.6	14.5	15.1	10.9	55.5	40.3	17.2	15.6	19.3	16.9	17.3	15.7
Professional	43.9	41.6	40.8	42.9	35.0	44.9	42.3	44.1	37.0	38.6	42.0	43.7
LVN	~	0.3	8.7	0.6	0.8	1.0	4.9	4.9	28.3	22.1	6.3	6.1
(Prof & LVN)	(43.9)	(41.9)	(49.5)	(43.5)	(35.9)	(45.9)	(47.2)	(49.0)	(65.3)	(60.7)	(48.3)	(49.8)
Clerical	7.2	7.5	4.6	7.2	5.0	6.6	5.1	6.1	12.0	5.8	5.5	6.0
Technical	35.2	36.1	30.8	38.4	3.6	7.2	30.5	29.3	3.5	16.7	28.9	28.5

(a) Supervisory includes Director, Supervisor, Head Nurse.
Professional includes Registered Nurse, Social Worker, Occupational Therapist, Dietician, Nursing Coordinators.
LVN includes Licensed Vocational Nurse Classification only.
Clerical includes Unit Secretary, Medical Secretary, Clerk, Clerk-Typist.
Technical includes Nursing Assistant, Technician, Mental Health Workers.

(b) Critical Care includes Intensive Care, Coronary Care, and Transitional Care.

(c) Maternity Care includes Labor and Delivery, Nursery, and Maternity Units.

(d) Nursing Service Areas include all the units shown before it in the table and the data for FY 74 includes Ambulatory Surgical Care. The FY 71 data do not include Ambulatory Surgical Care, which did not exist at that time.

(e) Inpatient Areas include Nursing Service Areas and Mental Health. Excluded from this category are Emergency Room, Renal Dialysis Unit, Operating Room.

The following changes were noted:

- The supervisory classification has decreased in proportion to the total staff in nearly all care areas.
- The professional classifications have increased in proportion to the total staff in nearly all care areas.
- The Licensed Vocational Nurse classification represents a small percentage of the total staff and is quite sensitive to small changes in staffing patterns. Overall, the proportion of LVN's has remained relatively constant.
- The Clerical classification has increased in proportion to the total staff in most care areas. As noted in paragraph 4.4.3.6, the Unit Secretary has been given responsibility for entering physician's written or standing orders and for handling the clerical functions relating to MIS. Clerical personnel have been added to provide weekend coverage and to provide coverage in the Critical Care Units.
- The technical classification has remained stable in proportion to the total staff in all care areas except the surgical area which decreased and mental health which experienced an increase.
- Nursing Administration shows a decrease in the supervisory classifications and an increase in the professional classifications. This shift in respective proportions of staff reflects, in part, the discontinuance of Assistant Director and Supervisor positions and the creation of Nursing Coordinator positions.
- The Mental Health Unit shows a decrease in the LVN and Clerical classifications and an increase in the

Technical classifications. This shift represents an organizational change resulting from the creation of the new classification of Mental Health Worker.

4.8.2 Distribution of Productive Hours by Shift

Table 4-7 shows the distribution of productive hours by shift for all skill classifications in each nursing area. The distribution of hours was obtained by dividing the productive hours by shift by the total productive hours for the appropriate fiscal year.

Overall, there appears to be very little change in the delivery of patient care services over the three shifts. The proportion of productive hours for the day shift remained constant at 44 percent. There were slight changes between the second and third shifts with the second shift increasing from 33 to 34 percent, and the third shift decreasing from 24 to 23 percent. There were some changes in care areas noted below:

- The Surgical and Orthopedic Units shifted to become consistent with the Medical Units. This is most likely due to the establishment of a standardized system for staff planning.
- Several areas showed a shift in productive hours from the day shift to the second shift: Critical Care Units, Maternity Care, Pediatrics, and Gynecology.
- In Nursing Administration, productive hours shifted to the day shift. This shift reflects the increase in the emphasis on new employee training and continuing nursing education occurring mostly on the day shift. It also reflects an increase in committee activity (standardization, goals, and objectives) occurring on the day shift also.
- The increase in the proportion of hours on the day shift in the Mental Health Area is due to several factors:
  - Increase in daytime outpatient services
  - Addition of a Social Worker
  - Addition of an Occupational Therapist.

TABLE 4-7. INPATIENT NURSING SERVICES: DISTRIBUTION OF PRODUCTIVE HOURS BY SHIFT AND BY AREA

Department	FY 71 Shift (%)			FY 74 Shift (%)		
	#1 (Day)	#2 (PM)	#3 (Night)	#1 (Day)	#2 (PM)	#3 (Night)
Medical	44	35	21	44	35	21
Surgical	43	34	23	46	34	20
Orthopedic	46	37	17	45	35	20
Total-M.S.O.	(44)	(35)	(21)	(45)	(35)	(20)
Critical Care Units[a]	41	29	30	36	35	29
Maternity Care[b]	43	30	27	41	32	27
Pediatrics	43	34	23	41	35	24
Gynecology	46	33	21	44	36	20
Nursing Administration	40	32	28	49	29	22
Nursing Service Areas[c]	43	33	24	43	34	23
Mental Health	48	35	17	55	28	17
All Inpatient Areas[d]	44	33	23	44	34	22

(a) Critical Care includes Intensive Care, Coronary Care, and Transitional Care.
(b) Maternity Care includes Labor and Delivery, Nursing, and Maternity Units.
(c) Nursing Service Areas include all of the units shown above it and the data for FY 74 includes Ambulatory Surgical Care. The FY 71 data does not include Ambulatory Surgical Care which did not exist at that time.
(d) Inpatient Areas include Nursing Service Areas and Mental Health. Excluded from this category are Emergency Room, Renal Dialysis Unit, and Operating Room.

5.0 NURSING ACTIVITY ANALYSIS

5.1 Summary of Results

The purpose of this analysis is to determine if MIS has changed the distribution of time nursing personnel apply to their work activities. The industrial engineering technique of work sampling was used to accomplish the analysis. Using the work sampling technique, observations were made during late 1971, prior to the implementation of MIS, to establish the time allocated to nursing activities. A second sample was taken in late 1972 and early 1973, but the results[4] were inconclusive, presumably, because MIS had not been implemented a sufficient period of time for work practices and activities to stabilize. A third sample was taken in the fall of 1974 to establish the time allocated to nursing activities using MIS. This section of the report compares the results of the pre-MIS observations with the results of the post-MIS (fall of 1974) observations to identify changes that have occurred in the distribution of time to nursing personnel work activities.

5.1.1 Major Results

Many changes transpired within the hospital between the two sample periods which have impacted the time allocated to work activities in nursing units. One of the largest impacts occurred in unit staffing coupled with changes in patient census. On the day shift the available nursing personnel minutes per patient-day changed as follows:

- Medical Units: -18.2 minutes per patient-day for a reduction of 10.8 percent
- Surgical Units: -20.5 minutes per patient-day for a reduction of 12.4 percent

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[4] The results of the referenced analysis are presented in Volume II of Battelle's Interim Report, "Evaluation Studies and Analyses on Evaluation of the Implementation of a Medical Information System in a General Community Hospital", September 30, 1973. NTIS PB-232785.

- Orthopedic Unit: -31.7 minutes per patient-day for a reduction of 17.7 percent
- Pediatric Unit: -58.6 minutes per patient-day for a reduction of 25.6 percent
- Intensive Care Unit: -135.1 minutes per patient-day for a reduction of 22.0 percent
- Coronary Care Unit: +38.30 minutes per patient-day for an increase of 12.4 percent.

These changes, most of which show a reduction in the available nursing time in minutes per patient-day during the day shift, have influenced nursing personnel in their allocation of time to work activities. Because of these changes and others, which will be discussed throughout this section, it is difficult to identify changes in time allocations that can be directly attributable to MIS. However, the impact of MIS is quite evident upon some nursing activities.

To assist in the analysis of the results, discussions were conducted with nursing personnel from each unit observed. The nurses that were selected for comments were, for the most part, at El Camino Hospital (ECH) during both observation periods. During the discussion the nurses were acquainted with the technical summary of results and were asked to comment on reasons for the observed changes. Many of the reasons for change presented in this section of the report are based on the comments received from the nursing personnel.

Both the day and evening shift were observed for comparing changes in nursing activities. However, in the pre-MIS observations only a 5-hour period of the evening shift (4:30 p.m. to 9:30 p.m.) was observed. During the post-MIS observations the total shift was observed to determine if the 5-hour period is representative of the remaining shift. It was found that the 5-hour period is <u>not</u> representative of the remaining shift. Hence, the evening shift data was not analyzed further, and only the day shift data are used in analyzing results and drawing conclusions.

The major results for the categories of Direct Patient Care Activities, Clerical, VMT, and Printer Activities, Communication Activities, and Other Activities are presented in the following paragraphs.

5.1.1.1 Direct Patient Care Activities. The Direct Patient Care Activities category includes activities associated with preparing and dispensing medications and attentive activities where the nurse is directly caring for the patient inside or outside the patient's room (further definitions are given in Section 5.3). There was no consistent change in Direct Patient Care Activities across the units observed. There were increases and decreases in time, expressed in minutes per patient-day, for some units but a clear pattern of change does not exist. It is believed that the changes observed are influenced primarily by the nursing time that is available on the units and many of the nurses believed that more time available on the unit would increase Direct Patient Care Activities. The results do not reflect this latter belief. It appears that most of the nursing time freed from some activities resulted in less time within the unit. It must be pointed out, however, that in some units (Medical and ICU) that the time in Direct Patient Care Activities increased while available nursing time decreased (on a patient-day basis). In other units the time allocated to Direct Patient Care Activities decreased but did not undergo the same rate of decrease as nursing time available to the unit. In one unit (CCU) there was an increase in the available nursing time of about 12 percent but the time applied to Direct Patient Care Activities decreased slightly.

Other changes in the hospital that influenced the time allocated to Direct Patient Care Activities include

- The implementation of the unit dose system for medications
- Changes from the large team concept of nursing to smaller teams and, in some cases, to the case method and in others to the primary nursing concept
- Changes in patient dependency that may have occurred
- Changes in nursing personnel.

5.1.1.2 Clerical, VMT, and Printer Activities. This category includes the activities associated with reading, writing, and handling charts, forms, etc. It includes the accomplishment of these activities at the nursing station as well as away from the nursing station. After the implementation of MIS it also includes the time associated with activities at the video-matrix terminal and at the MIS printer.

The time allocated to Clerical Activities, exclusive of VMT and Printer Activities, decreased for every type of unit observed. The reductions ranged from 4 percent for CCU to 47 percent for Surgical Units. After considering the new activities added through the use of the VMT and printer, there is still a reduction of time in each type unit observed with the exceptions of CCU and Orthopedics. In Orthopedics the total clerical time per patient-day remained about the same. In the CCU unit the VMT is used more extensively than in other units for entering detailed patient care notes and notes to assist nursing personnel in other units upon transfer of the patient out of CCU to other units. In the remaining units the net reductions ranged from 7 percent in Pediatrics to 33 percent in ICU.

The decrease in the time allocated to Clerical Activities which was measured through the nursing activity analysis is probably understated. The length of patient stay has been reduced between the pre- and post-MIS observation periods by about 6 to 7 percent. With the shorter stay the nursing personnel are processing more admits and discharges during the post-MIS observations than they were during the pre-MIS sample period. Thus, the clerical workload per patient day at the nursing units is higher now than it was during pre-MIS observations. The data reflected in this analysis measures the time, expressed in minutes per patient-day, expended in the activities and reflects that more time was required but does not identify where the demand for the various activities increased. In summary, if the clerical workload per patient day had remained the same during the post-MIS observations as it was in the pre-MIS observations, a larger decrease in the time expended in Clerical Activities would have taken place.

5.1.1.3 Communication Activities. The Communication Activities category includes the Report and Conference activities and verbal communications between nurses and doctors, patients (other than attentive activities), other nurses, individuals on the telephone, and other personnel.

The time expended in Report and Conference Activities decreased for every unit. In discussions with nursing personnel, it was indicated that the reduction in Report and Conference Activities is due, in part, to better patient records which are much more complete and legible than previous

records. The nurses also pointed out that changes in the approach to nursing care such as changes from the large team approach to the smaller team approach, means fewer people are involved in the reporting process and fewer communications are required during the shift.

The time allocated to verbal communications did not change in a consistent pattern. Most types of units (except Surgical Units and CCU) experienced a decrease in the time expended. The nurses attribute the decrease to the combined effects of better information which is more readily obtainable through MIS and changes in nursing care delivery procedures.

Changes in the amount of time allocated to the Communication Activities category do not exhibit a consistent pattern of change, but it does appear that Communication Activities and, especially, the Report and Conference activities have been impacted by MIS and by changes in nursing care delivery procedures.

5.1.1.4 Other Activities. The Other Activities category includes the following activities for which brief definitions are given. Further definitions are given in Section 5.3.

- Supply and Maintenance--activities involved with maintaining supplies or unit appearance
- Planned Nursing--activities involved in continuing education, lectures, planning, and management activities outside of the unit, etc.
- Nursing Station Other--activities at the nursing station which are not defined by other activities
- Outside Unit--nurse was not on the unit at the time of the observations and was not on personal time or involved in a planned nursing activity
- Personal Time--scheduled and unscheduled breaks and lunch.

The time expended on Supply and Maintenance activities decreased slightly in some units. The Supply and Maintenance activities increased for Orthopedics and CCU. A reason for the increase was not identified in Orthopedics, but in CCU, during the post-MIS observations, supplies shelves were being cleaned and reorganized.

Planned Nursing Activities increased for all types of units with the exceptions of Orthopedics and ICU. The increase ranged from about a 40 percent increase in Surgical Units to a 555 percent increase in Pediatrics. The head nurse in Pediatrics was very active in planning activities during the post-MIS observations. The nurses interviewed indicated that MIS has freed the head nurse and assistant head nurse from the nursing station where they spent most of their time prior to MIS. Now they can participate more in management and planning activities and can better influence patient care and nursing activities. On the Orthopedic Unit, which is one of the two units where Planned Nursing Activities decreased, the head nurse was terminating her position during the post-MIS observations and was not participating in developmental work for the unit. In ICU the nurses indicated that they did not have sufficient time to participate in planned activities (too busy).

The time allocated to Nursing Station Other Activities decreased for all unit types observed. Nurses indicated there is now (with MIS) less time required at the nursing station and when at the station less time is spent waiting for access to charts and records.

The amount of time allocated to activities outside of the unit decreased for all units. The decreases in time ranged from 86.7 percent in CCU to 95.8 percent reduction in Orthopedics. This activity involves trips by nursing personnel to locations outside of the unit except for personnel activities or to planned nursing activities. Usually the purpose of the trip was known by the observer but if the nurse being observed was outside of the unit and the activity was unknown (which was infrequent), the observation would be recorded to this activity. The nurses believe that, with MIS, better information is more readily available than with the previous manual system. They also point out, however, that better use is now being made of escort services and improvements have been made in the areas of equipment availability and in deliveries by service departments. These improvements limit the number of trips outside of the unit that must be made by nursing personnel.

The percent of time allocated to Personal Time by nursing personnel should be about 10 to 11 percent based on ECH practices. There was no statistically significant change in the percentage of time allocated to personal

time in the Medical, Surgical, and Pediatric Units (see Tables 5-4, 5-6, and 5-8, respectively). There was a significant increase in Orthopedics where the personal time increased from 10 percent of the time to 13.1 percent (Table 5-8). In CCU, the percent of time increased from 4.7 percent to 9.4 percent, which is a statistically significant increase, but the percentage of time taken for personal activities is still below the expected level. In ICU there was a statistically significant decrease in personal time where the percentage decreased from 12.9 percent to 9.5 percent (Table 5-8).

5.1.2 Major Conclusions

While it is very difficult and in many cases impossible to isolate the effects of MIS on nursing activities from other changes, it must be concluded that MIS has had a favorable influence on the nursing units observed. These favorable effects are most apparent in the Clerical Activities, Communication Activities, and Other Activities categories.

The time allocated to clerical activities, in most of the units observed, has decreased with MIS. The amount of the decrease shown in this analysis is very likely understated because it is believed that the clerical workload increased in the post-MIS observation period. The suspected increase in workload is a result of the shorter length of patient stay. Now, more patients are being admitted and discharged which very likely increases the clerical workload in the nursing units.

The Communication Activities category includes the activities associated with the shift report. The availability and form of the information provided through MIS makes the reporting activities easier to accomplish and less time consuming.

In the Other Activities category, nursing personnel are now spending less time off the unit because better and more complete information is readily available. Also, nursing personnel are now spending more time in Planned Nursing Activities which stimulates professional growth and also provides the opportunity and mechanism for better planning and management which will evolve other changes to patient care in the nursing units.

As discussed earlier, other factors also influenced these activities, but for changes in the Clerical Activities, Communication Activities, and

Other Activities categories it is believed that MIS played a significant role, and perhaps, the primary role in bringing about the change. MIS impacted other activities, but in most instances, it is difficult to separate the effects of MIS from other changes that have occurred.

5.2 Introduction

The purpose of the nursing activity analysis is to evaluate changes in the distribution of nursing time between nursing activities at the nursing unit level before and after the implementation of MIS. Two sample periods are covered in this report. The first period extends from October 19, through December 9, 1971. This was prior to the implementation of MIS and is referred to as pre-MIS in the nursing activity analysis portion of this report. The second period extended from September 6 through October 18, 1974, which is well after the implementation of MIS (completed October, 1972) and is referred to as post-MIS in reporting the results of the nursing activity analysis.

The second observation period was delayed to permit, to the extent possible, the implementation of nursing care plans and to provide additional time for the accomplishment of the hospital's Benefits Realization Program. At the time the second set of observations was initiated nursing care plans were only implemented in the Orthopedic Unit (5E) and the Benefits Realization Program was only partially accomplished. The Benefit Realization Program which began in March, 1973, was conceived and initiated to realize, to the maximum extent possible, the potential benefits for nursing unit operating efficiency. The delay in the post-MIS sample was in keeping with a request made by the HEW advisory committee that the sample period be delayed for one month, until August, 1974, to allow for perturbations of the system as a result of additions of nursing care plans to MIS.

The Advisory Committee also requested that the nursing activity analysis be accomplished in a surgical ward where nursing care plans had been implemented and also in a surgical ward without automated care plans so that the two might be compared. This was not possible, even though the observations were delayed until September, because the only unit with

automated nursing care plans was the Orthopedic Unit and a corresponding Orthopedic Unit without the automated care plan did not exist.

The work sampling procedure used in accomplishing the nursing activity analysis was designed to measure the allocation of nursing time to the activities performed by the nursing personnel. The first set of observations measured the allocation of time prior to the implementation of MIS and the second set of observations measured the allocation of time after the implementation of MIS. The before and after comparisons of these measurements are presented in the remainder of this section of the report. However, the results must be qualified for several reasons. As previously mentioned, the implementation of the Benefits Realization Program and nursing care plans have not been completed. Also, the second measurements include the effects of all of the non-MIS changes which have taken place in the nursing units as well as changes within other areas of the hospital which in turn affect nursing activities. These changes include: changes in census; changes in the number and mix of nursing personnel; changes in nursing care delivery procedures; changes in patient dependency; changes in the length of stay; changes in personnel; changes in the intensity of the management engineering program; the implementation of unit dose; and other changes to the nursing unit workload. The influences of these and other factors are all integrated into the results presented for the activity analysis. Recognizing the presence of all of these influences, it was determined that the work sampling results of "what" happened to nursing activities should be followed by discussions with appropriate nursing personnel to gain insight into "why" the changes occurred. Consequently, the technical summary of the results are reported under two headings: one concerned with a quantitative analysis of "what" happened and a qualitative discussion of "why" work activities changed as they did based on discussions with hospital nursing personnel. The technical summary of results is followed by a presentation of the detailed results of the analysis.

5.3 Study Approach

The industrial engineering technique of work sampling was used to perform the nursing activity analysis. In work sampling a large number

of observations are taken at random intervals and in the course of each observation the activity (or activities) of the object or person under study are recorded into a predetermined list of pertinent activities defined for the object or person. After all observations are completed the percentage of time spent in each activity is calculated based on the proportion of the observations which were observed for that activity.

In this analysis, a list of activities were developed for recording nursing activities during the observations. The delineation of the nursing activities for the study were designed to cover all nursing personnel time at the unit level. The level of the activity definitions were selected to detect any significant shift in nursing time and effort between major areas of nursing activities. Summarized definitions for the nursing activities used in the analysis are given below:

1. Medication-Preparation. Nurse (HN, Assistant HN, RN, or LVN) engaged in activities in the medication room, but not engaged in conversation with another staff member. During pre-MIS observations use of medication Kardex was recorded as a clerical activity because observer could not distinguish between medication Kardex or patient care plan Kardex. Thus, medication preparation in pre-MIS may have required more time than is indicated.
2. Medication-Dispense. Nurse (HN, Assistant HN, RN, or LVN) observed anywhere outside the medication room carrying medications, or at the bedside administering medications.
3. Attentive Activities-In Room. Nursing personnel engaged in activities in a patient's room, or in the process of leaving the patient's room, except when the activity is related to dispensing medications or communication with someone other than the patient.
4. Attentive Activities-Outside Room. Nursing personnel outside the patient room or nursing station performing a patient related task with or without patient contact. Exceptions are activities categorized as conversation,

supply and maintenance, reports, clerical, personal time, and planned nursing activities.

5. Supply and Maintenance. Activities of nursing personnel in or outside the patient room involved with providing services to maintain supplies or unit appearance.
6. Clerical-Nursing Station. Any activity at the nursing station in which nursing personnel are reading, writing in or on, or handling medical charts, forms, and so forth. Includes directly related activities such as the patient identification stamp and use of the pneumatic tube system. In pre-MIS activities included use of medication Cardex.
7. Clerical-Away From Nursing Station. Any clerical type activity of nursing personnel away from the nursing station. Exception is any clerical activity associated with a report or conference.
8. Reports and Conferences. Nursing personnel engaged in exchanging information in a structured manner such as discussing patient while referring to the patient chart, or conducting a meeting (generally in the nursing station or conference room).
9. Nursing Station Other. Nursing personnel at the nursing station, and not involved in the other defined nursing activities.
10. Communications. Nursing personnel engaged in verbal communications either as the communicator or as a listener with (1) nursing personnel-same unit, (2) doctor, (3) patient, i.e., any conversation with patient not classified as an attentive activity, (4) telephone, or (5) other hospital staff. (Observations were recorded by the subcategories.)
11. Planned Nursing Activities. Attendance by nursing personnel at a planned activity such as in-service education or lectures.

12. Personal Time. Nursing personnel known to be on scheduled breaks or at lunch at time of the observation round, or observed in personal activity such as drinking coffee in the conference room.
13. Outside Unit. Nursing personnel assigned to the unit that shift, but not on the unit at time of the observation round and not scheduled on personal time or not involved in a planned nursing activity.

For the post-MIS samples, it was necessary to modify three of the activity definitions to include changes due to MIS and the concurrent implementation of a medication unit dose system. Specifically, the Activity 1 (Medication-Preparation) definition was modified to include activities at the medication cart. The Activity 2 (Medication-Dispense) definition was modified to account for the medication cart in the dispensing function. Also, the definition for Activity 6 (Clerical-Nursing Station) was modified to include the reading, writing, handling, and filing of the printed material produced by the medical information system. In addition, two new activity definitions were required:

14. Video-Matrix-Terminal (VMT). Nursing personnel at the nursing station engaged in the use of the VMT. If engaged in conversation while using the VMT, priority is given to the VMT.
15. Printer. Nursing personnel at the nursing station removing printed material from the printer, handling paper or controls attached to the printer, or looking at printed material before it has been removed from the printer.

In accomplishing the observations, specific procedural steps were followed:

1. The primary observers were registered nurses instructed in work sampling techniques. In the pre-MIS observations, selected student nurses trained and supervised by an RN were also used. In the post-MIS observations, only Registered Nurses were used in making the observations.
2. Trial observation rounds were made at the beginning of each sample period by each observer to ensure uniformity of

procedure, and to identify any problems with interpretation of the activity descriptions.

3. Data were collected and records were maintained on unit staffing, number of patients, and scheduled personal time for each day and shift that a unit was observed.
4. Since several units were normally included during an observation day, randomization in the sequence of unit sampling during an observation round was used to avoid any set pattern. In addition, since each nursing station would be approached from the hallway, both the right and left hallways were used without a consistent pattern.
5. The observer wore either a nurses' uniform or laboratory coat while taking observations. The observer always attempted to remain "inconspicuous", particularly around the nursing station.
6. The observer, upon approaching a unit area, first recorded the activities of any nursing personnel seen in the hallway area. The personnel in the nursing station area were observed next. The observer then proceeded around the hallway where observations were made in patient rooms, the hall, and ancillary areas. A second round was made if necessary to observe all personnel, or to confirm that one or more nurses were off the unit.
7. Recording sheets were used to mark the observed nursing activities for each round. These were maintained for each unit along with the date, time, and number of personnel by category associated with the observations.

The nursing personnel were divided into four categories: (1) Head Nurse (HN) or Assistant Head Nurse (AHN), (2) Registered Nurse (RN) or Licensed Vocational Nurse (LVN), (3) Nursing Aide (Aide), and (4) Unit Secretary. The activities were observed, recorded and maintained for each of the nursing personnel categories.

Table 5-1 identifies the specific units and the type of units observed during the two sample periods. Between the sampling periods, the unit occupying 6-West (6W) was moved and the Medical Unit 3-West (3W) was

TABLE 5-1. NURSING UNITS SAMPLED

Type of Unit	ECH Nursing Units in the Sample	
	Pre-MIS	Post-MIS
Medical	3W,6E	6W,6E
Surgical	2E,2W,5W	2E,2W
Orthopedic	5E	5E
Pediatric	3E	3E
Specialty	ICU,CCU	ICU,CCU

moved to 6W. Consequently, the same Medical Units were observed during the sampling periods even though Table 5-1 shows different unit locations. The Surgical Unit 5-West was included in the pre-MIS sample but it was closed between the sampling periods because of a decrease in census. It had reopened prior to the post-MIS sample but it serves as an overflow for Orthopedic patients as well as other units and it also has some minor specialties. Since it was unlike the units included in the pre-MIS sample it was dropped from the post-MIS sample.

The daily time period covered in the pre-MIS sample was 7:30 a.m. to 3:30 p.m. The same daily time periods were observed for the post-MIS sample so that the results of the pre- and post-MIS observations could be directly compared. In making the observations, a relatively even distribution of observation rounds was made throughout the day shift. Records were maintained of the number of observations rounds by nursing unit and hour to maintain an even distribution of observations. The observations were made when student nurses were not working on the units to prevent any effect due to this factor.

5.4 Technical Summary of Results

In this section a quantitative analysis of the changes to nursing activities are summarized. Detailed quantitative analyses are presented in Section 5.6. The changes in the time allocated to nursing activities are

the result of all of the influences bearing upon the hospital. Because the number of influences are large and their degree of applicability variable between nursing units, and because the hospital is a dynamic organization providing critical services as opposed to an experimentally controlled environment, it is not feasible to measure the contribution to change of each of the influences. However, two of the major variables which impact nursing activities have been normalized in this analysis. The normalized variables are changes in patient census and changes in the number and mix of nursing personnel assigned to each unit. Table 5-2 identifies the changes to the average census and average number of staff for the day shift. The data shown are averages based on the staffing and census data collected on each day the unit was visited for nursing activity observations. The last two columns of Table 5-2 contain the staff to patient-day ratios that existed during the pre- and post-MIS observations. As may be seen in the table, the staff to patient-day ratio decreased for every unit observed with the

TABLE 5-2. CENSUS AND STAFFING DATA FOR THE SAMPLING PERIODS--DAY SHIFT

		Census		FTE's		Staff/Patient-Day	
Category	Unit	Pre-MIS	Post-MIS	Pre-MIS	Post-MIS	Pre-MIS	Post-MIS
Medical	6E	27.06	31.55	9.56	10.46	.353	.332
	3W[a]	28.93	29.42	9.64	8.74	.333	.297
Surgical	2E	25.61	30.00	8.89	9.15	.347	.305
	2W	26.63	29.85	9.12	8.86	.324	.297
	5W[b]	29.20	--	9.80	--	.336	--
Orthopedic	5E	36.56	36.04	13.67	11.10	.374	.308
Pediatric	3E	17.79	17.19	8.50	6.61	.478	.385
Specialty	ICU	4.25	7.84	5.44	7.83	1.28	1.00
	CCU	4.91	5.45	3.17	3.95	.646	.725

(a) 3W was transferred to 6W prior to the Post-MIS sampling period.
(b) 5W was closed for a period and then reopened. Because its content was changed upon reopening, it was dropped from the sample.

exceptions of the Coronary Care Unit (CCU) in which the ratio increased and the Surgical Unit 5W which was not observed during the post-MIS sample. Both the census and staff increased for the Intensive Care Unit (ICU) which reflects that ICU was expanded in size and capacity between the two sample periods.

The census and staff data presented in Table 5-2 are a measure of "what" happened in relation to census and staffing (Staff/Patient-Day) during the two observation periods, i.e., no inference is made or intended as to "why" the changes occurred as they did. The census and staff data presented in this table were used to normalize the result of work sampling observations of nursing activities. The work sampling observations resulted in a measurement of the percent of time allocated to each activity with the sum of all of the percentages for all activities totalling 100%. These data were normalized for changes in staff and census by using the census and staff data to calculate the available nursing minutes per patient-day for the day shift during each sample period and, for each sample period, allocating the available nursing minutes per patient-day for the day shift to each activity. The allocation of time to activities was accomplished using the percentages of time derived through the work sampling observations. The result is a measurement of the time, expressed in minutes per patient-day spent on each activity during the pre-MIS sample period and for the post-MIS sample period. These measurements can be directly compared for each activity permitting changes in the allocation of time to be identified.

Table 5-3 contains a summary of the changes in nursing time, by activity. There are two table entries for each row and column intersection. The top entry shows the direction of change and the amount of change expressed in minutes per patient-day for all nursing skill levels combined. For example, the preparation and dispensing of medications in Medical Units required 0.95 more minutes per patient-day during the post-MIS observations than was required during the pre-MIS observations. The table entry in parentheses gives the percentage of change, e.g., the 0.95 minutes per patient-day increase for Medications in Medical Units represents a 16.9% increase over the time required during the pre-MIS sample.

TABLE 5-3. SUMMARY OF CHANGES IN NURSING TIME (1971-1974)

Category & Activity	ALL NURSING PERSONNEL Changes expressed in minutes per patient-day and percent of change					
	Medical	Surgical	Orthopedic	Pediatric	ICU	CCU
Direct Patient Care Activities						
Medications	+0.95 (+16.9%)	-0.85 (-14.4%)	+1.24 (+26.6%)	-1.07 (-17.3%)	+5.49 (+99.3%)	+0.03 (+0.5%)
Attentive Activities	+3.37 (+5.6%)	-2.12 (-3.7%)	-8.33 (-11.3%)	-19.22 (-25.6%)	+117.96 (+77.4%)	-1.38 (-1.3%)
Total	+4.32 (+6.5%)	-2.97 (-4.7%)	-7.09 (-9.0%)	-20.29 (-24.9%)	+123.45 (+78.2%)	-1.35 (-1.2%)
Clerical, VMT, & Printer Activities						
Clerical	-10.45 (-33.1%)	-15.81 (-46.6%)	-9.38 (-40.8%)	-10.21 (-25.2%)	-33.68 (-46.5%)	-2.84 (-4.1%)
VMT & Printer	+7.63 --	+10.53 --	+9.61 --	+7.51 --	+10.07 --	+18.80 --
Total	-2.82 (-8.9%)	-5.28 (-15.6%)	+0.23 (+1.0%)	-2.7 (-6.7%)	-23.61 (-32.6%)	+15.96 (+22.8%)
Communication Activities						
Communications	-4.13 (-20.0%)	+0.96 (+5.2%)	-1.87 (-10.3%)	-10.97 (-29.7%)	-15.61 (-22.7%)	+16.82 (+41.7%)
Report & Conference	-1.24 (-20.9%)	-2.40 (-28.5%)	-2.40 (-39.3%)	-8.12 (-62.1%)	-40.52 (-82.4%)	-3.34 (-22.0%)
Total	-5.37 (-20.2%)	-1.44 (-5.4%)	-4.27 (-17.6%)	-19.09 (-38.2%)	-56.13 (-47.6%)	+13.48 (+24.3%)
Other Activities						
Supply & Maintenance	-0.50 (-17.9%)	-0.15 (-5.8%)	+0.41 (+15.2%)	+0.49 (+17.8%)	-9.10 (-38.0%)	+9.08 (+154%)
Planned Nursing Activities	+2.68 (+146%)	+1.13 (+39.8%)	-1.01 (-17.6%)	+11.43 (+555%)	-2.51 (-27.2%)	+7.73 (+125%)
Nursing Station Other	-3.76 (-40.1%)	-1.09 (-12.4%)	-2.37 (-31.4%)	-9.44 (-63.4%)	-47.67 (-76.8%)	-4.36 (-20.7%)
Outside Unit	-12.78 (-94.3%)	-9.16 (-90.8%)	-19.01 (-95.8%)	-12.21 (-93.4%)	-85.80 (-93.7%)	-20.41 (-86.7%)
Personal Time	+0.03 (+1.8%)	-1.54 (-9.3%)	+1.41 (+7.9%)	-6.79 (-27.7%)	-33.73 (-42.6%)	+18.17 (+125%)
Total	-14.33 (-32.2%)	-10.81 (-26.4%)	-20.57 (-38.3%)	-16.52 (-28.8%)	-178.81 (-67.2%)	+10.21 (+14.3%)
Total	-18.2 (-10.8%)	-20.5 (-12.4%)	-31.7 (-17.7%)	-58.6 (-25.6%)	-135.1 (-22.0%)	+38.30 (+12.4%)

The results for each type of unit will be discussed in the following paragraphs. Reasons for the changes are discussed in Section 5.5.

5.4.1 Medical Units

The available nursing time decreased from pre-MIS to post-MIS by 18.2 minutes per patient-day which is a reduction of about 10.8 percent of the time available during the pre-MIS sample period. This change was brought about by changes in patient census and by changes in the number of nursing personnel assigned to the unit. The time allocated to Direct Patient Care such as the preparation and dispensing of medications, and Attentive Activities in and outside of the patient's room increased 6.5 percent. There were decreases in the time allocated to Clerical Activities, Communication Activities, and Other Activities.

In the Other Activities category, it should be noted that the time required for activities outside of the unit decreased significantly (94.3 percent). The Outside Unit activity includes trips to the Pharmacy, Sterile Central Supply, Clinical Laboratory, etc. Also, the Nursing Station Other activity decreased 40.1 percent. This activity can generally be considered to be idle time at the nursing station. There was an increase of 2.68 minutes per patient-day (a 146 percent increase) for planned nursing activities which includes in-service education, participation in committees, etc.

5.4.2 Surgical Units

The available nursing time in Surgical Units decreased 20.5 minutes per patient-day, which represents a 12.4 percent decrease. There was a 4.7 percent reduction in the time spent in direct patient care. Clerical time decreased by 15.6 percent. Similarly, there was a decrease in the time allocated to Communication Activities and to the Other Activities categories. As in the Medical Units, there was a significant decrease in the time allocated to trips outside of the unit.

5.4.3 Orthopedic Unit

The available nursing time for the Orthopedic Unit decreased by 31.7 minutes per patient-day which is a reduction of 17.7 percent of the time allocated during the pre-MIS sample period. The time allocated to each activity category also decreased with the exception of Clerical, VMT, and Printer Activities. In that category, the saving in Clerical activities (9.38 minutes per patient-day) were offset by the time required for performing VMT and Printer activities (9.61 minutes per patient-day) added by MIS. In the Other Activities category, there was an increase in the time allocated to Supply and Maintenance activities and an increase in allocation of time to Personal Time.

5.4.4 Pediatric Unit

In Pediatrics there was a 25.6 percent reduction in the available nursing minutes per patient-day, which was a reduction of 58.6 minutes per patient-day. A similar percentage of reduction (24.9 percent) occurred in the allocation of time to Direct Patient Care Activities. Clerical type activities experienced a reduction of 6.7 percent and the time allocated to Communication Activities was reduced by 38.2 percent. In the Other Activities category, a 93.4 percent reduction occurred in Outside Unit activities, a 63.4 percent reduction in Nursing Station Other activities, and a 555 percent increase (or 11.43 minutes per patient-day) was allocated to Planned Nursing Activities.

5.4.5 Intensive Care Unit

Available nursing time was reduced 135.1 minutes per patient-day in the Intensive Care Unit. As can be seen in Table 5-2, the average census increase from 4.25 to 7.84 patients (84.5 percent increase) while the average staff increased from 5.44 to 7.83 or an increase of 43.9 percent. This resulted in a net decrease of 22 percent in the nursing time available per patient in the ICU. There was an increase in both the census and staff because the ICU was expanded between the two sample periods. Even though

there was a reduction in the available nursing time, the time allocated to Direct Patient Care Activities increased by 78.2 percent. Reduction of 32.6 percent and 47.6 percent were experienced in Clerical and Communication Activities, respectively. The time allocated to the Other Activities category was reduced by 67.2 percent. All of the activities in the "other" category contributed to the reduction but the primary contributors were the Outside Unit activities and Nursing Station Other activities.

5.4.6 Coronary Care Unit

The CCU is the only unit on the day shift which experienced an increase in the nursing minutes per patient-day. The increase was 38.3 minutes per patient-day or 12.4 percent. The nursing time spent in the Direct Patient Care Activities category remained about the same with a slight reduction of 1.2 percent. The CCU was unique in that the Clerical, Communication, and Other Activities categories all increased in time. The increases were 22.8, 24.3, and 14.3 percent, respectively. In the Other Activities category the activities of Outside Unit and Nursing Station Other both experienced a reduction in time.

5.5 Reasons for Change

Section 5.4 provided a quantitative presentation of the summary of results from the work sampling study. This section provides a qualitative discussion of why activities changed as they did based on discussion with ECH nursing personnel. After the quantitative analysis was completed and the results summarized, discussions were conducted with nursing personnel at ECH to acquaint them with the results and to solicit their opinions of why the activities changed as they did. Nurses were selected from each type of unit observed. Every effort was made to talk to nurses who worked in the particular unit being discussed during the pre-MIS observations and during the post-MIS observations. This was not possible in all units and the units where it was not possible are identified in the discussions to follow.

5.5.1 Medical Units

Direct Patient Care Activities increased because nursing time was freed from other activities. The time associated with Medication probably increased because considerable orientation was taking place on the unit during the post-MIS period, i.e., two nurses were preparing and dispensing medications for orientation purposes. Also, more attentive care activities are now being accomplished while medications are given. This may have caused the Attentive Activities to be recorded as Medication by the observer.

The reduction in the time allocated to Clerical Activities were attributed to the MIS operation as opposed to accomplishing the clerical activities manually.

In Communication Activities it is believed that less time is required for nurses to communicate with each other for two reasons. First, it is felt that better and more readily obtainable information is available with the current system. Second, the nursing care delivery processes have been changed from a large team nursing concept, which required more communications especially during reports, to a smaller team concept in some cases, and to primary nursing in others, both of which require less communication time.

The time required for the Other Activities category decreased primarily because of decreases in Outside Unit and Nursing Station Other activities. Less time is being spent off the unit because better information and communications are available between departments through MIS. Better delivery systems are provided from service departments and better use is being made of patient escort services by nursing personnel. The time expended in Nursing Station Other activities decreased because materials and information are more readily available at the nursing station (through MIS) and not as much time is spent in waiting (idle time) for the materials and information. Planned Nursing Activities increased in time by 146 percent. This increase was due to in-service training programs which took place during the post-MIS samples and because the head nurse assisted in the development of the primary nursing plan during the post-MIS observation period.

5.5.2 Surgical Units

As seen in Table 5-3, the number of minutes per patient-day spent in Direct Patient Care Activities decreased between the two sample periods. Most of the decrease took place in Attentive Activities. It is interesting to note, in Table 5-6, Section 5.6, that the percentage of time that all nursing personnel spent on Attentive Activities increased from 35 percent to 38.3 percent (a difference of 3.3 percent which is a statistically significant increase). Nursing personnel devoted more time to Attentive Activities during the post-MIS sample than in the pre-MIS sample. However, the increased time had to be distributed across a larger number of patients which resulted in a decrease of time expressed in minutes per patient-day.

The reduced time allocated for the Clerical Activities category is probably attributable to MIS. The reduction is large relative to some of the other units because in the Surgical Units physicians are entering their order sets into MIS while in some of the other units nursing personnel are performing this function. Also, in the Surgical Units, the VMT is being used for charting.

The decrease in time (on a patient-day basis) experienced in the Communication Activities category is the combined results of increased time in Communications and decreased time in Report and Conference activities. With the exception of the Coronary Care Unit, all other units spent less time in Communication Activities. A specific reason was not identified for the increased communication time but it was suggested that the fact that 2W is still using a large team nursing care procedure (2E has gone to a smaller team approach) might be a reason why more communications are required in the Surgical Units. It is believed that Report and Conference time was reduced because of better and more readily available information.

In the Other Activities category, less time was spent outside of the unit. The primary reasons given for the decrease are: better delivery system from Pharmacy, Sterile Central Supply, and General Stores; better ancillary services by nursing personnel; greater availability in the unit of some items of equipment such as wheelchairs; nursing personnel are using escort services more wisely; and better information and communication are provided through MIS. Less time on a per patient-day basis was consumed in

Personal Time. As presented in Section 5.6, the percentage of time spent in personal activities remained about the same (10.1 percent compared with 10.4 percent) but the time on a per patient-day basis decreased. In the Nursing Station Other activity the minutes per patient-day decreased at the same rate and in the same direction as the total nursing time, -12.4 percent. As discussed in Section 5.6, the percent of nursing time did not change for Nursing Station Other activities. Increased activities in meetings are a result of more progressive attitudes and greater involvement by nursing personnel. MIS has freed the Head Nurse from some of the nursing station activities and has permitted greater involvement in planning and management activities.

5.5.3 Orthopedic Unit

The Orthopedic Unit was undergoing an acute staffing change during the post-MIS sampling period. The head nurse was leaving and all of the nursing personnel on the unit were upset.

Further, the Orthopedic Unit was the pilot unit during the post-MIS sampling period for the development and implementation of standard nursing care plans. During the post-MIS sampling period, the Orthopedic Unit also experienced a high usage rate of float nurses. Consequently, the reader is cautioned that these influences are very likely reflected in the results obtained. Also, the nurse interviewed did not work on the unit during either sample period. However, the nurse was employed at ECH during both time periods and did have working knowledge of the Orthopedic Unit at the end of 1974.

Time on a per patient-day basis, associated with the clerical category of activities remained about the same. A decrease in effort had been anticipated for clerical activities but it did not materialize.

The time associated with the Communication Activities category decreased. One reason is that the Orthopedic Unit switched from the large team nursing approach to the case method where fewer people were involved in the reporting process. Also, better information is now readily available through MIS.

In the Other Activities category the primary activity contributing to the 10.81 minutes per patient day reduction are trips outside of the unit. It was expressed that better information is now available through MIS and fewer requisitions are lost than with the previous manual system.

5.5.4 Pediatric Unit

The Direct Patient Care Activities category decreased in minutes per patient-day by 20.29, or 24.9 percent. The percentage decrease is closely correlated to the overall decrease in nursing minutes per patient-day available. In Medication Activities it is believed that there was a greater proportion of surgical patients on the unit during the post-MIS sample than during the pre-MIS sample. The higher proportion of surgical patients during the second sample required less medications than medical patients--consequently, the 17.3 percent reduction. For the decrease in Attentive Activities it was pointed out that in Pediatrics children are often grouped under the supervision and observation of a few nurses. It is sometimes possible to add children to these groups without adding to the nursing staff. The activities of the nurses supervising and observing such groups would have been recorded as Attentive Activities. It was suggested that some of the decrease seen in Attentive Activities may have been brought about by having larger numbers of children in the groups. However, it was also pointed out that the decrease in available nursing time on a per patient-day basis also influenced the Attentive Activities.

The reduction in the Clerical Activities category time is attributed to MIS as compared to the manual system. Also, the unit secretary has become proficient at using the VMT and in instructing physicians and float nurses in using the VMT in regards to the special Pediatric matrices and displays.

The time applied to the Communication Activities category was reduced 19.09 minutes per patient-day. It was stated that new orders are obtained through MIS which eliminates the need for some of the Communication Activities previously required. Also, physicians are communicating more directly with the nurses rather than going through the head nurse who, prior

to MIS, was at the nursing station most of the time. Further, a switch from team nursing to the case method involves fewer people in the communication stream. With the current system, every nurse has a care plan for each of his or her patients which limits the need for communication between individual nurses.

The Other Activities category experienced a reduction in time of 16.52 minutes per patient-day for a reduction of 28.8 percent. Less time was spent on trips outside the unit because better information is available with MIS and the need to leave the unit has been eliminated in many cases. Also, it is believed that less need exists to follow-up on requests and to verify information. Nursing Station Other Activities experienced a reduction in time because, with MIS, nurses have fewer opportunities to be at the nursing station because they carry their nursing care plans and new orders with them in Pediatrics. Planned Nursing Activities increased 555 percent or 11.43 minutes per patient day. This large increase occurred because the head nurse spent a large percentage of her time during the post-MIS sample on this activity. The head nurse pioneered a new staff planning system for her unit during the post-MIS period. Other nurses on the Pediatric Unit are more active in the planning process than they were during the pre-MIS sampling period. It was also stated that, in general, MIS has freed the head nurse for such activities as planning, supervising, and managing where prior to MIS the head nurse was restricted to the nursing station and to activities associated with the nursing station.

5.5.5 Intensive Care Unit

The Intensive Care Unit was expanded between the two sample periods so the comparisons given were not observed in the same physical arrangement. The nurse observers commented that because of the physical arrangements of the ICU and because of restricted entry by the observers, it was difficult to identify specific activities and it was particularly difficult to distinguish between Attentive Activities and Nursing Station Other Activities. Consequently, activities in the ICU are not recorded as accurately as other units.

Direct Patient Care activities increased by 123 minutes per patient-day and Attentive Activities contributed 118 minutes per patient-day to the total. In discussions with nursing personnel, it is believed that open heart surgery patients being returned to the unit may have significantly influenced this change. Subsequent to the pre-MIS observations but prior to the post-MIS sample period, open heart surgery patients are returned (usually on the day shift) to the ICU which requires the Attentive Activities of at least two nurses for a minimum of one hour for each patient. Also, blood gas tests have been added since the pre-MIS observations and an increase has occurred in procedures for other departments. All of these factors have contributed to the increased time in Direct Patient Care Activities.

The 32.6 percent reduction in time allocated to Clerical Activities were attributed to MIS as compared with the manual system prior to MIS.

It is believed that the large reduction in Communication Activities time is a result of having less time available for talking during the post-MIS observations since less time (135 minutes per patient-day) was available during the post-MIS observations. Report and Conference Activities were reduced because reporting time has been cut in half through the use of MIS and the nursing care plans.

In the Other Activities category, a reduction of about 179 minutes per patient-day occurred. Most of the reduction is through reduced activities outside of the unit and less idle time at the nursing station (Nursing Station Other). It was commented that better information is more readily available from the laboratories, Pharmacy, etc., with MIS and fewer trips are required outside of the unit. It is believed that the Nursing Station Other activities were curtailed because the available time was reduced. The decrease of 33.73 minutes per patient-day in Personal Time is misleading, as presented in Section 5.6 of this report, because the percentage of time allocated to personal activities increased from 4.7 percent during the pre-MIS sample to 9.4 percent in the post-MIS sample. The same comment applies to Supply and Maintenance activities.

5.5.6 Coronary Care Unit

There is no significant change in the time or percent of time allocated to Direct Patient Care Activities in CCU. This occurred when 38.3 minutes per patient-day was added to the available nursing time for CCU in the day shift. The increased time was allocated to the Clerical, Communication, and the Other Activities categories.

The Clerical Activities category increased 15.96 minutes per patient-day. This increase is due to the combined effect that the Video-Matrix-Terminal and Printer activities required 18.8 minutes per patient-day and the manual clerical time did not decrease significantly. The only reason suggested for the small reduction in manual clerical time is that, in CCU, the nurses still spend much of their time at the nursing station because of the monitoring equipment which must be observed. This is not the case in other units and the added time at the nurses stations may have provided more opportunities for clerical work or may have been erroneously observed as Clerical Activities as opposed to Attentive Activities. The large time consumed in VMT and Printer Activities may have occurred for a number of reasons. CCU and ICU share a printer, and CCU personnel believe that they remove and separate a significant portion of the printed material routed to ICU. It was also suggested that CCU has more laboratory work than other units which results in more printed information which must be handled and filed. It was also indicated that CCU exercises an option to type, via VMT, a larger portion of the nursing care plans and nursing care orders than other units. These entries for CCU are fairly elaborate entries and in CCU emphasis is placed on this feature for patient care. The elaborate entries are intended, in part, to assist nursing personnel in other units when the patient is transferred from CCU to another hospital unit.

The time associated with the Communication Activities category increased about 24 percent, while for all other types of units in the day shift, the Communication Activities category time was reduced. Unit personnel rehabilitation program that was implemented after the pre-MIS observations and before the post-MIS observations. In the program, nursing personnel instruct patients on the unit as well as former CCU patients who have been transferred to other units within the hospital. Frequently, the former

patients return to CCU to continue their instructions. It is believed the reduction in the Report and Conference activity is attributable to MIS and, particularly, to typed nursing care plans. Also, it was pointed out that tape recorders were used in the reporting process during the post-MIS observations but were not used in the prior observations.

The Other Activities category experienced an increase of 10.21 minutes per patient-day. The Supply and Maintenance activity increased 154 percent because a new clerk organized all of the shelves, drawers, and supplies during the post-MIS sample period. Planned Nursing Activities increased because rehabilitation classes were conducted during the post-MIS sample period. Also, during the post-MIS observations, staff planning for the Critical Care Complex (ICU, TCU, CCU, and the Emergency Room) was accomplished by CCU personnel. This was not done during the pre-MIS period. Time decreased for the Nursing Station Other activity. It was suggested that some of this time may have been shifted to the VMT activity where the nurse may have been seated at the VMT and thinking as opposed to thinking at the nursing station. The reduced time for trips outside of the unit is attributed to better information, better distribution of supplies and materials from service departments, and because the Unit Secretary now makes one long trip during the shift in which many errands are accomplished. In the latter case it is believed that the one trip to many locations is more efficient than many trips to one location each. Time allocated to Personal Time increased 18.17 minutes per patient-day or 125 percent, but the percent of time increased from 4.7 percent to 9.4 percent which is still below the 10 to 11 percent that is normally anticipated.

5.6 Presentation of the Detailed Technical Results

Table 5-4 presents the change in the distribution of nursing personnel time expressed in percents of total time (summary Table 5-3 was concerned with time expressed in minutes per patient-day) between nursing activities for Medical Units. The table identifies the percentage of time distributed to each nursing activity for the Head Nurse/Assistant Head Nurse (HN/AHN), Registered Nurses/Licensed Vocational Nurses (RN/LVN), Nurse Aides (Aide), and Unit Secretary (Unit Sec.). For each of these skill classifications there is a column showing the distribution of time to the activities before MIS and the distribution after MIS. Each of these columns account for the total time (100 percent) for that skill category, e.g., the percentages in the HN/AHN, pre-MIS column sums to 100 percent as do the percentages under the column HN/AHN, post-MIS column. The third column under each skill category shows the difference (Diff.) or change experienced in each activity between the two observation periods. The percentages shown in Table 5-4 (and Tables 5-6 and 5-8) were derived by recording the number of times each skill level in the unit was observed performing the appropriate activity and, then, dividing the observations for each activity by the total number of observations for the skill level during the sampling period. The number of staff in a skill level may have changed from the first sampling period to the second and, similarly, the number of patients for which the activities were being performed may have been different for the two sampling periods. The percentages shown in Table 5-4 and the remaining tables that present changes in the distribution of time are the results of observing activities at the various units with all of the factors influencing change present.

