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