For changes in the distribution of time to activities (reference Tables 5-4, 5-6, and 5-8), it was possible to test for statistically significant differences in the pre- and post-MIS percentages observed for a given activity. The null hypothesis tested is that the percentage of time spent by nursing personnel in the twelve groups of nursing activities did not change significantly between the two sample periods (pre-MIS and post-MIS). A two-tailed test (95 percent confidence level) for significant change in the

TABLE 5-4. CHANGE IN THE DISTRIBUTION OF NURSING PERSONNEL TIME BETWEEN NURSING ACTIVITIES FOR MEDICAL UNITS

Activities	RN/AHN (% of Time)			RN/LVN (% of Time)			Aide (% of Time)			Unit Sec. (% of Time)			All Personnel (% of Time)		
	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.
Medication															
Preparation	1.4	1.6		3.1	4.6		0.0	0.0		0.0	0.0		1.8	2.8	
Dispensing	0.4	1.3		2.6	2.6		0.0	0.0		0.0	0.0		1.5	1.6	
Total	1.8	2.9	+ 1.1	5.7	7.2	+ 1.5	0.0	0.0	0.0	0.0	0.0	0.0	3.3	4.4	+ 1.1*
Attentive Activities															
Inside Patient's Room	3.2	17.8		25.2	37.5		31.0	44.4		2.1	0.4		22.2	33.3	
Outside Room	5.3	5.3		15.5	9.2		16.9	14.2		3.9	1.5		13.7	9.2	
Total	8.5	23.1	+14.6*	40.7	46.7	+ 6.0*	47.9	58.6	+10.7*	6.0	1.9	- 4.1*	35.9	42.5	+ 6.6*
Clerical															
At Nursing Station	38.4	11.6		14.5	12.7		10.9	7.9		34.8	33.4		18.0	13.5	
Away From Nsg. Sta.	0.7	1.0		0.4	0.6		1.1	0.5		1.3	0.2		0.7	0.6	
Total	39.1	12.6	-26.5*	14.9	13.3	- 1.6	12.0	8.4	- 3.6*	36.1	33.6	- 2.5	18.7	14.1	- 4.6*
Video-Matrix-Terminal	--	8.7	+ 8.7	--	5.0	+ 5.0	--	0.6	+ 0.6	--	6.1	+ 6.1	--	4.5	+ 4.5
Printer	--	1.0	+ 1.0	--	0.2	+ 0.2	--	0.0	0.0	--	3.4	+ 3.4	--	0.5	+ 0.5
Nursing Station Other	5.0	1.9	- 3.1*	4.8	2.5	- 2.3*	7.4	6.0	- 1.4	5.6	7.5	+ 1.9	5.6	3.7	- 1.9*
Communications															
Nurse--Same Unit	14.6	10.3		6.7	3.9		6.4	4.7		13.3	6.1		8.1	5.0	
Doctor	2.8	0.5		0.4	0.4		0.0	0.1		0.9	0.8		0.6	0.4	
Patient	0.7	1.3		0.1	0.8		0.0	0.9		0.0	0.9		0.2	0.9	
Telephone	5.7	6.0		1.3	1.8		0.1	0.7		7.7	9.9		2.0	2.8	
Other	0.4	3.9		0.8	1.5		0.1	1.4		1.3	2.9		1.3	1.9	
Total	25.7	22.0	- 3.7	9.8	8.4	- 1.4	6.8	7.8	+ 1.0	26.2	20.6	- 5.6	12.2	11.0	- 1.2
Supply & Maintenance	1.4	2.4	+ 1.0	0.9	0.4	- 0.5	2.6	0.9	- 1.7*	3.9	8.6	+ 4.7*	1.6	1.5	- 0.1
Report & Conference	2.8	2.4	- 0.4	4.5	3.7	- 0.8	2.5	3.2	+ 0.7	1.3	0.4	- 0.9	3.5	3.1	- 0.4
Planned Nursing Activities	5.0	15.2	+10.2*	1.0	1.7	+ 0.7	0.0	0.8	+ 0.8*	0.0	1.3	+ 1.3	1.1	3.0	+ 1.9*
Outside Unit	2.5	0.5	- 2.0*	7.5	0.3	- 7.2*	10.4	0.1	-10.3*	11.1	2.7	- 8.4*	8.1	0.5	- 7.6*
Personal Time	8.2	7.3	- 0.9	10.2	10.6	+ 0.4	10.4	13.6	+ 3.2*	9.8	13.9	+ 4.1	10.0	11.2	+ 1.2

Note: An asterisk in the difference column (Diff.) indicates a statistically significant change in the distribution of time to the activity indicated.

TABLE 5-5. CHANGE IN NURSING TIME BETWEEN ACTIVITY GROUPS FOR MEDICAL UNITS

Activity Groups	RN/AHN (Minutes/Patient-day)			RN/LVN (Min./Patient-day)			Aide (Minutes/Patient-day)			Unit Sec. (Min./Patient-day)			All Personnel (Minutes/Patient-day)		
	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.
1. Medication	0.33	0.50	+0.17	5.28	6.06	+0.78	0.00	0.00	0.00	0.00	0.00	0.00	5.61	6.56	+0.95
2. Attentive Activities	1.55	3.97	+2.42	37.69	39.28	+1.59	20.45	20.45	0.00	0.92	0.28	-0.64	60.61	63.98	+3.37
3. Clerical	7.11	2.17	-4.94	13.80	11.19	-2.61	5.13	2.93	-2.20	5.57	4.87	-0.70	31.61	21.16	-10.45
4. VMT & Printer	--	1.67	+1.67	--	4.37	+4.37	--	0.21	+0.21	--	1.38	+1.38	--	7.63	+7.63
5. Nursing Station Other	0.91	0.33	-0.58	4.44	2.10	-2.34	3.16	2.09	-1.07	0.86	1.09	+0.23	9.37	5.61	-3.76
6. Communications	4.68	3.78	-0.90	9.07	7.06	-2.01	2.90	2.72	-0.18	4.03	2.99	-1.04	20.68	16.55	-4.13
7. Supply & Maintenance	0.25	0.41	+0.16	0.83	0.34	-0.49	1.11	0.31	-0.80	0.60	1.24	+0.64	2.79	2.30	-0.49
8. Report & Conference	0.51	0.41	-0.10	4.17	3.11	-1.06	1.07	1.12	+0.05	0.20	0.06	-0.14	5.95	4.70	-1.25
9. Planned Nursing Act.	0.91	2.62	+1.71	0.93	1.43	+0.50	0.00	0.28	+0.28	0.00	0.19	+0.19	1.84	4.52	+2.68
10. Outside Unit	0.46	0.09	-0.37	6.94	0.25	-6.69	4.44	0.04	-4.40	1.71	0.39	-1.32	13.55	0.77	-12.78
11. Personal Time	1.49	1.25	-0.24	9.45	8.91	-0.54	4.44	4.75	+0.31	1.51	2.01	+0.50	16.89	16.92	+0.03
Total	18.2	17.2	-1.0	92.6	84.1	-8.5	42.7	34.9	-7.8	15.4	14.5	-0.9	168.9	150.7	-18.2

two proportions[5] was used. Each statistically significant change is indicated in the difference column with an asterisk.

Table 5-5 presents the change in nursing time, expressed in minutes per patient-day, between activity groups for Medical Units. The contents were derived using the percentages contained in Table 5-4 and translating the percent of time to minutes per patient-day based on staff to patient-day ratios and assuming a 480-minute day for each full-time equivalent.

Note in Tables 5-4 and 5-5 that the categories used to summarize activities in Table 5-3 have been dropped. Table 5-4 presents the time distribution by specific activity and Table 5-5 summarizes the specific activities within the groups of Medication, Attentive Activities, Clerical, and Communications.

Tables 5-6 and 5-7 are similar to Tables 5-4 and 5-5 but are presented for the Surgical Units. Tables 5-8 and 5-9 present similar results for all nursing personnel for Orthopedics, Pediatrics, Intensive Care, and Coronary Care Units; however, the breakout of the data by nursing skill classifications has been omitted.

5.7 Sample Size Error

In work sampling applications, an estimate can be made of the possible error associated with the results. The error is a function of the number of observations made, the true proportion of time required for the primary activity observed, and the degree of confidence that is acceptable.

Table 5-10 presents the absolute error provided by the number of nursing activity observations taken in each type of unit within a 95 percent confidence level. The absolute error estimates are based on the percentages obtained for Clerical Activities. Clerical Activities are used for estimating the error because it was anticipated that MIS would very likely impact Clerical Activities. Table 5-10 presents the absolute error estimates for pre-MIS and post-MIS observations.

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5 Acheson J. Duncan, Quality Control and Industrial Statistics (Homewood, Illinois: Richard D. Irwin, Inc., 3rd Edication, 1965), pp. 496-499.

All of the estimates of Clerical activities are within $\pm$ 3.4 percent or less absolute error of the true value.

TABLE 5-6. CHANGE IN THE DISTRIBUTION OF NURSING PERSONNEL TIME BETWEEN NURSING ACTIVITIES FOR SURGICAL UNITS

Activities	HN/AHN (% of Time)			RN/LVN (% of Time)			Aide (% of Time)			Unit Sec. (% of Time)			All Personnel (% of Time)		
	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.
Medication															
Preparation	0.7	2.4		4.4	3.5		0.0	0.0		0.0	0.0		2.4	2.2	
Dispensing	0.3	1.2		2.3	2.0		0.0	0.0		0.0	0.0		1.2	1.2	
Total	1.0	3.6	+ 2.6*	6.7	5.5	- 1.2	0.0	0.0	0.0	0.0	0.0	0.0	3.6	3.4	- 0.2
Attentive Activities															
Inside Patient's Room	5.0	15.4		24.4	32.1		33.0	44.6		1.7	0.2		22.8	29.3	
Outside Room	4.6	5.4		10.8	9.1		20.2	14.3		3.4	2.2		12.2	9.0	
Total	9.6	20.8	+11.2*	35.2	41.2	+ 6.0*	53.2	58.9	+ 5.7*	5.1	2.4	- 2.7	35.0	38.3	+ 3.3*
Clerical															
At Nursing Station	32.2	13.3		18.2	9.1		10.6	8.5		45.1	35.1		19.9	12.1	
Away From Nsg. Sta.	0.7	0.1		0.4	0.5		0.9	0.4		0.4	0.4		0.6	0.4	
Total	32.9	13.4	-19.5*	18.6	9.6	- 9.0*	11.5	8.9	- 2.6	45.5	35.5	-10.0*	20.5	12.5	- 8.0*
Video-Matrix-Terminal	--	7.0	+ 7.0	--	8.1	+ 8.1	--	0.1	+ 0.1	--	11.5	+11.5	--	6.6	+ 6.6
Printer	--	0.5	+ 0.5	--	0.1	+ 0.1	--	0.4	+ 0.4	--	5.3	+ 5.3	--	0.8	+ 0.8
Nursing Station Other	3.0	3.4	+ 0.4	5.8	5.5	- 0.3	4.9	6.4	+ 1.5	6.8	4.9	- 1.9	5.3	5.3	0.0
Communications															
Nurse--Same Unit	18.3	13.5		7.0	6.9		3.4	5.0		8.9	6.3		7.4	7.4	
Doctor	1.3	1.5		0.7	0.6		0.0	0.2		1.7	0.4		0.6	0.6	
Patient	0.7	1.6		0.2	0.7		0.0	1.8		0.8	0.6		0.3	1.1	
Telephone	6.0	4.8		0.7	2.2		0.3	0.5		6.8	7.1		1.7	2.7	
Other	1.6	2.6		1.2	13.4		0.5	1.1		2.5	2.9		1.1	1.6	
Total	27.9	24.0	- 3.9	9.8	11.8	+ 2.0*	4.2	8.6	+ 4.4*	20.7	17.3	- 3.4	11.1	13.4	+ 2.3*
Supply & Maintenance	0.0	3.2	+ 3.2*	0.6	0.6	0.0	2.8	1.1	- 1.7*	5.0	6.7	+ 1.7	1.5	1.7	+ 0.2
Report & Conference	8.3	3.0	- 5.3*	6.1	5.1	- 1.0	3.2	3.6	+ 0.4	1.7	2.0	+ 0.3	5.1	4.2	- 0.9
Planned Nursing Activities	3.7	9.2	+ 5.5*	2.1	2.2	+ 0.1	0.8	0.4	- 0.4	0.0	1.6	+ 1.6	1.7	2.8	+ 1.1*
Outside Unit	4.6	1.8	- 2.8*	5.0	0.3	- 4.7*	8.5	0.3	- 8.2*	6.8	1.6	- 5.2*	6.1	0.6	- 5.5*
Personal Time	9.0	10.1	+ 1.1	10.1	10.0	- 0.1	10.9	11.3	+ 0.4	8.4	11.2	+ 2.8	10.1	10.4	+ 0.3

Note: An asterisk in the difference column (Diff.) indicates a statistically significant change in the distribution of time to the activity indicated.

TABLE 5-7. CHANGE IN NURSING EFFORT BETWEEN ACTIVITY GROUPS FOR SURGICAL UNITS

Activity Groups	HN/AHN (Min./Patient-day)			RN/LVN (Min./Patient-day)			Aide (Min./Patient-day)			Unit Sec. (Min./Patient-day)			All Personnel (Min./Patient-day)		
	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.
1. Medication	0.18	0.74	+0.56	5.72	4.31	-1.41	0.00	0.00	0.00	0.00	0.00	0.00	5.90	5.05	-0.85
2. Attentive Activities	1.71	4.28	+2.57	30.06	32.30	+2.24	25.00	18.49	-6.51	0.76	0.34	-0.42	57.53	55.41	-2.12
3. Clerical	5.86	2.76	-3.10	15.88	7.53	-8.35	5.41	2.79	-2.62	6.78	5.04	-1.74	33.93	18.12	-15.81
4. VMT & Printer	--	1.55	+1.55	--	6.43	+6.43	--	0.16	+0.16	--	2.39	+2.39	--	10.53	+10.53
5. Nursing Station Other	0.53	0.70	+0.17	4.95	4.31	-0.64	2.30	2.01	-0.29	1.02	0.69	-0.33	8.80	7.71	-1.09
6. Communications	4.97	4.95	-0.02	8.37	9.25	+0.88	1.98	2.70	+0.72	3.08	2.46	-0.62	18.40	19.36	+0.96
7. Supply & Maintenance	0.00	0.66	+0.66	0.51	0.47	-0.04	1.32	0.35	-0.97	0.75	0.95	+0.20	2.58	2.43	-0.15
8. Report & Conference	1.47	0.62	-0.85	5.21	4.00	-1.21	1.50	1.13	-0.37	0.25	0.28	+0.03	8.43	6.03	-2.40
9. Planned Nursing Act.	0.66	1.89	+1.23	1.80	1.72	-0.08	0.38	0.13	-0.25	0.00	0.23	+0.23	2.84	3.97	+1.13
10. Outside Unit	0.82	0.37	-0.45	4.27	0.24	-4.03	3.99	0.09	-3.90	1.01	0.23	-0.78	10.09	0.93	-9.16
11. Personal Time	1.60	2.08	+0.48	8.63	7.84	-0.79	5.12	3.55	-1.57	1.25	1.59	+0.34	16.60	15.06	-1.54
Total	17.8	20.6	+2.8	85.4	78.4	-7.0	47.0	31.4	-15.6	14.9	14.2	-0.7	165.1	144.6	-20.5

TABLE 5-8. CHANGE IN THE DISTRIBUTION OF NURSING PERSONNEL TIME BETWEEN ACTIVITIES FOR THE REMAINING UNITS SAMPLED

Activities	Orthopedics All Nursing (% of Time)			Pediatrics All Nursing (% of Time)			ICU All Nursing (% of Time)			CCU All Nursing (% of Time)		
	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.
Medication												
Preparation	1.0	2.4		1.6	2.5		0.9	1.1		1.2	1.2	
Dispensing	1.6	1.6		1.1	0.5		0.0	1.2		0.7	0.5	
Total	2.6	4.0	+ 1.4	2.7	3.0	+ 0.3	0.9	2.3	+ 1.4*	1.9	1.7	- 0.2
Attentive Activities												
Inside Patient's Room	27.9	34.1		20.7	27.0		16.2	49.0		27.5	23.4	
Outside Room	13.3	10.3		12.1	5.8		8.6	7.4		7.1	7.0	
Total	41.2	44.4	+ 3.2	32.8	32.8	0.0	24.8	56.4	+31.6*	34.6	30.4	- 4.2
Clerical												
At Nursing Station	12.5	8.8		16.4	17.1		11.2	6.3		22.3	18.1	
Away From Nsg. Sta.	0.3	0.4		1.3	0.7		0.6	1.8		0.3	1.2	
Total	12.8	9.2	- 3.6*	17.7	17.8	+ 0.1	11.8	8.1	- 3.7*	22.6	19.3	- 3.3
Video-Matrix-Terminal	--	5.8	+ 5.8	--	3.9	+ 3.9	--	1.4	+ 1.4	--	4.4	+ 4.4
Printer	--	0.7	+ 0.7	--	0.5	+ 0.5	--	0.7	+ 0.7	--	1.0	+ 1.0
Nursing Station Other	4.2	3.5	- 0.7	6.5	3.2	- 3.3*	10.1	3.0	- 7.1*	6.8	4.8	- 2.0
Communications												
Nurse--Same Unit	8.0	5.7		11.2	8.3		7.3	5.2		7.6	7.7	
Doctor	0.5	0.4		1.1	1.3		0.0	1.0		2.0	0.8	
Patient	0.1	0.9		0.1	0.4		0.0	0.2		0.0	0.9	
Telephone	0.9	2.3		1.7	3.4		2.8	2.9		1.5	4.2	
Other	0.6	1.7		2.0	1.8		1.1	1.8		1.9	2.8	
Total	10.1	11.0	+ 0.9	16.1	15.2	- 0.9	11.2	11.1	- 0.1	13.0	16.4	+ 3.4
Supply & Maintenance	1.5	2.1	+ 0.6	1.2	1.9	+ 0.7	3.9	3.1	- 0.8	1.9	4.3	+ 2.4*
Report & Conference	3.4	2.5	- 0.9	5.7	2.9	- 2.8*	8.0	1.8	- 6.2*	4.9	3.4	- 1.5
Planned Nursing Activities	3.2	3.2	0.0	0.9	7.9	+ 7.0*	1.5	1.4	- 0.1	2.0	4.0	+ 2.0*
Outside Unit	11.0	0.5	-10.5*	5.7	0.5	- 5.2*	14.9	1.2	-13.7*	7.6	0.9	- 6.7*
Personal Time	10.0	13.1	+ 3.1*	10.7	10.4	- 0.3	12.9	9.5	- 3.4*	4.7	9.4	+ 4.7*

Note: An asterisk in the difference column (Diff.) indicates a statistically significant change in the distribution of time to the activity indicated.

TABLE 5-9. CHANGE IN NURSING EFFORT BETWEEN ACTIVITY GROUPS FOR THE REMAINING UNITS SAMPLED

Activity Groups	Orthopedics All Nursing (Min./Patient-day)			Pediatrics All Nursing (Min./Patient-day)			ICU All Nursing (Min./Patient-day)			CCU All Nursing (Min./Patient-day)		
	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.	Pre-MIS	Post-MIS	Diff.
1. Medication	4.67	5.91	+ 1.24	6.19	5.12	- 1.07	5.53	11.02	+ 5.49	5.89	5.92	+0.03
2. Attentive Activities	73.95	65.62	- 8.33	75.21	55.99	-19.22	152.37	270.33	+117.96	107.23	105.85	-1.38
3. Clerical	22.98	13.60	- 9.38	40.59	30.38	-10.21	72.50	38.82	-33.68	70.04	67.20	-2.84
4. VMT & Printer	--	9.61	+ 9.61	--	7.51	+ 7.51	--	10.07	+10.07	--	18.80	+18.80
5. Nursing Station Other	7.54	5.17	- 2.37	14.90	5.46	- 9.44	62.05	14.38	-47.67	21.07	16.71	-4.36
6. Communications	18.13	16.26	- 1.87	36.92	25.95	-10.97	68.81	53.20	-15.61	40.29	57.11	+16.82
7. Supply & Maintenance	2.69	3.10	+ 0.41	2.75	3.24	+ 0.49	23.96	14.86	- 9.10	5.89	14.97	+ 9.08
8. Report & Conference	6.10	3.70	- 2.40	13.07	4.95	- 8.12	49.15	8.63	-40.52	15.18	11.84	- 3.34
9. Planned Nursing Act.	5.74	4.73	- 1.01	2.06	13.49	+11.43	9.22	6.71	- 2.51	6.20	13.93	+ 7.73
10. Outside Unit	19.75	0.74	-19.01	13.07	0.86	-12.21	91.55	5.75	-85.80	23.55	3.14	-20.41
11. Personal Time	17.95	19.36	+ 1.41	24.54	17.75	- 6.79	79.26	45.53	-33.73	14.56	32.73	+18.17
Total	179.5	147.8	-31.7	229.3	170.7	-58.6	614.4	479.3	-135.1	309.9	348.2	+38.30

TABLE 5-10. ABSOLUTE ERROR[(a)] PROVIDED BY THE NUMBER OF OBSERVATIONS TAKEN

Unit Category	Day Shift Observations	
	Pre-MIS	Post-MIS
Medical	±1.5%	±1.0%
Surgical	±1.6%	±0.9%
Orthopedics	±2.1%	±1.8%
Pediatrics	±2.4%	±2.5%
ICU	±3.0%	±1.2%
CCU	±3.4%	±2.3%

(a) Absolute error entries are based on the Clerical activities using a 95% confidence level.

6.0 NURSING STAFF AND OTHER HOSPITAL STAFF ATTITUDE AND ACCEPTANCE OF MIS

The patients' care regimen as defined by the physicians depends upon the nursing staff for its implementation. Other hospital staff in ancillary services support the physicians in patient care through support services including diagnostic tests and therapeutic procedures. The introduction of a medical information system could be expected to alter the way in which information is processed and may affect role changes in professionals involved, as well as the quality of care delivered. This portion of Battelle's study elicited evaluation of MIS by nursing staff and other hospital staff personnel over time.

The nursing department of El Camino Hospital comprises approximately one-half of the total number of users of MIS, and is responsible for an equal magnitude of input and output transactions in the hospital-wide system. As such, the nursing assessment is particularly pertinent to the overall evaluation of the system.

Surveys of the nursing staff at ECH were conducted during four time periods--pre-MIS, during implementation, early full implementation, and during routine operation of the system. Questionnaires were designed to determine changes in attitude of the nursing staff over time and to assess the system's performance.

6.1 Conclusions

Detailed summaries of the 1974 survey of the nursing staff are presented in the following sections of this report, along with selected comparisons with earlier survey results. The following conclusions are indicated by the results.

1. The results of the 1974 survey of the nursing staff indicates a very favorable evaluation of MIS. Figures 6-1 and 6-2 present comparisons of nurses' evaluations of MIS for the years 1973 and 1974, based upon aggregated responses for various aspects of the system. In Figure 6-1, distributions of positive, negative, and neutral responses are shown. Figure 6-2 is similar

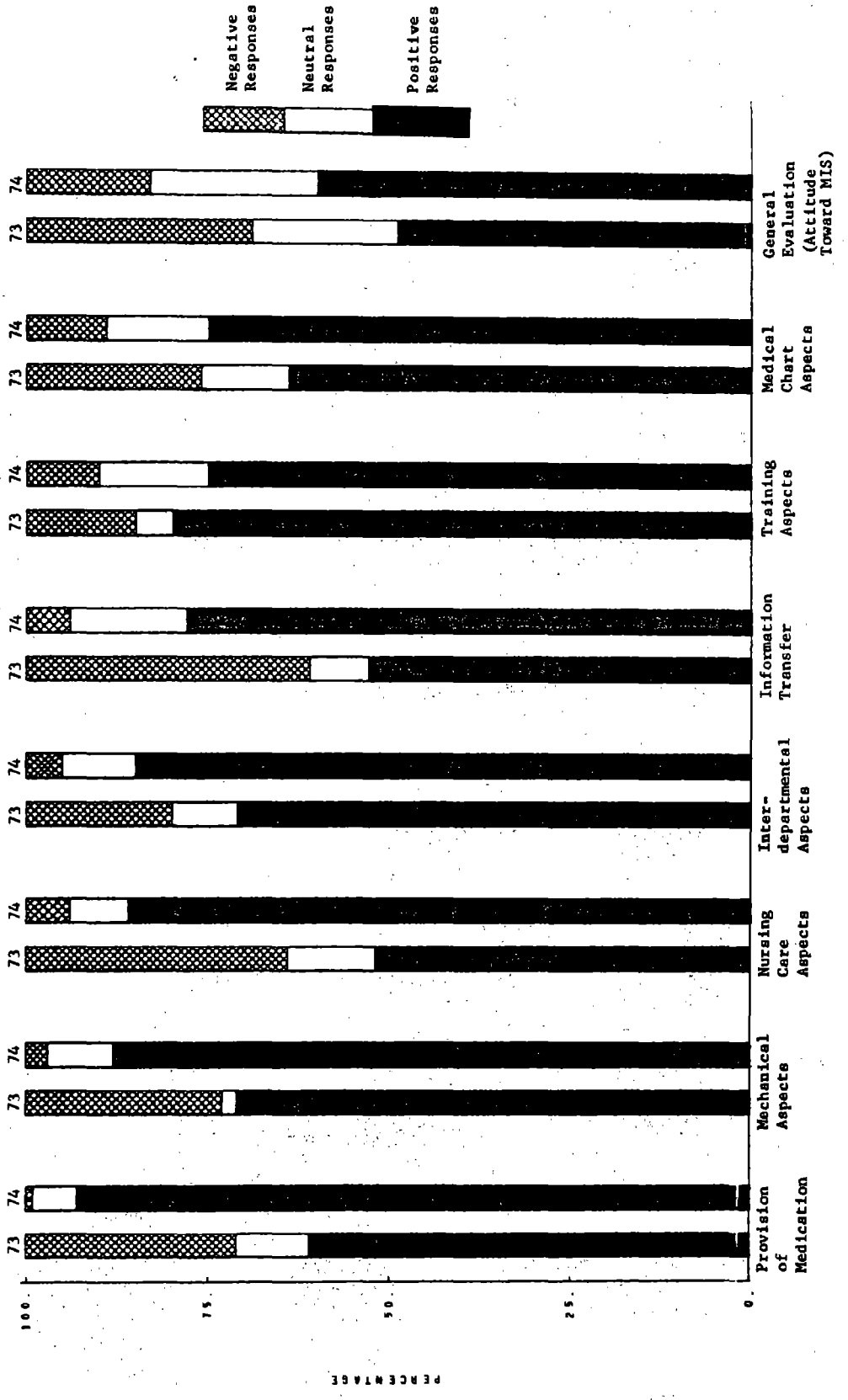


FIGURE 6-1. 1973/1974 NURSES' EVALUATION OF MIS

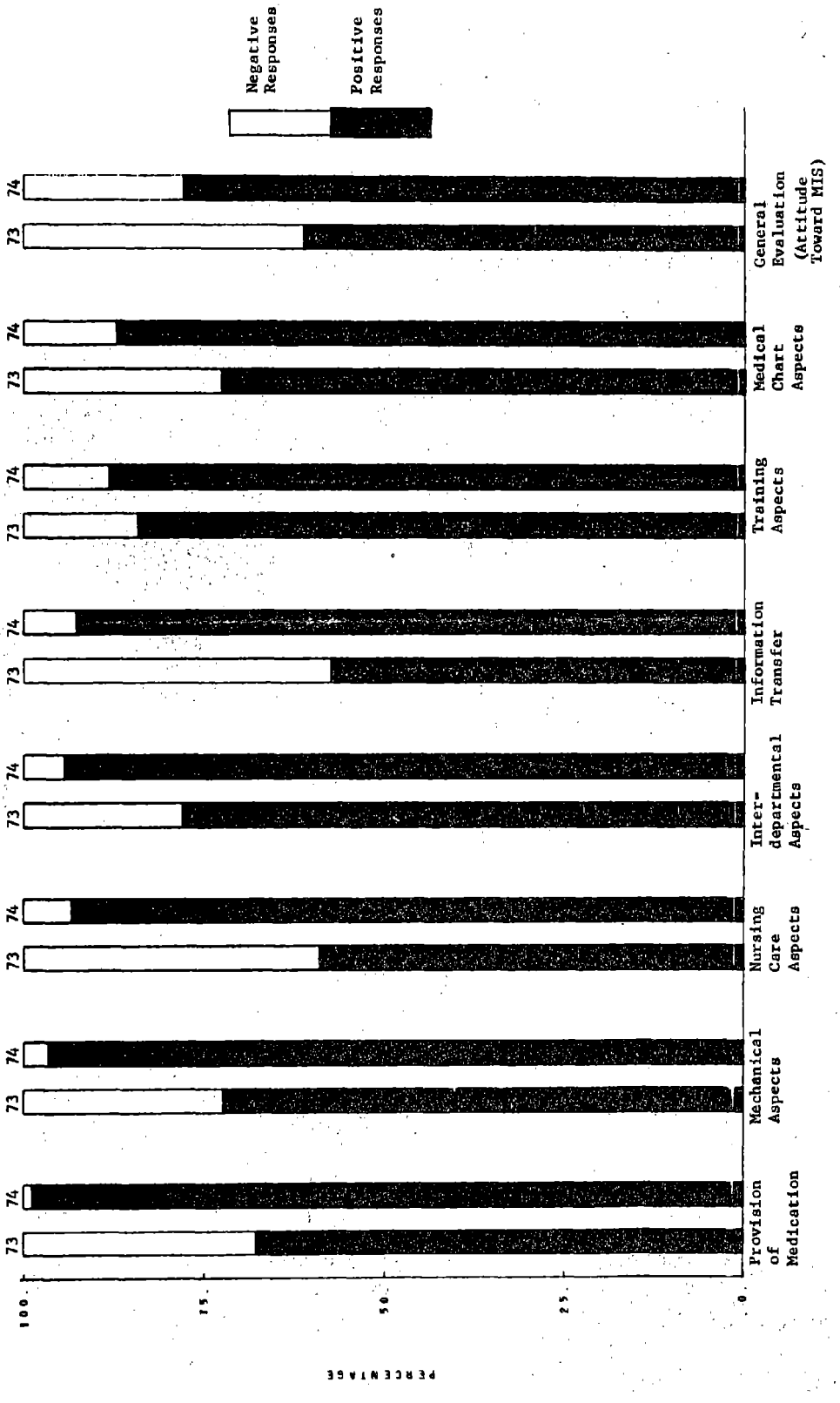


FIGURE 6-2. 1973/1974 NURSES' EVALUATIONS OF MIS - EXCLUDING NEUTRAL RESPONSES

to Figure 6-1 except that neutral responses are excluded. Neutral responses such as "no opinion" are excluded in this figure in order to establish a direct graphic correlation of definitely favorable versus definitely unfavorable attitudes toward MIS. This has the obvious effect of increasing the percentage figures for both positive and negative responses over their values when neutrals are included in the data. Details of all responses, including neutrals, are listed in subsequent tables.

Among the most favorable aspects of MIS appear to be its impact on the dispensing of medications (timeliness, charting, and availability) and on nursing care (time available for care, patient care planning, and scheduling). Comparisons with the earlier survey results show consistently favorable evaluations of training aspects of MIS, and marked increases in percentages of favorable responses on evaluations of mechanical, nursing care, and medications aspects of the system. Increasingly favorable responses were also noted for information transfer and interdepartmental aspects of MIS. A general evaluation of attitudes toward MIS indicated these attitudes were either consistent over time or became increasingly favorable, with a majority of favorable responses.

2. Analysis of responses by age groups shows that there is little correlation between respondent ages and attitudes toward MIS.

3. There is, however, a direct correlation between the extent of use and respondent attitudes expressed in their general evaluation of the system. Those who use the system most like it best. Conversely, negative responses come most often from those who have minimal involvement with MIS. For instance, registered nurses, unit secretaries and charge or head nurses are more favorably inclined toward MIS than nurses aides and licensed vocational nurses. Similarly, personnel from nursing units with a high information transfer rate--i.e., medical, surgical, and intensive care units--are much more enthusiastic about MIS than those from areas such as nursery and O.R. that have less interaction with the system by reason of a lower volume of information handling in these units.

4. This attitudinal response is also reflected in a comparative assessment of the responses of nursing with personnel in non-nursing areas such as pharmacy, laboratory, radiology, etc., that have less direct involvement with the system. Whereas personnel in these non-nursing departments hold

favorable attitudes toward MIS, they are in general less positive than the nursing staff, but more positive than the medical staff. Counting neutral responses separately, the nursing staff expressed a 60 percent positive attitudinal evaluation of MIS, while the other hospital staff indicated 54 percent positive responses, and the medical staff expressed 47 percent positive responses. Excluding neutral responses, the percentage of firm positive responses were respectively 78 percent, 71 percent, and 61 percent.

6.2 Nursing Staff Survey Findings

In the following section, the results of the 1974 nursing staff survey are presented. An overall general summary is provided for each major section of the questionnaire, followed by some detailed intergroup comparisons of attitudes toward MIS. Following these, comparisons of the 1974 evaluation of the system with the earlier evaluation are discussed in detail, so that any changes in opinions or attitudes can be detected. Detailed tabulations of the responses for each item of the questionnaire are contained in Appendix B.

6.2.1 1974 Nursing Staff MIS Evaluation

A general summary of the results for each major section of the questionnaire appears in Table 6-1. Responses have been aggregated over all items within the section. Positive responses to the items are indicative of favorable evaluations of MIS. Highly satisfactory responses have been combined with satisfactory responses to obtain the percent of positive responses. Similarly, highly unsatisfactory responses were combined with unsatisfactory responses for the negative evaluations. In the general evaluation, or attitudes, section of the questionnaire, several items' responses were inverted before aggregating because of the items' negative wording.

Overall, the results indicate positive attitudes toward the system. The most favorable evaluations are towards the impact of MIS on the dispensing of medications, dealing with the availability, timeliness of administration, and charting of medications. With the exception of the general evaluation, all other aspects of MIS were favorably evaluated more than 75 percent

TABLE 6-1. SUMMARY OF RESPONSES TO 1974 NURSING STAFF SURVEY

Questionnaire Category	Number of Questionnaire Items	Percent of All Responses Received			Percent of Those Responding Positively or Negatively	
		% Positive*	% Negative	% Neutral	% Positive	% Negative
Training Aspects of MIS	3	75.3	9.9	14.8	88.4	11.6
Mechanical Aspects of MIS	5	88.4	3.0	8.6	96.7	3.3
Medical Chart Aspects of MIS	13	74.6	11.4	14.0	86.7	13.3
Nursing Care Aspects of MIS	5	85.9	5.8	8.3	93.7	6.3
Provision of Medication with MIS	5	93.2	0.7	6.1	99.3	0.7
Information Transfer with MIS	6	78.0	5.8	16.2	93.1	6.9
General Evaluation (Attitude Toward MIS)	21	59.5	16.8	23.7	78.0	22.0
Interdepartmental Aspects of MIS	4	84.8	4.5	10.7	95.0	5.0
TOTAL	62	73.5	10.4	16.1	87.6	12.4

* Positive responses indicate favorable evaluations of MIS.

of the time, and unfavorable evaluations were made about 11 percent of the time or less. The differences between these percentages and 100 percent represent those subjects who expressed no opinion or a barely satisfactory rating of the system.

The general evaluation of the system received favorable responses about 60 percent of the time. Since this section of the evaluation represents staff attitudes toward the system, further summaries of the results are presented in Tables 6-2 and 6-3. In Table 6-2, comparisons across nursing units are made. Most positive attitudes toward MIS appear to be held by nursing staff assigned to 2E, 3W, 5W, 2N, Pediatrics and ICU. These areas have a need for a high level of information transfer. Based on the Battelle Nursing Activity Analysis, those nurses involved in high levels of information transfer are the most enthusiastic advocates of MIS because it simplifies their efforts. Less favorable attitudes exist for OR, AKU, ER, and Nursery. However, even here favorable responses outweighed unfavorable except in OR, and in AKU, which were essentially neutral. These areas are primarily out-patient services and have less interaction with MIS or do not have a great need for transfer of information. Within OR, the recovery room is the only area that interfaces to any extent with the system.

In Table 6-3, comparisons of attitudes on other grouping factors are presented. Most of the respondents indicated direct interaction with MIS, and the distribution of favorable attitudes is slightly higher for these. As their proficiency with MIS increases, their attitudes become more favorable. There does not appear to be a substantial difference in the percent of favorable attitudes toward MIS when compared across ages. Also, there does not seem to be any systematic differences when comparing across years of employment, although one category does appear to be less favorable than the others. The shift which the respondent works shows slight variations on the favorableness of the system with the day shift appearing to be lower than the other two. No substantial differences are noted for full-time versus part-time staff. The unit secretaries, registered nurses, and charge or head nurses appear to be slightly more favorably inclined to MIS (because they use it more) than the nurses aides and licensed vocational nurses seem to be.

TABLE 6-2. SUMMARY OF COMPARISON OF NURSING STAFF'S GENERAL EVALUATION* OF MIS BY NURSING UNITS

Unit	Number of Respondents	Percent of All Responses Received			Percent of Those Responding Positively or Negatively	
		% Positive	% Negative	% Neutral	% Positive	% Negative
AKU	5	35	34	31	51	49
CCU	4	56	28	16	67	33
ER	4	38	27	35	58	42
Float	14	56	18	26	76	24
ICU	10	70	11	19	86	14
Labor & Delivery	4	57	9	34	86	14
Maternity	7	68	17	15	80	20
Nursery	8	44	18	38	71	29
OR	13	25	29	46	46	54
Pediatrics	8	71	12	17	86	14
Recovery Room	5	50	20	30	71	29
TCU	11	62	18	20	78	22
IS	9	68	13	19	84	16
2E	8	83	8	9	91	9
2N	7	72	11	17	87	13
2W	8	58	17	25	77	23
3W	5	75	11	14	87	13
5E	12	61	17	22	78	22
5W	4	73	5	22	94	6
6E	8	67	14	19	83	17
6W	7	65	14	21	82	18
Total	161	59	17	24	78	22

* This evaluation elicited staff attitudes in general toward MIS, reflecting acceptance of the system. The same evaluation items were administered to the staff at several time points to measure changes in acceptance of the system over time.

TABLE 6-3. INTERGROUP COMPARISONS OF NURSING STAFF'S GENERAL EVALUATION* OF MIS

Unit	Number of Respondents	Percent of All Responses Received			Percent of Those Responding Positively or Negatively	
		% Positive	% Negative	% Neutral	% Positive	% Negative
Interaction with MIS						
Yes	150	60	16	24	79	21
No	12	52	24	24	68	32
Not reported	2	38	10	52	79	21
Proficiency with MIS						
Beginner	12	31	21	48	60	40
Intermediate	44	58	16	26	78	22
Proficient	90	63	17	20	79	21
Expert	13	73	14	13	84	16
Not report	5	24	6	70	80	20
Age						
18-29	69	59	17	24	78	22
30-39	47	60	16	24	79	21
40-49	24	64	14	22	82	18
50-59	21	53	21	26	72	28
Not reported	3	62	22	16	74	26
Years of Experience						
Less than 1 Year	27	59	14	27	81	19
1 Year	17	61	13	26	82	18
2 Years	23	63	17	20	79	21
3 Years	19	50	21	29	70	30
4 Years	14	67	16	17	81	19
5 or More Years	63	59	18	23	77	23
Shift						
Days	75	54	21	25	72	28
P.M.'s	57	64	13	23	83	17
Nights	31	63	13	24	83	17
Employment Status						
Full Time	124	60	17	23	78	22
Part Time	39	57	15	28	79	21
Not reported	1					
Position						
Registered Nurse	102	62	16	22	79	21
Nurses Aide	39	54	16	30	77	23
Licensed Vocational Nurse	6	42	31	27	58	42
Unit Secretary	6	69	12	19	85	15
Charge or Head Nurse	9	62	21	17	75	25
Not reported	2	81	5	14	94	6

* Staff attitudes toward MIS.

6.2.2 Comparison of Nursing Staff Evaluations

In the following tables, responses to individual items on the 1974 nursing staff questionnaire are compared with responses for similar items on the three earlier surveys. In general, the results show increasingly favorable responses over time with a few items showing either some decline or no substantial change in the percent of favorable responses. Because of rewording of items on the questionnaire to facilitate response, the correspondence of items from the latest questionnaire with earlier forms is not always exact. For clarity's sake, the item number of the earlier survey is presented in the tables to indicate which comparisons are being drawn, and so that reference can be made to the earlier results in Battelle's interim report. The exception to this is the comparison of attitudes toward MIS where the wordings of the items were retained almost verbatim.

Table 6-4 compares 1973 and 1974 evaluations of the training and mechanical aspects of MIS. Little change in these evaluations occurred with the exception of maintenance of the equipment. In 1974, maintenance of the equipment was rated satisfactory or better 85 percent of the time. In 1973, for a related item, over 70 percent of the time nursing staff indicated down time of the system interfered with nursing care. To the extent that these two items are comparable, they represent a significant positive shift in the evaluation of this aspect of the system.

In Table 6-5, evaluation of medical chart aspects of the system are compared for 1973 and 1974. Wherever comparisons can be drawn, there appears to be either an increase or maintenance of the percentage of favorable responses. Notable increases occur for the formatting of information, for MIS nursing notes, for the chart in general, for interpretation of physician's orders, and for patient care plan printouts. Substantial reductions in the percentages of unfavorable responses were prevalent, indicative of overall improved evaluations of this aspect of MIS.

In Table 6-6, nursing care aspects and medication aspects are compared for the two time periods. Dramatic increases in the percentage of favorable responses are obtained for each item. Especially noteworthy is the increase in the percentage of favorable responses concerning the timeliness of administration of medications, the time available for nursing, and time spent on clerical

TABLE 6-4. NURSING STAFF'S EVALUATION OF TRAINING AND MECHANICAL ASPECTS OF MIS

Evaluation Criteria	Item Number		% Favorable		% Unfavorable	
	1973 Survey	1974 Survey	1973 Survey	1974 Survey	1973 Survey	1974 Survey
Training						
Being trained to use the system	--	1	--	64.1	--	15.1
Becoming accustomed after training	8	2	88.7	85.3	8.4	7.7
Obtaining help when system does not respond	72	3	72.1	76.3	22.2	7.0
Mechanical Aspects						
Using keyboard	31	1	96.4	94.8	2.1	1.3
Using light pen	23	2	91.0	80.8	7.1	4.5
Legibility of printout	--	3	--	95.4	--	0.6
Equipment maintenance	70	4	25.1	85.1	70.9	3.9
System response time	--	5	--	85.8	--	4.5

TABLE 6-5. NURSING STAFF'S EVALUATION OF MEDICAL CHART ASPECTS OF MIS

Item Description	Item Number		% Favorable		% Unfavorable	
	1973 Survey	1974 Survey	1973 Survey	1974 Survey	1973 Survey	1974 Survey
Information readily accessible	7	1	83.1	83.4	14.6	10.2
Information in convenient format	42	2	60.7	79.8	27.2	11.4
All necessary information available	--	3	--	72.0	—	19.7
Information quickly available	—	4	—	75.3	—	17.1
Medications given readily verified	—	5	--	75.8	--	8.9
Fluid intake, output found in chart	--	6	—	40.5	--	11.6
Test data readily assessed	46	7	67.8	69.4	28.1	14.0
Radiology reports readily accessed	--	8	—	63.2	—	16.2
Chart appropriately organized	42	9	60.7	66.4	27.2	15.5
Chart satisfactory	73	10	48.0	72.6	28.4	13.3
Interpretation of physician orders	43	12	75.9	92.4	21.0	2.1
MIS nursing notes	73	13	48.0	91.1	28.4	1.3
Patient Care Plan printouts	74	14	69.2	97.2	14.9	0.7

TABLE 6-6. NURSING STAFF'S EVALUATION OF NURSING CARE AND MEDICATION ASPECTS OF MIS

Evaluation Criteria	Item Number		% Favorable		% Unfavorable	
	1973 Survey	1974 Survey	1973 Survey	1974 Survey	1973 Survey	1974 Survey
Nursing Care						
Organization of unit	1	1	58.9	91.6	31.1	6.3
Time available for nursing satisfactory	18	2	41.2	86.1	47.8	4.2
Time on clerical work satisfactory	17	3	38.7	77.4	52.4	8.9
Patient care planning	35	4	53.3	88.8	33.6	4.2
Scheduling for diagnostic X-ray, lab or therapy	62	5	70.3	85.9	16.0	5.2
Medication						
Availability of newly prescribed medications	28	1	56.4	84.3	27.7	1.6
Timely administration of scheduled medications	13	2	64.7	94.6	23.8	0.0
Charting of scheduled medications	36	3	79.6	97.7	12.7	0.0
Timely administration of prn medications	3	4	32.0	93.8	59.0	0.0
Charting of prn medications	52	5	70.1	95.4	20.2	1.5

work. Note also the absence of unfavorable responses in three of the five items on medication aspects, as compared to the 1973 results.

Interdepartmental and information transfer aspects of MIS are compared in Table 6-7 for the two time periods. Results indicate consistently increasing percentages of favorable responses over time and substantial reductions in unfavorable evaluations. A high degree of satisfaction with the impact of MIS in these respects is evidenced.

Tables 6-8 and 6-9 compare general attitudes toward MIS over each of the four surveys of nursing staff. In Table 6-8, the negatively worded items are compared. Decreasing percentages of agreement with these statements are increasingly favorable to MIS. Overall, agreement with these statements appears to decrease with time, and disagreement increases, indicating increasingly favorable dispositions toward MIS. Special notice should be given to the increasing percentage of disagreement with the statements. These represent increasingly positive attitudes toward MIS. The fluctuations in percentages of agreement with the statements may be due to fluctuations in the numbers of persons who were unwilling to make an evaluation earlier.

In Table 6-9, the remaining general attitude items are compared. A large percentage of favorable responses resulted. Items with lower percentages of agreement do not necessarily indicate unfavorable attitudes. For example, only 39 percent of the respondents agreed that MIS alters their work. This may be a neutral impact, or the fact that 44 percent indicated it did not alter their work may be a positive result. A very small percentage of respondents feel MIS saves money. The majority of respondents would not express an opinion on this item. Statements which carry a very positive attitude toward MIS tend to receive a substantial percentage of agreeing responses, indicative of an overall favorable attitude.

6-3 Other Hospital Staff Attitudes Toward MIS

In addition to the 1974 survey of physicians and nursing staff at El Camino Hospital, a sample of non-nursing, non-physician staff consisting of ancillary personnel (pharmacy, clinical pathology laboratory, radiology, etc.) were administered an abbreviated questionnaire similar to the general evaluation portion of the other questionnaires. The questionnaire is reproduced in Appendix D.

TABLE 6-7. NURSING STAFF'S EVALUATION OF INFORMATION TRANSFER AND INTERDEPARTMENTAL ASPECTS OF MIS

Evaluation Criteria	Item Number		% Favorable		% Unfavorable	
	1973 Survey	1974 Survey	1973 Survey	1974 Survey	1973 Survey	1974 Survey
Information Transfer						
Completeness of change of shift report	4	1	68.1	89.1	23.1	3.9
Speed of change of shift report	22	2	43.7	82.2	46.2	3.9
Speed of updating knowledge after days off	29	3	66.0	85.7	24.4	3.0
Knowing which lab work is to be done	37	4	67.6	86.2	24.9	3.1
Time for entering information before deadlines	38	5	38.4	72.3	50.9	6.1
Finding information during heavy usage	39	6	33.8	52.6	64.3	15.0
Interdepartmental Aspects						
Changes in diet orders by Dietary Department	50	1	54.7	72.9	23.4	8.6
Ordering from Central Service	6	2	84.2	91.8	12.4	2.7
Time for supplies to arrive from Central Service	12	3	69.4	77.8	25.2	6.3
Ordering laboratory procedures	30	4	75.5	95.8	17.4	0.7

TABLE 6-8. NURSING STAFF'S ATTITUDES TO GENERAL CRITICISMS OF THE MIS SYSTEM

Statements	% Agree*				% Disagree*			
	1971	1972	1973	1974	1971	1972	1973	1974
MIS no better than old way	13.3	20.0	33.8	15.1	51.2	45.6	57.4	61.2
MIS forces routine	8.8	8.0	16.1	7.1	61.6	54.4	64.5	74.8
MIS makes role less important	3.2	0.8	5.7	3.2	67.0	73.6	78.7	82.0
One department should try MIS first	62.2	65.3	52.8	27.2	22.0	20.2	28.4	47.0
Computerized system turns me off	11.0	14.3	14.1	6.5	66.4	69.0	74.3	83.8
MIS cannot perform as expected	3.2	17.6	38.6	16.9	42.5	38.4	42.6	56.5
Must wait in line with MIS	25.2	31.5	33.0	51.3	34.6	24.2	54.4	40.3
Another hospital should try MIS first	5.5	8.0	20.4	10.3	61.7	61.6	53.9	48.7

* Strong agreement responses were combined with agreement responses; likewise for strong disagreement and disagreement.

TABLE 6-9. NURSING STAFF'S GENERAL EVALUATION (ATTITUDES TOWARD MIS)

Statements	% Agree*				% Disagree*			
	1971	1972	1973	1974	1971	1972	1973	1974
Benefits outweigh trouble	55.3	41.0	52.8	80.0	9.1	22.9	28.0	12.3
ECH is a more desirable place to work	79.5	85.5	84.2	71.0	0.8	2.4	4.7	3.9
MIS facilitates communication	59.5	35.2	43.6	69.1	4.8	16.8	37.3	13.2
MIS alters work	32.0	24.0	46.9	39.4	46.4	46.4	44.0	43.9
MIS permits more effective work with others	47.6	27.0	43.3	58.5	11.9	35.7	47.2	22.0
Important that ECH try MIS	70.1	71.2	72.5	75.0	4.0	7.2	11.8	4.6
MIS works well	54.0	32.5	44.1	83.8	8.7	34.9	48.1	13.0
Mechanics of terminal easy	53.6	63.7	80.3	94.8	12.6	22.5	13.3	3.2
Patient's stay more satisfactory	40.8	11.2	16.0	38.1	15.2	28.8	38.4	17.1
Patient's stay reduced with MIS	15.7	9.6	4.0	13.1	35.5	38.4	44.1	24.9
MIS saves money	35.4	11.3	3.9	9.2	10.2	17.8	45.6	22.5
ECH functions more smoothly with MIS	53.9	28.8	30.5	56.9	7.1	16.0	47.6	12.5
More knowledgeable about patients	—	—	—	64.5	—	—	—	20.6

* Strong agreement responses combined with agreement responses; likewise for strong disagreement and disagreement.

A total of 51 staff members in this other category responded to the survey. This represents a response rate of 71 percent for the 72 staff members who were mailed the form. The responses allow for a comparison of the general evaluation of MIS by these non-nursing, non-physician staff members with the responses of the nursing staff and the physician staff. The comparison is shown in Table 6-10. Favorable responses represent agreement with statements supportive of MIS or disagreement with statements unfavorable to MIS. The complement of the total percentage of responses shown represents those with no opinion. The table shows that the nursing staff hold the greatest percentage of favorable responses to the system with the other hospital staff members slightly below them, and the physician's attitudes as the least favorable of the three groups.

Responses to individual items of the general evaluation by the other hospital members is summarized in Appendix D. In Table 6-11, those statements which received a large percentage of agreement or disagreement from the other hospital personnel are listed. When the direction of agreement is considered along with the favorableness of the statements toward MIS, all but one of the items are supportive of MIS. The conclusion is that these other staff members have a very favorable attitude toward MIS and their major negative evaluation is that they often have to wait in line to input and to obtain output information. A large percentage of physicians (48%) and of nursing staff (51%) expressed similar views on this aspect of MIS.

6.4 Study Approach for Nursing Staff Survey

To measure the extent of changes in attitude of the nursing staff toward MIS and to obtain user evaluations over time of the performance of the system at ECH, a sequence of surveys of the nursing staff was conducted.

Battelle's interim report presents results from the first three surveys which were initiated in August, 1971 (pre-MIS), February, 1972 (during MIS implementation) and March, 1973 (during early full implementation of MIS). The first two surveys were concerned solely with measuring attitudes toward and acceptance of MIS by the nursing staff. The third survey, broader

TABLE 6-10. COMPARISON OF GENERAL EVALUATION (ATTITUDE TOWARD MIS) BY HOSPITAL STAFF

Staff Group	Number of Responding Staff Members Using MIS	Number of Questionnaire Items	Percent of All Responses			Percent of Those Responding Positively or Negatively	
			% Positive	& Negative	% Neutral	% Positive	% Negative
Nursing Staff	164	21	59.5	16.8	23.7	78.0	22.0
Physicians (MIS-Users)	133	23	47.0	30.3	22.7	60.8	39.2
Other Hospital Staff	51	21	53.7	21.8	24.5	71.1	28.9

TABLE 6-11. STRONG ATTITUDES TOWARD MIS BY OTHER HOSPITAL STAFF

Statement	Percent of Responses In Agreement	Percent of Responses Not In Agreement
Mechanics of MIS relatively easy	84.3	11.8
Computerized system turns me off	10.0	84.0
Important that ECH tried MIS	80.4	3.9
MIS works well	76.0	18.0
Under MIS, more knowledge about patient	76.0	10.0
ECH is more desirable place to work	75.5	6.1
MIS makes my role less important	8.2	65.3
Benefits of MIS outweigh troubles	62.0	18.0
MIS not better than old way	22.0	54.0
One department should try MIS first	23.0	52.1
MIS forces me into a routine	12.0	52.0
Have to wait in line with MIS	52.0	34.0
Prefer another hospital try MIS	10.0	52.0

in scope, collected information for an evaluation of MIS as well as the information on acceptance and attidues toward the system.

The latest survey of nursing staff personnal was initiated in July, 1974, and represents assessments of MIS approximately two years after its implementation, and more than one year after the earlier survey conducted in March, 1973, during the early full operational period for the system.

The questionnaire for the 1974 survey was designed to elicit opinions of the nursing staff about the impact of MIS on their roles in the hospital and their attitudes toward the system after it had been fully operational for the additional period of time. The questionnaire used for the survey is presented in Appendix C. In addition to the identifying information on the respondent, it contains items organized into eight major sections. Many of the items are directly comparable to items used in the earlier surveys. This is especially true for the section on attitudes toward the system. The eight major sections of the questionnaires are the following:

1. The training aspects of MIS concerning evaluations of the training process itself and being able to use the system after training
2. The mechanical aspects of MIS including use of the instruments, equipment maintenance, system response time, and legibility of printouts
3. The medical chart aspects of MIS dealing with information availability, accessibility, and organization
4. The nursing care aspects of MIS covering its impact on scheduling, planning, and time for nursing care
5. The medication aspects of MIS dealing with availability of medications and their timely administration and charting
6. The information transfer aspects of MIS measuring its impact on the speed of updating and changing reports, and finding and entering information

7. The general evaluation of MIS measuring nursing staff attitudes toward the system and its impact on their work, hospital procedures, and patient care
8. The interdepartmental aspects of MIS dealing with its impact on interdepartmental orders.

6.4.1 1974 Nursing Staff Survey Response

Questionnaires were mailed to 229 members of the nursing staff at El Camino Hospital, representing a sample of approximately 40 percent. A total of 164 responses were received resulting in an overall response rate of 72 percent. These responses represent evaluations by 28 percent of the nursing staff at the hospital. The distribution of responses across nursing positions is shown in Table 6-12. The response rate for each nursing group appears to be satisfactory with the exception of the Head Nurse/Assistant Head Nurse category. Nevertheless, the correspondence between the distribution of responses and the distribution of staff is indicative of the respondents being representative of the staff.

TABLE 6-12. NUMBER AND PERCENT OF RESPONSES TO 1974 NURSING STAFF SURVEY

Nursing Group	Number of Nursing Staff Members	Number of Questionnaires Mailed	Number of Questionnaires Returned		Total Response Percentage
			Full Time	Part Time	
Registered Nurse	317	126	66	36	80.9%
Licensed Vocational Nurse	25	9	6	-	66.7%
Nurses Aide	145	62	36	3	62.9%
Head Nurse and Asst. Head Nurse	63	24	9	-	37.5%
Unit Secretary	31	8	6	-	75.0%
Not Reported	--	-	2	-	-
Total	581	229	125	39	71.6%

7.0 PHYSICIAN USE OF HOSPITAL SERVICES

The Technicon Medical Information System (MIS) interfaces directly with the physicians, who are intended to be the active agent in the placement of orders into the system. Although the physician has always assumed the primary role of initiating orders and selecting specific services for his patient, it is possible that a system which alters the mechanics of initiating orders may have other effects on the physicians' practice in the hospital that are not entirely anticipated.

This section examines physician utilization of the ordering input device--Video-Matrix-Terminal (VMT), and the number of order sets by day of patient stay he enters into the system. Battelle's interim report, September 30, 1973, presents the findings of these studies through early implementation of the system at ECH. A brief summary of an earlier study and results of a 1973 repeat study on number and timing of medical order sets by day of patient stay are also presented in this section of the report.

The quantitative focus of this section of the report is particularly important in judging whether MIS has achieved its intended goal of involving the physician in the operation of the system. No attempt is made in this section to interpret the possible significance of changes in the physicians' use of hospital services as a result of MIS as this topic is examined by the answers to direct questions submitted to the medical staff. Response to the physician questionnaire is reported in Section 8.0.

Two studies were repeated during the last two years to determine changes in physician use of hospital services after more than one year's experience with the fully implemented system. The studies are:

1. Physician Use of the Video-Matrix-Terminal--an analysis of the personnel involved in the entry of medical orders into MIS, and the total time spent by physicians on all VMT operations.
2. Medical Order Sets by Day of Patient Stay--an examination of order sets written for patients on each day of hospital stay.

7.1 Physician Use of the Video-Matrix-Terminal

A fundamental and distinguishing feature of the Technicon Medical Information System (MIS) is the physicians' central role in the placement of orders into the Video-Matrix-Terminal (VMT). MIS has been designed to make it possible and desirable for the physician to interface directly with the system through the VMT.

This section reports on two closely related studies to determine the extent that physicians have used the VMT during the first and third years of MIS operation:

- The first study examines the proportion of physicians (with patients in the hospital) who used the VMT.
- The second study examines the function of medical order writing to determine the proportion of order sets entered in the VMT by the physician and the proportion entered by nursing personnel.

7.1.1 Summary of Major Results

The major results of this section are:

- The proportion of physicians using the VMT has increased from 1972 to 1974. As of October, 1974, 78% of all physicians were using the VMT for order entry or data retrieval. Eighty-eight percent of all Internists, General Practitioners, Surgeons, Orthopedists, and Obstetricians-Gynecologists were using the system. The percentage of physicians (all specialties) who had patients in the hospital and used the VMT are given in Column 2 of Table 7-1.
- The proportion of order sets entered by physicians increased from July, 1972, to January, 1973, but has not changed significantly from January, 1973, to October, 1974. As of October, 1974, 68% of all order sets (excluding phone and verbal orders) were entered into the system by physicians. Percentages of order sets entered by physicians are given in Column 3 in Table 7-1.

During the 1974 samples, it was found that the time obtained from available computer listings (abstracts from the syslist) is not necessarily the time that physicians spend using the VMT. Using the methodology established in 1972 for this portion of this study, it was impossible to measure the physicians' actual time on the VMT. Consequently this portion of the study was not updated in 1974.

7.1.2 Proportion of Physicians Who Use the VMT

In this study the data were analyzed to determine what proportion of the physicians, who had patients in the hospital, used the VMT.

7.1.2.1 Study Approach. Two sets of information were required to calculate the percent of physicians who used the VMT.

- The names of physicians who used the VMT were obtained from data sheets which listed the physicians who signed on the VMT and the time each physician was signed on MIS.
- The names of physicians who had patients in the hospital on the days sampled were obtained from the Technicon BOS (Business Office System) report titled "Daily Account Balance Listing". Bed numbers are listed for inpatients as well as the names of their respective physicians.

A number of physicians used the VMT but had no inpatients. These physicians were counted both with users and with physicians who had inpatients. However,

TABLE 7-1. SUMMARY OF RESULTS

(1) Sample Month	(2) Proportion of physicians using VMT	(3) Proportion of order sets entered by physicians
July, 1972	55%	52%
January, 1973	74%	69%
March, 1974	78%	68%
October, 1974	78%	67%

physicians not eligible to have inpatients were excluded, i.e., Anesthesiologists, Radiologists, Pathologists, the Hospital Physiatrist, the Chief Psychiatrist, and the Emergency Room Director.

The proportion of physicians who use the VMT is given by the expression:

$$P = \left(\frac{U}{I + N} \right) \times 100$$

where, U = number of physician users

I = number of physicians with inpatients

N = number of physician users who had no inpatients.

7.1.2.2 Results. The results show an increase in the proportion of physicians who used the VMT in 1974 compared with the proportion of users in 1972. As shown in Table 7-2, the notable exception is Psychiatry with the highest percentage of users in July, 1972, close to the time that implementation occurred. Psychiatrists on the staff of ECH are not hospital oriented in in their practices thus they have not become accustomed to MIS through exposure. In addition the occupancy rate in the mental health unit has decreased since 1972.

Reasons that the proportion of users has increased include the following items:

- Increased acceptance by physicians has resulted in more physicians using the VMT. (See Section 8.0, Physician Attitudes and Acceptance of MIS.)
- A major system change in reporting latest test results first rather than in chronological order has increased use of MIS by physicians
- Efforts were made by the nursing staff to encourage physicians to enter orders through the VMT.
- More information has been included for the physician:
  -Announcement display for medical staff meetings
  -Antibiotic sensitivity survey
  -Antipsychotic agents and patient treatment
  -Antibiotic ordering information
  -Laboratory interpretation aids
  -Hyperlipemia workup

TABLE 7-2. PERCENT OF M. D. USERS WITH INPATIENTS

Specialty	July, 1972			January, 1973			March, 1974			October, 1974		
	M.D.'s with Patients	M.D. Users	Per-cent	M.D.'s with Patients	M.D. Users	Per-cent	M.D.'s with Patients	M.D. Users	Per-cent	M.D.'s with Patients	M.D. Users	Per-cent
Intern.med/ Gen'l practice	52	25	48	71	55	77	70	61	87	65	57	88
Surgery	36	27	75	50	41	82	43	38	88	41	36	88
Obs/Gyn.	23	15	65	23	20	87	25	20	80	27	24	89
Orthopedics	13	7	54	13	11	85	15	14	93	14	12	86
Pediatrics	19	7	37	15	9	60	15	10	67	17	10	59
Psychiatry	16	7	44	18	5	28	27	10	37	22	7	32
Total	159	88	55	190	141	74	195	153	78	186	146	78

-Psychiatry-subspecialty roster
-Radioisotope ordering aid (thyroid)
-Respiratory therapy indications
-Bedside pulmonary screening tests
-Surgical abstracts

- Standardized order sets and personalized order sets have streamlined VMT usage for the physician. Standardized order sets are predetermined order sets for a specialty stored in the computer that can be recalled by the physician; the physician selects the orders needed by checking them off on the checklist format presentation on the VMT display. A personalized order set is similar to a standardized order set, but it is prepared by the physician for his individual use.

In Table 7-2, the percentage figures for the individual specialties are sensitive to a variation of one user because of the small number of physicians (physicians with inpatients) used as the base number for the calculation. The percentage values most likely understate the proportion of users because of two situations:

- On the two days that the sample was taken a physician may have been ill or out of town and another physician covered for him. This would be reflected as a reduction in the number of users and the percentage of users as calculated would be understated.
- Near the end of a stay, the patient may not need changes in his care orders. Thus, it is possible that a physician with one or two patients may not have used the VMT during the period of this study. This would also be reflected as a reduction in the number of users and the percentage of users would be understated.

7.1.3 Proportion of Order Sets Entered by Physicians

In this portion of the task data were analyzed to determine what proportion of medical order sets were entered by physicians and what proportion were entered by nursing personnel.

7.1.3.1 Study Approach and Data Sources. The MIS has the capability for producing a daily listing, called the "syslist", of the transactions entered through each VMT in the hospital. During 1973 Technicon developed a syslist abstract to summarize the usage of the VMT for the entry of medical orders. The syslist and the abstract were made available to the evaluation team for this study.

The determination of the percentage of medical orders entered into the VMT by physicians used two separate sources of data. Information for the time period, January, 1972, through May, 1972, was obtained from a review of patient charts. The syslist was used to obtain data for the period July, 1972, through January, 1973.

A sample of patient charts was selected for units on which MIS was first implemented--one medical unit, one surgical unit, and the gynecology unit. The chart sample included all patients on a unit for a randomly selected day during the 1st and 2nd month of MIS operation. For the sample of charts, all order sets entered through MIS were analyzed.

During the time covered by the chart survey (January through May, 1972) the printout of physicians' orders from MIS produced a signature line whenever the physician selected an "enter order" command, or when the buffer storage capacity has been reached. For this reason it was necessary to define a criterion for counting order sets. One order set was defined to be one or more groups of patient care directions accompanied by a signature line, placed by one individual for the patient during a ten-minute time period.

Each group of patient care directions was accompanied by the name and title of the individual entering the orders. This was used to classify the agent entering order as: physician, registered nurse, or clerk. At the time of the chart survey, only physicians or registered nurses were authorized to enter orders on the nursing floor. Clerks in ancillary service areas entered preadmission orders and additional services performed; these orders were not counted.

The Technicon syslist was used as the data source for the period from July, 1972, through January, 1973. Each group of patient care directions was presented on the syslist, and each was accompanied by the name and title of the agent entering the orders.

Two considerations were important in counting the order sets from the syslist. First, a significant number of entries were "complete" or "hold" orders--entries to the system (almost always made by a registered nurse) to complete an order, or to hold an order temporarily inappropriate such as hold diet for special radiology procedures. Complete and hold orders were not counted, as this activity would not appear as an order in the chart study.

Second, it was not practical to group the patient care directions into order sets by the criterion (10 minute interval) used in the chart analysis. Because of the chronological sequencing of entries from the various terminals, the separate segments of an order could be several pages apart, and practically impossible to correlate. Analysis of the order segments in the chart study showed that the number of groups of patient care directions per order set was essentially the same for orders entered by physicians and orders entered by registered nurses. For this reason, the percentage of orders entered by physicians is the same whichever criterion is used to count orders.

For early 1972, data from the chart were summarized by the nursing unit on which the patient was located. Beginning in July, 1972, data were taken from the syslist. Data from the syslist were summarized by the location of the terminal through which the data were entered, and were divided into the medical specialty in proportion to the number of patients in each specialty served by that terminal.

Data for the 1974 studies were taken from the abstract listing following the same rules used with the syslist in the earlier studies.

7.1.3.2 Results. The percentage of medical order sets entered by physicians is shown in Table 7-3 and, as can be seen in the table, the percentage has not changed significantly from January, 1973, to October, 1974. Physicians entered 69 percent of their order sets in January, 1973, 68 percent in March, 1974, and 67 percent in October, 1974. During the final months of implementation, from July, 1972, to January, 1973, the percentage of order sets entered by physicians had increased by 17 percent, from 52 percent to 69 percent.

When an order set is entered by an agent for a physician, the type of authorization must be given as written, verbal, or telephone. Since MIS was designed to have direct order entry into the VMT to replace the physicians'

TABLE 7-3. PERCENT OF MEDICAL ORDER SETS ENTERED BY PHYSICIANS

Sample Month	Order Sets Entered by Physician	Written Order Sets Entered by Nursing Personnel
July, 1972	52%	48%
October, 1972	60%	40%
January, 1973	69%	31%
March, 1974	68%	32%
October, 1974	67%	33%

handwritten orders, the percentages shown in Table 7-3 are based only on written (written by physicians) order sets, i.e., verbal and telephone authorizations have been excluded. The percentage of order sets entered by physicians (P) was calculated as follows:

$$P = \left(\frac{E}{E + W} \right) \times 100$$

where E = number of order sets entered by physician

W = number of written order sets entered by nursing personnel.

The rationale for excluding verbal and telephone orders is that order sets authorized verbally or by telephone were used prior to MIS and use was continued after MIS was implemented.

Order sets made up totally of "complete" and "hold" orders were excluded from the count of order sets. Order sets entered by personnel in ancillary service departments also were excluded from the count.

7.1.3.3. Results of Further Analysis of Order Sets. Further analysis was made of the proportion of order sets entered by physicians to examine two additional aspects of order entry:

- Proportion of order sets entered by the physician considering all order sets entered by nursing personnel as agents authorized by written, verbal, or telephone orders. (Table 7-4).
- Proportion of order sets entered by physician by specialty. (Table 7-5).

Table 7-4 gives the percent of all order sets entered by physicians along with the distribution of the order sets entered by nursing personnel into written, verbal, and telephone categories. If the agent entering the order does not indicate one of the three authorization categories, then the order set is shown as "non-designated". The following conclusions can be drawn from the results:

- The proportion of order sets entered by nursing personnel decreased from 66 percent (July, 1972) to 54% (January, 1973), and then remained relatively constant through 1974 at 56 percent in March and 55 percent in October.
- The proportion of written orders followed the same trend as the total entered by nursing personnel.
- The proportion of verbal orders remained relatively constant throughout the study period.
- The proportion of telephone order sets showed a decrease from 22 percent (July, 1972) to 19 percent (October, 1974).
- The nondesignated order sets identified in 1974 belong in the other three categories. Unless the total 2 percent went into a single category, the trends would not be affected.

TABLE 7-4. PERCENT OF MEDICAL ORDER SETS BY AUTHORIZATION FOR ENTRY

Sample Month	Entered by Physician[a]	Entered by Nursing Personnel				
		Total	Written	Verbal	Telephone	Nondesignated
July, 1972	34%	66%	31%	13%	22%	
October, 1972	38%	62%	26%	13%	23%	
January, 1973	46%	54%	21%	12%	21%	
March, 1974	44%	56%	20%	12%	22%	2%
October, 1974	45%	55%	22%	12%	19%	2%

[a] Note: Table 7-4 includes verbal, telephone and nondesignated order sets that Table 7-3 excludes.

Table 7-5 shows the percent of all medical order sets entered by physicians by specialty. The number of order sets used in the calculation of

TABLE 7-5. PERCENT OF TOTAL MEDICAL ORDER SETS FROM NURSING UNITS ENTERED BY PHYSICIANS

Physician Specialty	Sample Month											
	1972							1973	Weighted Average	1974		Weighted Average
	Jan	Feb	Mar	Apr	May	July	Oct	Jan		Mar	Oct	
Intern.med/ Gen'l Pract	43.3	46.5			57.0	26.1	26.2	46.8	43.5	21.4	22.0	21.7
Surgery			54.7	56.3		41.2	48.9	51.4	52.3	61.8	63.7	62.6
Obs/Gyn.				44.0	48.1	24.5	31.5	38.9	39.3	49.2	55.8	52.2
Orthopedics						31.1	49.2	50.7	44.0	57.7	60.3	59.0
Pediatrics						5.25	55.9	51.7	53.5	28.6	31.4	29.8
Psychiatry						42.4	33.3	25.7	33.7	31.5	25.9	29.1
Weighted Average	43.3	46.5	54.7	51.9	51.9	34.4	38.3	45.9	45.3	44.3	44.6	44.4

Note: Table 7-5 includes verbal, telephone, and nondesignated order sets that Table 7-3 excludes.

percentages include verbal, telephone, and nondesignated order sets as well as written order sets entered by nursing personnel. The following conclusions can be drawn from the results:

- The minimum percentage for entry of order sets by physicians occurred in July, 1972. This drop corresponded with the period during which manual ordering sheets were sanctioned by the hospital administration upon the insistence of physician groups.
- The increase in the percentage of medical orders entered into the VMT by physicians between October, 1972, and January, 1973, correlates with efforts to increase the usage of standard order sets and personal order sets particularly for the surgical, obstetrics/gynecology, and orthopedic nursing units. Also, during this period there was a corresponding decrease in the percentage of handwritten orders from 26 percent to 21 percent of order sets (see Table 7-4).
- Increases in the percentage of orders entered by physicians occurred from January, 1973, to October, 1974, for surgery (51 percent to 64 percent), obstetrics/gynecology (39 percent to 56 percent), and orthopedics (51 percent to 60 percent).
- Decreases in the percentage occurred from January, 1973, to October, 1974, for internal medicine/general practice (47 percent to 22 percent), and for pediatrics (52 percent to 31 percent).
- The decrease in the percent of order sets entered by Internists and General Practitioners appears inconsistent with the increase in the proportion of users given in Table 7-2. Further analysis shows that a significant number of physicians used the VMT for retrieval <u>without</u> entering medical orders:

	No. of Users (Table 7-2)	No. of Users not entering orders	Percent of Users not entering orders
March, 1974	61	23	38
October, 1974	57	23	40
Total	118	46	39

- The percent of order sets by Psychiatrists shows little trend, but appears to fluctuate between 25 percent and 43 percent.
- Overall, the percent of order sets entered by physicians increased from 34 percent (July, 1972) to 46 percent (January, 1973) and then levelled off at 44 percent (March, 1974) and 45 percent (October, 1974).

7.2 Medical Order Sets by Day of Patient Stay

This was updated in 1974 however there was no significant change in the results compared to 1971. The study is summarized here.

The physician initiates hospital services for his patient by "writing" orders. Prior to MIS, physicians used a "yellow order sheet" for all orders. With the advent of MIS order matrices were displayed on the VMT, and the physician selected specific orders from those on the video screen. Orders not programmed into the matrices were to be typed in at the terminal. Although some physicians continued to use the yellow order sheet, all orders were processed through MIS (in this case a nurse or ward clerk entered the physician's orders).

The timing of order placements, relative to the patients' day of admission, affects the speed with which diagnostic tests will be scheduled and performed, and the time that results will be available so that additional diagnostic measures or appropriate therapeutic measures can be taken.

It is possible that the mechanics for order-entry through the use of a Video-Matrix-Terminal (VMT) and the subsequent processing of orders results in a change in physicians' use of hospital services. One way in which the physicians' use of hospital services may be affected is by a change in the number and timing of medical order sets entered during the patient's stay. A change of this sort would suggest that the physician has altered the number of occasions or the timing of the occasions during which he has chosen to initiate hospital services; this is the subject of the analysis reported in this section.

The analysis described below was carried out by direct examination of patient charts. This mode of data collection permitted information about

order sets and progress notes to be collected at the same time. The progress of the patient during his hospitalization is recorded by the physician in the form of patient progress notes. These notes are handwritten (or dictated) at various points during the patient's hospital stay. Areas covered include changes or confirmation of diagnosis, initiation of therapy, changes in condition, etc.

Since progress notes are handwritten by the physician both before and after the implementation of MIS, there is no apparent reason to expect a change in this aspect of medical practice; for this reason the number and timing of progress notes form a "control" which may be compared with the information found for order sets.

7.2.1 Summary of Results

The comparisons on the number of progress notes per patient day yielded no significant differences between time periods before and after MIS implementation. No differences were expected since the format and mode of entry did not change due to MIS. In comparing the number of medical order sets per patient day, overall increases of 20 to 35 percent were noted, between pre-MIS and post-MIS samples, which were statistically significant. The major increase in these values was observed in the first day of patient stay, where approximately 50 percent increases were observed. The increase in the first day of stay may possibly be explained by the fact that, after MIS implementation, any pre-admission order sets for the patient are accumulated and treated as first day of stay order sets whereas prior to MIS, they were entered as order sets on the day they were ordered prior to admission.

7.2.2 Procedures

Two separate samples of pre-MIS and post-MIS charts were selected and analyzed for this study. For the first sample, 308 charts were selected, 154 from the September-November, 1971, time period (T_1) which was immediately prior to phased implementation of MIS, and 154 from the March, 1973,

time period (T_2) which was during early full operation of MIS. A second sample of 150 charts were analyzed which were the identical charts selected for the comparative analysis of medical orders for accuracy and completeness (discussed in Section 9.0 of this report). For this second sample, 75 charts were selected from the July-December, 1970, time period (T_0) which represents a time period substantially before MIS implementation, and 75 charts were selected from the July-December, 1973, time period (T_3), representing the time period when MIS had been fully operational for approximately a year. The worksheet used for collecting data on the second sample is presented in Appendix E-2.

The sample of 308 charts during the T_1 and T_2 time periods were drawn from patients located on nursing units 2W, 3W, ICU, and TCU. Those from the T_0, T_3 time periods were drawn from patients located on nursing units selected at random (the sample was stratified by diagnosis).

Each day of a patient's stay during which a medical order set or a progress note could be written was counted. Thus, for the purpose of the study of medical orders and progress notes, the admission day, the discharge day, and all days between were counted as separate days of patient stay.

An order set is defined as one or more groups of patient care directions accompanied by a signature line and entered by one individual at one point of time, or within ten minute time intervals.

Separate progress notes were identified by a physician signature and date. If more than one progress note was written on a given day, the separate entries were readily identified. Since the format and mode of entry of progress notes were the same both before and after MIS implementation, there was no difficulty in obtaining a comparable definition and count for the samples.

8.0 PHYSICIANS' ATTITUDES AND ACCEPTANCE OF MIS

The purpose of this segment of the Battelle study was to assess physicians' attitudes and acceptance of MIS over time. This was a significant element of the total research effort in that the system at El Camino Hospital was the first of its kind to provide for direct physician/computer interaction.

At the outset of the research project many health-care professionals were highly skeptical about the willingness of physicians to communicate directly with a computer system. Hence, it was recognized that the El Camino experience could influence, in some measure, the design concepts of future automated information systems.

Structured questionnaires were administered to physicians on the attending medical staff during three time periods--pre-MIS, the implementation period, and during the system's routine operation. The questionnaires were designed to determine changes in physicians' attitudes over these three periods.

In addition Battelle conducted personal interviews with approximately one-third of the physicians on the active medical staff. The interviews were structured to determine reasons why physicians had developed particular attitudes and why physicians accepted or rejected the system or elements of it.

8.1 Conclusions

Detailed summaries of physicians' responses to the 1974 survey and to the personal interviews are presented in the following sections of this report along with comparisons of the 1974 survey responses with the earlier surveys. The following conclusions emerge from these summaries.

1. El Camino Hospital staff physicians have demonstrated that direct interaction between physicians and a computerized medical information system is acceptable, and many medical staff members view the system as desirable.

2. There is a general positive attitude toward MIS among physicians on the attending staff of El Camino Hospital. Acceptance of the system as measured

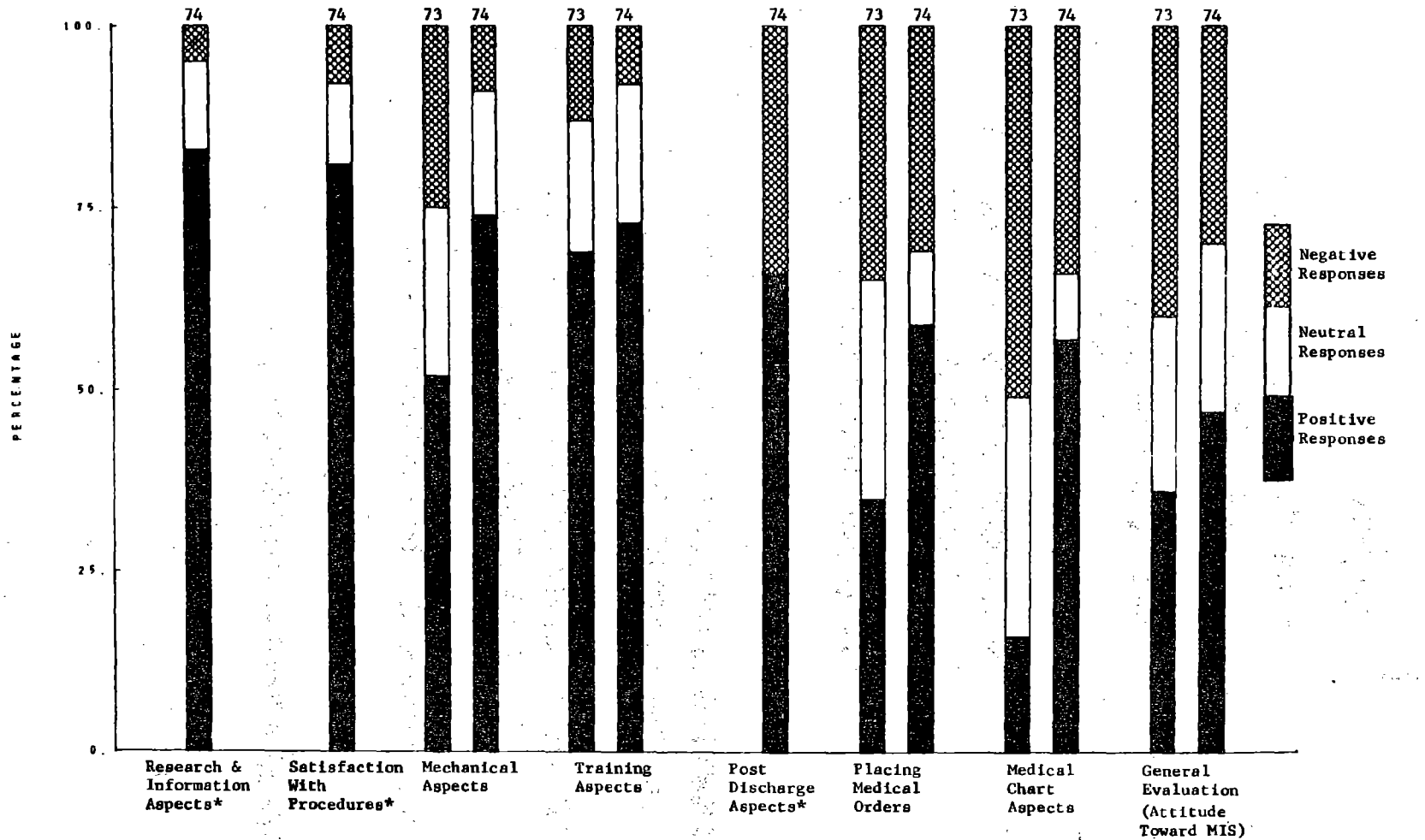
by actual usage is even greater than acceptance expressed by questionnaire responses. As noted in Section 6, 78 percent of all physicians voluntarily use MIS, whereas 74 percent of questionnaire responses were either positive (58%) or neutral (16%) to the system.

3. Physicians' attitudes toward MIS tend to be increasingly positive over time. Figures 8-1 and 8-2 depict comparative attitudes toward MIS for the years 1973 and 1974 based on a composite of questionnaire responses for various aspects of the system. Figure 8-1 contrasts attitude distributions for positive, negative, and neutral responses. Figure 8-2 contrasts firm positive and negative attitudes in a similar fashion to Figure 8-1 with neutral responses excluded from the calculation of the percentages. (In the hospital decision making process, neutral responses tend to either be construed as passive positive or overlooked entirely. Hence, for clear and direct correlation between the incidence of firm positive and firm negative attitudes, data in this section are often presented on the basis of exclusion of neutral responses.) The increasingly positive attitude toward MIS may possibly result from system enhancement and the medical staff's increasing familiarity with the system.

4. The El Camino physicians are exceptionally positive about the research, training, and education aspects of the system. Their evaluation of the medical chart and medical ordering aspects are less favorable, but on these elements also the majority of the staff is positive.

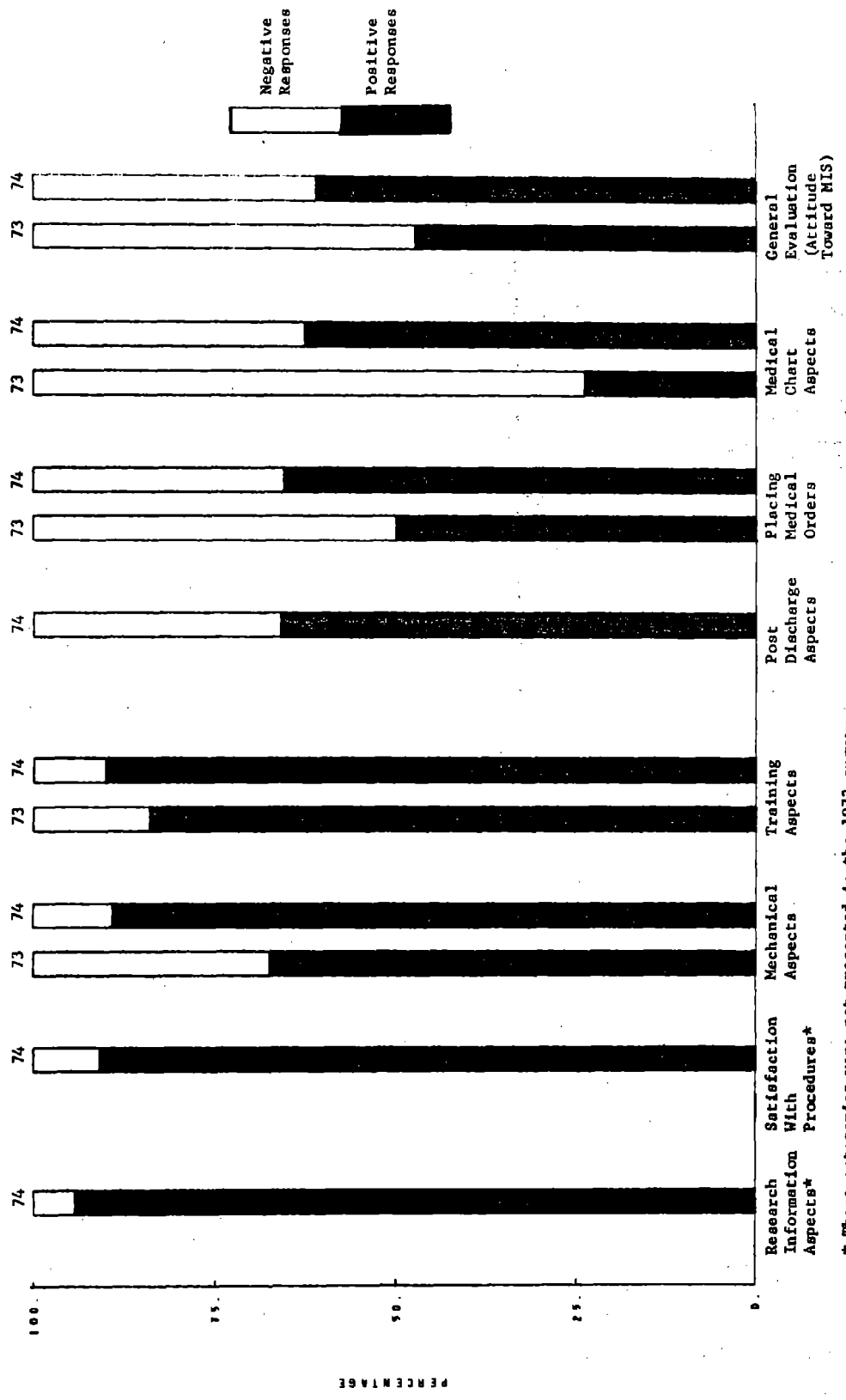
5. Among specialty groups, Obstetricians/Gynecologists, Urologists, Surgeons, and Radiologists are most favorably disposed to MIS, while Internists and General Practitioners are the least receptive.

6. Those physicians who regularly use the system most are its strongest proponents. This raises the unanswered question--"Do they use the system because they like it, or conversely, do they like it best because they use it most?" It is noted that in general those physicians who have adopted a personal order-set are the most enthusiastic group of physicians toward acceptance of the system. And also, it is relevant that Pediatricians and Psychiatrists, both specialties having a primarily "office-based" practice as opposed to a high incidence of hospital patients, are generally not positive toward MIS.



* These categories were not presented in the 1973 survey.

FIGURE 8-1. 1973/1974 PHYSICIANS' EVALUATIONS OF MIS



* These categories were not presented in the 1973 survey.

FIGURE 8-2. 1973/1974 PHYSICIANS' EVALUATIONS OF MIS - EXCLUDING NEUTRAL RESPONSES

7. The format and content of the computer-produced medical chart are of critical importance in physician evaluation of the system. Inadequacies in the chart design during the implementation and early operational experience of the system resulted in widespread negative attitudes. Subsequent improvements in the chart resulted in a dramatic increase in favorable attitudes from 16 percent in 1973 to 57 percent in 1974. (Subsequent to the final series of physician interviews in late 1974, several additional major chart improvements--such as cumulative test result summaries--have been made. The effect of these changes on physician attitudes is not reflected in this report.)

8. There was not substantial variation in general attitudes toward MIS among physicians in ten-year age groups between 30 and 59. The responses of the physicians confirm findings based on interviews that older physicians are equally as receptive as young physicians to computerized information systems.

9. Although the medical staff tend to hold a generally positive attitude toward MIS, their evaluations are less favorable than those of the nursing staff as described in Section 6.0 of this report. Several categories of the two surveys were essentially the same. Figure 8-3 contrasts 1974 responses for these categories with neutral responses included. Figure 8-4 does likewise with neutral responses excluded. Little difference is noted in the evaluation of the mechanical and training aspects of the system. The nursing staff expressed a high degree of satisfaction with the medical chart produced by MIS. Medical staff assessment of the chart is distinctly less favorable. The disparity in satisfaction with the chart may be a result of the difference in purposes of chart use, a difference in extent of chart usage, or a combination of the two. The difference in the general evaluation of the system may also be due to a correlation between extent of usage and degree of satisfaction.

10. Early negative attitudes resulting from system problems tend to change slowly. The El Camino experience underscores the importance of a system being thoroughly tested in sustained actual operation before full implementation. This was not the case at El Camino.

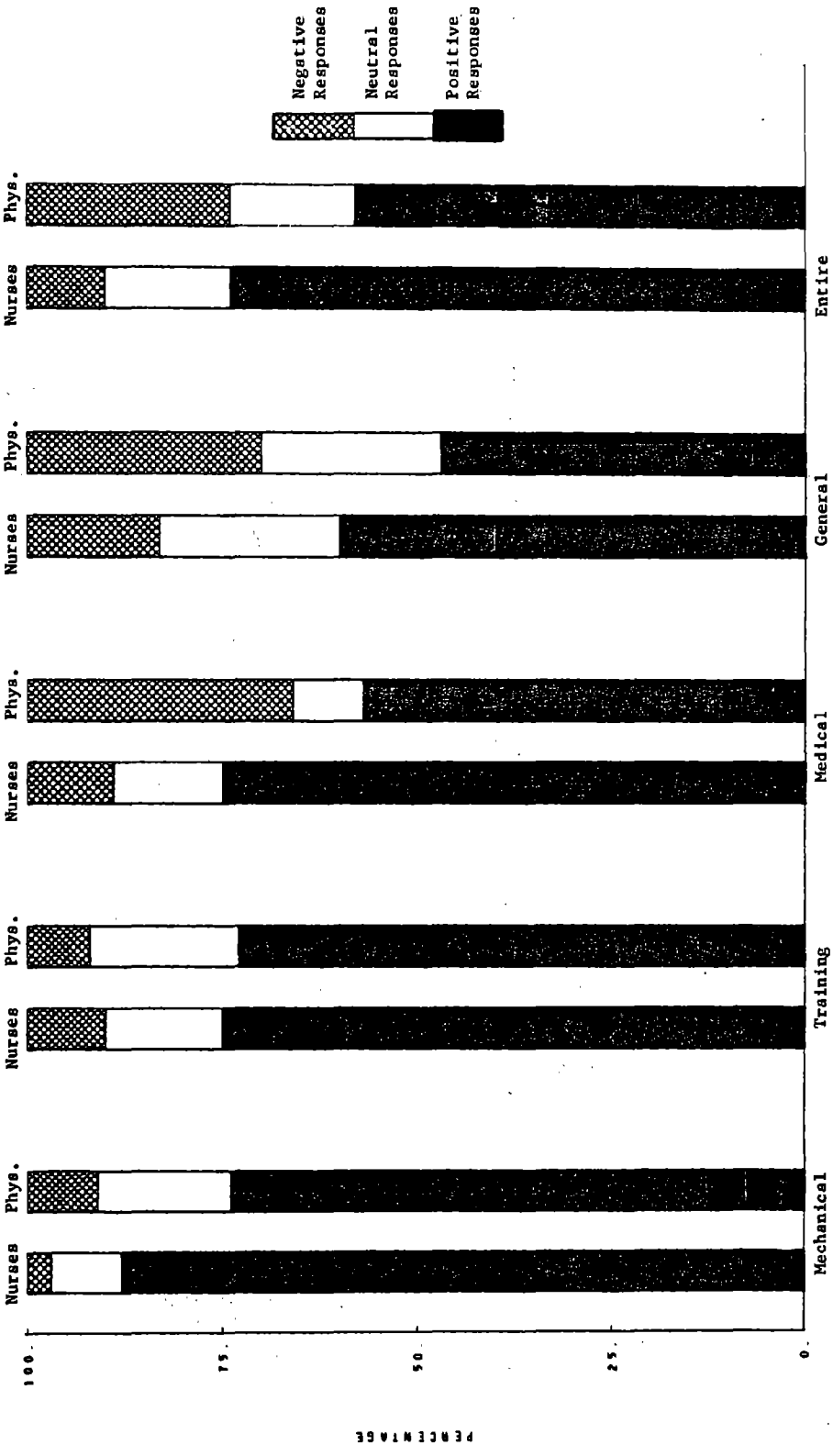


FIGURE 8-3. 1974 EVALUATIONS OF MIS BY NURSES AND PHYSICIANS

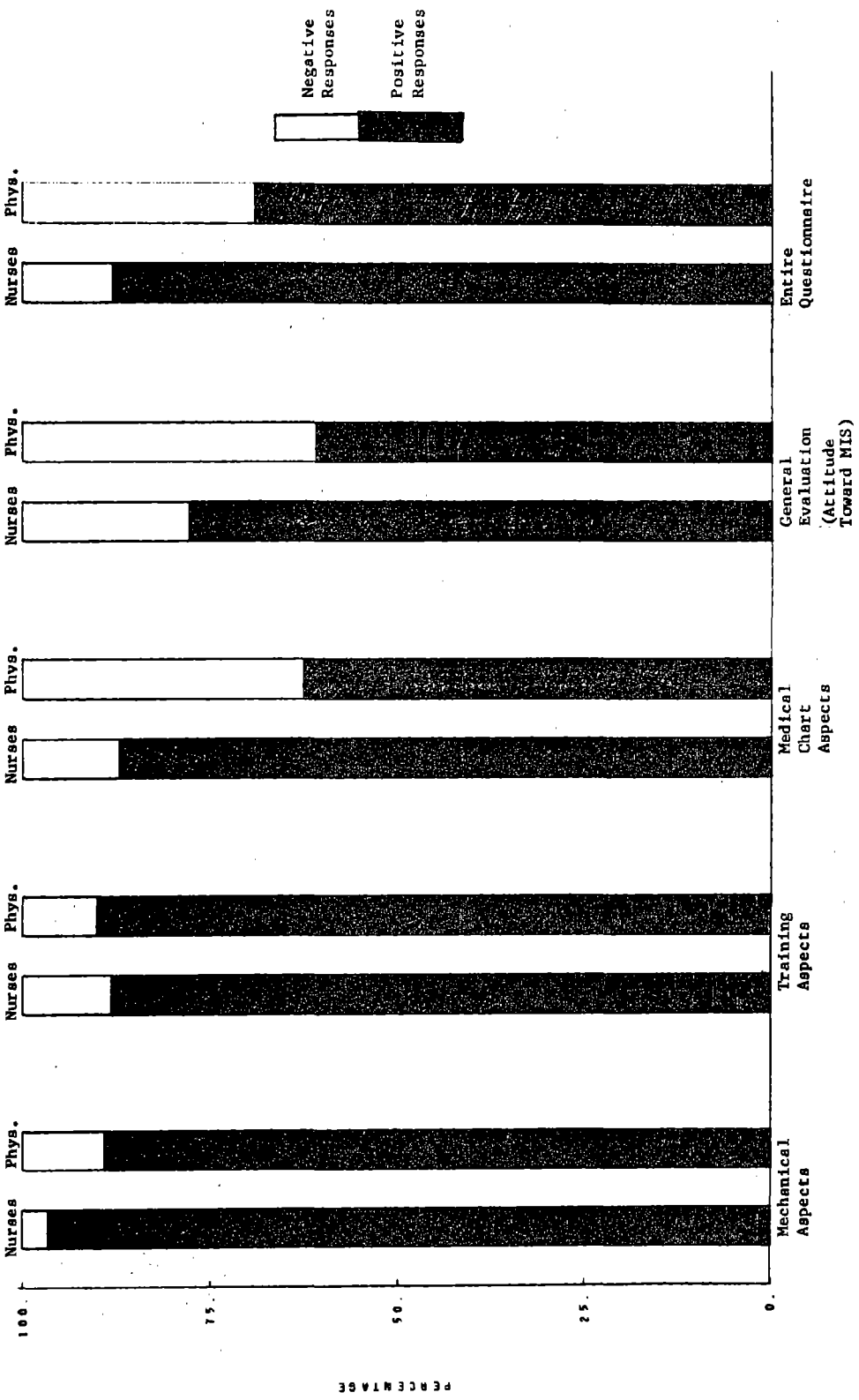


FIGURE 8-4. 1974 EVALUATIONS OF MIS BY NURSES AND PHYSICIANS - EXCLUDING NEUTRAL RESPONSES

11. An automated system that is predicated on direct professional interaction must provide specific advantages to the practicing physician if positive attitudes and acceptance are to be attained. Extensive interviews with members of the El Camino Hospital medical staff suggest three clear-cut levels of acceptance were experienced at the hospital:

- In the implementation and early operation periods the system was tolerated as new technology that held promise of benefits for nurses and administration, but which offered the individual doctor few immediate advantages.
- As problems were solved and features were added that were helpful to the physicians, the majority of the staff adopted a positive attitude.
- A third level has been achieved, where many physicians are participating in efforts to ensure the system's contribution in other medical areas including research, patient care assessment and continuing medical education. This ultimate acceptance level has not been attained on a widespread basis but there appears to be an increasing trend in this direction.

In conclusion, results of comparing physicians' responses to the surveys over the three time periods indicate that attitudes toward MIS have become more favorable and acceptance of the system has increased among the medical staff since full implementation of MIS at ECH. Discussions with physicians confirmed that the early polarization of the medical staff created by a minority dissident group of physicians has lost the sympathy of the majority of the staff. The proponents of the system have been successful in gaining support of the majority of the staff and many of the early neutral group have decided to "go along" with their peers. The controversy over acceptance of the system by the hospital has abated over the years to the current environment of general accord with MIS procedures among the physicians.

8.2 Summary of Findings, Physicians' Evaluation of MIS

In the following sections a general summary of the results of the 1974 physicians' evaluation is presented. Some detailed results are discussed, and a comparison of the 1974 evaluation with the 1973 evaluation is presented. Further detailed tabulations of responses to each item of the 1974 questionnaire are presented in Appendix E.

8.2.1 1974 Physicians' MIS Evaluation

In Table 8-1, the results for each of the 8 sections of the 1974 physicians' questionnaire are aggregated over individual questions. The percent of positive responses reported includes responses indicating satisfaction with a particular aspect of MIS or agreement with favorable statements about MIS. Correspondingly, the percent of negative responses reported covers responses indicating dissatisfaction with some aspect of MIS, or disagreement with favorable statements about MIS. The remaining responses represent those individuals who are either neutral to the system or who offered no opinion. To reflect direct correlation of firm positives to firm negative responses, a final set of columns excludes neutrals and lists only the percent of these responding positive and negative.

Overall, the results summarized at this level indicate a generally positive attitude on the part of the physicians to MIS.

For 7 of the 8 sections of the questionnaire, more than half of the responses were positive. The general evaluation of MIS was slightly below 50 percent positive, with a higher number of no expressed opinions than for other sections of the questionnaire. This may be a reflection of the fact that this section contained a substantial number of items allowing for more variability in response. The greatest positive response was to items on research and information aspects of MIS where the physicians have rated the clinical laboratory interpretation aids, antibiotic sensitivity and surgical abstracts as predominantly satisfactory or highly satisfactory. A high degree of satisfaction was also exhibited with MIS procedures regarding admissions, discharges, emergency room, and outpatient care. The training and mechanical aspects of MIS received favorable responses in almost 75

TABLE 8-1. SUMMARY OF RESPONSES TO 1974 PHYSICIAN SURVEY - USERS OF MIS

Questionnaire Category	Number of Questionnaire Items	Percent of All Responses			Percent of Those Responding Positively or Negatively	
		% Positive	% Negative	% Neutral	% Positive	% Negative
Training Aspects of MIS	3	73	8	19	90	10
Mechanical Aspects of MIS	5	74	9	17	89	11
Placing Medical Orders into MIS	9	59	31	10	66	34
Medical Chart Aspects of MIS	10	57	34	9	63	37
Hospital Practice and Patient Care with MIS						
Impact of MIS on patient care and rounds[(a)]	5	62	38	0	62	38
Satisfaction with MIS Procedures	4	81	8	11	91	9
General Evaluation (Attitude Toward MIS)	23	47	30	23	61	39
Research and Information Aspects of MIS	3	83	5	12	94	6
Post Discharge Aspects of MIS[(a)]	2	66	34	0	66	34
Total	57	58	26	16	69	31

[(a)] Not included in total since responses refer to usage, not favorableness of MIS.

percent of the responses. About two-thirds of the physicians indicated they used the take-home insurance information forms and discharged-patients clinical reports.

The general evaluation section of the questionnaire seeks data on the physicians' attitudes toward MIS in general, an important part of the study. Because of its importance Table 8-2 provides a further summary of these results characterized by other intergroup comparisons. Overall, 47 percent of the responses to these 23 items in this section were favorable. The sample of responses were predominantly male; still no practically significant difference appeared for female staff responses. For the three age groups with the most responses, the percent of positive responses does not vary much, the most significant result being for the 50-59 age group. This result tends to refute any claim that the younger staff members may be more positively oriented toward the computerized information system than the older staff would be. There does seem to be a positive correlation between the staff's proficiency with the system and their attitudes toward MIS, as is to be expected. A monotonically increasing percentage of positive responses were noted as the proficiency increased. Some differences in percentage of positive responses were noted among the various specialties represented in the survey, with the least positive attitudes noted for the general practitioners and internal medicine specialty while the results indicate most positive attitudes toward MIS from the urologists, radiologists, and obstetrics/gynecology specialties.

Further detailed summaries of responses for each item in the 8 sections are included in the following section.

8.2.2 Comparison of Physician Evaluations

The following tables summarize responses to individual items for various sections of the 1974 questionnaire and contrast these responses with similar items from the 1973 survey and selected items from the 1972 survey. In general, the results show an increase in the percent of positive responses and decreases in the percent of negative responses, indicating that the physicians' evaluations of MIS have become more favorable in the intervening year and a half of full operation. In making these comparisons,

TABLE 8-2. INTERGROUP COMPARISONS OF PHYSICIANS' GENERAL EVALUATION* OF MIS

Group Variable	Number of Respondents	Percent of All Responses			Percent of Those Responding Positively or Negatively	
		% Positive	% Negative	% Neutral	% Positive	% Negative
Sex						
Male	125	47	30	23	61	39
Female	7	40	37	23	52	48
Not reported	1	43	48	9	47	53
Age						
25-29	2	56	4	40	93	7
30-39	39	45	31	24	59	41
40-49	62	47	32	21	59	41
50-59	24	53	26	21	67	33
60 and over	3	38	34	28	53	47
Not reported	3	43	48	9	47	53
Proficiency with MIS						
Beginner	12	40	27	33	60	40
Intermediate	54	41	35	24	54	46
Proficient	56	52	28	20	65	35
Expert	7	66	17	17	80	20
Not reported	4	44	13	43	77	23
Specialty						
Anesthesiology	6	40	28	32	59	41
General Practice	12	35	42	23	45	55
General Surgery	14	56	24	20	70	30
Internal Medicine	21	39	42	19	48	52
Obstetrics/Gynecology	14	59	26	15	69	31
Opthalmology	7	44	19	37	70	30
Orthopedic Surgery	6	54	28	18	66	34
Pediatrics	15	42	31	27	57	43
Psychiatry	13	48	30	22	62	38
Radiology	4	65	5	30	93	7
Urology	3	68	20	12	77	23
Miscellaneous/ Unknown	18	46	29	25	61	39
Total	133	47	30	23	61	39

* This evaluation elicited physician attitudes in general toward MIS, reflecting acceptance of the system. The same evaluation items were administered to physicians at several time points to measure changes in acceptance of the system over time.

the correspondence between items on the 1973 survey and the 1974 survey are not always exact. In some cases, an item was restructured or reworded to facilitate the physicians' responses. In order to allow the reader to make direct comparisons of the wording of these items, the identification number from the earlier survey is listed along with the item from the later survey. The tables also contain an abbreviated paraphrasing of the items from the 1974 survey.

In Table 8-3, the evaluations of training and mechanical aspects of MIS are compared. The training aspects of the system were rated relatively high on the earlier study yet still showed a slight increase overall in the 1974 survey. The indication is that the physicians continued to hold the training aspects of the system in a favorable light.

The mechanical aspects of the system were rated marginally in the earlier survey of 1973, with several items receiving less than a 50 percent favorable response and substantial percentages of unfavorable responses. However in the 1974 survey, these mechanical aspects of the system received substantially greater percentages of favorable responses for each item presented, with marked decreases in the percentages of unfavorable responses.

In Table 8-4, physicians' experiences in placing medical orders into MIS are assessed. Once again, the earlier results of the 1973 survey were less favorable, with all but one item receiving less than 50 percent of favorable responses, and substantial percentages of unfavorable responses. A considerably greater percent of favorable responses were reported for the 1974 survey, although the percentage of unfavorable responses continued to be relatively high. These results indicate that a number of physicians may have reserved judgement in the earlier survey and subsequently expressed their opinion in the later survey after having more experience with the system.

In Table 8-5, the physicians' responses to questions on the medical chart aspects of MIS are summarized. The earlier survey showed great dissatisfaction with these aspects of MIS with large percentages of unfavorable responses to many items, and few favorable responses. The results of the later survey show some increase in the percentages of favorable responses but large percentages of unfavorable responses persisted. The conclusion must be that a significant number of physicians remain dis-

TABLE 8-3. PHYSICIANS' EVALUATIONS OF TRAINING AND MECHANICAL ASPECTS OF MIS

	Item Number		% Favorable (a)		% Unfavorable (b)	
TRAINING ASPECTS	1973 Survey	1974 Survey	1973 Survey	1974 Survey	1973 Survey	1974 Survey
Being trained to use the system	B-1	1	73	79	12	6
Becoming Accustomed to use the system	B-2	2	70	69	11	9
Obtaining help when system does not respond	B-5	3	64	70	16	9
MECHANICAL ASPECTS						
Using the keyboard	B-10	1	59	79	19	7
Using the penlight	B-8	2	63	68	20	10
Legibility of printout	B-12	3	41	77	42	8
Maintenance of equipment	B-14	4	49	69	15	10
System response time	B-11	5	46	76	29	8

(a) Includes both Favorable and Highly Favorable responses.

(b) Includes both Unfavorable and Highly Unfavorable responses.

TABLE 8-4. PHYSICIANS' EVALUATIONS OF MEDICAL ORDERS WITH MIS

MEDICAL ORDERS	Item Number 1973 Survey	Item Number 1974 Survey	% Favorable[a] 1973 Survey	% Favorable[a] 1974 Survey	% Unfavorable[b] 1973 Survey	% Unfavorable[b] 1974 Survey
Orders easy to enter	C-2	1	35	66	38	33
Orders clear and explicit	D-26	2	22	75	43	22
No problem signing orders	C-4	3	26	66	47	30
MIS saves time entering orders	D-25[c]	4	14	41	66	54
Convenient format for entering orders	C-2	5	35	55	38	43
Personal order sets satisfactory	B-7	6	47	59	7	7
Standard order sets satisfactory	B-6	7	44	48	18	14
Non-routine orders conveniently handled	-	8	-	38	-	58
Current orders readily located	C-5b	9	60	81	22	16
Use yellow sheets more than 25% of time	B-15b	10	38	35	62	65

(a) Includes both Favorable and Highly Favorable responses.

(b) Includes both Unfavorable and Highly Unfavorable responses.

(c) Inverted response for comparison.

TABLE 8-5. PHYSICIANS' EVALUATIONS OF MEDICAL CHART WITH MIS

MEDICAL CHART	Item Number		% Favorable[a]		% Unfavorable[b]	
	1973 Survey	1974 Survey	1973 Survey	1974 Survey	1973 Survey	1974 Survey
Information readily accessible	A-4	1	11	57	78	40
Information in convenient format	A-4	2	11	57	78	40
All necessary information available	A-3	3	10	54	60	38
Information quickly available	A-5	4	11	47	59	47
Medications given readily verified	C-9b	5	30	61	34	29
Fluid intake/output data readily found	C-10b	6	22	46	31	30
Test data readily accessed	C-11b	7	20	63	52	27
Radiology reports readily accessed	C-12b	8	15	73	22	20
Chart appropriately organized	C-14b	9	12	57	44	33
Chart satisfactory in general	-	10	-	57	-	40

(a) Includes both Favorable and Highly Favorable responses.

(b) Includes both Unfavorable and Highly Unfavorable responses.

TABLE 8-6. PHYSICIANS' EVALUATION OF HOSPITAL PRACTICE AND PATIENT CARE WITH MIS

HOSPITAL PRACTICE & PATIENT CARE	Item Number	% "Yes" Responses	% "No" Responses
Appropriate patient care and status data available at regular rounds time	1	66	34
MIS patient list compatible with rounds	2	92	8
MIS facilitates having relevant information at patient's bedside	3	59	41
MIS affects method of delivering care	4	41	59
MIS affects care delivery of patients with extensive complications	5	49	51
Satisfaction with MIS with respect to			
Admissions	6a	91	3
Discharge	6b	88	7
Emergency	6c	69	12
Outpatient care	6d	75	12

satisfied with the medical chart aspects of MIS even though overall more than half of the physicians evaluated these aspects favorably.

In Table 8-6, evaluations of hospital practice and patient care in light of MIS are summarized. No comparisons with earlier survey results are made for this category since similar questions were not asked in the earlier survey. An average of 62 percent of the physicians indicated that MIS had an impact on the availability and compatibility of data with their method of making rounds and on their delivery of care. A relatively high percentage of physicians (averaging 81 percent) indicated their satisfaction with MIS procedures relative to admissions, discharge, emergency room, and outpatient care.

In Table 8-7, the physicians' attitudes toward MIS are summarized. These items were retained almost verbatim from the early 1972 survey and from the 1973 survey for use in the 1974 survey. Consequently, this section of the evaluation allows for the most direct comparison of physicians' attitudes toward MIS for the three points in time. In these comparisons, no attempt was made to track responses of individual physicians. Most of the items were structured so that agreement with the statement indicated favorable evaluations. A few items were exceptions where agreement indicated unfavorable evaluations. These items are noted in the table. The results of this evaluation are mixed. Taking account of the inversions to reflect favorableness, 11 of the 23 items received 50 percent or more favorable responses in the 1974 survey. Only 5 of the 21 items in the 1973 survey received as favorable a response. Six of the 19 items on the 1972 survey were as favorable. The data indicate that even though physicians express mixed attitudes toward MIS, evaluating some aspects as predominantly favorable, and others in a less favorable light, nevertheless the overall percentage of favorable attitudes has increased to approximately double the earlier results.

Finally Table 8-8 presents results of the 1974 survey on the MIS data usage. The results indicate physicians tend to use these data frequently and are quite satisfied with the data. No comparable data from earlier surveys were available with which to compare these results.

TABLE 8-7. PHYSICIANS' GENERAL EVALUATIONS (ATTITUDES) OF MIS

GENERAL EVALUATION	Item Number 1973 Survey	Item Number 1974 Survey	% Agree[a] 1972 Survey	% Agree[a] 1973 Survey	% Agree[a] 1974 Survey	% Disagree[b] 1972 Survey	% Disagree[b] 1973 Survey	% Disagree[b] 1974 Survey
MIS no better than old way[c]	D-2	1	34	51	32	58	22	53
Benefits of MIS outweight troubles	D-3	2	49	36	55	37	44	35
MIS forces routine, less creative[c]	D-4	3	-	31	18	-	43	54
MIS makes my role less important[c]	D-5	4	2	3	4	86	72	72
One department of ECH should have tried MIS[c]	D-6	5	71	34	32	21	45	32
ECH is more desirable hospital	D-7	6	94	91	84	6	7	5
Computerized system turns me off[c]	D-8	7	18	16	9	76	56	82
MIS facilitates communication	D-9	8	39	19	23	43	49	48
MIS alters work significantly	D-10	9	36	45	35	58	27	50
MIS permits me to work effectively	D-11	10	38	15	20	39	51	54
Important that ECH tried MIS	D-13	11	65	67	68	26	24	17
MIS works well	D-14	12	51	34	62	30	36	32
Mechanics of MIS terminal easy	D-15	13	48	75	79	46	7	21
Patient stay more satisfactory	D-17	14	24	7	15	48	68	41
MIS cannot perform as expected[c]	D-18	15	23	42	26	45	31	59
Patient stay reduced	D-19	16	12	2	10	63	75	48
MIS saved money	D-20	17	26	3	17	42	90	18
MIS causes wait for input/output[c]	D-21	18	63	35	48	27	26	44
Hospital functions smoothly	D-22	19	47	16	31	36	59	34
Prefer another hospital try MIS[c]	D-23	20	24	37	30	57	38	43
Feel more knowledgeable about patient	D-24	21	-	17	29	-	53	56
Nursing staff helpful	-	22	-	-	78	-	-	8
Convenient to interact with records	-	23	-	-	36	-	-	32

Number of physicians responding:

1972 - 120
1973 - 208
1974 - 133

(a) Includes both Agree and Strongly Agree responses.

(b) Includes both Disagree and Strongly Disagree responses.

(c) These items should be inverted to summarize favorable responses.

TABLE 8-8. PHYSICIANS' EVALUATION OF RESEARCH, INFORMATION, AND POST DISCHARGE ASPECTS OF MIS

Research and Information Aspects & Post Discharge Aspects	Item Number 1974 Survey	% Favorable [a] 1974 Survey	% Unfavorable [b] 1974 Survey
Level of Satisfaction with Clinical laboratory interpretation aids	1	79	8
Antibiotic sensitivity	2	86	3
Surgical abstracts	3	84	3
Use of take-home insurance information form	1	50	50
Use of patient clinical reports after discharge	2	82	18

(a) Includes both Favorable and Highly Favorable Responses
(b) Includes both Unfavorable and Highly Unfavorable Responses

8.2.3 Physician Interviews[6]

As discussed earlier Battelle interviewed approximately one-third of the active medical staff to gain in-depth information to support the responses to the questionnaire on reasons for various attitudes toward the system and sub-systems. These interviews also substantiate "why" some physicians readily accepted MIS; some have "middle of the road" opinions (neither accept nor reject the system) and others that are outspoken opponents to expansion of MIS within the hospital.

The most obvious conclusion that evolved from the interviews was that the majority of MIS proponents are physicians that use El Camino Hospital frequently (usually their primary hospital). MIS appears to cause the most trouble for physicians who rarely use the hospital or have rare occasion for exposure to the system, e.g., Psychiatrists on the active staff with primarily an office-based practice.

It quickly became apparent that surgeons and surgical subspecialists tended to favor the system and internists and general practitioners tended to oppose it. Most pediatricians are opposed to MIS because their practice is very similar to specialists in internal medicine (baby internists). Specialists in obstetrics and gynecology are the greatest advocates of the system. Only an occasional physician in this group is opposed to the system. The majority of anesthesiologists are also strong advocates of MIS. The former group seemed to have no difficulty in developing personal order sets which are more or less stereotyped for the relatively limited kind of patient management problems which they are apt to encounter. For instance, the orders a surgeon would use for a patient undergoing appendectomy, herniorrhaphy, cholecystectomy, cystoscopy, laminectomy, etc., all could be more or less standardized. In fact most of the surgeons at ECH have devised personalized order sets which they find very time saving. On the other hand, internists have resisted devising personalized order sets on the assumption that the kinds of problems with which they deal are too varied and too complex to make personal order lists useful.

On the basis of what Dr. Rubenstein assessed as an emotional rather than a rational reaction on the part of members of the staff regarding personal order lists, he set up a personal order list for an internist

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[6] Edward Rubenstein, Associate Dean, Postgraduate Medical Education, Stanford University, College of Medicine, was a Battelle consultant during this study. Dr. Rubenstein is an internist and he continues to maintain a private practice in his specialty. Dr. Rubenstein conducted an independent survey of MIS and physicians' attitudes while maintaining a low profile at ECH. His observations and comments are included in this section of the report.

like himself. He accomplished this in less than an hour with MIS and is certain it would be very useful in his practice. He did note that it was a very real problem adding or changing personal orders. In the present system, it is difficult to insert a new or a revised personal order in its logical location on the list. New or revised orders generally are added only at the end of the list.

In regards to attitudes toward various aspects of the system the results of physicians' interviews tend to support the physicians' responses to the Battelle questionnaires. Most of the physicians complain about the MIS hard copy medical record. They initially missed the color coding of the manual system patients chart. Physicians do agree that Technicon has improved the chart through changes in printing and addition of other graphics; however they are continuing to voice discontent with the chart. The chart is too bulky and in many instances unnecessary duplicate copies of patients' data are found in the chart. In rare instances some reports, dealing with less than 1 line of information, occupy entire pages in the patient's record. Initially such entries inevitably led to bulky patient records which were tedious to review and which appeared to annoy many physicians, particularly specialists called to consult on patients whose hospital course has been lengthy and complex. Most of the problems leading to bulky patient charts have been eliminated.

In general, physicians like MIS announcements (Department meeting, education programs, etc.) and find the patient list extremely useful. Most physicians use the take-home documents, particularly the insurance forms.

The majority of physicians feel that the response time for ancillary services has improved, particularly the clinical laboratory. MIS reports are generally easier to interpret with the exception of radiology reports which many physicians indicated are harder to interpret since MIS.

Another complaint is that "hunt and peck typists" do not like to use the system for entering orders. These physicians write orders and the nurse inputs them into the system. Many of these physicians, however, appear to use the system for data retrieval.

One of the difficulties with a system as comprehensive as MIS is that the system continues to provide new features and changes. Frequently program changes are announced but the notification to the staff is not read. Doctors then are confused from time to time in finding some alteration in a program. Many of the physicians continue to be unaware of the changes until they encounter a problem, usually in entering an order and, to a lesser extent, in retrieving data.

Battelle found that many physicians interviewed felt that the quality of patient care had "slipped" since the implementation of MIS. These opinions were not in accord with the results of Battelle's surveys. Several physicians indicated that the level of the quality of care delivered was related to the nurses becoming more dependent on the system and not communicating with physicians to the extent that they did previously. Many physicians find that the nurses use the system with a certain degree of relish. In some cases nurses are too enthusiastic and criticize physicians who refuse to use the system. Several instances were cited where nurses who have used MIS extensively become "hardnosed" in assisting the physician, particularly in entering orders. In addition some doctors assert that MIS nursing notes are abused, particularly "patient is satisfactory". Many physicians feel they are forced to play a guessing game with the nurses. Some physicians indicate that all of these nursing care factors contribute to a lack of confidence in the system and detract from good patient care.

There is an inevitable paranoia in all hospital staffs, but it is useful to present some of the less provocative complaints that appeared prevalent during the period of transition to MIS. The most prevalent complaint that has definitely been refuted by Internist users of the system is that the MIS programming interferes with the physician's thought processes in developing his care plans. Although most physicians interviewed like the MIS physician aids, the excuse that these promoted "cook book medicine" persisted for some period of time. Some other complaints included "Technicon put one over on us," - "We're being used as an experiment for the government," "They cost account everything except the doctor's time," and the system was installed "for nurses and for the administration but is no good for doctors". The feud among the medical staff over whether the

hospital should keep the system, primarily created by a minority of dissidents, gradually subsided after the staff voted 60% to 40% to retain the system. A number of physicians indicated that they voted favorably because they felt that the system at present, while not satisfactory, was promising and that they assumed that the system will improve in time. Battelle found that most of the physicians eventually decided to go along with the majority and now some of the outspoken dissidents are beginning to use the system and even make suggestions for improving its use at ECH.

8.2.4 Physicians' Aspirations for MIS

The following discussion summarizes the physicians' aspirations for expansion of MIS capabilities at ECH. Most of the suggestions are based on the consensus of the medical staff regarding needs and aspirations, observations of Battelle medical consultants and Battelle's own exposure to the system on studies involving the medical staff.

In light of the burdens imposed on hospitals and physicians by P.L. 92-603, many of the needs for expansion focus on utilization review, patient care assessment, and continuing medical education needs.

A good trade-off may be to use the system to conduct reliable utilization review and medical care audit directed to continuing education. This could motivate the Internists to use MIS to compile reliable data, particularly for medical audit. Most Internists interviewed expressed interest in knowing whether they are practicing good medicine and would like to develop continuing education programs to improve inadequacies. The manual system for medical audit is too cumbersome and it appears that only a few diagnoses can be reviewed at a time. It can be concluded that MIS is a promising method for continuing education. The system is ideally suited for hospital audit and patient-care assessment programs. Displays of criteria sets related to the management of commonly encountered hospital problems could easily be incorporated into the system. These criteria sets should be developed by the medical staffs' various specialty and subspecialty groups, ratified by the staff, and externally validated by outside experts or by

comparison with standards developed in other institutions[7]. Such displays could be very useful to guide physicians in the management of many of their patient's problems, especially as an aid in the avoidance of errors of omission.

The potential for automated correlation between criteria sets and actual management decisions, along with laboratory and other data entered into the system, would greatly facilitate quality control audits. This would minimize potential difficulties related to the standards imposed by the Professional Standards Review Organizations (PSRO) legislation.

An additional dividend is that the system potentially could greatly simplify the physician's job in organizing discharge summaries. This is the most frequently suggested extension of the capabilities of MIS among physicians at ECH. A time-oriented flow sheet including all laboratory data, along with a list of medications prescribed during hospitalization and at discharge, could easily be produced for the patient's hospital and outpatient record.

The system holds great promise for on-line intervention, especially as it relates to drug interactions, the avoidance of the exposure of the patient to agents known to be noxious, and the correlation between laboratory data, and drug orders. Such on-line intervention is a goal toward which many persons involved in health care are striving. MIS seems ideally suited for such concurrent monitoring.

Finally, there are other education needs that MIS could satisfy including a program of displays which are concise reviews of current knowledge regarding the management of a number of common problems, especially those which are serious or life threatening. These displays probably should be composed by outside experts, then submitted to the appropriate staff for review and ratification and then incorporated within the system. They should be frequently updated and refined as the need arises. They should

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[7] Battelle is currently cooperating with the medical staff at ECH in developing and testing criteria for patient-care assessment programs. The criteria are being validated by conducting similar audits at O'Connor Hospital, San Jose, California.

emphasize current practical knowledge based on a critical review of the literature as well as practical expertise in the field. Virtually instantaneous access to such information would represent a powerful continuing medical education tool not currently in existence.

8.3 Study Approach

8.3.1 Physicians' Survey Methodology

In July, 1974, the active and associate staff of El Camino Hospital were asked to perform an evaluation of MIS. This evaluation followed their earlier evaluations of MIS in January, 1973, which had been performed in the midst of the early full operational period, and in December, 1971, through January, 1972, after training for MIS, but before major implementation activities within the hospital. The latest evaluation represents the medical staff's assessment of MIS approximately 2 years after its implementation.

The questionnaire designed for this later evaluation evolved from the experiences with the earlier surveys. The redesign was structured to facilitate the medical staff's response, by reducing the size and complexity of the survey instrument. The purpose of the 1974 evaluation was to determine the medical staff's assessment of MIS after it had been operational for a longer time period, and to determine changes in the staff's attitudes from the earlier evaluations. In most cases, the items in the questionnaire were designed to be cross-referenced with those on the earlier instrument. The questionnaire for this 1974 evaluation is presented in Appendix E.

The 1974 physicians' survey consisted of 8 areas of evaluation:

1. The training aspects of MIS which concerns evaluations of the training program for using MIS, becoming accustomed to its use, and obtaining help when needed.
2. The mechanical aspects of MIS including the instruments, response times, and legibility of printouts,
3. The placing of medical orders into MIS, assessed in terms of ease, clarity, signing, format, available order sets, and time required,
4. The medical chart aspects of MIS including the accessibility of information, its completeness, organization and convenience of format,

5. The impact of MIS on hospital practice and patient care as it relates to availability of information for hospital rounds, and compatibility of computer patient lists with rounds, and the degree of satisfaction with MIS procedures in admissions, discharges, emergency room, and outpatient care,
6. The general evaluation of MIS which measures physicians' attitudes toward the impact of the system on their patterns of practice, on hospital functions, and on patient care,
7. The research and information aspects of MIS covering satisfaction with clinical laboratory interpretation aids, antibiotic sensitivity and surgical abstracts, and
8. Post discharge aspects of MIS regarding utilization of take-home insurance information forms and discharged patients' clinical reports.

8.3.2 1974 Survey Response

A total of 374 physicians at El Camino Hospital received the questionnaire. The distribution of these questionnaires across specialties and between active and associate staff members is shown in Table 8-9. This table also shows the distribution of responses across these categories. A total of 158 questionnaires were returned. Twenty-five of these were from physicians who indicated no proficiency or desire to use MIS, and these responses were excluded from further analysis, leaving a total of 133 responses for analysis. The overall response rate was approximately 42 percent, which though sizable, was below that for the initial evaluations. The reason for the decrease in response rate is twofold. Some physicians indicated they considered the second evaluation to be redundant and burdensome even though the questionnaire had been refined to reduce redundancy, and yet maintain a tracking system to detect changes in attitudes. In addition the physicians had been subject to another survey conducted by the hospital during the same time period of this evaluation, adding to their burden. Nevertheless, the responses obtained are sufficient for a meaningful evaluation of the continuing impact of MIS at ECH.

TABLE 8-9. NUMBER AND PERCENT OF RESPONSES TO 1974 PHYSICIAN SURVEY

Physician Specialty	Number of Questionnaires Mailed		Number of Questionnaires Returned		Total Response Percentage	Total Number of Returned Questionnaires With MIS Interaction
	Active	Associate	Active	Associate		
Anesthesiology	12	1	7	-	53.8	6
General Practice	40	10	12	3	30.0	12
General Surgery	23	5	14	1	53.6	14
Medicine	50	7	26	1	47.4	21
Obstetrics/Gynecology	23	3	12	3	57.7	14
Opthalmalogy	10	3	7	-	53.8	7
Orthopedic Surgery	15	2	9	-	52.9	6
Pediatrics	19	3	16	-	72.7	15
Psychiatry	29	18	12	5	36.2	13
Radiology	8	8	4	-	25.0	4
Urology	8	0	4	-	50.0	3
Miscellaneous	44	33	14	8	28.6	18
Total	281	93	137	21	42.2%	133

8.3.3 Physicians' Interview Methodology

The population of physicians was stratified based on specialty, age, and on information gathered from the medical staff office and other members of the hospital staff on physicians' acceptance of MIS. The sample selected was representative of MIS proponents, opponents, and neutrals on the attending staff.

Before initiating the interviews a structured interview guide was prepared and approved by the hospital administration and the executive committee of the medical staff. The executive committee of the medical staff strongly endorsed the program and sent a letter to the medical staff members to solicit their cooperation. The majority of the physicians' interviews were very responsive and expressed appreciation for the opportunity to express their opinions.

9.0 COMPARATIVE ANALYSIS OF MEDICAL RECORDS FOR ACCURACY AND COMPLETENESS

As part of the evaluation of MIS, a sample of medical records were selected from each of two time periods - prior to MIS implementation and after MIS was fully operational. The records were reviewed in detail for irregularities in writing or entering medical orders and in reporting results. Comparative analyses of the rates of occurrences of these irregularities were made to determine whether or not changes had occurred after MIS implementation and if so, the direction of these changes. The results of this analysis are discussed in the following sections.

9.1 Summary of Results

This analysis focused on two distinct categories of errors associated with medical orders--those by the physicians and nurses acting as agents for physicians while writing or entering orders, and those by the nursing staff and other staff while charting or reporting results. In general, the frequency of both categories of errors decreased after the implementation of MIS.

In considering errors which may occur while writing or entering orders, three categories were studied - errors of omission, clarity-interpretation errors, and missing indications. Significant changes in errors of omissions in medical orders occurred in only one functional area of the hospital - the pharmacy function, primarily with a substantial decrease (down 22%) in omissions of route of administration, and a slight increase (up 2%) in omission of reason for prn medications. For clarity-interpretation errors, hard to read orders in pharmacy were eliminated while the percent of pharmacy orders requiring clarification of prescriptions increased (up 2%) and the percent of dietary orders requiring clarification increased (up 6%). Errors due to missing clinical or medication indications in the radiology and monitoring areas decreased significantly after MIS, a substantial improvement although lack of such data continued to occur for a large portion of the orders.

Variances in reporting results showed significant decreases which were primarily due to reductions in variances in reporting site and route of administration for medications (down 20% to virtually zero). Other reductions, while statistically significant, represent far fewer orders. With the exception of an increase in charting variances (up 7%), the general trend was either a reduction in variances or no increase after MIS implementation. Overall, a slight increase in clarity-interpretation errors in reporting results was noted (up 1%). This was primarily due to a significant increase in charting (up 6%) with significant decreases for laboratory (down 3%) and radiology (down 6%).

In summary there has been a significant improvement in the accuracy and completeness of medical orders. In some instances (hard to read) errors were eliminated. Improvement in the presentation of clinical data and medication indications in radiology and EKG have had a very positive impact on expeditiously providing more accurate reports.

9.2 Study Approach

The comparative analysis of medical records for accuracy and completeness of medical orders was accomplished by selecting a sample of medical records generated prior to the implementation of MIS and another sample of medical records generated subsequent to MIS implementation. These records were subjected to detailed reviews where any irregularities were noted, after which comparisons between the two sets were made on the rates of occurrence of the irregularities.

Orders were classified as primary or secondary orders for the study. Primary orders were considered for selection while secondary orders were excluded. Secondary orders included orders not requiring a physician's signature, orders to clarify, adjust, or supplement an order, or orders of equipment and supplies, orders to discontinue a primary order, to renew a primary order, to hold an order, or to restart an order.

To obtain a representative sample of medical records, the hospital population was stratified for a 6-month period before and after MIS implementation. The pre-MIS period was July-December, 1970, and the post-MIS period was July-December, 1973. Diagnosis was used as the primary stratification variable for obtaining a cross section of the patient population.

Average length of stay, age, and sex were used as secondary stratification variables. Records were selected from both time periods to provide comparable samples representing a cross section of the patient population.

Two work sheets were prepared with the assistance of physician specialists and subspecialists. The ancillary service areas at ECH were consulted to determine the information that was necessary to provide a complete and accurate order. Nurse specialists and members of nursing service at ECH were asked to provide information on reporting and charting requirements that should be included in the analysis. Based on the information gathered a work sheet was designed to detect errors in completeness and accuracy in writing or entering medical orders. Another work sheet was designed to detect errors in reporting results and charting.

In medical orders for medications, the consensus indicated important information that should be provided included dosage (volume or quantity), schedule, and route of administration (oral, intramuscular, intravenous). In a hospital setting all nurses cannot be expected to recognize a physician's pattern of care particularly in prescribing even the most common prescribed drug--Valium which is available in dosages of 2, 5, and 10 milligrams and can be administered by any of three routes. To provide less information on prescribing medications than suggested above is like asking the nurse to play a guessing game, often with drugs that may be life threatening unless properly administered.

In other ancillary services including radiology, electrocardiography (EKG), clinical laboratory and physical medicine, providing clinical information on the patient was considered very important in expeditiously completing tests or procedures. Examples of clinical information include in EKG--recent myocardial infarction, in radiology--past history of tuberculosis or suspected lobar pneumonia, in the clinical laboratory--possible anemia. Schedule is also important particularly for a series of tests. Site or location is valuable information for radiology (left, right, posterior, anterior, etc.) and for blood chemistry tests on selected patients (avoid use of veins on pediatric patients where the sample can be obtained by capillary puncture).

Copies of medical records for various diagnoses were obtained and, using the same group of records, nurses were asked to use the work sheets for recording errors and to make suggestions for use in tabulating data. Based on these results the work sheets were refined and two ECH staff nurses were trained to use the review of medical records described below.

The areas of the medical records which were reviewed for the analysis included all medical orders, orders to ancillary services, medication orders, fluid balance, vital signs, nurses notes, and progress notes. In the medications area, records were audited for errors of omission, wrong dose, extra dose given, wrong drug given to patients, wrong patient given drug, wrong dose form, and wrong time of administration. Nurses notes were reviewed for entries required, entries made, incorrect entries, and omissions. Orders entered by a physician or his agent were reviewed for completeness, legibility, and ambiguity.

Seventy-five records were selected from each time period (pre- and post-MIS) for the analysis. During the first stage of review of the records, the first 15 records were reviewed by each of two ECH nurses. Variations in the interpretations of the records were noted between the two nurses conducting the review. A second set of 15 records were also reviewed by each of two ECH nurses. Variations in interpretation diminished substantially. As a result, the first 15 records selected for review for each time period were excluded from the analysis on the basis that the nurses conducting the review were operating in a learning state mode. The remaining 60 records from each time period were used for statistical analysis.

The sample size of 60 records from each time period was determined to be adequate based upon considerations of the power of the proposed statistical test procedures, where power was measured in terms of the probability of detecting a difference of given magnitude in the mean measurements for the two time periods. For example, with this size sample, the probability of detecting a difference in means (each based upon 30 measurements) of about two standard deviations is approximately 80 percent when the critical level of the test is set at 5 percent. Furthermore, since each medical record actually yielded a number of data points for the analyses, the power of the analyses was in fact even greater.

The forms used for data collection are presented in Appendix G. From these data, percentages measuring the rates of occurrences of the various irregularities were determined, and tested statistically for significance.

9.3 Comparative Analysis of Medical Records For Errors In Entering Orders

The following analysis centers upon the impact of MIS on the frequency of errors occurring while writing or entering medical orders by doctors. The data for this analysis were collected using Data Sheet 2 which is reproduced in Appendix G. The analysis centers on three types of errors which could occur while writing or entering the medical order:

1. Errors of omission including
   a. omissions of dose, volume, quantity,
   b. omission of site, route of administration,
   c. omission of schedule, or
   d. omission of procedure notes and preps,
2. Clarity and completeness errors resulting from
   a. illegible orders,
   b. hard to read orders,
   c. ambiguous orders, or
   d. orders which require a clarifying secondary order or note,
3. Errors in clinical data presented resulting from written orders in radiology and monitoring where indications of medications (regimen) or clinical data were required but were not written.

The analyses for each of these types of errors are presented below.

9.3.1 Errors of Omission

A summary of the analysis of data on omissions is presented in Table 9-1. For this analysis, the data from each time period on the number of medical orders and the number of orders with omissions were cumulated over records. From these summations, the percent of medical orders which contained omissions was calculated for each type of omission, and the difference in percentages, pre- and post-MIS, was tested statistically.

TABLE 9-1. COMPARATIVE ANALYSIS OF OMISSIONS IN WRITING MEDICAL ORDERS

Type of Omission	Functional Area							
	Pharmacy	Laboratory	Radiology	Dietary	Charting	Monitoring	Therapy	All Areas
Number of Orders at T_1[b]	642	319	60	162	573	16	23	1795
Number of Orders at T_2	838	338	63	189	601	31	16	2076
1. Omissions In Dose, Volume, Quantity								
Percent Omissions at T_1	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.06
Percent Omissions at T_2	0.12	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Percent Difference	-0.04	N.O.	N.O.	N.O.	N.O.	N.O.	N.O.	-0.01
2. Omissions In Site, Route of Application, Administration								
Percent Omissions at T_1	21.96	0.31	0.00	0.00	0.00	0.00	0.00	7.91
Percent Omissions at T_2	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.39
Percent Difference	-21.01[a]	-0.31	N.O.	N.O.	N.O.	N.O.	N.O.	-7.52[a]
3. Omissions In Schedule								
Percent Omissions at T_1	1.87	2.19	8.33	0.00	0.00	0.00	0.00	1.34
Percent Omissions at T_2	0.72	0.59	0.00	0.00	0.17	0.00	0.00	0.43
Percent Difference	-1.15	-1.60	-8.33	N.O.	+0.17	N.O.	N.O.	-0.91[a]
4. Omissions In Procedure Notes, Patient Preparation								
Percent Omissions at T_1[c]	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent Omissions at T_2	2.03	0.30	0.00	0.00	0.00	0.00	0.00	0.87
Percent Difference	+2.03[a]	+0.30	N.O.	N.O.	N.O.	N.O.	N.O.	+0.87[a]

N.O. No omissions occurred in this category.

(a) Statistically significant at the 99% confidence level.

(b) T_1 = Pre-MIS

T_2 = Post-MIS

(c) These values are sometimes reported as 0.00 because this information was not required at T_1 although as discussed in study approach they should be considered part of an effective, accurate medical order.

The greatest reduction in the percent of orders with errors occurred for omissions of site or route of administration. This reduction resulted from the virtual elimination of omission in the functional area of pharmacy. Most of these orders were medications (95%) rather than parenteral solutions (5%). The omissions tended to be in the route of administration rather than site, and these omissions were essentially eliminated after MIS. This reduction is especially important in prescribing since most drugs allow the option of several routes of administration, e.g., Valium can be administered orally, intramuscularly, and intravenously.

9.3.2 Clarity and Completeness Errors

Clarity and completeness errors were studied from two points of view - in terms of errors in writing medical orders and in terms of errors in reporting of results. In Table 9-2, errors of this type in writing medical orders are summarized. The review of the records indicate there were no orders which were illegible but some were hard to read. The greatest percentage of hard to read orders were in pharmacy prior to MIS implementation and subsequently this problem was eliminated. On the other hand, the number of orders which required further clarification increased slightly.

Orders requiring further clarification after MIS may not be clinically significant. Most of the orders requiring clarification post-MIS were in areas of definition, terminology and expectations for more complete specific information on orders by ancillary services. This required nurses to submit secondary adjusting orders. Overall, this table indicates that after the implementation of MIS, problems with legibility and interpretation of orders were eliminated, as one would expect, but no improvement in clarity was shown.

9.3.3 Changes in Clinical Data Presented

The results of review of medical orders for clinical data indications were summarized for the two functional areas of radiology and monitoring. Table 9-3 summarizes the comparative analysis of data omission errors. The number of orders requiring medication indications (regimen) in

TABLE 9-2. COMPARATIVE ANALYSIS OF CLARITY AND COMPLETENESS ERRORS IN WRITING MEDICAL ORDERS

Type of Difficulty	Functional Area							All Areas
	Pharmacy	Laboratory	Radiology	Dietary	Charting	Monitoring	Therapy	
Number of Orders at T_1[b]	642	319	60	162	573	16	23	1795
Number of Orders at T_2	838	338	63	189	601	31	16	2076
1. Illegible								
Percent at T_1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent at T_2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Percent Difference	N.N.	N.N.	N.N.	N.N.	N.N.	N.N.	N.N.	N.N.
2. Hard to Read								
Percent at T_1	4.36	1.25	0.00	0.00	0.35	0.00	0.00	1.89
Percent at T_2	0.00[a]	0.00	0.00	0.00	0.00	0.00	0.00	0.00[a]
Percent Difference	-4.36	-1.25	N.N.	N.N.	-0.35	N.N.	N.N.	-1.89
3. Ambiguous								
Percent at T_1[c]	0.93	0.00	1.67	0.00	0.00	0.00	0.00	0.39
Percent at T_2	0.84	1.48	0.00	0.00	0.83	0.00	0.00	0.82
Percent Difference	-0.09	+1.48	-1.67	N.N.	+0.83	N.N.	N.N.	+0.43
4. Order Requires Clarification, etc.								
Percent at T_1[c]	1.09	3.13	0.00	0.00	0.00	0.00	0.00	0.95
Percent at T_2	2.86[a]	2.96	3.13	5.82[a]	0.67	0.00	0.00	2.46[a]
Percent Difference	+1.77	-0.17	+3.13	+5.82	+0.67	N.N.	N.N.	+1.51

N.N. No notations occurred in this category.

(a) Statistically significant at the 99% confidence level.

(b) T_1 = Pre-MIS

T_2 = Post-MIS

(c) These values are sometimes reported as 0.00 because this information was not required at T_1 although as discussed in study approach they should be considered part of an effective, accurate medical order.

TABLE 9-3. COMPARATIVE ANALYSIS OF CHANGES IN PRESENTING CLINICAL DATA IN WRITING MEDICAL ORDERS

CLINICAL DATA	RADIOLOGY X-RAY	MONITORING EKG
NUMBER OF ORDERS PRE-MIS	58	15
NUMBER OF ORDERS POST-MIS	59	28
. MEDICATION INDICATIONS		
No. of orders requiring medication indications pre-MIS	0	14
No. of orders requiring medication indications post-MIS	0	27
% with medication indications pre-MIS	0	0
% with medication indications post-MIS	0	22.22
% Increase	0	22.22(a)
. CLINICAL INDICATIONS		
No. of orders requiring clinical indications pre-MIS	51	15
No. of orders requiring clinical indications post-MIS	56	27
% with clinical indications pre-MIS	3.92	0.00
% with clinical indications post-MIS	35.71	44.44
% Increase	31.79(b)	44.44(b)

(a) STATISTICALLY SIGNIFICANT AT THE 95% CONFIDENCE LEVEL.

(b) STATISTICALLY SIGNIFICANT AT THE 99% CONFIDENCE LEVEL.

the monitoring area was small. Prior to MIS, medication indications were missing in all orders reviewed because indications were not explicitly called for on the medical order form. After MIS there was some increase in the percentage of orders with medication indications (regimen) because the VMT matrix prompted such a response. Likewise there was an increase in the percentage of orders with clinical indications after MIS. Almost all orders require clinical data in the radiology area with fewer requirements in the monitoring areas. Both areas experienced increases in the number of orders with such data after MIS.

The provision of clinical data is important in expeditiously completing tests or procedures. The patient's medication regimen is very important to EKG in interpreting the tracing. Clinical data alerts radiology and EKG and assists in interpretation of the X-ray and/or EKG tracing. The improvement in providing this clinical data has been indicated as a real advantage of the system by the ancillary service areas.

9.4 Comparative Analysis of Medical Records For Errors In Charting/Reporting Results

In this section, data are analyzed to determine the impact of MIS on the frequency of errors by the nursing staff and other staff which occur while charting or reporting results. Data Sheet 3, shown in Appendix G, was used to collect data for this analysis. The analysis considered two types of errors occurring while charting or reporting results:

1. Variances in reporting
   a. dose, volume, quantity,
   b. site, route of administration,
   c. schedule, or
   d. procedure notes, patient preparations,
2. Clarity/interpretation errors while reporting the schedule in compliance with a medical order.

9.4.1 Variances in Reporting Results

In Table 9-4, the results of the analysis of variances in reporting on the medical records are summarized. For each time period, pre- and post-MIS, the opportunities for variances and the actual number of variances which occurred were cumulated over records. From these summations, the percent of opportunities for variances which resulted in actual variances was

TABLE 9-4. SUMMARY OF COMPARATIVE ANALYSIS OF MEDICAL RECORDS FOR VARIANCES IN REPORTING RESULTS

Types of Variances	Functional Categories							All Categories
	Pharmacy	Laboratory	Radiology	Dietary	Charting	Monitoring	Therapy	
1. Variances in Dose, Volume, Quantity								
Opportunities at T_1	2325	16	2	0	346	15	32	2736
Opportunities at T_2	2072	18	4	0	291	31	12	2428
Percent Variances at T_1	0.65	0	0		1.16	0	0	0.69
Percent Variances at T_2	0.77	0	0		0.00	0	0	0.66
Percent Difference	+0.12	N.V.	N.V.	N.O.	-1.16	N.V.	N.V.	-0.03
2. Variances in Site, Route, Admin.								
Opportunities at T_1	2325	17	62	0	160	15	55	2634
Opportunities at T_2	2072	19	58	0	140	31	15	2335
Percent Variances at T_1	22.58	5.88	0		0	0	0	19.95
Percent Variances at T_2	0.77	0.00	0		0	0	0	0.68
Percent Difference	-21.81(b)	-5.88	N.V.	N.O.	N.V.	N.V.	N.V.	-19.27(b)
3. Variances in Schedule								
Opportunities at T_1	2325	321	62	144	874	16	55	3797
Opportunities at T_2	2072	310	59	179	840	31	15	3506
Percent Variances at T_1	8.26	11.21	16.13	0.69	3.09	0.00	0	7.15
Percent Variances at T_2	9.60	1.61	0.00	1.68	10.36(a,c)	3.23	0	8.62
Percent Difference	+1.34	-9.60(b)	-16.13(b)	+0.99	+7.27	+3.23	N.V.	+1.47(a)
4. Variances in Procedures Notes, Preps								
Opportunities at T_1	2325	323	61	144	874	16	55	3798
Opportunities at T_2	2072	310	59	179	840	31	15	3506
Percent Variances at T_1	7.10	0.00	0.00	0	0.23	0	0	4.39
Percent Variances at T_2	4.25	0.00	1.69	0	0.24	0	0	2.87
Percent Difference	-2.85(b)	N.V.	+1.69	N.V.	+0.01	N.V.	N.V.	-1.52(b)
5. All Variances								
Opportunities at T_1	9300	677	187	288	2254	62	197	12965
Opportunities at T_2	8288	657	180	358	2111	124	57	11775
Percent Variances at T_1	9.65	5.47	5.35	0.35	1.46	0.00	0	7.58
Percent Variances at T_2	3.85	0.76	0.56	0.84	4.22	0.81	0	3.70
Percent Difference	-5.80(b)	-4.71(b)	-4.79(b)	+0.49	+2.76(b)	+0.81	N.V.	-3.88(b)

(a) Statistically Significant Difference at the 95% Confidence Level
(b) Statistically Significant Difference at the 99% Confidence Level
(c) Increase due to changes in scheduled times for observations, treatments, etc., to coincide with time schedule at nursing station.
N.V. No Variances Occurred in This Category
N.O. No Opportunities for Variances Occurred in This Category

calculated for each time period. The changes in these percentages over the two time periods were tested for significance using standard statistical procedures for testing the difference between two percentages.

The number of opportunities for variances is relatively uniform between the two time periods, as shown in Table 9-4. When data are aggregated over all types of variances, the percentage of variances decreased after implementation of MIS by almost 4 percent, representing about a 50 percent reduction. A closer examination of Table 9-4 reveals that this reduction is primarily due to the virtual elimination of variances in site, route, and administration. The percentage of opportunities resulting in variances dropped from a high of almost 20 percent before MIS, to less than 1 percent after MIS. Furthermore, a majority of the opportunities for variances occurred in the functional area of pharmacy. The greatest reduction in percentage of variances occurred in this area. Under the charting category, there was a significant increase in variances. This increase was primarily due to minor errors and omissions in charting. Significant reductions in variance percentages were also realized in the functional areas of laboratory and radiology. The reductions occurred for variances in schedule.

For variances in site, route, and administration, the significant change for the pharmacy function was due to large reductions in the percentage of orders with variances in both scheduled medications and prn medications. The scheduled medications area had a large reduction in variances in reporting the route of administration while the prn medications had a large reduction in variances in reporting the injection site.[8] In scheduled medications the large statistically significant reduction in not reporting the route of administration or reporting the wrong route of administration may seem trivial. As discussed earlier, the implication of these errors of omission and reporting in caring for the critically ill in administering drugs could have adverse effects in interpretation of the patient's progress and physician's decisions in altering the course of treatment. The significant reduction in not reporting the injection site for prn medications may be trivial except for cases where the choice of injection site would effect the physician's course in treating the critically ill patient.

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8 These conclusions result from further in-depth study of the data for Table 9-4.

The significant reduction in variances in scheduling for the laboratory function was due primarily to the reduction in variances for providing clinical information. For radiology, the reduction in variances in scheduling was in diagnostic X-ray orders. For the charting function, the increase in scheduling variances was due to variances in reporting results of observations (these variances were also noted in physicians' interviews). The significant reduction in variances in procedure notes and patient preparations observed for the pharmacy function was due primarily to variance reductions in parenteral solutions orders.

9.4.2 Clarity/Interpretation Errors In Reporting Scheduling

The errors in reporting of schedules is predominantly in reporting the schedule in compliance with the order. Table 9-5 summarizes the changes in these error rates for the seven functional areas. Over all areas there was a slight increase in these errors, primarily due to an increase in the charting area (this increase could be due to the nurses changing the schedule to meet the nursing care routine). This was offset somewhat by a reduction in the rate of these errors for laboratory and radiology functions. The increase in the errors for charting was primarily in the area of observations, while the decrease for the laboratory function was in clinical laboratory test results and for the radiology function was in X-ray results. This is readily recognized as an improvement as confirmed by discussion with nurses and technologists; there is a significant improvement in scheduling. Again the increase in errors in charting observations could be due to clarification of the order to make it more compatible with the patient care regimen of the nursing units.

TABLE 9-5. CLARITY/INTERPRETATION ERRORS IN REPORTING SCHEDULING

FUNCTIONAL AREA	NUMBER OF OPPORTUNITIES FOR SCHEDULING VARIANCES		PERCENT REQUIRING CLARIFICATION/INTERPRETATION		PERCENT DIFFERENCE
	PRE-MIS	POST-MIS	PRE-MIS	POST-MIS	
PHARMACY	2325	2072	0.04	0	-0.04
LABORATORY	321	310	3.43	0.65	-2.78(a)
RADIOLOGY	62	59	6.45	0	-6.45(a)
DIETARY	144	179	0	0	-
CHARTING	874	840	2.06	7.62	+5.56(b)
MONITORING	16	31	0	3.23	+3.23
THERAPY	55	15	0	0	-
ALL AREAS	3797	3506	0.90	1.91	+1.01(b)

(a) STATISTICALLY SIGNIFICANT AT THE 95% CONFIDENCE LEVEL.

(b) STATISTICALLY SIGNIFICANT AT THE 99% CONFIDENCE LEVEL.

10.0 SELECTED PERFORMANCE EVALUATIONS

The implementation of a computer based, hospital-wide information system like the Technicon Medical Information System (MIS) at El Camino Hospital (ECH) has a direct or indirect impact on all information processing activities. The changes in the methods and procedures to accomplish these activities may alter hospital performance in various areas. In this section, analyses of several selected evaluation areas are discussed. The selected areas are listed below.

1. Turn-around-times for tests and procedures--an analysis of the elapsed time to accomplish a sample of tests and procedures before and after the implementation of MIS.

2. Scheduled and unscheduled down-time--a description of the scheduled and unscheduled down-time associated with the operation of MIS at El Camino Hospital during a sample time period.

3. Confidentiality of medical records--a review of system access control as implemented by El Camino Hospital.

Data were collected for these analyses at several points in time to allow for evaluations at two periods in time subsequent to MIS implementation. Initial evaluations of these areas were conducted in 1972-73, during early full operation of MIS. Selected follow-up evaluations in these areas were conducted during 1974-75, after extended full operation of the system.

10.1 Conclusions

Detailed analyses of the evaluation of MIS with respect to turn-around-times for tests and procedures, scheduled and unscheduled down-time, and confidentiality of medical records are presented in subsequent subsections of this chapter. The following conclusions follow from these analyses:

1. Significant reductions in turn-around-times for tests and procedures were observed for selected test groups and priority classifications. Significant reductions were noted in the time between placing orders until results are available at the service area for routine priority orders in radiology (with and without required preparations), biochemical tests, urinalysis, and hematology/serology, and for today priority

orders in urinalysis and hematology/serology. In addition, significant reductions in turn-around-time between orders and results available at the nursing station were noted for routine priority orders in radiology (with and without required preparations), urinalysis, hematology/serology, microbiology and electrocardiography, and for today priority orders in urinalysis, hematology/serology and electrocardiography.

2. The reliability of the system, measured shortly after MIS implementation, and well after full operation, was consistently above 99 percent, indicating little unscheduled down-time. The availability, also measured during the two time periods, remained near or above 96 percent, indicative of minimal scheduled and unscheduled down-time. Usage of the back-up system averaged 33 hours (4.5 percent of monthly operational hours) per month for the 1972-73 time period. This included both scheduled and unscheduled use of the back-up system. The high reliability and availability of the system may be a positive factor in the users' acceptance of the system.

3. The confidentiality of medical records was evaluated shortly after full implementation by William V. Nick, M.D., J.D., Consultant to Battelle Columbus Laboratories.

   This evaluation indicates that the data access controls provided by MIS are very flexible, and can be tailored to meet the needs of individual hospitals. The hospital has options on determining the classification, identification, and range of functions and retrieval capabilities of individual's accession to patient records. The option on system accessibility selected by ECH may not enhance confidentiality, however, they do conform with practical needs in patient care. The California Evidence Code which defines confidential communications between patient and physician could be construed to encompass the current system usage at ECH.

10.2 Analysis of "Turn-around-time" for Tests and Procedures

The purpose of this study was to analyze the "turn-around-time" associated with laboratory, radiology, and electrocardiography tests and procedures. Several samples of tests and procedures were analyzed to determine if any significant change occurred in the average time between initiation of the medical order and availability of the results at the service area, or at the nursing unit where the order was initiated. The

first sample time period (T_1) for which data were collected was prior to the implementation of MIS in the first nursing unit at the hospital (September 27 through November 30, 1971). The second sample time period (T_2) was during early full operation of MIS at the hospital (November 13, 1972, through January 20, 1973). A third sample time period (T_3), well after full implementation of MIS (December 12, 1974, through March 18, 1975), was used to further test the impact of MIS on the turn-around-time of tests in the chemistry and urinalysis laboratories. Analysis of turn-around-time was repeated in these two areas because of major system changes which affect the speed in returning test results to the service area. Implementation of the system to interface the Technicon blood chemistry analyzer, SMA 18/60, with MIS was completed in 1974. A mark-sense card input for urinalysis test results was also implemented in 1974. The system changes would not significantly impact turn-around-time for tests in other departments analyzed previously. Not all orders from these time periods were included. Rather, a subset of the orders written during these time periods were collected to provide a representative sample for measuring the impact of MIS on turn-around-time.

Due to differences during the sample periods in the availability of time data on the requisition or printed forms associated with the tests and procedures, data gathering methods were adapted as required. During the first sample time period (T_1), some special procedures in the nursing units and service areas involved were required to record additional time information on the appropriate forms. Subsequently, the patient charts from these nursing units were screened to extract the recorded times from the forms. A time-stamp clock was placed on each nursing unit involved during the period data were gathered. At the unit, the clock was used by nursing personnel to record the time of the requisition, and receipt of the results back at the nursing unit. The time increment between order writing and preparation of the requisition was estimated for the nursing units involved through sampling techniques. The data for the estimate were obtained primarily with an observer. Some sample data were obtained from the patient charts when the physician (or the nurse in the case of a verbal or telephoned order from the physician) noted the time the order was written in the chart.

It was feasible, during the second time period, to obtain the test and procedure time information from the processed requisition forms and other MIS printed material. Also, in gathering the second sample it was easier to control the sample size by test group and priority. In the first time period, the sample sizes by test group and priority were determined by the natural mix of the tests and procedures ordered for patients on the sample nursing units during the approximately two-week data gathering period on each unit involved. In the second time period, the filed requisition and report form(s) in the laboratory, radiology and electrocardiography service areas could be used as the primary information source. This permitted the sequential acquisition (or build-up) of sample data by test group and priority.

For the third time period, a listing of orders and results, containing all patients purged from the system during the third week in March, 1975, was used to obtain a sample. Orders from the chemistry and urinalysis laboratories were selected from the listing in chronological order, excluding any scheduled tests and pre-admit orders.

Sophisticated chemistry procedures which require an excessive amount of time to perform or are referred to an outside laboratory are not included in the samples. In addition tests requiring excessive preparation time such as fasting time following order of the test before sample is obtained are not included here.

Three times were recorded for each test and procedure in the first two samples. These are: (1) date and time the requisition is prepared (before MIS), or the order is entered through the Video-Matrix-Terminal (VMT) into the system (after MIS implementation), (2) date and time results are available at the service area (after implementation of MIS this means the the results are available at the service area but not entered yet into the system as verified results), and (3) date and time results are available at the nursing unit. Prior to MIS, this later time is the arrival time of the report at the nursing station. After implementation of MIS, it is the time that the results are entered into the system at the service area since they are then available at the nursing station through the VMT. Concurrent printing of the results at the nursing station occurs for high priority tests. For the third sample, only the first and third times were used.

Medical, surgical, and specialty nursing units were the origin of the orders for tests and procedures included in the samples. Orders from the emergency room, outpatient department, or associated with an admission were not included in the samples.

Three test and procedure priority classifications were used. These are: (1) Stat (immediately), and includes in this study other priority indications such as wet-reading and now, (2) Today, and (3) Routine. The "test group-priority" sample combinations used in the study are shown in Table 10-1 for order time to availability of results at the service areas, and in Table 10-2 for order time to availability of results at the nursing station. Electrocardiographic tests are not included in Table 10-1 since it was not feasible to record the time the cardiologist finished reading and interpreting the electrocardiogram. The high priority (Stat) and Today classifications occurred infrequently for tests and procedures where patient preparation or a relatively long period of time was involved (e.g., a radiology procedure requiring patient preparation, and microbiology type tests). In these cases, only the routine priority classification of orders were included in the analysis. At time T_3, only chemistry and urinalysis test orders were studied.

The results of the analyses are indicated in Tables 10-1 and 10-2. For each time period and "test group-priority" combination, the number of observations (n_i), mean time (m_i), and sample standard deviation (s_i) are shown. The difference between the sample mean times for each test group-priority combination is given in either the m_2-m_1 column or the m_3-m_1 column.

The mean turn-around-time for the first sample (m_1) in both tables includes an estimate of the elapsed time between order writing and requisition preparation. Based on a sample of 144 observations for the nursing units involved, the average was 0.3 hours for this time increment.

The null hypothesis tested in both tables with respect to each test group-priority combination is that there is no change in the mean time between ordering and having results available at the service area (Table 10-1) and at the nursing station (Table 10-2). A two-tailed test (95 percent

TABLE 10-1. TURN-AROUND-TIME[1] ANALYSIS--ORDERING TIME TO RESULTS AVAILABLE AT THE SERVICE AREA

Test Group	Priority	T_1			T_2			
		n_1[2]	m_1	s_1	n_2	m_2	s_2	m_2-m_1[3]
Radiology								
No Preparation Required	Stat	5	11.0	7.29	41	9.7	8.30	- 1.3
	Today	27	15.9	8.10	59	14.7	9.00	- 1.2
	Routine	37	20.4	9.64	94	14.9	9.80	- 5.5*
Preparation Required	Routine	16	23.2	4.17	47	18.9	8.63	- 4.3*
Chemistry								
Biochemical Tests	Stat	72	4.0	4.99	48	3.5	4.75	- 0.5
	Today	145	7.4	7.17	59	6.1	10.13	- 1.3
	Routine	260	18.2	8.46	154	20.6	12.19	2.4*
Urinalyses	Stat	14	5.3	5.7	20	6.1	9.70	1.4
	Today	68	3.5	4.55	57	6.2	6.09	2.7*
	Routine	68	12.8	11.86	140	5.2	7.05	- 7.5*
Hematology/Serology	Stat	68	3.2	4.98	44	4.2	7.51	1.5
	Today	198	9.6	11.94	98	6.2	8.73	- 3.4*
	Routine	299	19.3	12.63	193	15.1	11.19	- 4.2*
Microbiology	Routine	111	55.8	33.37	65	66.9	63.83	11.1

[1]Time measured in hours.

[2]n_i = number of tests and procedures; m_i = mean time between order writing and results available at nursing station; and s_i = standard deviation of the sample times.

[3]Asterisk indicates statistically significant change (difference in sample means, two-tailed test, 95% confidence level).

TABLE 10-2. TURN-AROUND-TIME ANALYSIS--ORDERING TIME TO RESULTS AVAILABLE AT THE NURSING STATION

Test Group	Priority	T_1			T_2			m_2-m_1	T_3			m_3-m_1
		n_1	m_1	s_1	n_2	m_2	s_2		n_3	m_3	s_3	
Radiology												
No Preparation Required	Stat	6	15.7	7.51	42	12.5	8.86	- 3.2				
	Today	28	19.0	10.20	59	17.1	9.07	- 1.9				
	Routine	41	27.4	12.90	94	18.0	9.71	- 9.4*				
Preparation Required	Routine	28	31.7	13.86	47	20.4	8.81	-11.3*				
Chemistry												
Biochemical Tests	Stat	15	4.6	4.74	48	4.2	5.07	- 0.4	69	3.8	7.80	-0.8
	Today	28	7.3	5.99	59	6.9	10.41	- 0.4	61	7.9	11.14	0.6
	Routine	136	20.3	7.55	154	23.2	18.55	2.9	40	17.7	10.40	-2.6
Urinalyses	Stat	8	6.0	5.46	20	7.2	9.53	1.2	4	5.9	10.22	-0.1
	Today	41	4.7	4.99	57	6.8	6.20	2.1	38	8.7	8.68	4.0*
	Routine	38	14.3	13.32	140	6.2	7.01	- 8.1*	48	18.3	26.35	4.0
Hematology/Serology	Stat	25	4.3	6.04	44	5.7	8.33	1.4				
	Today	92	12.8	12.35	99	7.5	9.18	- 5.3*				
	Routine	162	22.6	15.12	196	17.6	17.53	- 5.0*				
Microbiology	Routine	47	51.5	20.64	65	69.5	64.31	18.0*				
Electrocardiography	Stat	4	12.6	8.38	19	7.1	4.38	- 5.5				
	Today	12	16.8	7.29	49	9.6	5.97	- 7.2*				
	Routine	22	26.1	13.06	83	18.1	7.82	- 8.0*				

Note: Reference footnotes at the bottom of Table 7-1.

confidence level) for significant change between two means[9] was used. Each statistically significant change is indicated in the m_2-m_1 or m_3-m_1 columns of Tables 10-1 and 10-2 with an asterisk.

In summary, the implementation of MIS is effecting a general decrease in the turn-around-time associated with tests and procedures in several laboratory and ancillary areas. A primary factor involved with the decreases is the improved patient history, clinical information, and instructions provided with the requisition to the service area in a standard and routine manner. This has significantly reduced the need at the service area to obtain additional information regarding the patient before proceeding with the test or procedure.

In the radiology test group, there was a decrease in all three priority categories (Stat, Today, and Routine) where no patient preparation was required for the procedure. The decrease in the Routine category was statistically significant at the 95 percent confidence level (9.4 hours or approximately one-third). Where preparation of the patient was required (diet, medications, etc.), only the Routine category was sampled due to the low incidence of high priority requisitions. Again, a statistically significant decrease of approximately one-third in turn-around-time occurred (11.3 hours).

In the electrocardiography test group, a similar pattern of decreases occurred in all three priority categories (Stat--5.5 hours, Today--7.2 hours, and Routine--8.0 hours), with the decreases in the Today and Routine categories being statistically significant at the 95 percent confidence level. These represent decreases between 30 and 43 percent in turn-around-times in this ancillary area.

In the biochemical test group, there were no statistically significant changes in the average turn-around-times. In this largest volume area of the laboratory, entry of all results into the system originally was accomplished by laboratory clerks using the Video-Matrix-Terminal (VMT). Subsequently MIS changes were made to provide for automatic entry of a major portion of the test results. However, for the sample of orders selected

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[9] Acheson J. Duncan, Quality Control and Industrial Statistics (Homewood, Illinois: Richard D. Irwin, Inc., 3rd Edition, 1965), pp. 505-508.

at time T_3, there continued to be no significant impact of MIS on the turn-around-time for these tests.

In the urinalyses test group there was a statistically significant decrease (8.1 hours--approximately 55 percent) in the Routine priority category from time T_1 to time T_2. The increase in the today priority was not large enough to be statistically significant from T_1 to T_2 although the larger increase (4.0 hours--85 percent) from T_1 to T_3 was significant.

In the Hematology/Serology test group, there were statistically significant decreases in the Today (5.3 hours--41 percent) and Routine (5.0 hours--22 percent) priority categories at the 95 percent confidence level. The decreases in this test group are associated with two factors. First, with MIS the technologist can check more rapidly on previous patient test results and clinical data. The second factor is a change in procedure not associated with MIS. Between the two sample time periods, automation of the sample dilution procedure was implemented.

In the microbiology test group, only the Routine priority category was sampled due to the low incidence of higher priority requisitions. There was an increase in this area of 18.0 hours (35 percent) in the time from requisition to results available at the nursing station. This increase was statistically significant at the 95 percent confidence level. (Because of the large variability in the turn-around-times, an increase of 11.1 hours--20 percent--in time from requisition to results available at the service area was not significant at the 95 percent confidence level.) Microbiology results are difficult to enter into the VMT, particularly when multiple organisms are involved and the results must be typed in (reference Section 12.11). However, this is not considered a major contributing factor to the turn-around-time. It is possible that some of the time observations in the first sample inadvertently reflected the receipt at the nursing station of preliminary (or presumptive) test results instead of the final test report. This could not occur in the second sample.

10.3 Scheduled and Unscheduled Down-Time

Any computer based, hospital-wide information system will require scheduled periods of down-time for preventive maintenance, and program and

file maintenance activities. Also, an automated hospital information system will experience unscheduled down-time. In order to determine the extent of down-time for the Technicon Medical Information System at El Camino Hospital, data were collected for each of two time periods. The first period studied covered the months of October, 1972, through May, 1973. The second period extended from October, 1974, through May, 1975. Monthly data were collected on the number of operating hours for the system, on the hours of down-time (scheduled and unscheduled), and on the extent of usage of the back-up system. From these data, measures of reliability and availability of the system were derived.

The unscheduled down-time of the system was defined to include periods when any one of several situations occurred as a result of using the system. These are:

1. Hardware problems - when normal operation of MIS is interrupted by a failure directly attributed to the computer itself, or disk/tape unit, or any other piece of input/output equipment.

2. Software problems - when normal operation of MIS is interrupted by a failure attributed to the programs such as problem programs, system programs, or any other application of programs.

3. Operator Actions - when normal operation of MIS is interrupted by an erroneous operator action caused during a required response to the MIS system.

4. Internal system delays - when normal operation of MIS is temporarily interrupted for a short time period ranging from a few seconds up to approximately 90 seconds. These interruptions may be necessary for a soft recovery (that is a recovery not requiring a complete re-initialization of the system) or for certain options initiated by the systems people.

Scheduled down-time of the system was defined to include both regularly occurring events as well as occasional events arising from particular needs. These include:

1. Daily - when time is allotted each day for tasks to backup the system, such as disk to disk copies of the system and data base and also disk to tapes for a longer period of retention (this is done at 2:30 a.m.). Also included during this time are system updates and

additions of new programs. The normal duration for these functions ranges between 30-50 minutes, depending upon the workload.

2. Weekly - when time has been set aside for tasks such as preventive maintenance on the various hardware performed by the manufacturers. In order to do preventive maintenance on the operation computer, MIS operations must be moved to the backup computer for this period of time. Normal time given is approximately three hours on each complete system. MIS is down only for the time necessary to move to the backup computer.

3. Occasional - when time has been coordinated with the hospital, and the parties responsible request either to down the MIS system or to switch to the backup computer. Reasons could be for a critical program update, or system changes performed by the manufacturer.

System backup computer usage covers both scheduled and unscheduled times when MIS is moved to the backup computer. Such moves are required for the following situations:

1. Scheduled - when MIS is moved to the backup computer due to advance planning whether it is for weekly preventive maintenance or for engineering changes to the primary computer too lengthy for normal preventive maintenance time. Backup computer time is also used for normal program checkout and debugging daily.

2. Unscheduled - when MIS must be moved to the backup computer as a result of anything but scheduled times. Circumstances usually are primary computer problems not immediately definable or peripheral equipment problems not immediately rectifiable.

Following these definitions, data were recorded for the two time periods studied on the availability of the system. The resultant summary data on the scheduled and unscheduled down-times, operational reliability and availability, and backup computer usage of MIS at El Camino Hospital are shown in Tables 10-3 and 10-4. In Table 10-3, the data are reported for the time period of October, 1972, through May, 1973. Table 10-4 covers the same months for the 1974-75 time period. The monthly reliability factor shown was calculated as

$$\text{Reliability Factor} = \frac{(\text{Total Hrs. in Month} - \text{Scheduled Downtime} - \text{Unscheduled Downtime})}{(\text{Total Hrs. in Month} - \text{Scheduled Downtime})}$$

TABLE 10-3. SCHEDULED AND UNSCHEDULED SYSTEM DOWN-TIME, SYSTEM RELIABILITY AND AVAILABILITY, AND BACKUP COMPUTER USAGE (1972-73)

Table Entry	Month (1972-73)							
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
MIS Scheduled and Unscheduled Downtime								
1. Total Hours in Month	744	720	744	744	672	744	720	744
2. Scheduled System Down-Time[(a)]								
a. Daily	18.4	15.9	17.7	11.8	18.0	27.2	21.1	20.0
b. Weekly	0	1.3	1.3	.7	1.3	0	0	0
c. Occasional	1.0	1.3	1.5	.7	.4	1.0	7.6	0
Subtotal	19.4	18.5	20.5	13.2	19.7	28.2	28.7	20.0
3. Unscheduled System Down-Time[(a)]								
a. Hardware Problems	.7	1.3	2.8	2.3	5.3	4.9	3.9	1.5
b. Software Problems	.8	1.2	3.0	2.5	3.6	2.6	.6	2.3
c. Operator Actions	.1	.3	.1	.2	.1	1.0	.4	.1
d. Internal System Delays	1.0	.8	.5	.4	.5	.3	.8	.5
Subtotal	2.6	3.6	6.4	5.4	9.5	8.8	5.7	4.4
4. Reliability Factor	.996	.995	.991	.993	.985	.988	.992	.994
5. Availability Factor	.970	.969	.964	.975	.957	.950	.952	.967
MIS Backup Computer Usage[(a)]								
1. Scheduled	4.8	4.6	4.5	7.7	6.4	54.8	19.5	0
2. Unscheduled	18.8	6.6	20.5	0	0	25.7	51.8	34.5
3. Total	23.6	11.2	25.0	7.7	6.4	80.5	71.9	34.5

[(a)] All figures, in hours & tenths, represent total hours for the month.

TABLE 10-4. SCHEDULED AND UNSCHEDULED SYSTEM DOWN-TIME, SYSTEM RELIABILITY AND AVAILABILITY, AND BACKUP COMPUTER USAGE (1974-75)

Table Entry	Month (1974-75)							
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
MIS Scheduled and Unscheduled Downtime								
1. Total hours in month	744	720	744	744	672	744	720	744
2. Scheduled System Down-Time	21.8	18.4	21.0	21.0	22.4	18.7	18.9	20.9
3. Unscheduled System Down-Time	2.6	3.4	7.3	3.2	5.2	2.3	3.4	4.5
4. Reliability Factor	.996	.995	.990	.996	.992	.997	.995	.994
5. Availability Factor	.967	.970	.962	.967	.959	.972	.969	.966
MIS Backup Computer Usage[(a)]								
1. Scheduled	3.6	5.2	0.7	4.7	16.0	14.9	2.6	5.9
2. Unscheduled	1.3	3.4	28.1	0	4.7	0	5.0	0
3. Total	4.9	8.6	28.8	4.7	20.7	14.9	7.6	5.9

(a) All figures, in hours and tenths, represent total hours for the month.

and the monthly availability factor was calculated as

$$\text{Availability Factor} = \frac{(\text{Total Hrs. in Month} - \text{Scheduled Downtime} - \text{Unscheduled Downtime})}{\text{Total Hrs. in Month}}$$

These two factors are of particular importance to the user. They may strongly influence the acceptance of the information system by him. A plot of the monthly reliability and availability factors for the two time periods is shown in Figure 10-1. The system exhibited high levels of operational reliability and availability during the earlier time period shortly after implementation and continued to maintain these high levels during the later time period. The overall reliability and availability figures for the 1972-73 time period were 99.2 percent and 96.3 percent respectively, while for the 1974-75 time period, these figures were 99.4 percent and 96.7 percent. The indication is that the system has been able to maintain a high level of reliability and availability since its implementation. This may be a major contributing factor to the acceptance of the system by the users.

10.4 Confidentiality of Medical Records

This section of the report summarizes the evaluation of the procedures for maintaining the confidentiality of patients' medical records. The data access controls provided by MIS are very flexible, and can be tailored to meet the needs of individual hospitals. The hospital has options on determining the classification, identification, and range of functions and retrieval capabilities of individuals' accession to patients' medical records.

The data access control system provides each person who is given access to the system a unique four character identification code. This identification code serves the following purposes:

1. Identifies the person to the computer and stores his identification with all records which he generates. For each identification code, the computer stores the user's full name, initials, class code, e.g., doctor, nurse, etc. and specialty code, e.g., cardiology, pediatrics, etc.

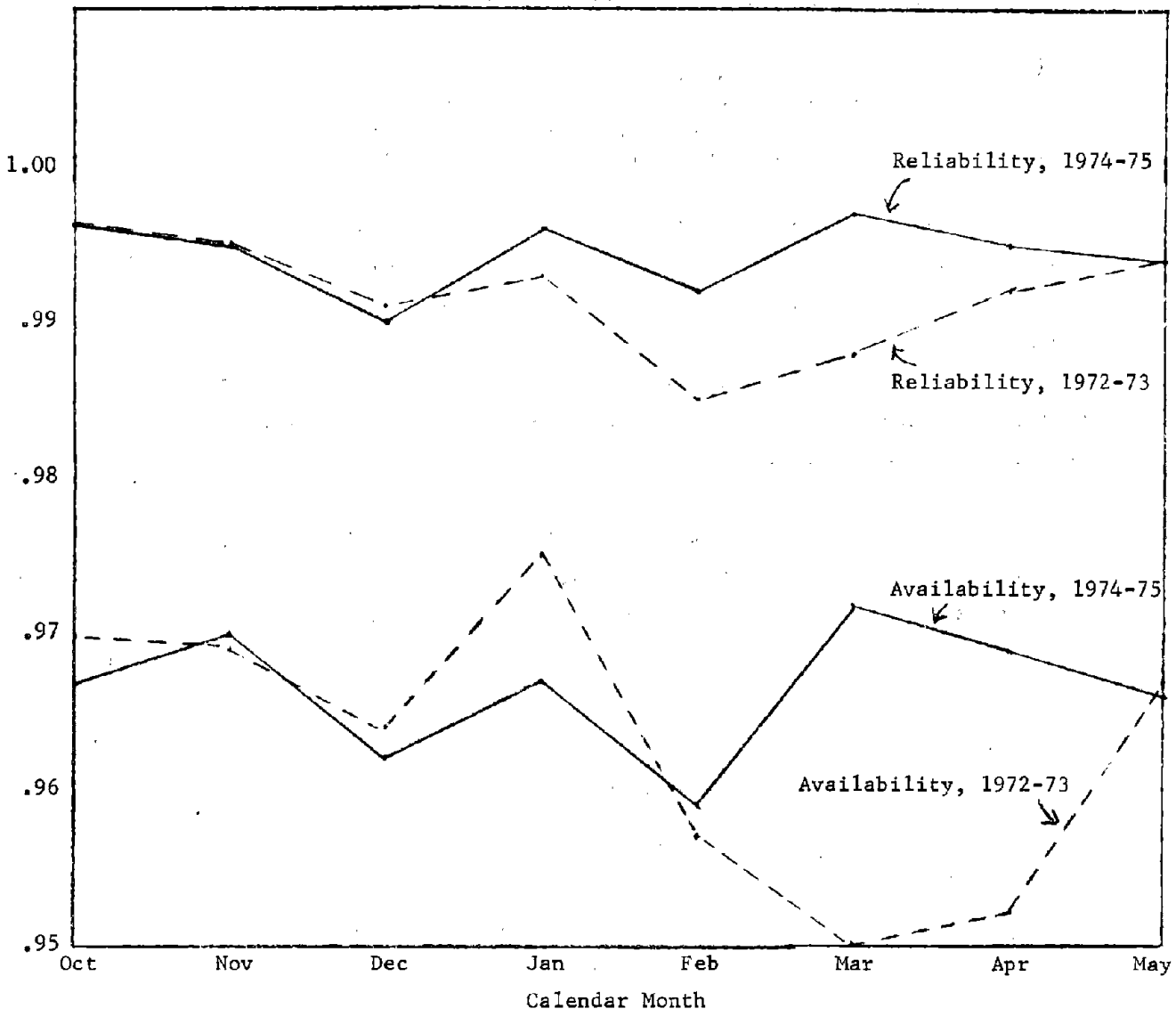

FIGURE 10-1. MIS RELIABILITY AND AVAILABILITY FACTORS

2. Governs the range of functions and retrieval capabilities made available on the Video-Matrix-Terminal (VMT).

3. Provides for tailored video displays for users' specialty or for him as an individual, e.g., (a) a pediatrics nurse automatically is presented with displays tailored for pediatrics reporting; (b) a physician may establish a "personal order set" which only he can access.

A person's identification code, "class", and "specialty" are stored in a computer "table" which can be modified as frequently as necessary. The total number of "classes" and "specialties" can also be modified as required.

At El Camino Hospital, the personnel department classifies staff members by "class" and "specialty" and forwards requests to Technicon for assignment of identification codes. Technicon has appointed one individual to be responsible for assigning identification code numbers and maintaining the computer "table". Technicon sends El Camino Hospital's personnel department the user identification number, and the individual is personally presented a confidential form (Figure 10-2) which indicates his MIS

CONFIDENTIAL CONFIDENTIAL

MIS-1 USER IDENTIFICATION CODE

The User ID Code issued to you is your unique code which identifies you to MIS. Please keep this code secret and reveal it to no one. You, and you alone, are responsible for all entries of orders, information and data into the system under your code.

If you feel the confidentiality of your code has been broken, please contact the Systems Director designated for your shift so he may cancel your old code and issue you a new code.

Your ID Code is _____.

Issued by _____ Date _____

Form No. 920-01
7/71

FIGURE 10-2. FORM FOR MIS USER IDENTIFICATION CODE

user identification code. If the individual or the hospital determines that the confidentiality of the code has been broken, Technicon is informed immediately and a compromise procedure allows Technicon to delete the code and issue a new number. Approximately once every six months requests have been made to issue new numbers because of suspected or actual breakdown of confidentiality of a user identification code. The Hospital and Technicon do not feel that this compromise rate is significant enough to justify periodic change of the entire computer identification code table in order to maintain confidentiality.

Appendix F presents a table of the current MIS user classes and their associated input and retrieval capabilities selected by El Camino Hospital. The input and retrieval capabilities to various categories of personnel is a hospital policy question and not an intrinsic characteristic of MIS.

10.4.1 Summary of Findings[10]

The listing of input and retrieval capabilities (Appendix F) identifies the disparity which arises between practical patterns of patient care and system capabilities in providing confidentiality. A thorough examination of the restrictions which can be applied to patient data retrieval exemplifies the evolution that has occurred at ECH with the system to date. The input capability has provided the physician with help in entering orders, to the extent that a nurse or clerk can act as the physician's agent in many respects, and enter handwritten orders and schedules acting in the capacity of an agent. With recent changes, the clerk at ECH has been given the same access capability as a registered nurse. While this does not enhance confidentiality, it does conform with practical needs in patient care.

This is not to suggest a deviation from the California Business and Professions Code, or the rules and regulations which pertain to that code. Use of the system appears to maintain the same degree of security

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[10] This portion of the report was prepared by William V. Nick, M.D., J.D., consultant to Battelle Columbus Laboratories.

with respect to custody, access and transmittal of medical records as is currently the custom in hospitals in the state. The existing matrices and display screens do not appear to compromise privacy or confidentiality, unless a discharge summary, history, physical examination or progress notes are entered in the system as well. At this point, a discharge summary in the traditional sense is not in the present system.

The California Evidence Code defines a confidential communication between patient and physician as including information which, so far as the patient is aware, discloses the information to no third persons other than those who are present to further the interest of the patient or those to whom disclosure is reasonably necessary for the transmission of the information or the accomplishment of the purpose for which the physician is consulted, and includes a diagnosis made and the advice given by the physician in the course of that relationship. The system, as restructured by the hospital, is being used in this context. While not specifically oriented to system design and function, the Evidence Code could well be construed to encompass the current system usage where information is being utilized by hospital personnel to further the interests of the patient.

Suggestions on system accessibility are that the conditions of admission should state the existence of the computerized recordkeeping system, its necessity for the maintenance and transfer of medical information, and such other matters as are advisable so that the patient becomes formally aware of its use. Careful consideration should be given to the location of the terminals on a floor in the open style nursing stations to restrict casual observation. Access to the complete system in hospital service areas even if by reason that a department head is also an attending physician, may expose the patient's record to personnel who have no valid reason to view it. Similar thoughts may be extended to a nurse or physician on one floor being capable of locating records of patients elsewhere in the hospital. Yet, for a practical matter, restrictions on geographic access and hospital service areas have been unwieldy in patient care design.

There are advantages in maintaining the system's confidentiality which, in balance, may be outweighed by patient care needs. Yet those needs may create additional legal difficulty. For example, the authority of others to act in an agency relationship for a physician may, at times, become a disputed matter.

A major objective of the evaluation of the confidentiality of medical records was to determine if ECH can maintain confidentiality, utilizing the system, consistent with the needs of the hospital in supporting health care. With the aforementioned considerations, it is apparent that a second order of security could be implemented to enhance confidentiality. The user identification code form in Figure 10-2 might be reworded so that by accepting the code, the user agrees to keep it secret, and agrees to request a new code if confidentiality has been impaired. Key employees could be bonded, for example the programmer who issues codes. In respect to a vendor as a custodian and independent contractor of records and systems, a method of insuring safekeeping and freedom from liability is to have a contractual indemnification agreement between the vendor and the hospital. Finally, the patient should be made formally aware of the system in the conditions of the admission document.

11.0 QUALITATIVE ASSESSMENT OF THE IMPACT OF MIS IN THE ANCILLARY SERVICES AND SUPPORT AREAS

This section of the report presents the results of the qualitative assessment of the impact of the Technicon Medical Information System (MIS) in the ancillary services and support areas of El Camino Hospital (ECH). In this qualitative assessment two levels of adjustment in the hospital organization were evaluated: the department level and the individual level. Some repetition was anticipated, however in general the levels of adjustment can be separated.

11.1 Summary of Findings

The Technicon Medical Information System (MIS) is designed to accommodate the diversity of information processing requirements presented by various departments within hospitals such as El Camino Hospital (ECH). Many of the ancillary and support areas have unique information needs because of the variety and highly technical nature of the procedures performed. Application programs had to be developed for these areas for MIS to provide the functions for ordering, scheduling, entering results, printing, transmittal of reports, entering patient charges and other functions encountered in routine operation of these areas within the framework of ECH.

A qualitative assessment of the impact of MIS in the ancillary and supportive areas was conducted to determine the department and personnel adjustments required to adapt to the system throughout ECH. During the course of the qualitative assessment, interviews were conducted with directors of the various departments, supervisors, technologists and, in most departments, technicians and clerks. The qualitative longitudinal study over time, using the same panel of respondents, has resulted in detecting change in attitude toward the system.

The studies included evaluation of only those procedures relating to a distinct impact of MIS on 17 departments providing ancillary and supportive services within ECH. The following major advantages (improvements)

or problems were detected or perceived as a result of the implementation of MIS:

1. The operation of the Admitting Department has improved considerably as a result of more efficient procedures initiated through implementation of the system. Practically all of the functions for patient pre-admission, admission and discharge are provided by the system. As a result there has been a reduction in the time required to admit patients, assign rooms, transmit admission information and orders to other departments and transfer patients, and a reduction in forms to be typed and time spent typing. Physicians are provided messages on admitting policies when bed utilization is high. These messages assist the physician in making admission/discharge decisions for their patients. A "Ward Census Report" can be requested at any time to determine a current status of beds occupied and beds available. There has also been an improvement in the interface between Admitting and the Business Office. Less errors are recorded and errors can be corrected through the Video-Matrix-Terminal (VMT) without retyping of forms. As a direct result of MIS, the Admitting Department increased productivity. The emergency room and OB can admit directly.

2. The Business Office used the Technicon Business Office Service (BOS) for financial management and control. MIS incorporated all the advantages of BOS which practically eliminated much of the staff and time required for keypunching and batch processing of transaction cards (four keypunch operators have been eliminated). Census information and patient charges are provided by MIS to BOS via magnetic tape transfer at the Technicon computer center. Elimination of keypunching in providing information on about 90 percent of patient charges has resulted in reducing need for keypunch operators. Keypunch functions have not been eliminated for payroll, accounts payable, and general ledger. Financial and insurance information completed through MIS prior to discharge reduces need for patient to go to Business Office before leaving the hospital. It is anticipated that 2 more full-time-equivalents could be eliminated by combining some business office operations required in processing special service changes through the system (this has not been realized since full implementation).

   Since implementation of MIS, there are fewer errors in processing patient charges. System automation generates patient's number and eliminates need for addressograph plates. The system patient identification number accurately identifies patient and charges.

3. The central sterile supply (CSS) department encountered only minor problems in converting to MIS. The system provides a highly efficient method for ordering supplies and equipment from CSS and automatically enters patient charges. The CSS catalog contains in excess of 2000 items, approximately 300 items are used routinely. Nearly all of the more frequently used supplies are on VMT matrices. Patient charges for CSS items are processed automatically with the exception of equipment which is billed on a rental basis. One clerk has been eliminated in CSS due to automatic pricing of items.

4. The Department of Electrocardiography and Electroencephalography has VMT matrices developed for entering orders for electrocardiograms (EKG) and electroencephalograms (EEG) which have been extremely helpful. The MIS orders are better organized and provide more information (diagnoses, medications, reasons for test, etc.) than the order form used prior to MIS.

   Two copies of the order are printed. One copy is used as a work sheet, and the other copy serves as the report. EKG and EEG test results are not entered through the system because the physicians prefer to see the tracings. Patient billing is automatically initiated at the time the order is entered into the system.

   No major problems have been encountered by this department in implementing MIS. Department personnel have a positive attitude toward the system.

5. The Emergency Room (ER) uses a VMT to register patients, enter orders and enter patient charges. The attending physician in ER usually does not interface with the system, the nurse enters verbal and written orders into the system through a VMT. Recently a preprinted form was designed with a space for a label containing patient information. Three of these printed labels have resulted in reduction of printing time to 10 percent of time previously required to print out three sequential copies of a registration form.

   In essence ER uses the system for all patient information processing. MIS has provided ER with easier, more efficient procedures for entry and retrieval of medical and administrative patient information. Thus the department is very dependent on the system and is sensitive to system down-time and equipment failures.

6. The major impact of MIS on the Food Services Department is in the dietary service area. The system prints a diet list (patient name, room number, diet and date) on the nursing units, and prints diets for newly admitted patients, diet

changes, transfers and discharges in the Food Services department. Prior to MIS, these documents were generated manually on the nursing unit and/or by the Admitting Department and transmitted via pneumatic tubes to Food Services.

The system also provides VMT displays of the most frequently used diets to assist the physician in proper selection of diets. Dieticians use the VMT to review diet orders and enter notes.

The problems encountered by Food Services has been in adjusting and discontinuing diet orders and in scheduling food preparation. Minor program changes should alleviate these problems. No changes have occurred in the Food Services Department staff as a result of MIS.

7. The Department of Respiratory Therapy worked closely with Technicon in development of matrices compatible with its needs for ordering effective therapeutic procedures, charting and entering its charges into the system. As a result there were no major problems encountered by the department in implementation of MIS. Respiratory Therapy has benefited through receiving more complete, concise orders, ease of charting through VMT's at the nursing stations and in entering patient charges.

8. Implementation of MIS had initially created several problems for the Clinical Pathology Laboratory. The difficulties encountered ranged from minor problems concerned with recognition and interpretation of orders to the major problem in entering test results though the VMT.

Program improvements over time have alleviated the difficulties encountered in recognition and interpretation of orders. As of March, '75, major system modifications, including interfacing the Technicon SMA 18/60 blood chemistry analyzer and mark-sense input for urinalysis test results, have resolved many of the problems of entering test results into the system. Major development efforts are being directed to implementing mark-sense inputs for serology and differential blood cell counts. Technicon is also close to interfacing the Coulter Model S blood cell counter. However the Clinical Pathology Laboratory has not elected to eliminate clerks that were added to the staff to input results into MIS. Instead, three clerks are being trained for other positions in the laboratory.

Providing assistance to physicians and nurses in improving the delivery of patient care has received priority in implementation of MIS. This has resulted in delays in resolving the problems encountered in the laboratory.

9. The increase in information available for patients' medical records as a result of the implementation of MIS has produced a range of problems for the Medical Records Department. The major problems are missing physicians' signatures, particularly on medical orders and resumes, and chart bulk because of increase in documents produced by the system. The problem initially encountered in identifying reports has been resolved. However, many problems have become apparent since implementation of the system which were not recognized before.

    Staffing reductions from the level reached during implementation have not been effected. An increase in the number of admissions has increased the number of charts to be handled and abstracted. A second increase in workload resulted from an increase in the number of requests for copies of charts for subpoenas. An increase in workload has also resulted from special studies being undertaken for utilization review and medical care review programs.

    Matrices giving diagnoses with HICDA codes are being developed. This system change will provide diagnoses that may be selected to provide a more uniform and precise primary diagnosis. This change will reduce the amount of interpretation presently required by medical records personnel in abstracting patient data. It will also provide the mechanism to assist the medical staff in implementing PSRO requirements. As of the end of 1974, selectable diagnoses for Gynecology had been implemented as the pilot program.

10. The impact of MIS on the Pharmacy Department has been in improving the efficiency of all areas of the operation within the department including ordering, dispensing and billing of medications. Although the system can accommodate conventional or unit dose pharmaceutical services, MIS provided a means of implementing unit dispensing of medications with minor changes in staff. Implementation of the MIS/Unit Dose system at ECH was accomplished with the addition of one clerk. In addition the department lost one pharmacist staff position since the time of transition to MIS.

    Pharmacy had to make a radical change, but this change has resulted in a superior system. The department did not encounter major problems during the period of transition and very few adjustments were required after implementation.

11. The Radiology Department was extensively involved in development and refinement of administrative procedures, computer programs and equipment during the time of transition to MIS. Nuclear medicine and radiation therapy are apparently satisfied with the current system. In the diagnostic

area the patient volume is much greater and the system interface is more complex. In this area the radiologists continue to dictate their findings as they did previously. However, since full implementation, packaged reports are used for normal chest examinations. The secretaries are now satisfied with changes in transcribing the report on to VMT displays using a special keyboard. The configuration of the keyboard was changed several times before a configuration was found to satisfy the needs of the secretaries. The new keyboard in combination with the report header information provided by the system has significantly reduced the typing time required to enter reports.

Several other system improvements have been made including changes in the format of the report and in the matrices for entering orders. A number of tailored matrices have been developed for entering orders which provide information on patients' history, and clinical data pertinent to radiology. Since full implementation of the system the number of orders with clinical information has increased through the use of matrices by physicians.

Although Radiology is not completely satisfied with the system, the department is providing better service as evidenced by a reduction in turn-around-time for routine tests and reduction in the number of stat orders.

12. Other ancillary and supportive service areas interface with the system to a lesser extent than the departments discussed above. The information processing requirements of these other areas are not complex, and as such, few problems have been encountered in implementation of MIS.

Although the system has been fully implemented throughout El Camino Hospital, improvements are being made continuously. As discussed above these continuing improvements should produce significant changes, particularly in the clinical pathology laboratory.

11.2 Introduction

In order to adequately monitor the adjustments required during development and implementation of MIS, information was collected during five time intervals: before implementation, the period of transition to MIS, and after implementation of the system throughout the hospital, approximately one year after full implementation and again after approximately one and one-

half years experience with the system. The information collected before any changes as a result of MIS is important in becoming familiar with the manual and semi-automated systems and procedures used for performing a comparative evaluation after implementation. This is particularly true in evaluating the technical adequacy of a new procedure. In many instances, a procedure may be technically adequate but is not used effectively because of personal attitudes developed over time and resistance to change. It is important to detect these attitudes and degrees of resistance over time since these may or may not change as individuals gradually become accustomed to the new procedure, or the degree of resistance becomes apparent in effective operation of the system. The information gathered during the period of transition is useful in determining duplication of efforts required, early attitudes, and required department and individual adjustments. This should be of historical value in development and implementation of systems in other hospitals.

The information collected during the two earlier time intervals was used to evaluate qualitatively the overall impact of MIS after implementation. In continuing to evaluate adjustment to MIS, Battelle updated the information on all departments, approximately one year after full implementation and after nearly two years operation of the system. Every attempt was made to interview the same individuals over time.

The following questions were used as a guide during qualitative assessment of the impact of MIS after full implementation of the system:

1. Benefits reported in Phase I of the HEW study:
2. Problems reported in Phase I of the HEW study:
3. What additional benefits have been realized with MIS which were not included in Phase I of the HEW study?
4. What additional problems have been encountered with MIS which were not included in Phase I of the HEW study?
5. What effort has been made to overcome the problems listed in Item 2?
6. What organizational changes -
   a. Have been made since the implementation of MIS?
   b. Are being made or planned for the future?

7. What procedural changes -
   a. Have been made since the implementation of MIS?
   b. Are being made or planned for the future?
8. What new tests or procedures have been added during the past 3 years (due to changing technology, not MIS)?

During the course of the evaluation, interviews were conducted with directors of the various departments, supervisors, technologists, and in most departments technicians and clerks.

Appendix H presents a description of MIS at El Camino Hospital. Therefore, little effort will be devoted to describing MIS operations and procedures in this section of the report. Only those procedures relating to a distinct impact on the departments are described to assist the reader in understanding the advantages (improvements) or problems detected or perceived as a result of the implementation of MIS. The information on changes through full implementation of the system was presented in the Battelle interim report, September 30, 1973. The information presented below is based on information gathered during the two time periods after full implementation of the system. Since the interim report significant changes occurred in Admitting, Business Office, the Emergency Room, Clinical Pathology Laboratory, Pharmacy, and Radiology.

11.3 Admitting

The operation of the Admitting Department has improved considerably as a result of more efficient procedures initiated through implementation of MIS. Pre-admission information is entered in MIS for use by Admitting, the Business Office, and physicians. Physicians can order tests up to 14 days prior to admission for those patients pre-admitted. The Business Office can now process pre-admission patients financial and insurance information. MIS also prints a pre-admission list for any date on request by the Admitting Department to ascertain that patients scheduled for surgery are also scheduled for admission. Verification can also be made through the VMT without printing the pre-admission list.

When a patient is admitted, the act of transferring a patient's record in MIS from pre-admit to inpatient status causes the patient's

preadmit orders to appear on the VMT screen automatically. The admitting clerk then is able to direct the patient to the Laboratory, Radiology or to his room after reviewing the preadmit orders.

Messages have been developed to provide information on admitting policies when the bed utilization is high. These are presented on the initial VMT matrix. These messages are directed to physicians for their use in making admission/discharge decisions for their patients. The messages are of three types:

- "Med/surg beds are extremely short
  Elective admissions may have to be
  rescheduled. Please phone admitting
  for bed status (ext. 4711)"
- "Limited beds available. Please
  discharge as soon as possible
  Phone admitting (4711) for bed status"
- "Emergency beds only
  Please discharge if possible
  All admissions will be screened
  Phone admitting (4711) for bed status"

Room assignment is facilitated by MIS through providing a more accurate and current bed availability status. The system generates an advance discharge notice after the discharge information is entered into the VMT on the nursing unit, and prints the patient's name and room number in Admitting. Usually discharges are known by 10 a.m. so bed availability can then be ascertained. This permits Admitting to color code the file card for this patient as a pending discharge, indicating a room will be available shortly. Rooms also can be assigned prior to patient admission, but currently actual assignment is not made until the patient arrives and is admitted. Admitting completes the admission of new patient via the VMT and MIS prints the admission and discharge record at the appropriate nursing unit.

Patient time required for admission has been reduced. Prior to MIS, a seven-part admission form was completed with information provided by the patient and any pre-admission information available. Copies of the admission forms were transported via pneumatic tube to six locations throughout the hospital and one copy was filed in Admitting. Now, MIS records the pre-admission information which requires verification and update through the

VMT at the time of admission. This change saves approximately five minutes per patient. The patient then signs the conditions of the admission and insurance forms, receives a wrist band, and is escorted to the Laboratory by Admitting staff for the admission screening tests. The system assigns a unique patient identification number to each new patient, and prints the admission in the appropriate departments throughout the hospital. This eliminates the need for an addressograph plate and any errors associated with its preparation. Completion of requisition slips by Admitting for the admission tests are not required since the admission screening tests are standard orders in MIS for each new admission. The system prints a 4 x 8 card for the admitting card file with all appropriate patient information. In addition, several pages of adhesive labels (name, number, physician, etc.) are printed for each patient in Admitting and carried by the patient to the Laboratory and to the nursing unit. They are used throughout the hospital where manual patient identification still is required. One label is being considered for use as the wrist band insert for patient identification. These printed labels reduce transcription errors when recording patient information.

MIS generates a "Ward Census Report" that prints out at midnight to be used for preparing the "Daily Census Report". The "Ward Census Report" can be requested at any time to determine a current status of beds occupied and beds available.

Emergency Room (ER) admissions prior to MIS required notification by telephone from ER to Admitting with patient name, diagnosis, physician, and age. Admitting located a room in the card file, called the unit to verify room availability and transmit the patient's name, etc., and notified ER of the patient's room number. Admitting then completed the admission form and transported via pneumatic tube the face sheet, addressograph plate and wrist band to the nursing unit. MIS allows ER to establish an ER record (name, physician, etc.) on patients by entering these data through the VMT. If the patient is admitted ER initiates a transfer from ER to inpatient status.

Obstetrics (OB) admits its own patients, 95 percent of which have been pre-admitted. Nursery admits all newborns independently of Admitting. Admitting prepares a wrist band for OB admissions and newborns and transports them via pneumatic tube to the OB department. OB can admit patients and automatic transfer of newborn records saves time in newborn admissions. Prior to MIS the Admitting office was open 24 hours per day, seven days per week. Because ER can admit patients following implementation the department was closed two nights a week from midnight to 6:30 a.m. on Saturday and Sunday.

Transfers prior to MIS required a telephone call from the unit to Admitting for a room, a telephone call to the nursing unit to assign the new room number, and a telephone call to the unit originating the transfer. MIS permits the nursing unit to transfer patients within a unit; only one phone call is required for clearance from Admitting before the transfer is made.

Another report available provides a summary of the number of patients in MIS by type of admission: inpatient, pre-admit, recurring outpatient, one-time outpatient, and AKU. The Admitting Supervisor uses the number of pre-admits to monitor department activity for work assignments to maintain the number of pre-admit records entered above a minimum level. Gathering pre-admission information and entering the information into MIS through the VMT is a major activity done by the department personnel.

For transfers to another nursing unit, the nursing unit enters a transfer order (a medical order) in MIS. An "Advance Transfer Notice" is printed in Admitting. When a bed is available in the new unit, Admitting phones the old unit to tell them the transfer may be made. Less time and fewer telephone calls are required for transfers since implementation of MIS, and Admitting can locate a bed more rapidly as a result of accurate and current bed availability data.

Responsibility for admitting outpatients was transferred from the Business Office to the admitting department.

Some additional advantages of MIS in the Admitting department include:

1. Reduction in the number of forms to be typed and the time spent typing (20 percent of all admit forms were retyped due to errors which can now be corrected on the VMT).

2. Updating of information on pre-admissions at the time of admission is easier, and less time consuming utilizing the VMT.

11.4 Business Office

Prior to MIS the Business Office utilized Technicon's Business Office Services (BOS) patient billing system which provided a complete patient census and accounting service in a batch processing mode. Transaction cards were keypunched by the Business Office for each patient admission, patient charge, room transfer, and discharge. In addition, cards could be keypunched to update tables in BOS that describe hospital data such as beds per nursing unit, beds per room and their charge, and laboratory and radiology charges, etc. All input cards were keypunched by the hospital, and delivered by courier to the Technicon computer center for processing. The system also provided the hospital with census reports, patient statements, medicare billing, accounts receivable, hospital activity reports, and financial management.

As a result of implementation of MIS, most patient charge items required by BOS for hospital financial management and control are provided by MIS. Census information and patient charges are provided by MIS to BOS via magnetic tape transfer at the Technicon computer center. Keypunching is eliminated on about 90 percent of patient charges. As a result, the need for keypunch operators has been eliminated. Cash receipts for patient accounts are entered into MIS through the VMT; cashiers were trained to perform this function. A 10 percent capability for keypunching is still required. Keypunch capability is maintained through an outside service to process special charges not included in MIS. Processing of physical therapy procedures, renal dialysis supplies, and a few drugs not included on MIS matrices are typed into MIS and printed in the service area for pricing.

After pricing they are forwarded to the Business Office for keypunching. Operating Room (OR) charges are entered manually on a form by the OR staff and transported by pneumatic tube to the Business Office for keypunching. Patient information transcription errors on the OR charge sheet are reduced by using the patient labels printed by the system upon admission for all patients. Adjustments to patient accounts including corrections and credits also are keypunched. There are a number of keypunch functions that have not been eliminated by MIS. These functions include payroll, accounts payable, and general ledger.

Since implementation of MIS, there are fewer errors in the patient charging process. Keypunch errors of patient information and charges have been virtually eliminated. Transcription errors by the Business Office, nursing units, and service area personnel have been reduced, the number of forms and requisition slips requiring patient names and tests requested have been reduced. The MIS patient identification number identifies each patient for MIS charges, and eliminates the need for an addressograph plate. Resolution of addressograph plate errors, which required considerable time if any requisitions had already been stamped, have been eliminated.

In general, billing errors requiring correction have been reduced since implementation of MIS. Charges submitted against a non-existent patient are virtually eliminated as a result of MIS assigned patient identification numbers, and charges are processed directly against this number at the time of order entry. Previously one business office clerk spent most of her time resolving billing errors. This time has now been diverted to other business office functions. Write-offs for bad charges have also been reduced.

Balancing daily receipts has also been improved with the system. Prior to MIS, a cashier listed the cash and checks received by patient name and number, totaled and compared the total with cash on hand at the end of the day. Another cashier performed the same procedures for payments mailed to the hospital. The bank forwarded ECH a tape list of all transactions. If the total of the El Camino and bank lists were equal, the hospital list was keypunched for crediting to the patient's account. The cashier's list was also keypunched after balancing. Since implementation of MIS, all receipts are entered by patient number in the VMT by the

cashier or receipts clerk, and a receipt list by patient and totals is printed. These totals can be compared to cash on hand and the bank total. This process eliminates the manual generation of patient (name and number) lists, cash and bank receipts totals, and keypunching. Efforts are being made to complete the financial records for each patient prior to discharge. The patient counselor has the capability of entering a message in the VMT to request the patient to stop by the Business Office at the time of discharge. This message prints in the Patient Care Plan for the patient at the nursing unit. As of the end of 1974, about 20 percent of patients are discharged with the convenience of leaving the hospital without going by the Business Office. Plans are to train patient account representatives to verify insurance and to initialize patient financial records and be upgraded to patient counselors. Financial and insurance information thus completed prior to discharge is expected to reduce financial problems presently encountered upon discharge.

The Business Office has encountered some minor problems since implementation of MIS including excessive time and duplication of efforts involved in verification of patient charges using the VMT, and time involved in gaining access to the proper matrices on the VMT. During the transitional period from BOS to MIS, some items and/or services were improperly charged. These problems have been overcome through experience and through improvements in matrix accessibility and design.

11.5 Central Sterile Supply

Central Sterile Supply (CSS) did not encounter major problems in converting to MIS. Administration and information processing needs of CSS were readily adaptable to computer control and processing. Effective VMT matrices were developed early in the El Camino Hospital program. The system provides a highly efficient method for ordering supplies from CSS by the various departments, and automatically enters accurate patient billing charges. It practically eliminates hand transcription and physical distribution of CSS requisitions and the entering of charges for patient billings.

The CSS catalog contains in excess of 2,000 items, approximately 300 items are used routinely. The supplies are listed in the catalog in alphabetical order. Approximately 90 percent of the more frequently used supplies are on VMT matrices.

Requisitions and cancellations are received on a printer located in CSS. Printing of requisitions and cancellation notices occur when nursing personnel requisition supplies from CSS via MIS. Patient charges for CSS items are processed automatically with the exception of equipment, which is billed on a rental basis, and items ordered via type-in or by telephone.

Two copies of the CSS requisition are printed. A copy of the requisition accompanies the supplies delivered to the nursing unit. When re-usable equipment is requisitioned, a tag is placed on the equipment control board.

A cancellation notice is printed when a previously ordered item is deemed not to be required. If the item has not been sent to the nursing unit, it is returned to stock and both the requisition and cancellation notice discarded. If the item has already been sent to the nursing unit, the item is returned to CSS and a determination is made if the item is still eligible for re-issue. If the item can be re-issued, it is returned to stock. If the item cannot be re-issued, CSS contacts the nursing unit and the nursing unit decides if the charge is made to the patient or to the nursing unit. If it is to the patient, CSS prepares a charge slip and forwards the original to the Business Office. If the charge is to the nursing unit, it is posted to the department charge log.

CSS had minor difficulty during the transition to MIS. During that period of time CSS had to maintain two systems and there was considerable duplication of efforts.

Minor problems are prevalent today including excessive Stat orders because nurses do not plan ahead and they order Stat when an item is not available on the unit.

Prior to MIS, there were multiple item requisitions and charges for a series of supplies. MIS provides a requisition for each item and individual charges for items ordered which causes a greater volume of paper and more time to sort requisitions.

During the transitional period it required an excessive amount of time to enter new items into the system. Since implementation, this time has been reduced to a reasonable level.

The department appears to respond more quickly in serving the needs of the nursing stations and interfacing with the Business Office.

11.6 Electrocardiography-Electroencephalography

This department performs all electrocardiograms (EKG) and electroencephalograms (EEG). Although this department does not interface extensively with MIS, the personnel have a positive attitude toward the system. The VMT matrices developed for entering orders for EKG's and EEG's have been extremely helpful. In general, the department personnel feel that users do not take full advantage of the matrices for ordering EKG's, e.g., indicating patients' medications.

Orders for EKG's and EEG's are received on a printer located in the department. The MIS orders are better organized and provide more information (diagnoses, medications, reasons for test, etc.) than the order form used prior to MIS. The order also includes the work sheet. Two copies of the order are printed; one copy is used as a work sheet for performing and interpreting the test, and the other copy serves as the report. During the transitional period the MIS matrices were used to report normal and abnormal tests. After a trial period, the decision was made not to use MIS for reporting because the physicians insisted upon receiving the tracing. Currently the tracing and written report are transmitted to the nursing station via pneumatic tube. The technician does status the test after completion through the VMT at the nursing station.

An order can be discontinued (DCed) which produces a cancellation notice which is printed on the department printer immediately following VMT entry.

Patient billing is automatically initiated at the time the order is entered into MIS. If the patient is not to be billed for the procedure, a credit must be entered for the procedure via the Business Office. The charges are automatically posted each evening to the patient's account.

MIS provides matrices for scheduling EKG and EEG orders. This is particularly helpful for patients who are scheduled for more than one EKG or EEG. The system holds the orders and prints out an order on the day or time the procedure is to be performed and provides a daily EKG summary and daily EEG summary as management aids to the Department. They are in two sections, each of which may be requested individually. The first section, "Orders Completed", lists all of the orders completed during the day. It serves as a permanent record of work performed and serves a reference function, showing the departmental file numbers and procedure (billing) numbers. The second section, "Orders Pending", shows pending work and serves as a worksheet while the work is in progress; it also serves as a reminder notice of work overdue. Both sections are printed every evening, and the second section may be requested several times during the day: in the morning to aid in the manual scheduling of the work, and in the afternoon to aid in checking that the work is progressing satisfactorily and is not overdue.

This department shares the printer with the Pharmacy Department and the Physical Medicine Department. The resulting traffic flow creates congestion during peak hours and is considered a nuisance rather than a major problem. Although a yellow light automatically alerts the departments that they have an order on the printer, the personnel in this department must identify EKG and EEG orders. This is difficult in the evening when only one technologist is on duty.

There has been an increase in the frequency of stat (immediately) EKG's since implementation of MIS. The abuse of this service by both nurses and physicians ordering stat when there is no urgency has created a problem. There are times when the number of stat orders requested exceeds the number of technologists available to perform the procedure. It is difficult to determine the "real" stats. The use of new categories of orders such as "urgent" and "soon" may help to alleviate this problem.

If an outpatient comes to the department without first registering in the Outpatient Department, technicians have been trained to register the patient.

11.7 Emergency Room

The Emergency Room (ER) extensively interfaces with MIS. El Camino Hospital has over 3000 emergency patients per month. During busy weekends ER receives 160 to 170 patients per day. Because of the urgent nature of the treatment administered and the volume of patients, initially any system failures and down time had an immediate impact on the ER. Many of these early problems have been resolved through system improvements discussed below.

This department uses a VMT to register ER patients and to enter physicians orders including orders for laboratory, radiology, EKG, EEG, and inhalation therapy. Usually attending physician orally communicates medical orders to the nurse and she enters them via VMT as the physician's agent. During the evening and night shifts and on weekends ER has to alert the Laboratory and Radiology Departments by telephone because of the size of departments personnel may not hear the Stat bell. Central sterile supply items are also entered via VMT. Most medications are floor stocked in ER. Non floor stock medications are ordered through the automated system.

Initially MIS generated and sequentially printed three copies of a registration form on NCR paper that provided space for nurses and physicians to write medical orders and care information. The time delay of 3 to 10 minutes required to print out the three forms became an irritant to emergency room personnel. ER nurses were dependent on MIS generated requisition forms to process patients.

In early 1974 a preprinted form was designed with a space in the upper right corner for a label containing the patient information. The labels are printed three across resulting in a reduction of printing time to 10 percent of the time to print out three sequential forms previously. In case of system delay the preprinted form allows nurses to gather data for subsequent entry into MIS.

Charges for ER patients including attending physician charges, floor stock items, and ER service charges are entered through the VMT by the clerk. Other items are charged when ordered as in the rest of the hospital.

In general, ER nurses agree that it is easier and more efficient to register patients and enter orders and charges since implementation of MIS.

The ER department has two permanent VMT's and uses a third VMT between 5:00 p.m. and 7:00 a.m. and on weekends. However, there is some VMT queueing during the day. Some of this queueing is caused by physicians using the ER terminal to locate patients prior to making rounds.

The system allows this department to transfer ER patients to inpatient status and assign rooms. ER directly admits patients when necessary.

During periods of equipment failure and system down time, ER registrations are manually prepared and orders entered by telephone. After the system becomes operational, the registration and orders must be entered into the system before charges can be entered.

11.8 Food Services

The major impact of MIS on the Food Services Department is in the dietary service area. The system prints a diet list (patient name, room number, diet and date) on the nursing units, and prints diets for newly admitted patients, diet changes, transfers and discharges in the Food Services Department. Prior to MIS, these documents were generated manually on the nursing unit and/or by the Admitting Department and transmitted via pneumatic tube to Food Services.

When the diet list is received, it forms the basis for meal service. Any admissions, diet changes, transfers and discharges that occur after the diet list is received are entered into MIS by nursing and/or telephoned to food services. Changes entered in MIS print immediately in Food Services and are used to make last minute changes to the diet list, in addition to any telephoned changes.

Another advantage of the system is the VMT display of the most frequently used diets for selection by the physician. Prior to MIS, physicians had to refer to a diet manual for this information or recall it from memory. According to the dieticians the availability of a wide variety of diets for selection by the physician results in

more complete diet orders. In addition, the dieticians feel that errors resulting from manually transcribing orders to the diet list have been virtually eliminated.

Dieticians on the floor utilize the VMT to review diet orders and enter explanatory dietetic notes concerning each diet order. Dietetic notes are carried with the diet order and can be printed on the nursing unit for the patient's chart or in food services.

No changes have occurred in the Food Services Department staff as a result of MIS. However, some adjustments in staff scheduling have been made to allow more time for the clerk to reconcile the updated diet list with the last minute diet changes transmitted via MIS printer.

11.9 Housekeeping

MIS has not had a significant impact on Housekeeping. No staff or organizational changes have occurred and only minor procedural changes were required as a result of implementing the system. A bed status report is printed every day for Housekeeping showing the status of all beds and includes pending discharges. Housekeeping uses this report for staff scheduling and for identifying rooms that could be closed to patients for a day for periodic cleaning (including painting if necessary). The bed status report provides current information for housekeeping to schedule their staff more effectively.

As a result of implementing the system, Housekeeping feels that there is more waste paper produced, resulting in more trash receptacles, and more effort required by staff to collect this additional waste paper. However, this increased effort has not required addition to the staff.

11.10 Respiratory Therapy

The Department of Respiratory Therapy worked closely with Technicon in development of matrices compatible with its needs for ordering effective therapeutic procedures, charting and entering its charges into the system.

The matrices used for entering orders are in the format of a requisition providing clinical information, type of therapy, length of

treatment, medication, etc. The order is printed on the printer located in the nursing unit nearest respiratory therapy. After the technician completes the treatment, he enters his charting through the VMT at the nursing station. Charges for the department are entered once a day at any VMT that is available. Respiratory Therapy does not enter charges for outpatients.

There has been a significant increase in the volume of respiratory therapy orders since implementation of MIS. This increase in volume may be due to the VMT displays reminding the physician to prescribe therapy.

Respiratory Therapy Department personnel agree that administrative functions and information processing are easier and more efficient since implementation of MIS.

11.11 Clinical Pathology Laboratory

Early development of the system for the Laboratory has been primarily physician and nurse oriented to assist in providing improved patient care. Thus MIS did not produce the positive impact on the operations of the Laboratory that can be realized through application of current state-of-the-art technology and interfacing automated instruments with MIS for on-line data processing. As of the end of 1974, development and implementation of systems to interface automated laboratory instrumentation with computerized data processing was continuing. El Camino Hospital is expanding laboratory automation and Technicon is developing programs to computerize laboratory data processing for interface with the total system.

Implementation of the system to interface the Technicon blood chemistry analyzer, SMA-18/60, with MIS was carried out in May and June of 1974. The technologist controls the entry of results into MIS by first loading the specimen identification numbers into the typewriter terminal of the mini-computer. As the specimens are analyzed on the SMA-18/60, the results are collected in the mini-computer. The technologist then obtains a printout of the results on her terminal for auditing purposes. The technologist has several audit options: delete one result, delete a group

of results, or delete all results. Following audit, the results are then released to MIS and inserted in the patient records.

A mark-sense card input has been developed for urinalysis test results. As of the end of 1974 mark-sense card inputs for serology test results and differential (blood count) results are being developed. A problem presently occurring with mark-sense input is to locate a rejected card in the deck.

As of the end of 1974, Technicon is also developing an interface capability for entering CBC results from the Coulter Model S Counter.

The interfacing of the SMA-18 has reduced the manual input of test results by 20 percent by the end of 1974. This has resulted in an adjustment in staffing by assigning one clerical person to the Bacteriology Section as a laboratory aid. As more test results are entered through both direct and mark-sense card interface methods, additional adjustments will be made by assigning clerical persons to laboratory aid positions and by training them to be phlebotomists.

VMT matrices used by physicians and nurses for entering orders for laboratory tests have been adapted to the extent that can be anticipated based on acceptance of change by the medical staff in other areas that interface with the system. The system eliminates duplication of efforts in manual transcription of physicians' orders and transmission of requisitions to the Laboratory. The computer also assists the nurses in preparing the patient for the test, e.g., diet requirements, timed samples, etc. In most cases reporting results to the nursing station has improved in terms of response time, accuracy, and ease of interpretation of results. In addition, the status (completed, sample not received, in progress, etc.) can be determined. VMT retrieval of patient data which includes diagnosis, medications and previous tests results has reduced the time required to search the chart and has been used extensively by the medical staff and laboratory technologists. The computer also prints out a summary of all laboratory results for the period of hospitalization which is mailed to the physician shortly after the patient is discharged.

Currently the system has provided the Laboratory some assistance in specimen preparation and collection, and scheduling work flow. At El Camino Hospital the Laboratory receives batched

blood specimen pickup lists from the computer for the first pickup each morning, and twice additionally during the day. These pickup lists are sorted in bed-number sequence for each floor and indicate the patient's name, the tests ordered, type of specimen required and amount of specimen. The computer prints individual pickup sheets for stat (immediately) and timed specimens. The computer holds tests for future dates and prints the order in the Laboratory on the proper date. The computer prints work sheets or requisitions for the various sections of the Laboratory (hematology, chemistry, etc.) which are used for writing in test results. The results are entered into the VMT by the technologists (stats) or by a laboratory clerk (routines). A VMT matrix, identical to the work sheet, is used to type in numeric results, and narrative results (microbiology, etc.) are entered by lightpenning the words or phrases on test reports. Abnormal results are automatically indicated in bold print on the computer-produced laboratory test result printout. The charge for each laboratory test is stored in the system. Initially the Laboratory manually prepared a daily worksheet for the Business Office to enter credits or adjustments; this procedure was simplified by writing the required coding directly on the cancellation notice printout and sending the printout itself to the Business Office.

Most of the supervisory personnel and many of the technologists in the Clinical Pathology Laboratory feel major changes have been made since early transition to the system. The major problem of entering test results through the VMT will be eventually eliminated through system interfaces and mark-sense input of test results. Technologists believe that the ability to check on previous test results and entering high priority test results through the VMT has made an improvement as compared to pre-MIS method of sorting through reports and entering results manually. However, some test results are still being entered through VMT's by clerks and they cannot afford to hire experienced technologists for entering routine test results. The use of laboratory clerks increases the potential for errors. In addition, due to lack of knowledge, these clerks can make transcription errors in entering test results. Also, microbiology (bacteriology) results were difficult to enter into the VMT, particularly when multiple organisms were involved which had to be typed in. Changes were made to permit listing multiple organisms.

An early system improvement reduced the time required to call up the laboratory work sheets on the VMT. This shorter computer path to the worksheets eliminated the time required to go through an alphabetical listing of documents to obtain various worksheets for data input. Initially, all worksheets were printed on the Laboratory's printer. For specimens collected by a nurse at the nursing unit, the worksheet had to be matched with the specimen at the Laboratory. Printing of the worksheet was changed to the nursing unit to print when the specimen was statused as collected by the nurse. The specimen and worksheet are banded or taped together and then sent to the Laboratory. This change simplified the handling of specimens and worksheets for the Laboratory.

Initially, the technologists missed the convenience of color coded requisitions for the various sections of the Laboratory (chemistry, urinalysis, etc.). This has to some extent been resolved over time and changes in graphics allow easier identification of requisitions.

The specimen pick up sheets have been received with mixed reaction by Laboratory personnel. The information on type of specimen required is an aid to laboratory clerks and to the technology students.

The MIS prepared work sheet is similar to the laboratory work sheet used prior to MIS. Because of the MIS specimen numbering system, many sections of the Laboratory continue to prepare their own daily work sheet. Initially, each test printed on one sheet of paper created more bulk, but system's changes were made to combine tests from the same specimen on one worksheet when appropriate.

The Laboratory perceives more difficulty in detecting duplicate orders since MIS which may be due to duplicates that were detected by nurses transcribing the order before MIS. Currently the clerk or technologist notices a duplicate test when the order is received, or the technologist detects it at the time for specimen pick up (when the technologist goes to draw the blood). Some duplicate tests are undetected. In the case of duplicate tests, the order must be discontinued (DC) through the system and a manual credit entered through the Business Office.

The qualitative longitudinal study over time, using the same panel of respondents has resulted in detecting changes in attitude toward the system. In the Laboratory, a few of the senior technologists have had a complete change in attitude between the transition period and implementation. They had a very negative attitude when interviewed during early exposure to the system. Several months after implementation these technologists felt they would have difficulty functioning without the system. Utilizing the VMT for retrieval of previous test results and entering stat test results were cited as distinct advantages. These technologists feel that computer programs could be developed to relieve them of most of their clerical tasks and time involved in maintaining statistical data.

This change in attitude may be indicative that acceptance of an automated system requires continuous exposure and time to become accustomed to new procedures and flow of information. Changes over time directed to meeting needs have promoted acceptance.

11.12 Medical Records

The increase in information available for patients' medical records as a result of the implementation of MIS has produced a range of problems for the Medical Records Department. Some problems were obvious during early transition to MIS and apparently increased as El Camino Hospital implemented the system. Missing physicians' signatures, particularly on medical orders and resumes, and chart bulk because of increase in documents produced by the system are the major problems.

It is difficult, under the current circumstances, to maintain objectivity in assessing the problems of Medical Records. Much of the increased burden is the result of developing a more efficient and accurate information system to support other areas of the hospital, particularly those areas involved in patient care. Some problems can be related to the system. Others could have been created as a result of having more accurate information available for medical records than prior to

MIS. Unfamiliarity of new information may have produced lack of confidence in some of the system documents resulting in increased scrutiny.

The Medical Records Department, as in all hospitals, validates the accuracy and completeness of patient information and thus the system has created a burden on this department. All of the problems are not MIS related; however, the multiplicity of problems that have become more apparent since implementation of the system has caused increased resistance to change. It appears that much of the early effort of Technicon and the hospital administration has been directed toward justifying their position on procedural changes in Medical Records required to implement the system. This effort has had some impact on improving the situation, e.g., clerks are now convinced that the report summary is accurate and less time is devoted to scrutinizing test results, medications, etc. In addition, Technicon has been working with Medical Records to develop aids and procedures to help reduce the burden on clerks in compiling complete and accurate records including:

1. A patient abstract form is printed shortly after patient discharge. This is used as a source document for medical records abstracting. (Discontinued on July 1, 1973, in favor of using P.A.S.)

2. New computer graphics that are easier to read and various documents can be easily identified, and temporary and permanent documents can be distinguished. (The nursing station clerks should discard temporary documents before forwarding the patient's chart to Medical Records.)

3. All test results are available in summary form within 24 hours after the patient is discharged. A statement of open orders is also included.

These improvements and other MIS procedures and printouts available to Medical Records, including the test results summary (available shortly after discharge), medical records purge (active to inactive computer storage), on-line patient locater, list of pre-admits and outpatients and the discharge list, have produced positive results in the department.

The personnel in Medical Records readily agree that some of the problems are the result of confusion on the part of physicians in entering information into MIS and lack of attention on the part of nurses in assuring

that clerks perform their duties in sorting and preparing the record in proper form before it is sent to Medical Records. These problems have nearly disappeared with use and experience.

The department has had to add two Saturday and Sunday clerks and 4.5 fulltime equivalents to staff to handle the increased workload during the transition and early implementation period. It was projected that experience will eliminate the need for additional assistance. Staffing reductions from the level reached during implementation have not been effected. An increase in the number of admissions has increased the number of charts to be handled and abstracted. A second increase in workload resulted from an increase in the number of requests for copies of charts for subpoenas. An increase in workload has also resulted from special studies being undertaken for utilization review and medical care review programs.

Matrices giving diagnoses with HICDA codes are being developed. This system change will provide diagnoses that may be selected to provide a more uniform and precise primary diagnosis. This change will reduce the amount of interpretation presently required by Medical Records personnel in abstracting patient data. It will also provide the mechanism to assist the medical staff in implementing PSRO requirements. As of the end of 1974, selectable diagnoses for Gynecology had been implemented as the pilot program.

In providing a better, more efficient system for patient care and data processing for administrative control, it should be anticipated that some departments that are closely associated with information processing will have to adjust to the increased volume of information produced to improve the hospital system. Medical Records has adjusted to the changes imposed by MIS, and has helped to develop system improvements consistent with the needs of Medical Records and system capabilities.

11.13 Outpatient Department

The major impact of MIS on the Outpatient Department (OPD) is in patient registration. Prior to MIS, first time patients filled out a form that included name, address, employer, insurance, and ancillary

service area (X-ray, Laboratory, etc.). The OPD staff assigned a patient number and completed a requisition slip for the appropriate service area, and sent the patient to that area. The physician usually ordered the tests earlier by telephoning the appropriate service area. Business Office staff key punched information on the patient form for subsequent entry into the "Business Office System". After the test was performed, service area staff completed the requisition slip and forwarded a copy to the Business Office for key punching and charging, and mailed a copy to the physician. Patients who had previously received outpatient services at El Camino were entered into the log by original registration number by the OPD, and given a requisition slip and sent to the service area.

With MIS, first time patients are registered by OPD in the VMT and sent to the appropriate service area. MIS automatically assigns a patient number. When the test is completed, service area personnel enter the test results for each patient in the VMT for subsequent billing. Test results are printed in the service area by MIS for pick up by the Mail Room staff, and mailed to physicians. Specific tests are called in by physicians as before. Recurring patients give their names to the OPD staff who interrogates the system to see if they are still in the system. (Recurring patients scheduled for a series of tests are carried in MIS for 21 days after their last activity). If so, they are sent directly to the service area. If not, they are processed as a first time patient.

If an outpatient bypasses the Outpatient Department and goes directly to another department, personnel in the ancillary department will register the outpatient in MIS. This was introduced as a convenience to the patient to reduce the trauma of being sent back and forth between hospital departments.

As a result of MIS, less time is required to register patients. It is estimated that the time required to register first time patients is five minutes less than the time required using the manual system. The saving in registration time has permitted the OPD to process more patients per day without increasing staff. In addition, the OPD staff (1-1/2

clerks) have more time to devote to other tasks. Patient billing is automatically performed by MIS as a by-product of entering test results. Other benefits of MIS include the elimination of key punching patient and charge information, the elimination of errors associated with manually assigned and recorded patient numbers, and the elimination of manually recorded patient information errors on requisition slips.

11.14 Personnel Department

There is essentially no impact on operation of the Personnel Department, except the health services section, as a result of MIS. However, one small task has been added to support MIS. Since Personnel processes all new, terminated, and transferred personnel, they were given the responsibility for coordinating MIS personal identifier codes. An explanation of the procedure utilized by Personnel and Technicon to assign MIS code numbers is explained in the section on confidentiality (Section 10.4).

11.15 Pharmacy

The impact of MIS on the Pharmacy Department has been in improving the efficiency of all areas of the operation within the department including ordering, dispensing, and billings of medications. There has also been a significant improvement in the services provided by Pharmacy throughout the hospital in the delivery of patient care. Although the system can accommodate conventional or unit dose pharmaceutical services, MIS provided a means of implementing unit dose dispensing of medications with minor changes in staff. Implementation of the MIS/Unit Dose system at El Camino Hospital was accomplished with the addition of one clerk. It required approximately one month to train this clerk to fill patients' trays with medications.

Pharmacy did not encounter major problems during the period of transition. This department worked closely with the vendor in development of the pharmacy subsystem. Also, the department tested the matrices and made necessary changes prior to implementation of the system. Very few adjustments were required during transition and after implementation.

With few exceptions, department personnel have maintained a very positive attitude toward the system. Supervisory personnel in Pharmacy attribute the smooth implementation of MIS to the participation of the department staff in planning and transition to the system.

Utilizing both unit dose and MIS, only medications that are required for a 24-hour period are sent to the floor (excluding floor stocked medications). Pharmacy receives a 24-hour Medication Supply List (MSL) by nursing station, patient's name and bed number, which is prepared by the system at a scheduled time during the day. The system also produces gummed labels for each new medication order on a labeling machine located in Pharmacy. The labels contain the patient's name, bed location, attending physician, and the medication ordered. The labels are affixed to the container for the initial dosage of the medication. Each patient has an individual tray and all dosage forms for a 24-hour period are placed in the tray for that patient. Specially designed cassettes have been developed to transport the trays to the individual nursing stations (the cart remains on the station and could be considered an extension of Pharmacy). The systems have practically eliminated returned medications, and the time required to credit these. However, restocking of returned prn medications takes some time but saves inventory. Dosage errors have been reduced and those that go undetected initially are detected much sooner than with the previously used conventional system of dispensing. The medical supply list also has eliminated the "hunt-and-pick" technique required using the old medical order which listed all medical orders for the patient, including medications. The filling of the cassettes from the MSL could be simplified more if the number of doses would be extended by the computer, i.e., multiplying the quantity to be given by the number of times the drug is to be given during the 24-hour period.

El Camino Hospital developed a formulary which contains approximately 800 drugs. The generic names of the drugs are cross-referenced with all the various trade names. If a doctor orders by a trade name rather than the generic name, they are allowed to substitute. This permission to substitute is usually in agreement with the attending physicians. If they do substitute a medication, they insert a card indicating the generic name and stating that the substituted drug has the same ingredients as the

drug ordered by trade name. The formulary is not exhaustive, and physicians and nurses still type-in the order when they can't locate the drug. Pharmacy indicates that the process of adding drugs into the system or taking drugs out is too slow and the hospital is not taking full advantage of the system. The delay in updating the formulary has been a problem during 1974.

At El Camino Hospital, the printout of the nursing station medication supply lists is received on a printer located in the EKG-EEG department. This presents only a minor inconvenience since the list for a nursing station is printed only once a day. Pharmacy does have a VMT to adjust orders for physicians.

Pharmacy maintains a medication price list in the MIS computer system. As each medication is administered, the nurse's VMT charting entry causes the appropriate charge to be triggered into the patient's billing account. This system ensures that the patient is billed precisely for the medications actually received. The automated system appears to be working well with the exception of charges for parenteral solution additives, and the administration of "when required" (prn) medications.

In summary, Pharmacy had to make a radical change, but this change has resulted in a superior system. There is much less writing required, and in their opinion they are able to deliver faster service with less error.

The Pharmacy Department anticipates the development of additional MIS capabilities for assuming narcotics control, and the assumption of responsibility for dispensing all parenteral solutions (adding additives under controlled conditions in Pharmacy). As of the end of 1974, these additions had not been realized.

11.16 Physical Medicine

MIS has had very little impact on the Department of Physical Medicine. The order (prescription requisition) is received on the printer in the EKG-EEG department. A light is turned on at the printer to alert the personnel in the Department of Physical Medicine that an order has been received. The system of prescribing physical medicine procedures has created some confusion, e.g., occasionally receiving multiple orders.

The patient brings the chart to the department and charting is performed manually after treatment. Patients' charges are manually entered on a department form and submitted to the Business Office.

11.17 Pulmonary Medicine

This department performs and interprets all pulmonary function tests (vital capacity, flow rate, etc.) and evaluates the results of respiratory therapy. El Camino Hospital also has a separate laboratory devoted to performing tests for blood gases. The Department of Pulmonary Medicine and the Blood Gases Laboratory interface with the system to some extent, like other departments of the hospital. A system is provided for automating requisitions, reporting and patient billings. Some difficulty has been encountered in entering results, most of which is narrative and is typed in. The procedures for entering charges also needs some refinement.

11.18 Purchasing and Stores

The MIS impact on this department has been primarily in the elimination of purchase, storage and inventory of forms ($3177 per month savings). Form requirements not currently provided by MIS are produced by the hospital print-shop at less costs than outside sources. MIS also produces an alphabetical patient list for the mail room which results in faster sorting of mail for delivery to patients. Inventory control and other Purchasing and Stores activities that are possible with MIS are planned for future implementation.

11.19 Radiology

The Radiology Department had to make radical changes in procedures to accommodate MIS during the transitional phase. In addition to operating dual systems during this time, significant effort was devoted to assist Technicon in making changes in MIS compatible with functional constraints

of the department. Although numerous improvements have been made, the Radiology Department perceives some system problems.

Nuclear Medicine and Radiation Therapy have worked closely with Technicon in development of the system and appear satisfied with MIS.

In the diagnositc area the patient volume is much greater and the system interface is more complex. In this area, the Radiologists are not extensively affected by MIS. They still dictate their reports by the same methods as they used previously.

The major impact is on the secretaries in both areas that transcribe the reports. They type the report onto video displays using special VMT keyboards. The original keyboards were slow (because of configuration); however, a keyboard was found which is quite satisfactory. The new keyboard in combination with the report header information provided by the system has significantly reduced the typing time required to enter reports. Packaged reports for normal chest examinations have been developed and are used for the majority of normal chests for annual examinations of employees, auxiliary members, and many admissions. This represents approximately 20% of the volume of examinations. Standardized packaged reports for other examinations are not used.

The format of the report has also been improved. The current format allows entry of a preliminary report and a final report. In addition, it is easier to enter information.

The matrices for entering orders have also been improved. The technologists are pleased with the patient information provided (diagnosis, indications, etc.). Several of the medical specialties have tailored matrices for entering orders because of specific information on patients' history and clinical data pertinent to radiology. The number of orders with this specific information is increasing through the use of personalized order sets by physicians.

Although by their own design different types of orders on a patient appear on one form (pre-surgery, intravenous pyelogram, lower gastro-intestinal examination--barium enema). This causes confusion in preparing the patient and scheduling the procedure. Time series also appear on one requisition and Radiology cannot insure that they will be read by one Radiologist. Therefore, a separate requisition must be entered for each

procedure in a time series. This adds to the paperwork. Through additional education, many physicians and nurses are entering the orders properly for the time series of examinations. There has been a slight increase in workload due to statusing of X-rays.

When an outpatient comes in for an examination or treatment, he may go directly to the Radiology Department. If he is not registered as an outpatient, the receptionist will register him without sending him back to the Outpatient Department.

APPENDIX A

TIME SPAN FOR MAJOR EVALUATION COMPONENTS

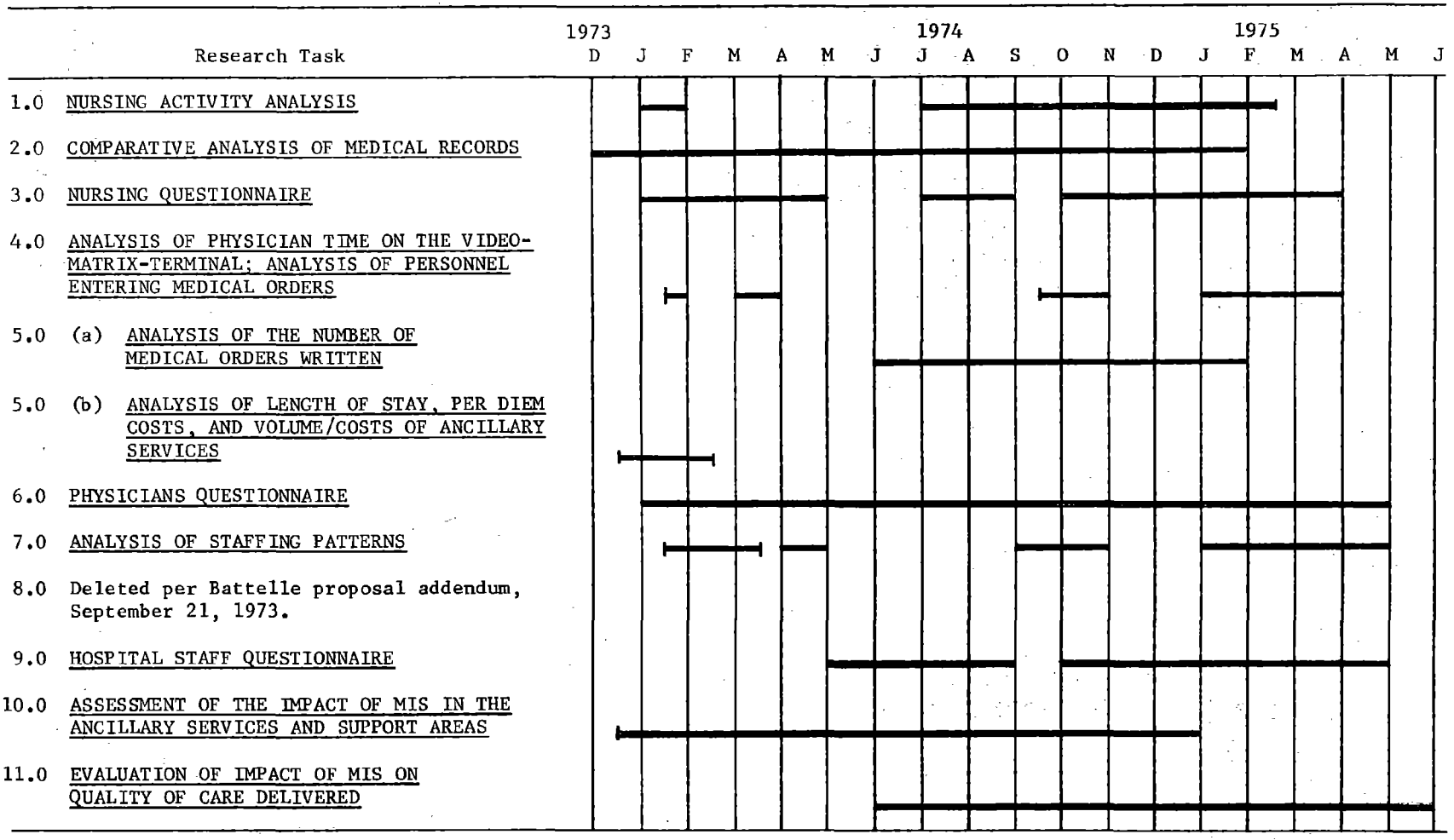

FIGURE A-1. TIME SPAN FOR MAJOR EVALUATION COMPONENTS

APPENDIX B

INITIAL SYSTEM IMPLEMENTATION AT EL CAMINO HOSPITAL

(This appendix describes the early implementation of the system at El Camino Hospital through 1972.)

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APPENDIX B

INITIAL SYSTEM IMPLEMENTATION AT EL CAMINO HOSPITAL

1.0 BACKGROUND

The rapid development of information systems technology over the last two decades has provided the potential for meeting the need for improved information handling methods in hospitals.

Recognizing this promise, the hospital and medical staff at El Camino Hospital (ECH) in Mountain View, California, began working with computer system specialists from Lockheed Missiles & Space Company in 1965 to define the requirements for an advanced hospital information system. Work on the system started with a series of studies on major information handling operations at the hospital to determine the feasibility, design characteristics, and potential benefits of such a system.

Based on these analyses, the initial design characteristics of the Lockheed Medical Information System (MIS) were established in 1966. El Camino Hospital served as the pilot hospital for the actual demonstration and evaluation of the clinical and business office elements of the system. Operation of the business office system was attained in November 1967, and included the functions of Patient Billing/Accounts Receivable, Payroll, General Ledger, and Accounts Payable.

The clinical elements of the system began to reach fruition in 1967. Throughout this period there was active participation by the hospital staff in the evolution of the design and feedback of requirement needs to the system development specialists. On-line display and printer terminals were first installed in the hospital in 1968 in the Doctor's Lounge and at a nursing station to make it possible for the hospital staff to have direct interaction with the system. In 1969, as the system development continued, more terminals were installed at the hospital in Admissions, Laboratory, Radiology, EKG, Pharmacy, Food Services and at an additional nursing station. Pilot parallel operations were carried out in 1969-1970 at all of these stations on a limited basis.

During this period a MIS Operations Committee, consisting of key members of the hospital and medical staff, met regularly to review the system development progress and give advice and guidance on needed improvements for incorporation in the system. In early 1970, members of the El Camino Hospital staff worked in conjunction with the staffs of nine other hospitals in the San Francisco Bay area over a 3 month period in a series of education and evaluation sessions on MIS to determine the applicability of the system to hospital of different types, and to offer additional design suggestions for the final system configuration.

During April, 1970, four physicians were trained in the use of the system. They entered all orders for their patients' entire stay. Next, the day shift nursing staff at nursing station 4-West was trained and operated the nursing portions of MIS during June, 1970. For a one month period beginning in August, 1970, all portions of MIS except nursing notes were operated in parallel with the current system for all patients at the 4-West nursing station. The next step in the progressive sequence of prototype operations was to include the nursing note function.

During this last phase of prototype operations of MIS, a task force composed of key memebers of the hospital and medical staffs reviewed and evaluated the performance of the system and the MIS generated products. They found the system to be highly effective and most satisfactory. The MIS design contributions of physicians, nurses, and medical professionals since 1965 were responsible for these results.

In April of 1970, a proposal was received by the hospital from Lockheed for the full installation of MIS. This proposal was evaluated extensively and thoroughly by a 45 man evaluation team including the systems engineering staff and members of the hospital and physician staff. More than 18 man-months of effort were devoted to this task. Three-fourths of the effort was utilized to determine the economic benefits of MIS to the hospital, and the remainder to other aspects of the evaluation, including system performance characteristics and system capabilities. The major conclusion resulting from the evaluation was that a computerized hospital information system was conceptually and economically feasible for the hospital. In addition to the economic benefits of the system to the hospital, each department identified other significant advantages and disadvantages of the system to their organization.

Following this evaluation of MIS, the hospital undertook an extensive evaluation of other vendors offering hospital information systems. The vendor comparison analysis was performed by the hospital systems engineering staff and included investigation of the following elements for each vendor (where such data was provided by the vendor):

- System Philosophy
- Installations and Progress
- Input/Output Devices and Hardware Configuration
- Department and Functions covered
- System Outputs
- Cost per Patient Day

It was determined in these vendor evaluations that the Lockheed MIS service offered the most comprehensive and cost effective hospital information system available.

In the spring of 1970, El Camino Hospital and Lockheed entered into an agreement to install MIS in the hospital. Because of the developmental nature of the system, the agreement specified that implementation costs would be borne by the vendor. Furthermore, payments by the hospital for service would be made only as cost benefits were actually realized. A Cost Savings Bureau composed of hospital and vendor representatives was therefore, established to monitor and track the financial aspects of the project. This group functioned early in implementation to determine the cost of installation, and later to determine the net cost savings accrued due to MIS usage. The cost bureau thus acts to identify and evaluate potential cost benefits as well as to track and accumulate on-going savings. Cost savings which exceed accumulated service cost redound exclusively to the hospital.

For reasons internal to company operation, in 1970, Lockheed Missile and Space Company entered into negotiation with Technicon Corporation, a manufacturer of automated laboratory instruments located in Tarrytown, New York, for the acquisition of Lockheed Information Systems by Technicon. After researching the total hospital information system field, on May 31, 1971, Technicon concluded a purchase agreement with Lockheed for the Medical Information System. The contract included the provision that the Lockheed personnel associated with the project who wished to join the new Technicon subsidiary, Technicon Medical Information Systems, would have that option which 97% subsequently

elected.

Late in 1970, the National Center for Health Services Research and Development issued a request for proposal for a comprehensive, in-depth study of a real-time total hospital information system. Such a study, which had never been done before, would entail the evaluation of a comprehensive working system; that is, a system which would be in full-time use by the hospital as the major non-verbal communication tool and would comprehend all the major functional elements of the modern hospital. Such a system would have not only the capability for handling patient care data, but also would provide hospital management information. As a result of proposal competition, El Camino Hospital in Mountain View, California, was awarded a contract to demonstrate and evaluate the hospital information system developed by Lockheed, and now owned by Technicon.

2.0 PREPARATION FOR IMPLEMENTATION

2.1 Staff Adjustments and Committees

Several adjustments were made by both the hospital and Technicon Medical Information Systems to accommodate the implementation process and to maintain lines of communication between Technicon and ECH Systems Engineering, Administration, and the hospital departments.

Implementation at the hospital was supervised by the Systems Engineering Department, consisting of a manager of industrial engineering supported by two staff industrial engineers. An ECH nurse also joined this group on a full time basis to assist and provide the critically necessary understanding of nursing procedure.

The Technicon implementation team was composed of a project staff directed by a Manager for Implementation, supported by a Manager for Requirements and a Hardware Supervisor.

A committee structure was developed to facilitate communication between all concerned groups. The Executive Committee consisted of the President and Vice President of Technicon Medical Information Systems, the Administrator and Associate Administrator of El Camino Hospital, and the manager of the Systems Engineering Department at ECH. The function of this committee was to review implementation and operation status, and to make decisions regarding policy and contract changes such as final review of major system change requests.

An Implementation Committee was established to serve as the central planning and coordinating body for the installation and operation of MIS throughout the hospital, and to resolve problems referred from the Department Task Groups. All members of the Systems Engineering Department, the Associate Administrator, and key implementation personnel from Technicon Medical Information System served on this committee.

Each department within the hospital was assigned a Technicon Medical Information Systems representative and an El Camino Hospital Systems Engineering representative. These personnel, in conjunction with a department representative, formed the Department Task Group. The function of these

groups was to develop departmental plans and operating methods which related MIS to the full function of the department.

A Progress Review Board was organized to review the progress of the implementation and operation of MIS and to recommend changes to the administration of the hospital. Members on the board included representatives of hospital administration, systems engineering, and various departments.

A MIS Physician Committee served to review the system, report any problems from a physician's point of view, and recommend changes. An active member from each medical staff department served on this committee.

As mentioned earlier, because of the developmental nature of the system during the time period of its implementation at El Camino Hospital, the agreement between the hospital and the vendor specified that implementation costs would be borne by the vendor and that payments by the hospital to the vendor for service in excess of cost benefits realized by the hospital would be defined until ultimately matched by such benefits. A Cost Savings Bureau composed of hospital and vendor representatives was established to monitor and track the financial aspects of the project. This functioned early in implementation to determine the cost of installation, and later was to determine the net cost savings accrued due to MIS usage.

2.2 Hardware Installation

Reliability was a primary goal in the hardware design for the hospital. Two data transmission lines were installed over different routes from the computer center at Technicon to ECH. Each carries half the information load. These telephone lines are each connected to a multiplexer which distributes data to the video-matrix-terminals around the hospital. A switch between these two enables one to carry all terminals if the other fails. Two print distributors connected to the hospital printers exist for the same reason. Equipment in the computer center was installed in a similarly redundant design.

Capacity was also a primary consideration. The cable for the hospital data distribution network has 100% excess capability to all floors. The distributors have 50% extra capability.

Implementation required special set-up considerations including 1) a training site for 7 terminals during the first six months of installation and start-up, and 2) establishment of implementation priorities for equipment installations.

In determining the number and sites of video-matrix-terminals and printers for El Camino Hospital, Technicon first established the quantity of information flow, the communications centers, and the peak hour needs. From this, projections were made to determine hardware configuration necessary to handle the system as it was then designed. Actual installation took place over several months during the summer and fall of 1971.

2.3 Training

In preparing for implementation at ECH, training was given a high priority and was conducted differently for each area within the hospital.

2.3.1 Nurse Training

Nursing, because of sheer number of employees who would be using the system and also due to its interaction with all other departments, claimed most attention.

The formal pre-implementation training sessions were conducted by Technicon employees over a six-week period from August 1 through September 11, 1971. All nursing personnel in the hospital were trained during that time in classes of up to seven people. The schedule consisted of five one-hour sessions to be attended by each RN and LVN within no more than a two-week period. The content of these sessions was as follows:

Session A - Introduction: film overview, explanation of general mechanics of the system, interaction between various departments, role changes, benefits, implementation schedule.

Session B - Giving and Charting Medications (including information on the unit-dose system which was being implemented concurrently)

Session C - Entering Doctors' Orders

Sessions D & E - Other System Capabilities: transfer-discharge system to keep patient list current, Patient Care Plan, vital signs, central service requisitions, entry of nursing orders, and other printouts.

Ward clerks and nurses aides attended separate classes corresponding to sessions A, D, and E.

A MIS practice hospital which simulated a real hospital was developed in order that all personnel could practice what they had learned in the training sessions. Technicon's Director of Nursing Systems drew up practice workbooks, a kind of programmed learning tool for use on the nursing unit. Also prepared were nursing user guides for the purpose of continuing education.

2.3.2 Physician Training

The Technicon physician representative handled all physician training arrangements in conjunction with the Assistant Chief of the hospital medical staff. All doctors were to be trained in the fall of 1971 before implementation began, roughly in the order in which their specialties corresponded to the sequence in which nursing stations were to be implemented. Originally, two sessions of one-hour each were scheduled for each doctor. When attendance at the second sessions declined, however, one session of an hour and forty-five minutes was found practicable. Although seven terminals were available for training at one time, the normal attendance was five doctors out of seven scheduled.

These training sessions included a general introduction to the system, use of the equipment, and the displays. Specific instructions were given on writing orders, retrieving data, and using the new chart documents. A description of ancillary department output corresponding to physician input was also provided. The concept of personal order sets was introduced. Each doctor received a handout of samples of those chart documents which he would be using.

As implementation progressed, a letter was sent to physicians informing them that the Doctors' Lounge would be open daily for practice on the system and refresher training classes. These were very poorly attended.

As each nursing unit was newly implemented, doctors were provided full-time on-site assistance using the terminals by the Technicon physician representative. This support was gradually reduced to the heavy physician usage periods, and finally to roving ad-hoc assistance for several hours each morning.

2.3.4 Training of Ancillary Personnel

Training for those ancillary employees who would be using MIS was handled by the Technicon representative assigned to each area.

In Radiology, Inhalation Therapy, and Pulmonary Function, a group meeting was held for each department to explain the general functioning of the system. For specific usage, the Inhalation Therapists and the Radiology Technicians were trained individually according to their own needs.

In Medical Records, group sessions were held to teach the personnel how to request reprints and to retrieve portions of a patient's chart. Individual training was carried out for the clerk who would be the principal user.

In Clinical Pathology, a group orientation was held to explain the general use of the equipment and plans for implementation. The group was then broken down into three sub-groups corresponding to the way in which they would use the system. First, two people were trained individually on the maintenance of the tables to govern laboratory processing. Second, the laboratory technologists in groups of three received instruction on a limited basis for statusing. Third, the clerical personnel, also in groups of three, were trained more extensively as they would be the principal laboratory users. They were instructed in collection procedures, worksheet request and routing, test result input, and billing procedures.

Also available to laboratory employees were a variety of written materials, including a users' guide. In addition, one training brochure covered statusing and test results entry procedures. Another, destined to be out-dated soon after implementation, outlined clerical procedures.

2.4 System Start-Up Preparation

2.4.1 Saturation Test

In November, 1971, a system saturation test of 2½ hours duration was designed by Technicon and the ECH System Engineering staff to determine system performance under heavy use. Conditions imposed on the system were: a full patient load extrapolated to the year 1975, a complete range of activities and speciality information processing capabilities available for use, hospital-wide routing of reports, and a peak hour traffic load. The latter condition differentiated between predominant nursing and ancillary usage. The full complement of printers and terminals were operated during the test by hospital staff.

In preparation for the test, a full hospital load with special test patients was entered into MIS. Complex scenarios of activity were developed. System users were familiarized with the data by the systems engineering staff prior to the test, and monitors were assigned to assist them. Terminal usage times were carefully controlled.

In general, El Camino was responsible for verifying the operation of all VMTs and printers, summarizing user reports, and verifying printer routings. Each user completed a system evaluation form, evaluating system response for matrix selection, lightpen response, information retrievals, information updates, special messages, printing of reports, and priorities.

Quite satisfactory response times were observed over the two hour test span. Some minor hardware problems were encountered, primarily the failure of a number of printers. Technicon took steps to improve preventive maintenance and worked with the printer vendor to develop changes to improve printer performance.

2.4.2 Additional System Tests

Prior to implementation, a number of additional planned system tests were conducted by Technicon. One such test was a 24-hour

"clock-driven" test to determine if all time-triggered printouts would print at the proper time in the right place. In October and November, 1971, simulations were run in the laboratory, radiology, and other ancillary departments with sample data supplied to hospital personnel. These tests were run both as a proof of the system and also as an extra training device. The results of this test were basically good with the exception of the laboratory. There, the system was not complete and, as a result, appeared difficult to use. As a consequence, laboratory personnel developed a somewhat negative feeling toward the system and became hesitant to accept new features of the system as they were developed.

Technicon also conducted an analysis of disc file storage space to determine if the allocated space would be adequate. An audit also was accomplished with respect to MIS/BOS to ensure that the interface between the medical information system and the business office system was operating properly and that all charges were accurately and automatically accounted for with respect to all departments.

Before implementation, copies of all matrices were distributed to the respective departments in order that they might check the displays for completeness and accuracy. Also, all user codes were issued, finalized, and checked.

2.5 Initial and On-Going Operational Support

Plans were made previous to actual initiation of service on a nursing unit for support of the nursing staff as the nursing stations were implemented. During the first week a unit was operational on MIS, one Technicon systems representative and one hospital RN would support regular unit personnel on each of the day and evening shifts. For the night shift, this support was reduced to one ECH RN. For the second week, one hospital RN assisted on each shift. During the first two weeks of implementation, Radiology and Laboratory had day and evening support from their respective Technicon representatives, while Pharmacy and Business Office had only day support. The Technicon physician representative was available to assist doctors during heavy periods of their usage of the system for the first

few weeks of implementation on a unit. All Technicon departmental representatives were on-call on a twenty-four hour basis.

In addition to these provisions relating to the support of particular units and departments, an overall system support structure was maintained. This consisted of a Technicon MIS duty officer, a Technicon hardware technician, and an on-call ECH Systems Engineering staff member. The duty officer performed trouble-shooting for user and technical problems and provided liaison between hospital authorities and the computer center regarding all problems and daily operational changes. The hardware technician carried out maintenance and kept both terminals and printers in an operational status. Full 24-hour duty officer coverage was continued for 9 months when it was progressively reduced to 7 A.M. to 7 P.M. coverage with hardware technicians trained to carry out duty officer responsibilities during the remaining 12 hours.

2.6 Initial Nursing Station Check Out

During November and December, 1971, MIS was tested on 4-West. Technicon personnel entered complete records on six selected patients at a time, in effect maintaining duplicate records on those patients for their entire length of stay.

Selection and preparation of the first station to be implemented was carried out as soon as check out of the system on the test nursing station had reached an acceptable level. Because of high motivation, long familiarity with the system as a demonstration and development unit, and overall strength and cohesiveness as a unit, 4-West, a 34 bed medical nursing unit, was selected as the first station to become operational.

2.7 Method of Implementation

Implementation proceeded differently for nursing and the ancillary departments. Admitting, the nursing units, and the outpatient department were implemented sequentially in the transition from manual information handling to utilizaton of MIS. Throughout this sequential implementation,

the ancillary departments were operating with both manual and machine procedures until the last nursing unit became operational.

3.0 IMPLEMENTATION

3.1 Admitting Implementation

In late December, 1971, the Admitting Department began entering all new patients to the system. Start-up support was present for most of the first week. The MIS admitting function was designed to duplicate the information processing of the Admitting Department as it had operated manually. Before long, it became apparent that improvements in the system could be made. Admitting notes for the Mail Room and Housekeeping were, for example, printed in Central Service, and notices for the Reception and Information Desk printed in PBX, these areas being the closest printer locations.

Consequently, the early months of 1972 saw the gradual development of a new admitting system. Housekeeping, the Mail Room, and the Reception Desk no longer received admit notices. An Alphabetical Patient List which printed twice a day was created for those three departments. Paper usage was thus greatly reduced. Another system change enabled automatic assignment of patient numbers, which initially had to be typed into the system after selection from a manual log book.

Early in implementation, Admitting handled all transfers and discharges. This was a large workload for the small department, and the responsibility was soon transferred to the nursing units.

A degradation of system response time, a condition which plagued the system for a number of months, occurred every day about mid-afternoon just at Admitting's busiest hour.

3.2 Nursing Implementation

Detailed plans were designed to accompany the start-up of 4-West. These included plans for switching patient records. A verification that the patient's record was converted to MIS and checked by a nurse was included in each chart.

On the day shift prior to start-up day, Technicon staff manned the terminals to admit all current patients to the system, enter all current

orders, and keep the 4-West patient list up-to-date. During the following evening shift, comparison of the Rand (manual system orders catalogue) with the MIS Patient Care Plan was initiated in order to reconcile any discrepancies and obtain updated, corrected care plans for the night shift.

On the third shift, requests for Diet Lists and Unit Worksheets were initiated. El Camino nurses began preparation of these items and sent requisitions for morning work in the laboratory, radiology, and other ancillaries. At this time, nursing assumed responsibility for verifying the care plans with the Rand and maintained these through the end of the shift.

On Tuesday, January 4, 1972, at 7 A.M., actual operation of MIS began on 4-West. Census was restricted to twenty patients for approximately 2½ weeks, expected to be the most difficult period of change. Physicians entered orders into MIS while nurses used MIS for all reporting and ordering. Use of the unit dose medication system at El Camino was phased in with MIS implementation on the nursing units. With the exception of the old drug delivery system, the manual system was maintained for 48 hours in parallel with MIS operation. On the night shift, the first 24-Hour Patient Summaries were initiated and placed in the patient's charts. At midnight on January 6, 1972, manual procedures ceased, and the operational status of "stand-alone" was realized. The only exception was laboratory ordering which was handled by both systems for approximately two more weeks. At midnight on January 7, automatic billing of patient charges was initiated on 4-West.

After several days of MIS operation on 4-West, it became obvious that problems identified during this initial full nursing unit implementation would prevent moving ahead with implementation on other units as rapidly as had been planned. For example, no statusing function existed for ancillary orders, and patient labels were not being printed on the unit. A number of procedural and programming problems were identified for review. To achieve resolution of these early implementation problems as rapidly as possible, daily problem review sessions were held with the head nurse in attendance. In addition, several group meetings were held with 4-West nursing personnel to answer their questions and to allow them to express themselves regarding MIS operation.

Several weeks elapsed before it was determined that most problems had been identified, if not resolved, on 4-West and that it would be advisable to implement MIS on a surgical unit in order to investigate the different kinds of problems that might exist there. At this time it was also decided that on-the-job training in the form of one day spent on a MIS operational unit by each of the new unit's personnel would enhance their ability to visualize the change.

On February 22nd, MIS was implemented on 2-East, a 34 bed surgical unit. Because of concern regarding system performance, parallel (manual/MIS) operations were planned. The system performed, however, with a sufficient degree of accuracy, and because of the inherent difficulty in using two systems simultaneously, 2-East achieved stand-alone status after twenty-four hours. Several additional MIS problems were identified in relation to surgical patient care. For example, the pre-op check list system was not efficient, and the diet list was procedurally defective.

Early in April, it was felt that further delay in the implementation of subsequent stations might cause a loss in the momentum of change. On April 11, 1972, 6-West, a 32 bed Gynecology unit, was implemented. The change progressed with little difficulty. Much of the credit for this should be attributed to the fact that many doctors developed and used personal order sets. This allowed the nurses more time to cope with their own learning process and the remaining problems.

The relative facility of start-up on 6-West prompted an ambitious implementation of several closely related units -- Maternity, Nursery, Labor and Delivery, and 2-North, a 12 bed short-term Gynecology unit, on May 2, 1972. These four areas were implemented together because of their close interaction and interdependency. Reaping the benefits of previous training and system use on 6-West, the physicians made the adjustment from the manual system to MIS much more easily than had been the case in other units. Implementing such a large area at once, however, did have its drawbacks, most importantly, the need for a great deal of support effort. No area received the attention it should have, a factor which probably outweighed the advantage of bringing up all like units at once. Implementing one unit right after the other in quick succession might well have been a better plan.

A further problem arose due to the fact that the system's nursing concept didn't apply well to Nursery, and specific changes had to be made in time-schedule configurations.

Systems problems and difficulty in scheduling on-the-job training due to high census delayed implementation of the Pediatrics and Teenage Unit until May 30, 1972. The census remained high, complicating start-up. Furthermore, the question of whether the system should contain nursing notes was then becoming crucial. Pediatrics nurses were correspondingly reluctant to accept this part of the system.

A 34 bed psychiatric unit, 1-South, was implemented on June 7, 1972. It had been decided not to involve this staff in on-the-job training and observation on another unit because it was thought that the significant operational differences of this unit would obviate the benefits. Experience proved this to be poor judgment. The value of on-the-job training was not to see how one's own unit would function but how a unit could function. The staff was reluctant to change their methods of operation.

As a result of Pediatrics and 1-South being implemented within one and one-half weeks of each other, neither unit received sufficient support. It appeared then that two weeks was the optimum period of time between unit implementation.

The five bed artificial kidney unit began using MIS when an inpatient from 4-West whose medical record was on the system started dialysis treatments. The implementation proceeded incrementally, closely tied to implementation of the outpatient system.

Absence of support personnel held up further implementation until June 27th when 5-East, a 42 bed orthopedic unit, came up. By this time, entry of nursing notes had been limited to certain nursing stations. No serious problems were experienced, and remaining medical and surgical units were implemented with a minimum of problems. MIS operation was initiated on July 11th for 2-West, a 34 bed surgical unit; August 15th for 6-East, a 34 bed isolation and med-surgical unit; and August 29th for 3-West, a 34 bed medical unit.

During September, the critical care areas were implemented within days of one another to take advantage of their close interaction, and yet

avoid the drain on support personnel that was experienced in the previous simultaneous implementation in obstetrics.

The operating rooms were implemented incrementally as the surgical stations were implemented, and thus all El Camino nursing stations except the Emergency Room were using MIS by mid-September, 1972. The process had taken nine months, longer than original expectations by at least several months.

3.2.1 Problems Encountered in Nursing Implementation

3.2.1.1 24-Hour Summary

As designed, the MIS 24-Hour Summary listed all data entered in time sequence. This concept was unacceptable to physicians who wanted to be able to track one type of data over a period of time. The summary then was divided into segments in March of 1972. At this time, nursing records (numerical and medication data) were separated from nursing notes (description of patient status).

3.2.1.2 Terminal Queuing and Nursing Notes

Terminal queuing was only an acute problem during initial implementation of a nursing unit. This was primarily due to the slowness of the new user. For the first few units implemented, complaints were voiced because the users did not realize that the queuing would diminish as their proficiency increased. Later, units were warned to allow at least a month before questioning their need for an additional terminal.

Nursing notes being entered into MIS also created terminal queuing because most nurses seemed to do much of their charting at the end of the shift. Even though they did learn somewhat to chart across the shift, it was determined that those units entering nursing notes into the system did need an additional terminal.

By June, 1972, it was evident that the notes were a drain on the capacity of the system. Technicon, at that time, wanted to discontinue entering nursing notes, but ECH nurses wanted to retain this

capability. A compromise was worked out whereby those units already implemented (4W, 2E, 6W, and the Maternity complex) continued entering nursing notes, but no others were subsequently added. Later, 4-West decided to return to the manual system due to the pressure from their physicians. In retrospect, it seems that the judgment to discontinue MIS nursing notes may have been made too soon. While at that time no time savings were apparent, MIS usage now seems to be saving time on those units still entering nursing notes. A program is currently under way involving nursing personnel and a nursing consultant to the hospital, to develop a new approach to nursing notes reflective of patient care planning. The results of this may precipitate another look at MIS entered nursing notes. For further discussion, see Section 3.15, Post-Implementation Activities.

3.2.1.3. Unit Start-Up Trauma

Every unit experienced an emotional response to MIS implementation which lasted approximately one month. It was necessary for nursing personnel to relearn all methods of information processing. They were required during initial implementation to think through each action instead of automatically performing it, resulting in mental strain which surfaced in the form of exhaustion, anger, and frustration. Such reactions were most apparent during the second and third weeks of implementation: the first week tension being modified by interest in the new machine, the fourth week tension decreasing due to increased familiarity with the system.

Another emotional phenomenon seen, though certainly to a much lesser degree, was fear, the anxiety that the nurse would not be able to learn the new system. This was dealt with when encountered by supplying additional support during the initial learning and use stages.

3.2.1.4 Surgery Coordination Problems

The fact that the MIS operating room (O.R.) system was developed while the O.R. supervisor was on a leave of absence, and thus without her cooperation and verification, created surgery coordination problems. As originally designed, the O.R. checklist involved multiple

handling of the same data. Due to its low priority for change action, the MIS O.R. checklist was abandoned, and the manual checklist reinstituted for the time being. Neither was the recovery room system of data entry adequate; and therefore, a new reporting system had to be developed. There is now in process a plan to develop an improved Pre-operative Summary for the operating room which would pull together all pertinent data according to their needs and eliminate these problems.

3.2.1.5 System Downs

Nursing, from the beginning of implementation, tolerated well all system problems with the exception of system downs. The attitude of nursing to MIS varied directly with the pattern of downs and slowdowns in system response time. Generally, more important than the length of the down was the time at which it occurred. For example, when new orders had to be entered on a critical patient, a down would create more distress than if the system went down when all orders were already entered. An elaborate manual back-up system exists for lengthy downs so that the proper patient care can be delivered without the availability of the MIS system. So far, circumstances have not required full scale use of the back up system throughout the hospital.

3.2.1.6 Training

The training of nursing personnel was a well-planned effort, the success of which hinged on all implementation plans proceeding according to schedule. Due to the developmental nature of the system, however, this was not the case. Because of implementation schedule delays, the training program lost the impact it should have had. By the time most stations were implemented, nursing personnel had forgotten much of the information they had learned in the training sessions several months previously.

3.3 Clinical Laboratory Implementation

Upon implementation of 4-West, the laboratory subsystem was found to be the least satisfactory of the subsystems in terms of completeness and reliability. This can be partially attributed to the fact that the functions of the laboratory are extremely complex and their definitions not always clear-cut.

Due probably to the incompleteness of its development when initial implementation began, the MIS laboratory system started off on a "bad footing" with laboratory personnel. Lengthening their period of frustration and deepening this disaffectation was the fact that laboratory personnel were forced to "crutch" the system manually to wait out changes for other areas which had a higher priority.

Now, with significant increase in development, the system is becoming more accepted and more willingly used by laboratory personnel. Two major improvements to make possible direct interface between the test readout and entry of the results into MIS are planned for future implementation. Results from the automated SMA-18 chemistry panel, which comprise one-third of the test load, will be read directly into MIS by means of a supplemental interface computer. A mark sense results entry system will speed the handling of approximately another one-third of the results entry.

3.3.1 Statusing

At the outset, a major system problem for both nursing and the laboratory concerned the statusing of orders. Orders for laboratory work were either open or complete with no indication as to whether the specimen had been collected. This was soon largely remedied by 1) automatic statusing of all items printed on the batch specimen pick-up list, 2) automatic statusing of all high priority orders, and 3) nursing entry of status for specimens they collected, and laboratory entry of status for lab-collected specimens. Further improvement in this problem area was achieved through automatic statusing of all orders scheduled for a specific time. The laboratory also gained the capability of changing the time of specimen

collection if it varied significantly from the automatically assigned status. With the addition of more batch pick-ups, the majority of tests are now automatically statused.

Confusion was generated among nurses, doctors, and laboratory personnel alike by ambiguities of dating results in the original laboratory system. For some tests the date and time appearing on the test results summary corresponded to the order entry time; while, for others it corresponded to the date and time of entry of test results into the system. The development of a statusing subsystem corrected this by printing the date and time the specimen was collected and statused. Still more improvement in the statusing function is planned.

3.3.2 Scheduling

When implemented, the laboratory system allowed only for the entry of general schedules: stat, today, tomorrow, and daily. All tests not so timed would be scheduled by the laboratory. Tests prescribed by the doctor for a specific time could be entered only via a type-in which occasioned extra work and often resulted in missed pick-ups. Scheduling matrices for ordering laboratory tests thus had to be developed to meet these nursing requirements.

3.3.3 Test Results Entry and Format

The system, as originally designed, was to have laboratory results entered by the technologist performing the test. Laboratory management, however, rejected this approach, and clerical personnel handled this function for many months. Gradually, technologists have begun to enter Stat results and other results as they have time.

When the laboratory system was first implemented, the test results entry system was cumbersome. To enter results, the technologist or clerk had to retrieve the worksheet on the screen. Retrieval of a single patient worksheet could only be accomplished by means of a very indirect route. Rectifying this situation reduced test result entry time in half,

greatly reduced overtime, and had a significant impact on the changing attitudes of the technologists toward entering their own results.

Another factor which contributed to the technologist's disinclination to enter test results was the mid-afternoon system slowdown. This phenomenon occurred when high usage of the system was experienced throughout the hospital and caused significant delays between user commands and system response. Hardware changes, software improvements, and reduction of nursing note entry alleviated this developmental problem.

The system was designed with a batched reporting capability. The laboratory, however, has found the batch reporting system an unsatisfactory mode of operation.

The chart format for laboratory test results, early in implementation, was unacceptable to physicians because it was difficult to read. A major change was made which reorganized the results and highlighted abnormal results.

3.3.4 Dual System

Implementation of MIS in the laboratory progressed incrementally with the addition of each nursing station. A dual system was thus in operation for a period of nine months. This created confusion due to dual filing systems and difficulty in handling patients who transferred between MIS and non-MIS units.

This incremental implementation also meant that the laboratory was constantly being presented with non-proficiency problems associated with new users. An implementation plan whereby the laboratory system came up over the whole hospital at once would have eliminated these problems in an operational system, but would have created a dangerous situation for patients in a developmental system because of the prohibitive amount of monitoring required.

3.4 Radiology Implementation

The Radiology Department was implemented incrementally as nursing stations began using MIS and suffered some of the same general system deficiencies as did the clinical laboratory. One of these was the absence of a statusing system. When a solution was first designed, it was necessary for the radiology technologists to make seven selections on each patient to be able to status. An interim solution makes statusing possible in three steps per patient, eliminating not only selections but also more complex data accesses. Another initial problem shared with the laboratory was an inadequate scheduling system. The scheduling matrices were not explicit enough to meet the needs of Radiology.

The reporting matrices were set up with "normal" results statements which could simply be selected by light pen, thus eliminating the need for typing repetitive statements into the terminal by a medical secretary. The statements, however, did not consistently conform to the style of the radiologists, and they often did not use them. Future work is expected on the development of standard radiology statements.

The original keyboard used with the system was layed out differently from the IBM Selectric typewriter previously in use. Consequently, it took the transcriptionists longer to type reports. This problem was corrected in July, 1972, with the installation of a third generation keyboard on the terminals involved identical to the IBM Selectric.

As was the case in the laboratory, the MIS radiology system was not fully developed when it was initially implemented at El Camino Hospital. Consequently, there were continuing problems which were aggravated by the fact that system changes were given priorities which often left the x-ray department waiting. In contrast, the Nuclear Medicine and Radiation Therapy departments experienced only minor problems with implementation.

3.5 Pharmacy Implementation

A unit dose dispensing system was implemented at El Camino concurrently with the MIS information processing system. It was judged more advantageous from the nursing point of view to make the two important changes

at once rather than to create a second major adjustment. From a pharmacy perspective, to implement unit dose without MIS would have necessitated at least several more employees.

Because many months of work by the ECH pharmacists went into the pharmacy system before actual implementation, relatively few problems were encountered after 4-West start-up. Some minor problems with schedules and duplicate orders due to initial user proficiency were initially recognized. Intravenous additive medications are a problem because incomplete information prints on the label which is produced in the pharmacy by MIS.

Operating on a dual system also created some difficulties for the Pharmacy if a patient was transferred between MIS and non-MIS units. Pharmacy now receives MIS notification of transfers to facilitate drug deliveries to the nursing units.

Future development plans for the pharmacy include drug interaction notices, drug allergy alerts, and a narcotic control system.

3.6 Medical Records Implementation

Difficulties in changing clerical procedures at a rate to keep pace with new methods of hospital wide information processing occurred during implementation in Medical Records. Upon implementation of the first nursing station, Medical Records began a phase of extensive checking of all chart documents which soon resulted in a large backlog. This was probably due to 1) the substantial degree of caution which a Medical Records department must exercise to insure compliance with accreditation and legal standards; 2) the discovery of system deficiencies early in implementation; 3) a lack of knowledge of the intricacies of the system; and 4) insufficient support to evaluate the probable frequency of chart deficiencies and develop efficient methods for discovery and elimination of such deficiencies. To handle the backlog which had developed, Medical Records increased their staff to a peak of 4½ full time equivalents additional.

MIS supplied Medical Records with much more chart information for monitoring of clerical accuracy, including the sequential numbering of physician's orders. In Septemter, 1972, Technicon began printing a Medical Record abstract for each patient for use in compiling statistical reports.

An improved format now permits Medical Records clerks to scrutinize the chart more easily. Another program to ease the workload and reduce staff to its original level is soon to be implemented. Nursing clerks will organize the charts before sending them to Medical Records and will have the capability to order reprints of any missing data, formerly a level of access limited to Technicon System directors.

3.7 Central Service Implementation

Central Service was converted to MIS usage relatively smoothly. The early elimination of admit notices for Housekeeping and the Mail Room which were being printed in Central Service greatly reduced the amount of paper handling there.

Probably the most significant problem involved the organization of Central Service items by category on the ordering matrices. Items were difficult to find and rather than search for an item, the nurse would often type it in, requiring, then, manual charging by Central Service. In November, 1972, newly designed matrices became available. Items were cross-indexed alphabetically and by category. There is also a matrix for all commonly ordered items.

The original requisition supplied Central Service with only the patient's room number and not the ordering location. Thus, if an item were ordered by the recovery room, for instance, the item would still be sent to the patient's nursing station. This problem also has been corrected.

3.8 Food Service Implementation

The food service system was designed to print doctor's orders and a diet list for each nursing unit in dietary service. Also printed were all admit, transfer, and discharge notices. These notices were later discontinued and the data incorporated into the diet list. This system did not account for the fact that nurses modify doctor's orders (such as making more explicit the order for diet as tolerated) and that more than one diet order can exist at one time. Currently, the diet list is printed on the

unit, checked by a nurse, annotated if necessary, and returned to dietary to ensure that dietary knows which orders are appropriate. This procedure is planned for change in the future.

3.9 Outpatient Implementation

The use of MIS by the Outpatient Department was implemented in late May, 1972, immediately following training. By that time, MIS operation on several nursing stations had stabilized and approximately 40% of in-patients were on the system.

The major problem in the outpatient registration system was one of computer processing priorities. Orders for tests could not be entered until the computer updated the file to include registration of that patient. Because of processing priorities, this often took from 15 to 30 minutes, causing delays in the ancillary department where the tests were to be run. This has been changed whereby the outpatient clerk can register a patient and enter an order immediately thereafter. Another improvement involved delaying the purge of outpatients from the system to extend the time period over which results could be reported.

3.10 Emergency Room Implementation

In July, 1972, the Emergency Room subsystem was tested at the hospital. Numerous problems were experienced with incorrect charges, patient transfers, incompleteness of selections, and specialized E.R. requirements.

Because manpower was needed to solve outstanding system problems, the decision was made to defer work on the E.R. module in order to concentrate efforts on improving the larger system operation.

Emergency Room personnel had been trained to use MIS in July of 1972 but by the time implementation was imminent in the fall, the system design had changed drastically and retraining was necessary. Because certain E.R. information processing could not be delayed if the computer system experienced operational difficulties, an important part of training was

skilled use of a manual back up system.

In September, MIS hospital wide operations had stabilized somewhat and the effort to implement the E.R. was renewed. Thorough testing of the redeveloped system was undertaken on all three shifts with vendor and hospital staff providing support.

On October 23, 1972, the Emergency Department began full-time operation on MIS. Unfortunately, concurrently with implementation, the E.R. experienced record workload demands as they struggled to adapt to a new set of work tools and a new approach to their work. Originally, 2 video-matrix-terminals and one printer had been deemed sufficient for E.R. use. It now became apparent that a third terminal was necessary on evenings, weekends, and holidays for additional registration capabilities to handle a peak volume of patients in a short period of time. To solve this problem, an arrangement was made whereby a terminal in a nearby ancillary department could be moved into the E.R. during peak hours which coincided with its availability in the ancillary.

Problems experienced in the first months of emergency room implementation included E.R. chart format changes, lengthy waits for printouts, transfer of patients to inpatient status, and insufficient information selection capabilities.

A specialized Emergency Room problem was the need for a quick registration chart with only name, patient number, time, and date. E.R. personnel also needed the ability to register John Doe or X as the patient name and to correct this with the actual name when it was available. By mid-January, however, most of these problems had been solved and even the most skeptical of E.R. nurses acknowledged that the system was quite a help to her.

3.11 Business Office Implementation

Since El Camino Hospital had a Business Office System approximately 3½ years before MIS was implemented, transition in the Business Office to use of the whole hospital system was relatively simple. As ECH departments began using MIS, implementation consisted of replacing keypunch input to the

computer with the automatic collection of data through MIS. Corrections of charges and entry of cash receipts were handled by one clerk through use of the lightpen and keyboard at a VMT. An auditing procedure was initiated by the controller, to ensure that charges were being properly collected by MIS and channeled into the Business Office System.

3.12 Implementation in Other ECH Departments

Implementation of MIS for Inhalation Therapy was accomplished with few problems. With the exception of changes to some matrices, the largest problem for Inhalation Therapy was that their volume of information processing was not deemed large enough to require a dedicated VMT and printer. While using a printer elsewhere is not a significant problem, using available VMTs situated in other areas is inconvenient and occasionally delays entry of data on therapies.

Basically, the same problems existed for the Pulmonary Laboratory, except that the lack of a printer was more important. At first, the nursing unit where their requisitions printed discarded many orders as scrap paper. This situation was immediately remedied, and operations are now functioning smoothly. At present, blood gas test reports cannot be entered due to matrix design inadequacy; change has been slow due to low priority.

The EKG-EEG Department uses MIS primarily as a source of requisitions for tests and to enter billing data. An attempt was made to enter test reports but since the doctors preferred a copy of the tracing itself, the report entry development was discontinued. A soon to be implemented change to consolidate the worksheet and requisition formats will improve paper handling efficiency even more.

3.13 Physician Interface Experience

During implementation, the problems faced by physicians can roughly be divided into two categories, terminal interface and chart document usage.

Physician interface with the video-matrix-terminal was made difficult by the fact that training and corresponding system familiarity occurred

in most cases many months before implementation. Because of this, some physicians found the system cumbersome and preferred to continue handwriting their orders. Each doctor was encouraged to develop his own personal order set which would decrease the amount of time spent either handwriting or entering orders to the VMT. Surgeons, obstetricians and gynecologists, urologists, and ophthalmologists made extensive use of personal order sets. Internists, however, in general, preferred to handwrite their orders. This is thought to be a function of the nature of internists' order sets which tend to be more lengthy and non-standardized, factors which make them less amenable to formulation into time-saving personal order sets.

Early in implementation, orders not meeting the correct system format requirements would be rejected by MIS, to the dismay of the entering physician. To ameliorate this situation, an "error override" option was introduced which would cause the incorrectly formulated order to print out at the nursing station exactly as entered and flagged for nursing attention. A nurse would interpret and reformat the order in a form acceptable to both the doctor and the system. This error override feature eased the transition period during which physician user proficiency increased and the system requirements were modified. Little use has been made of this option in recent months.

Because patients are often attended by more than one physician, one of the first problems with MIS for the physician was the need to have patients listed on multiple doctor's lists. This was resolved in April, 1972; an unlimited number of physicians may now write orders in the system on the same patient.

Immediately following the first nursing station implementation, the lack of a fully developed scheduling system for ancillary service ordering was a problem for the physician. No future scheduling on a laboratory or radiology test was possible, and high priority (Stat) ordering on more than one test was unclear with frequently only the last test being scheduled Stat. This situation has also been corrected.

Usage of many new chart documents presented added transitional problems for the physician. The MIS 24-Hour Summary was originally designed in a time sequence format. The doctor, however, preferred to review data by type as it was organized in the manual chart, and the 24-Hour Summary was, therefore, reorganized in this manner.

Laboratory reports were changed several times in an attempt to make them more readable. The latest format uses three letter case sizes with highlighting achieved by double imprinting of desired characters and flagging of abnormal values. Physicians have enthusiastically approved this new design.

As originally implemented, MIS did not provide a seven-day medications summary. At the physicians insistence such a document was supplied although its usefulness is now questioned. The seven day comparative laboratory summary first printed regularly once a day and whenever specially requested. Physicians requested that since this summary duplicated other printouts, regular printing should be discontinued.

Throughout implementation, any physician with a complaint or suggestion could channel it to the MIS Physician Committee through use of the hospital dictation-transcription service. In actuality, relatively few doctors used this opportunity.

3.14 Problems and Changes

Problems with and changes to the Technicon Medical Information System during implementation at El Camino Hospital were monitored through the MIS Change Request (MCR) Control System established for that purpose. From the summer of 1971 through the summer of 1973, approximately 4000 items were documented as areas for review. Change requests were generated both by hospital and vendor personnel and existed largely due to the developmental nature of the system.

The MCR Control System encompassed several different kinds of system changes. The first of these involved operational procedures to make MIS work, types of problems which had, generally, the most immediate need for correction. During implementation, examples of such problems were as follows:

1. Information missing from printouts
2. Unwarranted proliferation of reprints
3. Equipment malfunction
4. Determination of the optimum number of VMTs in a department

5. Afternoon system slowdown
6. Delays in record update for outpatients
7. Lack of operating procedures for computer operators
8. Indefinite time and date designations for laboratory specimens
9. Inadequacies of the dietary system
10. Incomplete scheduling system for medications, radiology, and laboratory

A second type of change within the MCR Control System involved matrix changes. These encompassed the correction of spelling errors, item coding errors, and redesign of matrix format, as well as the addition of requested items to matrices.

Another kind of system change was initiated by a transmittal form. These enabled changes to be made in charge tables, the ancillary service order tables, and user identification tables.

System change requests were also initiated by the hospital to expand the capabilities of MIS. These were often major and long-range changes though they might be otherwise. Examples of these follow:

1. Secondary laboratory order capability
2. Automatic patient numbering
3. 7-Day Meds summary report
4. Expanded 7-Day test results summary
5. Error override for physician's orders
6. Patient chart revisions
7. Lab test results format
8. Medical records abstract
9. Graphic reporting of TPR's
10. Printing of physician's patient list at his request
11. Printing of insurance information at physician's request
12. Statusing of ancillary tests & procedures
13. Modification of keyboard for radiology secretary
14. Drug interaction and allergy control

Technicon also initiated system changes to upgrade the hardware and system programming. The MIS computer capability was upgraded in November, 1971, from an IBM 360/40 and 360/50 configuration to a 360/50 and

IBM 370/145 and 370/155 combination. Within that time other hardware changes were made to change soft-recovery (recovery from a software generated computer processing failure) records from tape to disc, to expand the patient master file by adding a third disc, and to add core (memory) to increase processing capacity. Software changes in the first nine months of 1972 included an improved report generator program, increased speed of retrieval and processing of test data for ancillary reports, revised print-out management programs, increased speed of admission/discharge programs, and a revised internal monitoring program to improve systems analysis of computer tasks.

3.15 Post-Implementation Activities

This history has described the technical implementation of MIS at El Camino Hospital. Since MIS became operational throughout the hospital, an extensive project has been undertaken to further improve system capability and performance and to realize the benefits made available by MIS through changes in work content.

System changes that have occurred and other improvements since 1972 are discussed in this report, particularly in Section 11.0 and Appendix H.

APPENDIX C

1974 NURSING QUESTIONNAIRE

C-1-a

APPENDIX C

1974 NURSING QUESTIONNAIRE

On the following pages, the questionnaire for the 1974 nurses' evaluation of MIS appears. The percentage distribution of responses for each item has been inserted. To the left of the item, the number of nurses who responded to the item is shown.

NURSING SERVICE QUESTIONNAIRE - CONFIDENTIAL
PERCENTAGE DISTRIBUTIONS FOR RESPONSES

Identifying Information

Name*_____ Date _____
(last) (first) (middle initial)

Responses

Unit to which you are usually assigned _____

163 Shift: 46.0 Days (1) 35.0 P.M.'s (2) 19.0 Nights (3)

163 Number of years employed at El Camino:

16.6	less than 1 year (1)	11.7	3 years (4)
10.4	1 year (2)	8.6	4 years (5)
14.1	2 years (3)	38.7	5+ years (6)

161 Age:

42.9	18-29 (1)	14.9	40-49 (3)	0.0	60+ (5)
29.2	30-39 (2)	13.0	50-59 (4)		

163 Employment Status: 76.1 (1) Full Time 23.9 (2) Part Time

162 Position: RN 63.0 (1) LVN 3.7 (2) NA 24.1 (3) Clerk 3.7 (4)

Charge or Head Nurse 5.6 (5) Other (specify) 0.0 (6)

162 Do you interact directly with the MIS Terminal? 92.6 (1) Yes 7.4 (2) No

159 Please rate yourself in terms of your proficiency in using MIS:

7.5	27.7	56.6	8.2
Beginner (1)	Intermediate (2)	Proficient (3)	Expert (4)

*It is important to the evaluation of MIS that you be identified on this form. You are assured that individual responses will not be divulged, and will be utilized only to track your prior response to questionnaires.

TRAINING AND MECHANICAL ASPECTS

For each of the following statements about the training and mechanical aspects of MIS please check (✓) the blank which most nearly reflects your degree of satisfaction.

		Highly Satisfactory (1)	Satis-factory (2)	Barely Satisfactory (3)	Unsatis-factory (4)	Highly Unsatis-factory (5)
	TRAINING ASPECTS					
153	1. Being trained to use the system	9.2	54.9	20.9	10.5	4.6
156	2. After training, becoming accus-tomed to use the system	13.5	71.8	7.1	7.1	0.6
156	3. Obtaining help when the system does not respond as expected	19.9	56.4	16.7	5.1	1.9
	MECHANICAL ASPECTS					
155	1. Using the keyboard	30.3	64.5	3.9	1.3	0.0
156	2. Using the light pen	17.3	63.5	14.7	3.2	1.3
154	3. Legibility of machine print-out	37.0	58.4	3.9	0.6	0.0
155	4. Maintenance of equipment	16.1	69.0	11.0	3.9	0.0
155	5. Time for system response when entering or accessing information	15.5	70.3	9.7	4.5	0.0

THE MEDICAL CHART

For each of the following statements about the medical chart aspects of MIS, please check (✓) the blank which most nearly reflects your opinion.

	WITH MIS:	Strongly Agree (1)	Agree Somewhat (2)	No Opinion (3)	Disagree Somewhat (4)	Strongly Disagree (5)
157	1. Information is readily accessible	35.0	48.4	6.4	10.2	0.0
158	2. Information is in convenient format	36.1	43.7	8.9	10.1	1.3
157	3. All necessary information is available	25.5	46.5	8.3	17.8	1.9
158	4. Information is quickly available	32.3	43.0	7.6	15.2	1.9
157	5. Medications given are readily verified	47.1	28.7	15.3	8.3	0.6
146	6. Fluid intake and output data are readily found in the chart	15.8	24.7	47.9	6.8	4.8
157	7. Test data are readily accessed	36.9	32.5	16.6	12.1	1.9
155	8. Radiology reports are readily accessed	27.7	35.5	20.6	12.3	3.9
155	9. The chart is appropriately organized	27.7	38.7	18.1	15.5	0.0
157	10. In general, the chart is satisfactory	28.7	43.9	14.0	10.8	2.5

		Highly Satis-factory (1)	Satis-factory (2)	Barely Satis-factory (3)	Unsatis-factory (4)	Highly Unsatis-factory (5)
145	12. Interpretation of physician orders	30.3	62.1	5.5	2.1	0.0
78	13. MIS Nursing notes (if applicable to your unit)	30.8	60.3	7.7	1.3	0.0
144	14. Patient Care Plan printouts	51.4	45.8	2.1	0.7	0.0

NURSING CARE ASPECTS

For each of the following statements about the nursing care aspects of MIS, or areas where MIS may have an impact, please check (✓) the blank which most nearly reflects your degree of satisfaction.

	MIS IMPACT UPON:	Highly Satis-factory (1)	Satis-factory (2)	Barely Satis-factory (3)	Unsatis-factory (4)	Highly Unsatis-factory (5)
143	1. Organization of the unit	25.2	66.4	2.1	6.3	0.0
144	2. Time available for direct nursing care	27.8	58.3	9.7	4.2	0.0
146	3. Time on clerical work	26.7	50.7	13.7	7.5	1.4
144	4. Patient care planning	31.9	56.9	6.9	3.5	0.7
134	5. Assistance in scheduling of patients for diagnostic X-ray, laboratory procedures and therapy	28.4	57.5	9.0	4.5	0.7

MEDICATION ASPECTS

For each of the following statements about provision of medication aspects of MIS, please check (✓) the blank which most nearly reflects your degree of satisfaction.

	MIS IMPACT UPON:	Highly Satis-factory (1)	Satis-factory (2)	Barely Satis-factory (3)	Unsatis-factory (4)	Highly Unsatis-factory (5)
127	1. Availability of newly prescribed medications	25.2	59.1	14.2	0.8	0.8
129	2. Timely administration of scheduled medications	41.1	53.5	5.4	0.0	0.0
130	3. Charting of scheduled medications	50.0	47.7	2.3	0.0	0.0
130	4. Timely administration of P.R.N. medications	42.3	51.5	6.2	0.0	0.0
130	5. Charting of P.R.N. medications	47.7	47.7	3.1	1.5	0.0

INFORMATION TRANSFER ASPECTS

For each of the following statements about information transfer aspects of MIS, please check (✓) the blank which most nearly reflects your degree of satisfaction.

	MIS IMPACT UPON:	Highly Satis-factory (1)	Satis-factory (2)	Barely Satis-factory (3)	Unsatis-factory (4)	Highly Unsatis-factory (5)
129	1. Completeness of change of shift report	24.0	65.1	7.0	3.9	0.0
129	2. Speed of change of shift report	20.2	62.0	14.0	3.9	0.0
133	3. Speed of updating knowledge after days off	27.8	57.9	11.3	3.0	0.0
131	4. Knowing which lab work is to be done on any given day	38.9	47.3	10.7	2.3	0.8
130	5. Time for entering information before printout deadlines	13.8	58.5	21.5	4.6	1.5
133	6. Finding computer generated information during heavy use periods	6.0	46.6	32.3	13.5	1.5

GENERAL EVALUATION OF MIS

For each of the following statements about MIS, please check (✓) the blank which most nearly reflects your opinion.

		Strongly Agree (1)	Agree Somewhat (2)	No Opinion (3)	Strongly Disagree (4)	Disagree Somewhat (5)
1. 152	MIS is no better than the way things used to be done at El Camino.	3.3	11.8	23.7	43.4	17.8
2. 155	The benefits of MIS to me have outweighed the trouble of learning to use the system.	49.7	30.3	7.7	5.2	7.1
3. 155	MIS forces me into a routine, making me less creative.	2.6	4.5	18.1	53.5	21.3
4. 155	MIS makes my role less important.	1.3	1.9	14.8	72.3	9.7
5. 151	One department or service of the hospital should have tried MIS for awhile before committing the entire hospital.	10.6	16.6	25.8	31.8	15.2
6. 152	El Camino is a more desirable hospital in which to practice than other hospitals around here.	52.6	18.4	25.0	1.3	2.6
7. 154	The whole idea of a computerized medical information system turns me off.	1.3	5.2	9.7	68.2	15.6
8. 152	MIS facilitates communication with other professionals.	20.4	48.7	17.8	3.3	9.9
9. 155	MIS significantly alters the way I perform my work.	8.4	31.0	16.8	28.4	15.5
10. 154	MIS permits me to work with others more effectively.	15.6	42.9	19.5	9.7	12.3
11. 152	It is important that El Camino Hospital tried out MIS.	42.1	32.9	20.4	1.3	3.3
12. 154	Taking everything into account, MIS works well.	43.5	40.3	3.2	2.6	10.4
13. 155	The mechanics of using the MIS terminal are relatively easy.	41.9	52.9	1.9	3.2	0.0

		Strongly Agree (1)	Agree Somewhat (2)	No Opinion (3)	Disagree Somewhat (4)	Strongly Disagree (5)
152	14. The patient stay in the hospital is more satisfactory with MIS.	10.5	27.6	44.7	11.8	5.3
154	15. MIS cannot perform as expected.	2.6	14.3	26.6	21.4	35.1
153	16. The length of patient's stay in the hospital has been reduced.	2.6	10.5	62.1	13.1	11.8
151	17. MIS has saved money.	2.6	6.6	68.2	5.3	17.2
156	18. With MIS I have to wait in line to input and to obtain output information.	7.1	44.2	8.3	25.6	14.7
153	19. The hospital functions more smoothly with MIS.	17.0	39.9	30.7	10.5	2.0
154	20. I would prefer that another hospital had tried MIS before El Camino.	3.2	7.1	40.9	18.8	29.9
155	21. Under MIS I feel more knowledgeable about my patients.	23.2	41.3	14.8	14.8	5.8

INTERDEPARTMENTAL ASPECTS

For each of the following statements about MIS, in interaction with other hospital departments, please check (✓) the blank which most nearly reflects your degree of satisfaction.

	MIS IMPACT UPON:	Highly Satisfactory (1)	Satisfactory (2)	Barely Satisfactory (3)	Unsatisfactory (4)	Highly Unsatisfactory (5)
129	1. Changes in diet orders by the dietary department	16.3	56.6	18.6	3.9	4.7
146	2. Ordering from Central Service	42.5	49.3	5.5	2.7	0.0
144	3. Time for supplies to arrive from Central Service	27.1	50.7	16.0	5.6	0.7
141	4. Ordering laboratory procedures	36.2	59.6	3.5	0.7	0.0

COMMENTS

We welcome any and all comments you may have about MIS at El Camino Hospital.

164 63.4% with comments.

PLEASE TAKE A MOMENT TO MAKE SURE YOU HAVE ANSWERED ALL QUESTIONS. THANK YOU FOR YOUR COOPERATION IN FILLING OUT AND RETURNING THIS FORM. WE APPRECIATE IT VERY MUCH.

APPENDIX D

OTHER HOSPITAL STAFF QUESTIONNAIRE

APPENDIX D

OTHER HOSPITAL STAFF QUESTIONNAIRE

The questionnaire used for the 1974 survey of non-nursing, non-physician hospital staff, referred to as other hospital staff, is presented on the following pages. For each statement on the form, the distribution of responses has been inserted, and the total number of non-blank responses appears in the left margin. These tabulations apply for the 51 staff members who responded to the form.

OTHER HOSPITAL STAFF QUESTIONNAIRE
GENERAL EVALUATION OF MIS

For each of the following statements about MIS, please check (✓) the blank which most nearly reflects your opinion.

	Strongly Agree (1)	Agree Somewhat (2)	No Opinion (3)	Strongly Disagree (4)	Disagree Somewhat (5)	
1. MIS is no better than the way things used to be done at 50 El Camino.	12.0	10.0	24.0	26.0	28.0	38
2. The benefits of MIS to me have outweighed the trouble of 50 learning to use the system.	36.0	26.0	20.0	6.0	12.0	39
3. MIS forces me into a routine, 50 making me less creative.	2.0	10.0	36.0	34.0	18.0	40
4. MIS makes my role less 49 important.	0.0	8.2	26.5	57.1	8.2	41
5. One department or service of the hospital should have tried MIS for awhile before committing 48 the entire hospital.	6.3	16.7	25.0	27.1	25.0	42
6. El Camino is a more desirable hospital in which to work than 49 most other hospitals around here.	59.2	16.3	18.4	2.0	4.1	43
7. The whole idea of a computerized medical information 50 system turns me off.	0.0	10.0	6.0	68.0	16.0	44
8. MIS facilitates communication 50 with others.	28.0	22.0	6.0	12.0	32.0	45
9. MIS significantly alters the 50 way I perform my work.	16.0	28.0	16.0	24.0	16.0	46
10. MIS permits me to work with 50 others more effectively.	14.0	28.0	18.0	14.0	26.0	47
11. It is important that El Camino 51 Hospital tried out MIS.	49.0	31.4	15.7	0.0	3.9	48
12. Taking everything into account, 50 MIS works well.	34.0	42.0	6.0	2.0	16.0	49
13. The mechanics of using the MIS 51 terminal are relatively easy.	43.1	41.2	3.9	0.0	11.8	50

		Strongly Agree (1)	Agree Somewhat (2)	No Opinion (3)	Disagree Somewhat (5)	Strongly Disagree (4)	
14. 50	The patient stay in the hospital is more satisfactory with MIS.	8.0	22.0	50.0	10.0	10.0	51
15. 49	MIS cannot perform as expected.	6.1	24.5	28.6	18.4	22.4	52
16. 49	The length of patient's stay in the hospital has been reduced.	6.1	4.1	75.5	4.1	10.2	53
17.	MIS has saved money.	5.9	11.8	47.1	17.6	17.6	54
51 18. 50	With MIS I have to wait in line to input and to obtain output information.	4.0	48.0	14.0	20.0	14.0	55
19. 50	The hospital functions more smoothly with MIS.	10.0	34.0	28.0	18.0	10.0	56
20. 50	I would prefer that another hospital had tried MIS before El Camino.	4.0	6.0	38.0	22.0	30.0	57
21. 50	Under MIS I feel more knowledgeable about patients.	38.0	38.0	14.0	6.0	4.0	58

APPENDIX E

1974 PHYSICIAN QUESTIONNAIRE

APPENDIX E

1974 PHYSICIAN QUESTIONNAIRE

On the following pages the questionnaire for the 1974 physicians' evaluation of MIS is reproduced. For each item on the form, the percentage distribution of responses have been inserted. To the left of the item, the number of physicians who responded to the item is indicated. These tallies apply only to the 133 physicians who indicated some use of MIS. The twenty-five physicians who responded that they had no desire to use MIS were excluded from the tabulations.

Date _____

PHYSICIAN QUESTIONNAIRE

Identifying Information:

Name* _____
(last) (first) (middle initial)

Responses

132 Sex: 5.3 Female 94.7 Male

Specialty: _____

128 Years on staff at El Camino: _____ 30.5 No more than 5 years 21.9 6-10 years 39.1 11-15 years 8.6 since start of ECH

Age:

130

1.5 25-29 (1)	47.7 40-49 (3)	2.3 60+ (5)
30.0 30-39 (2)	18.5 50-59 (4)	

Please rate yourself in terms of your proficiency in using MIS:

129

NA	9.3	41.9	43.4	5.4
No Desire to Use MIS (1)	Beginner (2)	Intermediate (3)	Proficient (4)	Expert (5)

* It is important to the evaluation of MIS that you be identified on this form. You are assured that individual responses will not be divulged, and will be utilized only to track your prior response to questionnaires and to correlate with the number of patient days (from medical records) you are responsible for at El Camino.

TRAINING AND MECHANICAL ASPECTS

For each of the following statements about the training and mechanical aspects of MIS please check (✓) the blank which most nearly reflects your degree of satisfaction.

		Highly Satisfactory (1)	Satis-factory (2)	Barely Satisfactory (3)	Unsatis-factory (4)	Highly Unsatis-factory (5)
	TRAINING ASPECTS					
124	1. Being trained to use the system	12.9	66.1	15.3	4.8	0.8
123	2. After training, becoming accustomed to use the system	8.1	61.0	22.0	7.3	1.6
122	3. Obtaining help when the system does not respond as expected	13.1	57.4	20.5	7.4	1.6
	MECHANICAL ASPECTS					
122	1. Using the keyboard	12.3	66.4	13.9	5.7	1.6
123	2. Using the light pen	13.0	54.5	22.8	8.9	0.8
123	3. Legibility of machine print-out	30.9	46.3	14.6	4.9	3.3
121	4. Maintenance of equipment	6.6	62.8	20.7	9.1	0.8
123	5. Time for system response when entering or accessing information	9.8	65.9	16.3	4.9	3.3

MEDICAL ORDERS

For each of the following statements about placing medical orders into MIS, please check (✓) the blank which most nearly reflects your opinion.

	WITH MIS:	Strongly Agree (1)	Agree Somewhat (2)	No Opinion (3)	Disagree Somewhat (4)	Strongly Disagree (5)
126	1. Orders are easy to enter	23.0	42.9	0.8	19.8	13.5
125	2. Orders are clear and explicit	30.4	44.8	3.2	16.8	4.8
125	3. There is no problem in signing orders	36.0	29.6	4.8	23.2	6.4
126	4. Entering orders into MIS saves time	22.2	19.0	4.8	27.8	26.2
124	5. The format for entering orders is convenient	19.4	35.5	2.4	28.2	14.5
124	6. Personal order sets are satisfactory	30.6	28.2	33.9	3.2	4.0
125	7. Standard order sets are satisfactory	18.4	29.6	37.6	12.0	2.4
125	8. Non-routine orders are conveniently handled	4.8	32.8	4.0	32.0	26.4
125	9. Current orders are readily located	35.2	45.6	3.2	9.6	6.4

118 10. Do you use the yellow order sheets (1) 6.8 100% of the time
(2) 10.2 Between 75% and 100% of the time
(3) 3.4 Between 50% and 75% of the time
(4) 14.4 Between 25% and 50% of the time
(5) 65.3 Less than 25% of the time?

THE MEDICAL CHART

For each of the following statements about the medical chart aspects of MIS, please check (✓) the blank which most nearly reflects your opinion.

	WITH MIS:	Strongly Agree (1)	Agree Somewhat (2)	No Opinion (3)	Disagree Somewhat (4)	Strongly Disagree (5)
129	1. Information is readily accessible	11.6	45.0	3.9	25.6	14.0
129	2. Information is in convenient format	12.4	44.2	3.9	21.7	17.8
129	3. All necessary information is available	13.2	40.3	8.5	27.1	10.9
129	4. Information is quickly available	14.0	33.3	5.4	27.9	19.4
128	5. Medications given are readily verified	16.4	44.5	10.2	21.1	7.8
127	6. Fluid intake and output data are readily found in the chart	11.8	33.9	24.4	22.0	7.9
128	7. Test data are readily accessed	21.1	42.2	10.2	15.6	10.9
128	8. Radiology reports are readily accessed	24.2	49.2	7.0	15.6	3.9
129	9. The chart is appropriately organized	10.9	45.7	10.1	22.5	10.9
129	10. In general, the chart is satisfactory	11.6	45.7	3.1	20.9	18.6

HOSPITAL PRACTICE AND PATIENT CARE

Please indicate your response to the following questions about hospital practice and patient care by placing a check (✓) in the appropriate boxes, and by commenting where indicated.

WITH MIS:

122 1. Is appropriate patient care and status information available at your regular time(s) of making rounds? [ ] Yes [ ] No
(1) (2)
66.4 33.6

122 2. a. Is the MIS patient list compatible with your method of making rounds?
[1] Yes [2] No 91.8 - Yes 8.2 - No

b. If No, why not? _____
12.0 - Comments

98 3. a. (check appropriate box) Does the MIS charting procedure [1] facilitate or [2] hinder your having relevant information at the patient's bedside? 59.2 - FAC 40.8 - HIN

b. If a hindrance, why? _____
39.1 - Comments

125 4. a. Does MIS effect your methods of delivering patient care? [1] Yes [2] No

b. If Yes, in what way? 40.8 - Yes 59.2 - No
39.1 - Comments

115 5. a. Does MIS effect the way you deliver care to patients who have extensive complications? [1] Yes [2] No

b. If Yes, in what way? 48.7 - Yes 51.3 - No
45.1 - Comments

6. Please indicate your degree of satisfaction with MIS procedures in the following areas by placing a check (✓) in the blank which most nearly reflects your opinion.

	MIS PROCEDURES WITH RESPECT TO:	(1) Highly Satisfactory	(2) Satisfactory	(3) Barely Satisfactory	(4) Unsatisfactory	(5) Highly Unsatisfactory
118	a. Admissions	36.4	54.2	5.9	3.4	0
121	b. Discharge	31.4	56.2	5.8	5.8	0.8
113	c. Emergency room	13.3	55.8	18.6	10.6	1.8
95	d. Outpatient care	14.7	60.0	13.7	7.4	4.2

E-7

GENERAL EVALUATION OF MIS

For each of the following statements about MIS, please check (✓) the blank which most nearly reflects your opinion.

		Strongly Agree (1)	Agree Somewhat (2)	No Opinion (3)	Strongly Disagree (4)	Disagree Somewhat (5)
127	1. MIS is no better than the way things used to be done at El Camino.	15.7	16.5	15.0	27.6	25.2
128	2. The benefits of MIS to me have outweighed the trouble of learning to use the system.	20.3	34.4	10.2	22.7	12.5
127	3. MIS forces me into a routine, making me less creative.	3.9	14.2	27.6	29.9	24.4
127	4. MIS makes my role less important.	0.8	3.1	23.6	53.5	18.9
125	5. One department or service of the hospital should have tried MIS for awhile before committing the entire hospital.	13.6	18.4	36.0	17.6	14.4
127	6. El Camino is a more desirable hospital in which to practice than other hospitals around here.	64.6	18.9	11.8	3.1	1.6
126	7. The whole idea of a computerized medical information system turns me off.	3.2	5.6	8.7	58.7	23.8
128	8. MIS facilitates communication with other professionals.	7.0	15.6	28.9	19.5	28.9
127	9. MIS significantly alters the way I perform my work.	12.6	22.8	15.0	22.0	27.6
127	10. MIS permits me to work with others more effectively.	5.5	14.2	26.8	24.4	29.1
126	11. It is important that El Camino Hospital tried out MIS.	31.0	36.5	15.9	5.6	11.1
127	12. Taking everything into account, MIS works well.	21.3	40.9	6.3	20.5	11.0
127	13. The mechanics of using the MIS terminal are relatively easy.	23.6	55.1	0	11.0	10.2

		Strongly Agree (1)	Agree Somewhat (2)	No Opinion (3)	Strongly Disagree (4)	Disagree Somewhat (5)
128	14. The patient stay in the hospital is more satisfactory with MIS.	4.7	10.2	43.8	19.5	21.9
125	15. MIS cannot perform as expected.	8.8	17.6	14.4	24.0	35.2
126	16. The length of patient's stay in the hospital has been reduced.	4.8	5.6	42.1	23.0	24.6
124	17. MIS has saved money.	2.4	14.5	65.3	9.7	8.1
126	18. With MIS I have to wait in line to input and to obtain output information.	5.6	42.1	7.9	14.3	30.2
127	19. The hospital functions more smoothly with MIS.	5.5	25.2	35.4	1.50	18.9
128	20. I would prefer that another hospital had tried MIS before El Camino.	16.4	13.3	27.3	24.2	18.8
128	21. Under MIS I feel more knowledgeable about my patients.	6.3	22.7	14.8	27.3	28.9
128	22. Nursing staff have a helpful attitude in my interaction with MIS.	38.3	39.8	14.1	2.3	5.5
127	23. With MIS, it is convenient to interact with medical records.	7.9	28.3	31.5	12.6	19.7

CONTINUED ON BACK SIDE

RESEARCH AND INFORMATION ASPECTS

For each of the following statements about research and information aspects of MIS please place a check (✓) in the blank which most nearly reflects your degree of satisfaction.

		Highly Satis-factory (1)	Satis-factory (2)	Barely Satis-factory (3)	Unsatis-factory (4)	Highly Unsatis-factory (5)
116	1. Clinical Laboratory interpretation aids	21.6	57.8	12.9	6.0	1.7
108	2. Antibiotic sensitivity	28.7	57.4	11.1	2.8	0
74	3. Surgical Abstracts	28.4	55.4	13.5	2.7	0

POST DISCHARGE ASPECTS

1. Do you, or your office assistant, utilize the take-home insurance information form? [1] Yes [2] No

   Comment 49.6 50.4 17.3 Comments

2. Do you utilize patient clinical reports mailed to your office after discharge? [1] Yes [2] No

   Comment 82.4 17.6 20.3 Comments

COMMENTS

We welcome any and all comments you may have about MIS at El Camino Hospital.

57.1 Comments

PLEASE TAKE A MOMENT TO MAKE SURE YOU HAVE ANSWERED ALL QUESTIONS. THANK YOU FOR YOUR COOPERATION IN FILLING OUT AND RETURNING THIS FORM. WE APPRECIATE IT VERY MUCH.

APPENDIX F

MIS INPUT AND RETRIEVAL CAPABILITIES BY CLASS

TABLE F-1. MIS INPUT AND RETRIEVAL CAPABILITIES BY CLASS(a)

Class	Input Capabilities	Retrieval Capabilities
Physician (M.D.)(b) (primary and consultant)	Diagnostic data (primary and secondary) Medical orders, including renew and discontinue--all classes of orders, e.g., medications, laboratory tests, etc. Discharge data on all patients Allergies Name of operative procedure performed and complications	All admission, medical data and nursing data for any patient--multiple indices includes inpatients, all patients, pre-admissions and unit, e.g., Emergency Room (ER), Outpatient Department (OPD), etc. Guide to use of MIS admission record (c)M.D. announcements (c)Antibiotic survey (c)Roster of psychiatrists by subspecialty (c)Insurance form (c) Surgical abstracts
Registered Nurses (RN)	Direct access to all nursing stations Medical orders (acting for physician); requires physician's signature. All patients' data A hospital-wide locator permits RN to access any patient's record. As an agent for M.D., RN has access as M.D. Enter status of laboratory tests, etc. Central service ordering	List of occupied and available beds by nursing station and total for hospital. All admissions and medical data on any patient on the ward where assigned (and patients on other wards because of transfers). Reprint requests for ward printouts (reprint any document up to 9 copies) Request printout of: 1. Unit work sheet 2. Patient status report 3. Diet list 4. Medications lists 5. Care plan

TABLE F-1. (Continued)

Class	Input Capabilities	Retrieval Capabilities
		6. Admissions and discharge records 7. Labels 8.(d) M.D. orders summary 9.(d) Nursing records and notes 10. Interim summary reports 11. Laboratory results
LVN, Ward Clerk or Nurse's Aide (e)	All nursing data for her unit. Central service ordering Enter status of laboratory test, etc.	Same as RN except cannot act as M.D. agent
Admissions Department (Only 1 Class)	All admission data (new and revised) and preadmission data including ER patients	All admission and pre-admission data Patient locator Available beds on each ward (ER registration data) Reprints of printouts of: 1. Preadmission data 2. Admission data 3. Admit from pre-admission 4. Admit from ER
Outpatient Department (Only 1 Class)	All patient registration data (new or revised) Enters medical orders as physician's agent (RN & Clerk) Request reprints for OPD printouts	All patient registration data All medical orders
Chief Pharmacist	Reprint requests for pharmacy printouts Adjust medication orders as M.D. agent. Note: All pharmacy charges and adjustments are entered by the business office	All medical data for all patients except for X-ray and ancillary tests and nursing notes. List of common medications by specialty. List of common medications by function. Antibiotic survey M.D. announcements

TABLE F-1. (Continued)

Class	Input Capabilities	Retrieval Capabilities
Pharmacist	Same as above	Same as above except for diagnoses
Emergency Department M.D.	Same as regular M.D. plus ER charges	Same as regular M.D. plus ER registration data
Emergency Department Nurse	Same as regular RN, plus charges and registration data Reprint requests--ER registration records	Same as regular RN plus ER registration data and ER charge data
Emergency Department Clerk	Emergency patient Registration data and charges Reprint requests	Emergency patients Registration data ER charge data
EKG, EEG, Pulmonary Medicine Departments (Only 1 Class)	Enter medical orders for his department as an agent for the physician. Enter charge codes Enter status of work Request reprints	All medical data on any patients. Department charge data
Inhalation Therapist (Only 1 Class)	Enter respiratory therapy orders as agent for physician. Enter changes Enter treatment data Request reprint of requisition	All medical data on all patients
Physical Medicine Department (Only 1 Class)	Request reprints for department Enter physical medicine orders as M.D. agent	None
Dietary Department (Only 1 Class)	Request reprints Dietition notes Enter dietary orders as M.D. agent	Allergies, diet orders, diet notes

TABLE F-1. (Continued)

Class	Input Capabilities	Retrieval Capabilities
Medical Records Department (Only 1 Class)	Request early or late record purge	All patient data on VMT Printouts of: 1. Index to patients 2. M.D. orders 3. Nursing notes and records 4. Admission and discharge list 5. Discharge list 6. Test results 7. Abstracts 8. 24 hours summary 9. 7-day medication list 10. 7-day input/output data 11. Pre-admit data 12. Nursing station patient list 13. ER patient list 14. OPD patient list 15. M.D. announcements 16. Total test results for hospital stay 17. Discharge summary
Pathologists (M.D.)	Verify test results Enter orders for laboratory followup tests. (sensitivities, etc.)	All patient data
Laboratory Technologist/ Clerk with ordering authority	Enter laboratory orders as agent for physician. Enter test results and verify results. Request printouts and reprints Enter status of laboratory work	All medical data for all patients
Laboratory Technician and Clerks without ordering authority	Enter test results and verify results. Request printouts and reprints Enter status of laboratory work	Medical data on patients who have open laboratory orders
Radiologist	Enter followup orders for any patient. Enter status of tests Enter charges Verify test results	All admission and medical data for all patients

TABLE F-1. (Continued)

Class	Input Capabilities	Retrieval Capabilities
Supervisory Radiology Technician	Enter all orders as agent for attending physician or Radiologist Enter test results and verify Enter status of work Order central service supplies Reprint requests Outpatient registration	All medical data as agent for a physician. Outpatient registration data.
Business Office Code 1 (Supervisor)	Enter charges, receipts, and adjustments Enter insurance data	Admission and insurance data
Code 2 (Clerk)	Enter insurance data	Admission and insurance data
System Directors (ECH Systems Engineering Department and Technicon Engineering representatives)	Request printouts or reprints. Can view all input matrices Entry authority is controlled administratively.	Act as any class of user Retrieve all MIS data--all types. Controlled administratively.

(a) Prepared by Technicon for El Camino Hospital, October, 1971. Revised April 3, 1973, and June 1974.

(b) If physician does not take VMT action within 10 seconds for confirmation display (obtained when orders are entered) and 120 seconds on all other displays, terminal is signed off for security purposes.

(c) RN can not retrieve.

(d) Previous date capability.

(e) Some nurse's aides at ECH have "RN" type access.

NOTE: M.D. narcotics control number is not entered in MIS.

APPENDIX G

DATA COLLECTION FORMS USED IN THE ANALYSIS OF MEDICAL RECORDS

APPENDIX G-1a

DATA COLLECTION FORMS USED IN THE ANALYSIS OF MEDICAL RECORDS

The forms used to collect data for the comparative analysis of medical records for accuracy and completeness in medical orders are presented on the following pages. Data Sheet 1 provided a summary of order sets and progress notes for each medical record selected for review and was used as the data base for analysis of medical order sets by day of stay (Section 6.2). Data Sheet 2 allowed for the collection of data to be used in determining irregularities in writing of medical orders. Data Sheet 3 provided for the collection of data on irregularities in reporting of results.

PATIENT NUMBER	DIAGNOSIS CODE	PHYSICIAN CODE	AGE	SEX	HOSPITAL SERVICE	DAYS STAY	DISCHARGE MONTH		DATA SHEET 1

PROGRESS NOTES & ORDER SETS BY DAY OF STAY				ORDER COUNT BY TYPE OF ORDER																					
							PHARMACY		LABORATORIES				RADIOLOGY			DIET	PATIENT CARE			MONITORING		THERAPY			
DATE	DAY NO.	NO. ORDER SETS	NO. PROG. NOTE SETS	SEC. ADJ.	DC RENEW	HOLD RE-START	MED	IV	CLINIC	PATH	XFSN	PULM. FUNC.	X-RAY	NUCLEAR MED DIAG.	NUCLEAR MED THR'Y	DIET	OB-SERV-ATION	Rx's	PERS. CARE & OTHER	EKG	EEG	RESPIR-ATORY	PHYS. SPEECH OCCUP.	NONE	TOTAL
TOTAL																									

PATIENT NUMBER	DIAGNOSIS CODE	MEDICAL ORDERS	DATA SHEET 2

		NUMBER OF ORDERS	OMISSIONS				CLARITY/INTERPRETATION				CLINICAL DATA PRESENTED				TOTALS
			DOSE VOLUME QUANTITY NO./DATE	SITE ROUTE APPLICATION ADMINISTRATION NO./DATE	SCHEDULE NO./DATE	PROCEDURE NOTES PREPS NO./DATE	ILLEGIBLE	HARD TO READ	AMBIGUOUS	ORDER REQUIRES CLARIFYING SEC. ORDER OR NOTE	MEDS. # orders / # orders	INDICATIONS # orders / # orders			
PHARMACY	MEDICATIONS														
	PARENTERAL SOLUTIONS														
LABORATORIES	CLINICAL														
	PATHOLOGY														
	TRANSFUSION (BLOOD BANK)														
	PULM. FUNC.														
RAD'LOGY	X-RAY														
NUC. MED.	DIAG.														
	THERAPY														
	DIETARY														
PATIENT CARE	OBSERVATIONS														
	Rx's														
	PERSONAL CARE & OTHER														
MON.	EKG														
	EEG														
THERAPY	RESPIRATORY														
	PHYS. SPEECH OCCUPATIONAL														
	TOTALS														

PATIENT NUMBER		DIAGNOSIS CODE	REPORTING OF RESULTS	DATA SHEET 3

	OP'Y: NO. DOSES SCHEDULED, NO. DOSES GIVEN PRN, NO. TESTS SCHEDULED, NO. TREATMENTS SCHED., ETC.	NUMBER OF ORDERS	VARIANCES IN REPORTING								CLARITY/INTERPRETATION					EXCEPTIONAL REPORTING			
			DOSE VOLUME QUANTITY		SITE ROUTE APPLICATION ADMINISTRATION		SCHEDULE		PROCEDURE NOTES PREPS		ILLEGIBLE	HARD TO READ	AMBIGUOUS		ORDERS PROCEDURES COMP.& ENT. INTO CHART	REASON FOR VARIANCE REPORTED	INTERVENTION, RECOM. OR ACTION REPORTED	ABNORMAL RESULT EMPH.OR WARNING	TOTALS
			OP'Y	NO./DATE	OP'Y	NO./DATE	OP'Y	NO./DATE	OP'Y	NO./DATE									
PHARMACY	MEDICATIONS SCHED.																		
	PRN																		
	PARENTERAL SOLUTIONS																		
LABORATORIES	CLINICAL																		
	PATHOLOGY																		
	BLOOD BANK																		
	PULM. FUNC.																		
RAD'LGY	X-RAY																		
NUCL MED.	DIAG.																		
	THERAPY																		
	DIETARY																		
PATIENT CARE	OBSERVATIONS																		
	Rx's																		
	PERSONAL CARE & OTHER																		
MON.	EKG																		
	EEG																		
THERAPY	RESPIRATORY																		
	PHYS. SPEECH OCCUPATIONAL																		
	TOTALS																		

APPENDIX H

DESCRIPTION OF THE TECHNICON MEDICAL INFORMATION SYSTEM (MIS) AT EL CAMINO HOSPITAL

PREPARED BY
TECHNICON MEDICAL INFORMATION SYSTEMS

APPENDIX H

DESCRIPTION OF THE TECHNICON MEDICAL INFORMATION SYSTEM (MIS)

AN OVERVIEW OF MIS

The Technicon Medical Information System (MIS) is a hospital-wide system which uses a computer to store data and to send it, automatically or upon request, to the people who need to act upon it. The computer adds speed and accuracy to the transmission of information throughout the hospital and also performs many data processing tasks such as sorting, copying, filing, summarizing, checking for abnormal data, pricing, and a variety of other functions which are usually done by physicians, nurses, technologists, clerks, and other hospital personnel. A broad range of medical data (physicians' orders, test results, etc.) and administrative data (responsible party, insurance coverage, etc.) are processed by the computer.

Hospital personnel communicate with the computer by means of two devices: the Technicon Video Matrix Terminal (VMT) and the Technicon Multiprinter. The VMT consists of a television screen, a "lightpen", and a keyboard (see Figure H-1). VMTs are located throughout the hospital and are used to record (send) new information to the computer, or to retrieve information such as laboratory results, the time of the last dose of medication, etc. Each person who is authorized to use the VMT has a unique identification code. This code limits the capability to send and receive information, based upon the individual's position and the hospital's policies concerning data access control. Use of the VMT is based upon the elementary communication technique of pointing. The television screen is used to display lists of items, for example, laboratory tests. A specific item is selected by pointing the lightpen at the desired word (or phrase) and pressing a switch on the barrel of the pen. Using the lightpen, a physician can select the specific patient, and then "write" a full set of medical orders (laboratory work, medications, X-rays, diet, activity, vital signs, etc.). The computer then stores the orders and sends appropriate documents (laboratory requisitions, pharmacy labels, X-ray requisitions, etc.) to the proper hospital departments.

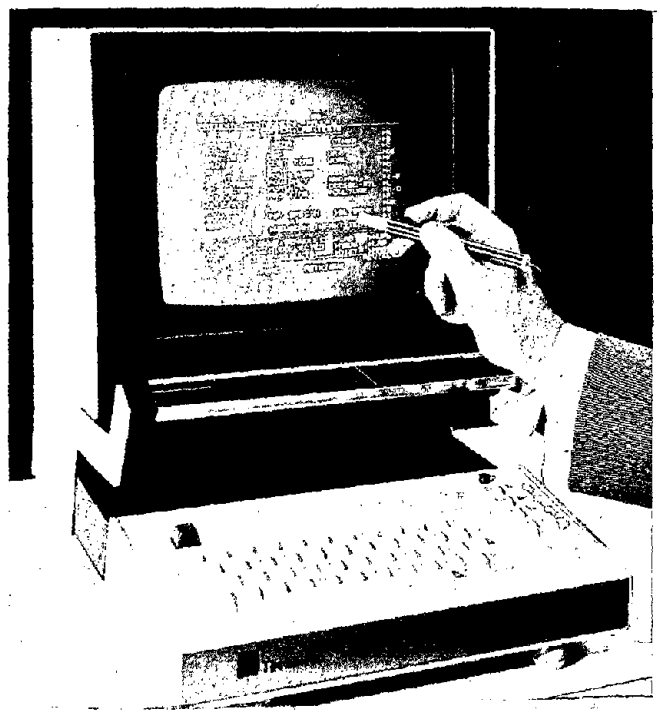


FIGURE H-1. TECHNICON T-201 VIDEO-MATRIX-TERMINAL (VMT)

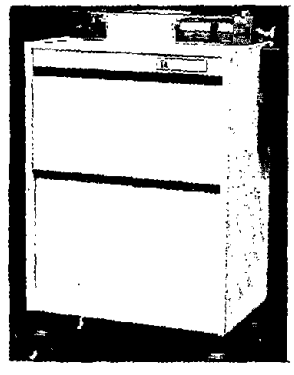


FIGURE H-2. TECHNICON T-300 PRINTER

The keyboard on the VMT is used to supplement the lightpen. In departments such as Admitting, the keyboard is used extensively to record the patient's name, address, responsible party, and other such information which cannot be written using the lightpen technique. Physicians, nurses, and other hospital personnel use the lightpen technique extensively and employ the keyboard only occasionally. The keyboard permits complete freedom to write special instructions or unique orders that are not available for lightpen selection.

The Technicon Multiprinter is a quiet, high-speed, computer-driven printer (see Figure H-2). These printers are located throughout the hospital so that each document prints where it is needed. Computer produced printouts, in addition to those previously referred to, include: Patient Care Plans, Medications Due Lists, Laboratory Specimen Pickup Lists, Cumulative Test Results Summaries, Radiology Reports, Discharge Summaries, and more than one hundred documents.

MIS is available as a total medical information system or the Financial Management subsystem can be operated on a stand-alone basis. The system is available under two distinct operational methods:

- Regional Computer Center - Under this method MIS is operated from a Technicon regional computer center with costs shared by several hospitals on a service-fee basis. Large-scale computers in the regional center are connected to the VMTs and printers in participating hospitals via high-speed communication lines. A "test hospital" data base is also operated from the regional center for new development, demonstration and validation purposes. A regional center is capable of simultaneously processing several hospitals for total MIS Systems, for stand-alone financial management systems or for a mix. Each hospital serviced by the regional center maintains full flexibility for unique tailoring to meet their special needs.
- Individual Hospital Computer Center - MIS software is available to hospitals for operation on their own in-house computer. Under this arrangement the hospital provides the computer center facility, computer equipment and operations

personnel. Technicon provides terminals and software, plus support for implementation and software maintenance. If desired, Technicon will also provide on-site computer management services.

In summary, MIS is a comprehensive data system for patient care and hospital management functions. It uses a large-scale computer and advanced input/output devices to record information at its source and to make this information available throughout the hospital when and where it is needed. Its basic objective is to provide better patient care and more efficient hospital operations through an improved communication system. MIS substitutes computer processing for manual data processing, thus gaining advantages in terms of speed, accuracy, cost, legibility, and completeness and consistency of data.

MIS SCENARIO - ADMISSION TO DISCHARGE

A patient's computer record originates when he is admitted or pre-admitted. Using special VMT displays which are similar in content to conventional Admitting forms, the admission clerk assembles the patient's basic record, consisting of name, age, sex, address, insurance coverage, etc. The computer stores this information and makes it available for use by physicians, nurses, and other hospital personnel.

The physician, upon identifying himself by typing in his code at any VMT keyboard, receives a list of his patients on the VMT screen. He selects a particular patient and can then either write new orders for the patient, or review any previous orders, test results, etc. When the physician writes new orders or renews or discontinues previous orders, a New Orders sheet is immediately printed at the patient's nursing station. In addition, all orders are automatically printed as service requisitions in the appropriate hospital departments. Each requisition is uniquely formatted to minimize handling. For example, a laboratory requisition prints in the form of a worksheet for the specific test ordered, including spaces for all results to be filled in. In addition, the computer periodically prints Specimen Pickup Lists pre-sorted in bed number sequence. For each drug

order, the computer automatically prints appropriate documents in the Pharmacy--a prescription record, a gummed label for the medication bottle, an allergy alert notice and a patient medication profile for use in pharmacies employing "Unit Dose" dispensing. Dietary orders print in the form of a consolidated Diet Orders List, generated just prior to each meal. This Dietary Department printout is in bed number sequence with a separate page for each nursing station.

The computer also generates many follow-on documents as a result of medical orders. These include: Medication Due Lists printed at each nursing station for each hour of the day, Daily Orders Summaries which show both newly written orders and all current orders, Reminder Notices for overdue laboratory work, medications, etc. For all orders which are to be accomplished on a future date, the computer automatically schedules these requisitions to print in the appropriate departments on the correct dates.

When the laboratory, radiology, or other service department has completed a diagnostic test or examination, the results are entered into MIS by lightpen, by specialized keyboard, and by direct hardware interface, depending upon which method is more efficient and accurate. As test results are entered into the computer, they immediately become available for screen retrieval by authorized personnel at any VMT. In addition, the computer summarizes and prints all laboratory results for each patient periodically at the nursing station. "STAT" tests receive special immediate processing throughout the system, and the laboratory also has the capability to assign "RUSH" (immediate) processing to any unusual test result.

Just prior to the start of each shift, the computer prints a Patient Care Plan for each patient. This document combines diet and fluid balance orders, medications to be given, laboratory work, nursing instructions, and patient data such as "wears dentures" or "speaks Spanish", etc. The care plan is used for the shift change report and for giving (and annotating) care throughout the shift.

Nurse reporting of medications given, intake and output, and other patient data is done by VMT using special video displays and the lightpen.

Every night the computer reviews each patient's record to determine the charges that have accrued for the day (daily hospital service charge, medications given, laboratory tests, etc.). The appropriate charges for each

item are looked up by the computer and the billing file is updated.

After the patient is discharged, the computer goes through the complete patient file and prepares a series of documents, including a Test Results Summary, insurance forms, the patient's bill and a Medical Record abstract.

Throughout the patient's stay in the hospital, and at discharge time, the computer has printed a series of documents which now become a part of the chart to be filed in Medical Records. In addition, the patient's complete computer record is retained on magnetic tape at the computer center.

A DETAILED DESCRIPTION OF HOW MIS FUNCTIONS (BY DEPARTMENTS AND USER GROUPS)

Admitting, Outpatient Department, Emergency

Admitting clerks use VMTs to generate, review, and modify patient admission records. Data is typed directly onto "VIDEO-FORMS" on the VMT screen rather than on paper (see Figure H-3). The computer stores admission data, assists in bed assignment, and automatically prints admission records and notices at various locations in the hospital. The following paragraphs describe the MIS system as it impacts upon:

- Pre-Admission Records
- Admission Records
- Case Number Assignment
- Bed Assignment
- Transfer/Discharge/Expiration Data
- Outpatient Processing
- Emergency Room Patient Processing

Pre-Admission Records

For elective admissions, a Pre-Admission Record is established in the computer prior to admission. This record is generated by typing onto VIDEO-FORMS and may be retrieved on the screen as frequently as necessary to add data or revise data prior to admission. Physicians can use the patient's

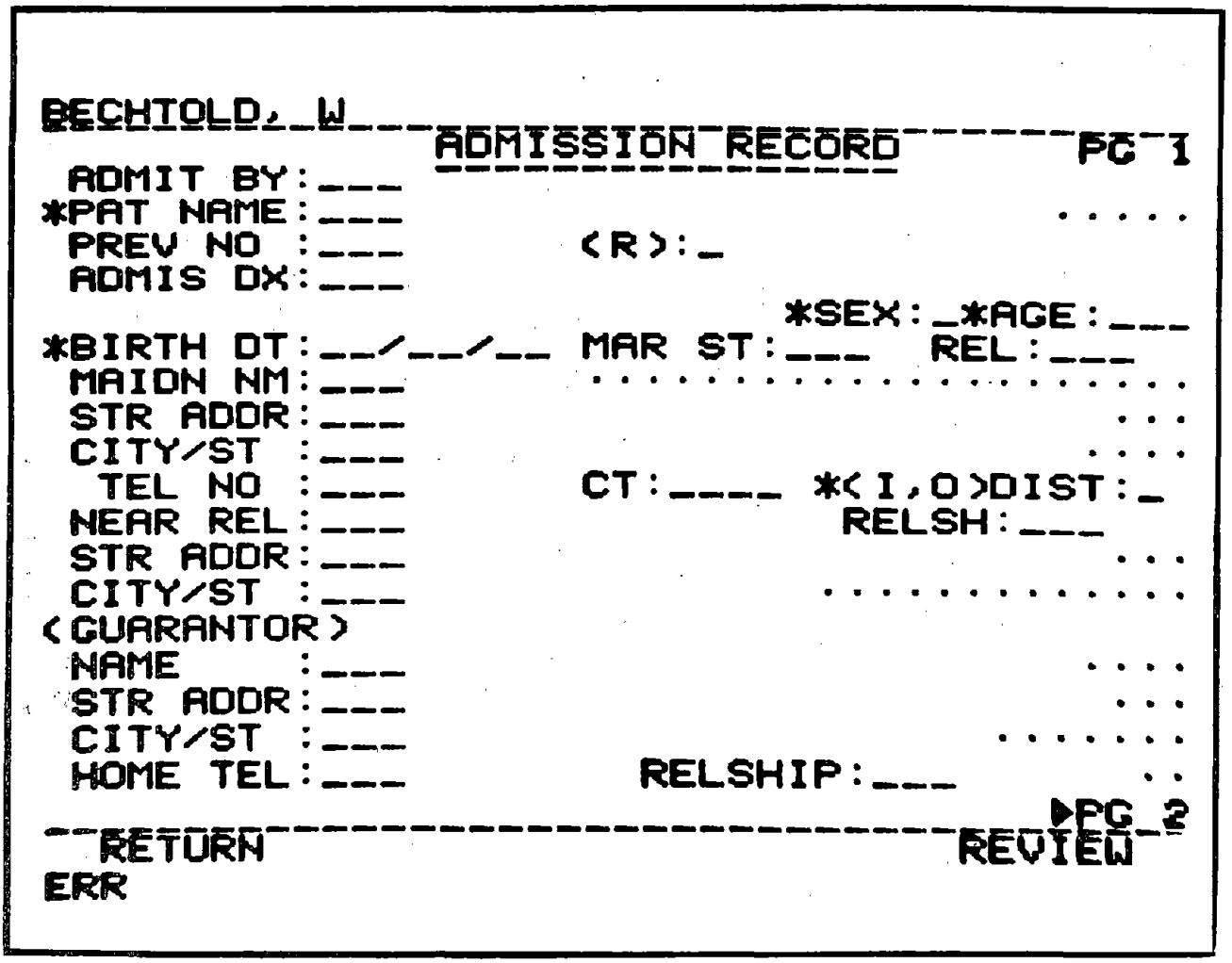


FIGURE H-3. ADMISSION VIDEO FORM

Pre-Admission Record as a basis for writing medical orders to be accomplished either before or at admission time. It is generally not necessary to maintain any paper record for patients in pre-admission status.

Admission Records

When a patient is admitted, the admitting clerk either completes a Pre-Admission Record, or, if the patient is nonelective, generates a complete admission record using the video form. A new long-term storage file is now being added to MIS. This file will contain a permanent on-line record of all inpatients and outpatients including case numbers, full name, previous name(s), last address, etc. This file will simplify the re-registration process.

The video form technique of generating admission records differs from paper records in several respects:

1. VIDEO-FORMS are limited to 800 characters per page on the video screen. However, the computer can consolidate several screen pages into one printed form.
2. Typing errors can be corrected on the screen without erasure by simply backspacing and over-typing. This saves both time and spoiled forms.
3. Tabbing from one type-in area to the next is more convenient on the video form, as the computer-controlled tab key moves to the next area, regardless of its position on the page.

On admission the computer automatically sends printed admission notices to various hospital departments as designated by hospital policy. For example, these records might be sent to the patient's nursing station, the Business Office, and Information Desk in addition to the Admitting Department itself. The patient's admission record is available for VMT screen retrieval throughout the hospital by any authorized person.

Case Number Assignment

A hospital may elect to have the computer automatically assign case numbers to inpatients, outpatients, and emergency room patients with

separate patient number logs being maintained in the computer for each category or at the hospital's option a manual case number assignment may be made. MIS can accommodate any type of hospital unique alpha-numeric case numbering system, or can use the social security number as the hospital case number.

Bed Assignment

The Admitting Department receives two kinds of computer assistance in assignment of beds. First, the computer periodically prints a total hospital Bed Status Report. This report shows all available beds and includes age, sex, diagnosis, and attending physician for each patient. Secondly, as patients are admitted, the admission clerk can view an up-to-the-minute list of available beds at each nursing station on the VMT together with information about roommates (age, sex, diagnosis, smokes). For some nursing care areas (e.g., Psychiatry, Pediatrics, etc.) the Admitting Department may assign the patient only to a nursing unit. The unit then assigns the specific bed number. Once the patient's bed assignment has been entered into the computer, it is immediately available for retrieval by any authorized person in the hospital. The computer also periodically prints Patient Locator Lists which are used by many hospital departments.

Transfer/Discharge/Expiration Data

When a patient is transferred from one bed to another, this information is entered into MIS at the nursing station. MIS automatically makes all the necessary record changes and immediately notifies affected departments.

MIS discharge/expiration processing is as follows:

1. The physician uses the VMT to write a discharge authorization or an expiration statement.
2. The nurse uses the VMT record to record the discharge time and notes or the expiration notes.
3. The computer stores this information and immediately notifies all affected hospital departments.

Upon receipt of discharge or expiration data for a patient, the computer sets a series of actions in motion which will continue over the next two to four days. These include:

1. Preparation of the last Daily Summary for the patient.
2. Preparation of a complete Test Results Summary for the hospital stay.
3. Preparation of a Medical Records Abstract.
4. Preparation of the patient's bill.
5. Movement of patient data from active computer storage to inactive storage. This action is under the control of the Medical Records Department.

Outpatient Processing

MIS recognizes two kinds of outpatients: "one-time" and "recurring". When the patient is expected to have only one outpatient visit for X-rays, laboratory work, etc., his record is retained in the computer for two days or any other time span stipulated by the hospital. Recurring patients, on the other hand, are likely to have repeated visits (for physical therapy, etc.). For such patients the computer records are maintained indefinitely, as long as there is activity at least once per month. This obviates re-registering the patient for each visit. Outpatient registration is accomplished by video form. Entry of medical orders for outpatients is also done by VMT; optionally, at the Outpatient Desk, or by the department doing the work. The computer prints requisitions for laboratory tests, X-rays, electrocardiograms, etc., at the appropriate departments. Test results are recorded into MIS, along with the applicable procedure number(s), and printed for us in the hospital and at the physician's office. A new capability is now being added to MIS which will enable the Outpatient Department to use the VMT to look up the case number of an outpatient regardless of the time lapse since the last visit.

Emergency Room Patient Processing

Emergency Room patients are registered using the video form technique. The computer immediately prints an Emergency Room Record on two-part NCR paper. Emergency Room treatment notes are then handwritten on this document. Medical Orders for laboratory tests, X-rays, medications, etc., for Emergency Room patients are recorded into MIS by VMT. The computer automatically codes all Emergency Room orders for STAT processing. Emergency Room test results are entered through VMTs in the laboratories, Radiology, etc., and these results are automatically printed in the Emergency Room immediately. Emergency Room charges are entered by VMT and billing is done by the computer. Since the Emergency Room records are maintained in the same computer memory system with inpatient records, a consolidated Emergency Room/Inpatient Record is available when an Emergency Room patient is converted to inpatient status.

Medical Staff

The medical staff interacts directly with the computer by means of VMTs and by using a variety of computer-produced documents. However, the personal use of the terminal by physicians is not mandatory. An individual physician may choose to write his medical orders in the conventional manner and have the nursing staff enter them into MIS in his behalf. The major areas of physician interface are:

- Patient lists and locators
- Patient data retrieval (by VMT)
- Medical Information retrieval (by VMT)
- Medical order writing
- MIS documents

Patient Lists and Locators

Upon entering his identification code at any VMT in the hospital, the physician immediately receives a display of all patients for whom he is

either an attending or consulting physician. This patient list is up to the minute and shows patients' names, case numbers, and bed locations (see Figure H-4). In addition, the physician can obtain the patient list of a colleague for whom he may be seeing patients. Physicians can add patients to their list whenever this is appropriate. Many physicians request the computer to print their patient list, and carry this list as they make rounds. The list is date and time stamped by the computer and is used by some physicians for billing purposes.

Patient Data Retrieval (by VMT)

Physicians can quickly retrieve patient data at any VMT in the hospital. Retrieval is accomplished by selecting the desired type of information from the Retrieval Guide. The retrieval categories include:

- Admissions data
- Laboratory test results
- X-ray reports
- Medications given
- Current orders
- All orders since admission
- Nursing notes
- Diagnoses
- Allergies

Each category can be broken down more specifically to isolate the desired data. For example, laboratory results can be retrieved by department and/or date(s). VMT retrieval reflects all information that has been entered from any point in the hospital up to the moment of the retrieval request.

Medical Information Retrieval (by VMT)

MIS has a generalized storage and video retrieval capability which can be used for a wide variety of medical data. Its present usages include abstracts of current articles from surgical journals, antibiotic sensitivities

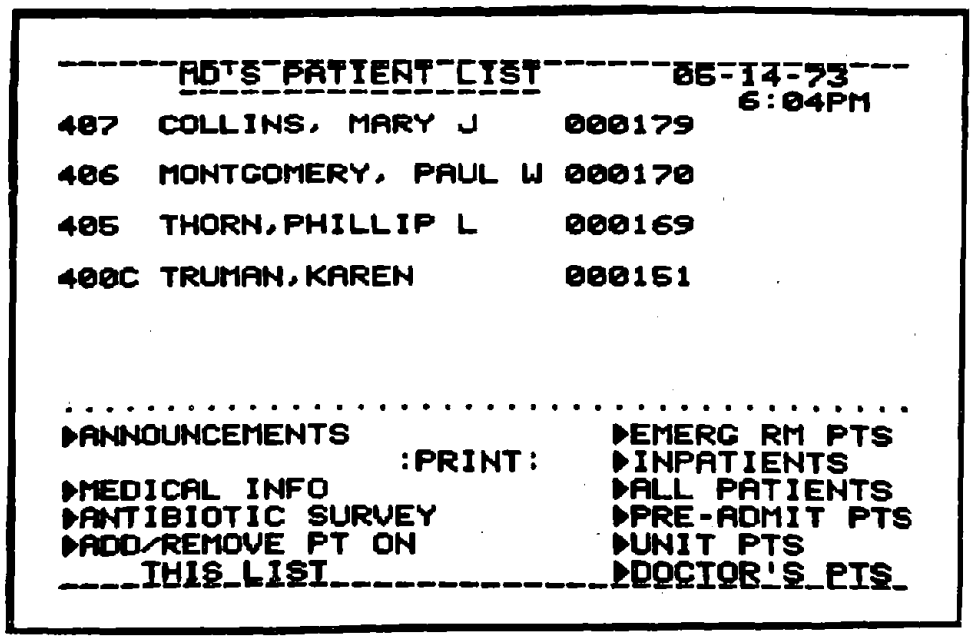


FIGURE H-4. PATIENT LIST (VMT)

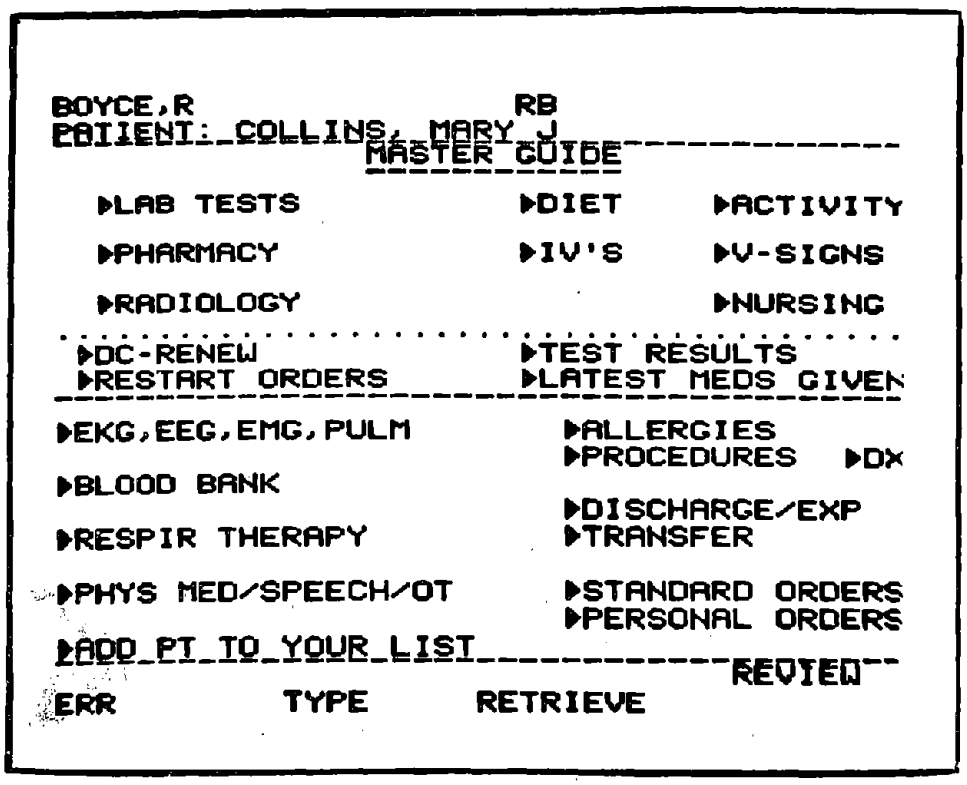


FIGURE H-5. PHYSICIAN MASTER GUIDE

and drug of choice information, lab test results interpretation aids, hyperlypedemia workup information, and several other subjects of interest to physicians in hospitals now using the MIS System.

Medical Order Writing

In using the VMT to write medical orders, the physician receives a number of computer assists. These include:

- Medical information retrieval capabilities as described above.
- An order-writing Master Guide which helps remind the physician to "touch all bases" (laboratory work, medications, vital signs, diet, fluid balance, activity, etc.). (See Figure H-5.)
- Specialized VMT displays which show hospital or departmental guidelines for treating particular types of patients. These may include coronary care, hemodialysis, psychiatry, pediatrics, maternity, etc.
- A VMT display showing all orders now in effect for the patient. This display also permits the physician to discontinue or renew any order.
- The capability to store personal order sets in the computer. The physician can generate a personal order set for any pre-operative or post-operative condition or for any diagnosis. He can then write the complete order set for any patient with a single lightpen selection. He also has the capability to use any part of a personal order set and modify, delete, or add other orders.
- The terminology used in the VMT order-writing displays (laboratory test names, radiological procedures, etc.) is coordinated with all hospital departments when the displays are originally created and each time they are modified. This means that standard, well-understood terminology is used.
- The VMT displays are designed to insure complete orders. Two examples of this are: vital signs must be specifically stated as temperature, pulse, respiration (TPR), etc., and

medication orders must contain the drug, dose, route, and frequency.

- The computer generates a printed copy of new orders immediately after they are entered. This eliminates the common problem of legibility of the physician's handwriting.
- The computer automatically routes all orders to the appropriate hospital departments without the need for manual transcription onto requisition forms. This ensures that the orders go to the proper department, are worded precisely as stated by the physician, and are received immediately. For orders to be accomplished on a future date (fasting laboratory work, etc.), the computer holds the order until the proper time and then releases it to the appropriate department.
- The computer follows up to ensure that the physician's orders are carried out on a timely basis. If they are not, a Reminder Notice is printed at the appropriate location.

MIS Documents

The medical staff uses a variety of computer-produced printouts in analyzing and documenting the patient's status and care. Twice daily, just prior to morning and afternoon rounds, the computer produced Patient Data Summaries showing new orders, test results, X-ray reports, medications given reports, and nursing data. In addition, all STAT work is printed immediately after it is entered into the computer. MIS also produces seven-day accumulative reports for test results, medications, and intake/output. These seven-day reports enable the physician to quickly spot trends. After the patient is discharged, the computer produces a complete printout of all laboratory and X-ray reports. A copy of this document is mailed to the physician's office. The physician can obtain an Insurance Form from MIS for use by his office in filing for third-party payments.

Nursing

Nursing personnel use MIS extensively. One or more VMTs is located at each nursing station. These VMTs are used by registered nurses, licensed vocational nurses, aides, and ward clerks. The VMT functions of each user class are determined by hospital policy. The nursing functions which are impacted by the computer system include:

- Patient-care planning
- Medication administration and reporting
- Requisitioning tests and supplies, including medicines
- Reporting of nursing data (Charting)
- Verbal and telephone orders

Patient Care Planning

On either a daily basis or an each shift basis, MIS prints two copies of a Care Plan for each patient. One copy is retained by the head nurse, and the other copy is used by the nurse(s) responsible for patient care. The Care Plan consolidates all appropriate (i.e., current) medical orders, nursing instructions, and general patient information that has been entered into the computer at various times by various personnel. The format of the Care Plan is optional. The following kinds of information may be included:

Basic patient data (name, age, sex, attending physician, etc.)

- Diagnoses and surgical procedures
- Vital signs orders
- Diet and fluid balance orders and instructions
- Hygiene/Activity/Safety orders
- Medication orders
- Other orders (laboratory tests, X-rays, electrocardiogram orders, etc.
- Care planning instructions, problems, objectives, target dates.

Figure H-6 shows sample Care Plans.

```
4WEST-0040          EL CAMINO HOSPITAL
10/20/75  8:31 AM          PAGE 001          PATIENT CARE PLAN.
WISE, DEXTER E          M 62 IC05  SERV: MED
  294112      ADM: 10/01/75  REGESTER, W D, MD          7:00 AM 10/20/75
```

DX:
CHONIC HEPATITIS
10-16-75:RUPTURED ESOPHAGEAL VARICES; BLAKEMORE TUBE PLACED.

PT CARE PLANNING:

10/1	--PT. WEARS DIAPER, OCC. INC. URINE AND STOOL. ?ALCOHOLISM
10/1	PT WEARS GLASSES
10/1	EXISTING COND---PAIN, ABD, BACK AND SIDES., EDEMA BOTH LEGS AND FEED.
10/1	MED TAKEN AT HOME---MEPROBAMATE, SUTIFED, TYLENOL, CODEINE.
10/1	ALLERGIC TO: ASPIRIN
10/1	ALLERGIC TO:--IVP DYE.
10/2	**** BUSINESS OFFICE-INCOMPLETE ****
10/2	--HX OF JAUNDICE ANOREXIA, LETHARGY & CONFUSION FOR 1 MO. HX OF HEPATITIS IN 1970.
10/7	--PT. EXPERIENCED COMA POST 25MG DEMEROL. HE MAY ASK FOR PAIN MED INJ. BUT DON'T CALL ON CALL MD FOR MED ORDERS WITHOUT EXPLAINING PTS. HEPATIC FUNCT.
10/9	--DEXTER NEEDS TO BE TURNED ET REPOSITIONED Q.1-2H. DUE TO PITTING EDEMA ESPECIALLY IN BOTH LEGS.
10/16	--PT. HAD ENDOSCOPY DONE 10-16-75. ESOPHAGEAL VARICES VIEWED. PT. VOMITED LARGE AMT. BLOOD AND CLOTS. BLAKEMORE TUBE PUT DOWN.

VITAL SIGNS:
10/16 VITAL SIGNS, BP-P-R, Q1H, GRAPH RESULT, (BCL).

DIET AND FLUID BALANCE:

10/3	RECORD STOOL-NUMBER & CHARACT
10/16	DIET, NPO P MN, (BCL).
10/16	RECORD I & O, (BCL).
10/16	RECORD STOOL-NUMBER & CHARACT, (BCL).
10/16	INSERT NG TUBE, SIZE: 16 NOW, SUCTION LOW INTERMITTENT--INTO ESOPHAGUS AND DO NOT IRRIGATE, (BCL).
10/16	IV'S....D5/W, INFUSE AT 50ML/HR--LT, ARM IV., (BCL).
10/16	IV'S....D5/0.2% NACL, 500 ML--KEEP OPEN RT, ARM IV, (BCL).
10/19	INFUSION INSTRUCTION, P-CELLS, 2 UNITS, START WHEN AVAILABLE, (BCL).

HYGIENE/ACTIVITY/SAFETY:
10/16 POSITIONING: ELEVATE HD OF BED--6 INCH BLOCKS, (BCL).

MISC. ORDERS:
10/16 WATCH FOR-NOTIFY DR OF, PULSE OVER 120, BLOOD PRESSURE UNDER 80 SYSTOLIC, RESP DISTRESS, SEVERE PAIN, VOMITING, HEMORRHAGE, ESOPHAGEAL, (BCL).

MEDICATIONS:

*10/1	THEX FORTE-1ML, IM, BID, (10/01 05PM-..) 9
*10/16	* T *NEOMYCIN SO4 AS ENEMA 1 GM IN 60CC AS RETENTION ENEMA, Q12H , (10/16 09PM-..), (BCL). 9
*10/16	NEOMYCIN SO4,ORAL SOLN, 8TSP,PO--VIA BLAKEMORE TUBE, QID, (10/16 01PM-..) 9 1
10/17	AQUA-MEPHYTON: PHYTONADIONE 5 MG, SLOW IV, NOW, (BCL).
10/18	*AMICAR 25% IRR, BLAKEMORE WITH 15CC PER 50CC ICED NS, PRN--

CONTINUED

FIGURE H-6, PATIENT CARE PLAN

Medication Administration and Reporting

In the MIS nursing data system there are no Kardex files or medication tickets. Instead, the computer prints an hourly Medications Due List for each nursing station, showing all medications to be given during that hour. The Medications Due Lists can be used in conjunction with a conventional pharmacy dispensing system or with a unit-dose pharmacy system as described under Pharmacy, below. After medications are administered, they are reported at the VMT by selecting "Given" or "Not Given" in conjunction with each order. When reporting injectible medications, the site is also selected by lightpen. When a medication is reported as "Not Given", the VMT immediately displays a list of reasons why the medication was not given, from which the nurse selects the proper choice. If a particular medication is not reported, a Reminder Notice is printed by the computer. Medication reporting generates both daily and weekly reports and also triggers computer billing for the precise amount of the medication that was administered. There is no need to adjust the billing for unused medications.

Requisitioning Tests and Supplies, including Medicines

All medical orders entered into the VMT by physicians are automatically transmitted (as requisitions) to the proper departments; therefore, nursing personnel do not have to transcribe orders onto either requisition forms or charge slips. Both the initial supply and follow-on supplies of medications are sent to the nursing section by the Pharmacy, based upon computer-produced printouts in the Pharmacy. When Central Service supplies are required, the nurse uses the VMT to request the desired items. The computer then prints a requisition in the Central Service Department and inserts the correct charges into the patient's billing file.

Reporting of Nursing Data

The scope of nursing data entered into the computer system may vary from nursing station to nursing station. For instance, all stations may report medications given, intake/output, and patient-care planning

instructions. While certain stations may also use the VMT to report vital signs, activity, procedures, and general nursing notes. The system lends itself to goal-oriented care planning and reporting using exception reporting principles.

Two modes of entering nursing data by VMT are programmed into MIS. The first--functional reporting--permits the nurse to enter routine vital signs or scheduled medications for all patients on the unit instead of calling up each patient's record, one at a time. This reporting procedure is very efficient for recording one particular type of data for a series of patients. The second method--individual reporting--involves calling up a particular patient's record and entering one or a series of data items for that patient only. This method is used for non-routine vital signs, diet and fluid balance, unit tests and exams, hygiene/activity/safety procedures, unscheduled medications, and miscellaneous information and observations.

The MIS system includes specialized VMT displays for nurse reporting in Pediatrics, Psychiatry, Surgery, Maternity, Nursery, and other specialties. All nursing data entered into the VMT is printed on periodic Patient Data Summaries.

Verbal and Telephone Orders

Nurses use the VMT to enter medical orders which they have received verbally or by telephone. These orders are printed by the computer, showing both the physician's and nurse's names. They are processed like orders entered directly by the physician, except that the doctor must subsequently sign all orders which were entered by a nurse.

Laboratories

MIS impacts the clinical and pathology laboratories in the following areas:

- Ordering of tests/generation of requisitions and worksheets
- Specimen collection
- Recording and routing of test results
- Billing for laboratory work

Ordering of Tests/Generation of Requisitions and Worksheets

The MIS VMT displays used by physicians to write orders for laboratory tests contain all of the tests performed in the hospital laboratories, plus any common "send out" tests. When the physician writes an order for a test, the computer analyzes the order in terms of schedule information, fasting requirements, or other necessary preparatory actions for the test, and the "batch code" for the test. Batch codes are controlled by the laboratory and tell the computer whether or not to batch the specimen for collection, and whether the test will be run on an individual or batched basis. The batch coding capability permits the laboratory to control the flow of work, including both specimen pickup and performance of tests. Non-batched work flows into the laboratory immediately when it is ordered, and is printed on a single-patient document. Batched work flows in either at specified times, or when requested by the laboratory. Batched documents may optionally be in single-patient or multi-patient format. The format of each requisition and worksheet printed in the lab is tailored to the specific test. For example, a CBC (complete blood count) order prints in the laboratory as a worksheet showing the eleven hematology and morphology results to be determined, with spaces for the entry of each result. STAT tests receive special computer processing. They are clearly marked by the computer and a light and bell are activated in the laboratory when a STAT requisition prints. Tests ordered for a future date are held in the computer and released to the laboratory on the correct date.

Specimen Collection

Specimen collection documents may be printed on any desired schedule or upon demand. Typically, the laboratory might elect to receive batched blood Specimen Pickup Lists from the computer for the first pickup each morning, and two or three times additionally during the day. The computer prints the Specimen Pickup Lists in bed number sequence, showing patient names, case numbers, tests to be performed, type of specimen (EDTA, clotted, etc.), and volume of blood required. For STAT tests and specimens

to be collected at a specific time, the computer prints individual Specimen Pickup Sheets. When making a STAT or other special specimen pickup, the lab technologist may request the computer to print all other pickups required for that patient and/or for all patients on the same nursing station. This capability saves trips to the floor and also eliminates drawing blood from the patient more than once.

Recording and Routing of Test Results

Lab test results are entered into MIS by four methods. The most efficient and accurate method is used for each type of test. High volume test results are entered by linking automated laboratory instruments (SMA, Coulter, etc.) to the MIS computer. The other methods are by lightpen selections made on special VMT displays, by specialized keyboard entry, and by optical mark reading (OMR) of results cards. When results are entered, they are immediately available for retrieval by any authorized person at any VMT in the hospital. The results are also printed at the nursing station for insertion into the patient's chart under the following controls:

1. STAT tests print immediately
2. Routine tests print on daily Cumulative Laboratory Results Summaries (see Figure H-7)
3. The lab can signal "RUSH" on any result and thereby cause it to print immediately as though it had been a STAT test
4. After the patient is discharged, a total Lab Results Report is printed in one document for insertion in the patient's medical record

The computer-produced laboratory results printout shows the normal range for each test, and if this patient's result falls outside of that range, it is highlighted in either red ink or bold-face type. If the laboratory fails to enter a particular test result within a specified time, the computer automatically prints a Reminder Notice to the laboratory.

1/25/75 9:54 AM PAGE 002

WISE, DOLORES QI6382 M 47 IC06
275597 ADM: 01/18/75
CUMMINGS, D. W., MD

LAB RESULTS SUMMARY

REPORT PERIOD: 1/18/75 12:00 MN - 9:54 AM 1/25/75

HEMOGRAM — HEMATOLOGY

			PCV	HGB	RBC	MCV	MCH	MCHC
LO-HI:			VAR-	VAR-	4.2-6.2	82-92	27-31	32-40
UNIT:				GM%	MILLION	CUMICR	MMG	%
SAT	1/25	4AM	38.8					
FRI	1/24	6PM	34.7					
FRI	1/24	4AM	35.1					
THU	1/23	6PM	35.9	11.9				
THU	1/23	12NN	33.2	11.0				
THU	1/23	6AM	32.8	10.8	3.66	89.	29.7	33.4
THU	1/23	2AM	34.5					
THU	1/23	2AM		11.2				
WED	1/22	6PM	38.9	12.8				
WED	1/22	6AM	37.5	12.4	4.17	90.	29.9	33.5
TUE	1/21	6PM	36.1	11.8				
TUE	1/21	6AM	32.5	10.7	3.62	89	29.7	33.3
MON	1/20	10PM	31.1	10.3				
MON	1/20	6PM	34.0	11.1				
MON	1/20	2PM	35.5	11.6				
MON	1/20	12NN	32.1	10.5				
MON	1/20	7AM	29.4	9.7	3.25	90.	30.1	33.7
SUN	1/19	10PM	33.3					
SUN	1/19	6PM	31.9	10.5				
SUN	1/19	7AM	40.1	13.1	4.47	89.	29.4	33.0
SUN	1/19	1AM	41.9	13.7	4.63			
SAT	1/18	6PM	35.8	11.8				
SAT	1/18	6PM	32.7	10.8				
SAT	1/18	2PM	26.1	8.5				
SAT	1/18	12NN	34.6	11.7				
SAT	1/18	9AM	34.8					
SAT	1/18	7AM	32.9					
SAT	1/18	5AM	30.9	10.1	2.96	104	34.5	33.3

CONTINUED

CUMULATIVE LAB SUMMARY

FIGURE H-7. CUMULATIVE LAB RESULTS

Billing for Laboratory Work

The charge for each laboratory test is stored in the computer system. Every midnight a computer run is made to trigger the correct charge for all tests performed that day.

Pharmacy

MIS is designed to operate in either a "unit dose" or conventional pharmacy dispensing environment. A hospital installing MIS may wish to simultaneously convert to the unit dose dispensing method, which has proved to be especially effective and economical when used in conjunction with MIS. MIS also impacts upon pharmacy operations in other areas, including:

- Medication orders/routing to the pharmacy
- Preparation of medication labels
- Dispensing of medications
- Review of patient data (medications, profile, etc.)
- Billing for medications given

Medication Orders/Routing to the Pharmacy

Physicians use the VMT to write medication orders. The computer analyzes each order to determine if the medication is floor-stocked at the patient's nursing station. If not, the computer generates a prescription record and a medication label, printed on gummed paper, in the pharmacy (see Figure H-8). STAT orders are specially marked and a light and bell are activated in the pharmacy. Non-STAT orders are printed immediately in the pharmacy, but do not require special processing. For floor-stocked medications, the pharmacy receives only a prescription record. The MIS system enables the pharmacy to receive all new medication orders promptly and in legible form.

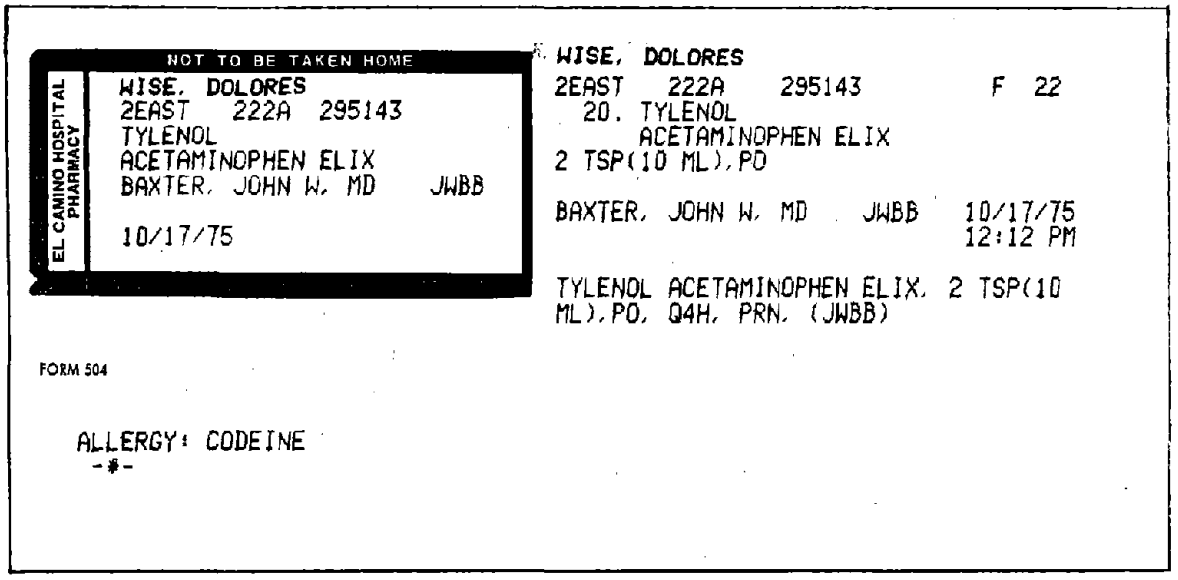


FIGURE H-8. MEDICATION PRESCRIPTION RECORD & LABEL

Preparation of Medication Labels

Since the computer produces gummed labels for each new medication order, it is not necessary for the pharmacy personnel to type such labels. The label showing the patient's name, bed location, attending physician, and the medication ordered is affixed to the container for the initial supply of the medication. This supply is just enough to last until the next unit-dose servicing of the patient's nursing station. The patient's medication allergies are also printed alongside the medication label to assist the pharmacist in checking for allergy problems.

Dispensing of Medications

When unit dose is used in addition to the initial dispensing of medications, as described above, the pharmacy prepares a medication drawer for each patient, containing a 24-hour supply of medication, packaged in

unit-dose form. These medication drawers are prepared with the assistance of a computer-produced "Medications Supply List" (MSL). The MSL shows all medications to be given to each patient during the next 24 hours. The computer prepares MSLs for each nursing station at a different time of day to level the pharmacy workload.

Review of Patient Data (Medications Profile, etc.)

The Chief Pharmacist and other authorized pharmacy personnel use the pharmacy VMT to retrieve patient data, as required. The most frequent use of this capability is to review the patient's medications profile. VMT displays showing all medications the patient is taking plus his drug allergies readily obtained.

Billing for Medications Given

The hospital maintains a medication price list in the MIS computer system. As each medication is administered, the nurse's VMT entry causes the appropriate charge to be triggered into the patient's billing account. This system ensures that the patient is billed precisely for the medications actually received. This eliminates the need to credit the patient for medications returned from the nursing station to the pharmacy.

Radiology

The Radiology Department, like other hospital departments, uses VMTs and printers to interact with the computer data network. Through these devices, the department has immediate contact with other hospital personnel and direct access to a wide range of information on radiology patients. The installation of MIS significantly changes departmental data processing functions. The affected areas include:

- Orders for radiological exams and their routing to the department
- Preparation and release of radiology reports
- Retrieval of patient data
- Billing for radiological procedures

Orders for Radiological Exams and Their Routing

Physicians write X-ray orders using VMT displays. These displays contain the standard terminology for all radiological procedures performed at the hospital. The displays are so arranged to encourage the physician to provide the radiologist with "indications" (the specific reasons why the test is being ordered). New radiology orders are printed in the department as soon as ordered, unless they are to be done on a future date. STAT orders are specially marked and activate a light and bell in the Radiology Department. In addition to showing the test ordered and indications, radiology requisitions also show the patient's name, age, sex, case number, bed location, attending physician, and diagnosis. The requisition also indicates if a portable X-ray machine is to be used.

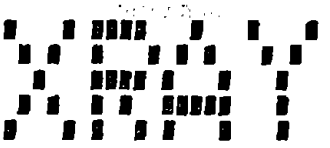
Preparation and Release of Radiology Reports

X-ray interpretations are dictated by the radiologists in the usual manner, except that they have the capability to refer to standard, normal sentences or paragraphs which are frequently used. These phrases are permanently stored in the computer. Radiology secretaries type the report for verification by the Radiologist. After the report has been verified, a verification signal is entered into the VMT. This causes the report to be released for VMT retrieval throughout the hospital and to simultaneously print at the patient's nursing station (see Figure H-9). The Radiology Department also has the capability to release reports with a "preliminary" status. A complete summary of all radiology reports (and all laboratory reports) is printed after the patient is discharged. One copy of this summary is mailed to the doctor's office, and one copy is retained in the Medical Records Department.

Retrieval of Patient Data

If the radiologist requires additional information to that shown on the requisition, he can retrieve patient data, using the VMT. VMT retrieval

4WEST-9635 EL CAMINO HOSPITAL
1/26/73 5:20 PM PAGE 001



SMITH, SAM F 51 401A
223644 ADM: 01/26/73
JONES, JOSEPH J. MD

RADIOLOGY RESULTS

ORDER: ABDOMEN 9.01., CHEST-PA & LAT 10.01.

XRAY FILE: 0-11-14 RADIOLOGIST: CARL R.MD

ABDOMEN: 1-26-73. SUPINE SCOUT FILM OF THE ABDOMEN SHOWS MINIMAL SMALL BOWEL GAS AND GAS SCATTERED IN THE PROXIMAL COLON. THERE IS VERY MINIMAL DILATATION OF THE LEFT THIRD OF THE TRANSVERSE COLON. NO ABNORMAL ABDOMINAL MASSES ARE EVIDENT. THERE ARE NO OPAQUE CALCULI.

IMPRESSION: NON-SPECIFIC ABDOMEN.

CHEST(PA AND LATERAL): 1-26-73 THE LUNGS ARE CLEAR. THE MEDIASTINUM AND HILA ARE WITHIN NORMAL LIMITS. THE HEART SIZE AND CONFIGURATION ARE NORMAL. THERE IS NO PLEURAL EFFUSION OR THICKENING.

IMPRESSION: NORMAL EXAMINATION OF THE CHEST. UNCHANGED COMPARED WITH THE STUDY FROM 1968.

LS

LAST PAGE

FIGURE H-9. SAMPLE RADIOLOGY REPORT

is used for obtaining previous current stay radiology reports, medications that the patient is taking, secondary diagnoses, etc.

Billing for Radiological Procedures

As radiology reports are keyed into the VMT, a procedure number is also entered. The computer uses this number to look up the appropriate charge and post it to the patient's billing file.

Other Diagnostic and Therapeutic Departments

Using the MIS system, all medical orders are entered into the computer. Consequently, all diagnostic and therapeutic departments receive their requisitions in the form of computer printouts. Computer-produced requisitions and worksheets are tailored for each specific department and for each specific test. In general, the requisitions contain the patient's name, case number, age, sex, nursing station, bed location, diagnosis, attending physician, date and time of the order, and the precise wording of the order as written by the physician. STAT orders are clearly marked for special attention. Orders to be accomplished on a future date are held in the computer and released to the appropriate department on the correct date. Optionally, some departments elect to receive future orders a day early for workload planning purposes. Some ancillary departments enter treatment notes into the computer system by VMT. Other departments elect to hand-write or type their treatment notices into the patient's chart. All departments perform patient billing via the computer. Each department can optionally establish fixed charges for specific procedures, generate individual charges for each activity, or use a combination of the two charging methods. Personnel of the various ancillary departments use the VMT to access patient data (medications, previous test results, dietary information, etc.) as necessary for their work and as permitted by hospital policy. The computer controls each individual's access, based upon his identification code. All diagnostic and therapeutic departments use the MIS system, - EKG, EEG, EMG, Physical Medicine, Pulmonary Medicine, Nuclear Medicine, Respiratory Therapy, and others.

Dietary

Dietary orders and special instructions are entered into the VMT by both physicians and nurses. Three times daily, prior to each meal, the computer prints an up-to-the-minute Diet Orders Listing in the dietary office. There is one page (more if required) for each nursing station. The printout shows each patient's name and bed location, together with all current diet orders and instructions.

Dietitians can also use the computer system to communicate information to physicians and nurses. When a dietitian's note is entered into a VMT, the computer prints the note both at the nursing station for inclusion in the patient's chart and at the dietary department for inclusion in their patient file.

The dietary department has an option to receive all patient admission, transfer and/or discharge notices as they occur throughout the hospital, to be used to supplement the Diet Orders Listing in routing food trays to patients.

Medical Records

MIS impacts Medical Records in two broad areas: the contents of the chart and general aids to Medical Records operations.

The chart has both MIS components and non-MIS components. The MIS components include laboratory and X-ray results, doctors' orders, the nurse notes and reports (including medications sheets) and the admit/discharge record. The major distinguishing characteristics of the MIS portions of the chart are that they are legible and that they have standard format. Thus, the patient name, hospital number, and physician name all appear in the same place on each document. The computer automatically puts a date and time on each report, so it is easy to keep the documents in proper sequence.

Each order entered by a physician for a patient is assigned an order number. For each patient, these order numbers are in sequence. A quick scan of doctors' orders allows one to determine if all of the orders are in the chart. It also allows easy reference to any telephoned orders which the physician may have not signed while the chart was at the nursing

station. (In the hospitals currently using MIS, orders which are entered directly by the physician do not require a handwritten signature.)

Shortly after patient discharge, a complete listing of laboratory, radiology, and other test results is printed at Medical Records. This printout guarantees that all results entered into MIS will be included in the chart--there is no need to check for lost test results. This printout also indicates any orders for which the results are not yet reported (e.g., cultures).

A Patient Abstract form is printed at approximately the same time as the test results listing. This form is used as a source document for Medical Records abstracting. MIS fills in much of the form: name, case number, diagnoses, etc., from information extracted from the patient file. Other data is hand-transcribed onto the form to provide the data source for medical records abstracting.

Unless Medical Records elects early or delayed release, the patient's file is removed from computer disk storage two days after the patient is dismissed from the hospital. However, all computer records are saved on magnetic tape.

Central Service

The Central Service Department receives their requisitions from the computer. When nurses or other personnel require central service items, they place their order by VMT, indicating the patient for whom the item is needed.

Central Service requisitions print immediately and, in contrast to the pre-MIS system, contain standard nomenclature printed in fully legible form. Billing for central service items is automatically and accurately processed by MIS.

Business Office

Technicon provides a comprehensive Business Office Services (BOS) package which is integrated into the total MIS system. It can also function as a stand-alone system. The total integrated system works as follows: each

real-time computer process (admission, transfer, discharge, medical order, laboratory, X-ray and ancillary report, medication given, central service order, etc.) generates an appropriate charge, based upon charge-tables stored in the computer. Adjustments and credits are also fed into the computer (by VMT) as appropriate.

Each night the computer searches all records for all inpatients and outpatients and posts the appropriate charges to the patient's billing files. The computer automatically produces the patient's bill, incorporating insurance prorations.

In addition to preparing patient bills and Accounts Receivable documents, the Business Office Services portion of MIS also provides a full range of computer processing and documents for other financial and administration controls. These services include:

- Accounts Payable
- General Ledger
- Budgetary Control
- Inventory Control
- Employee Payroll
- Labor Distribution
- Workload Statistics

Other Departments

Nearly every hospital department is served by MIS either directly or indirectly. For instance, the Housekeeping Department uses computer-produced Bed Status Reports to determine bed makeup requirements related to the discharging of patients. Similarly the mail room, flower room, information desk, chaplain service and others use computer-produced Patient Locator Lists throughout the hospital. The application of MIS produced documents and data is almost limitless in scope.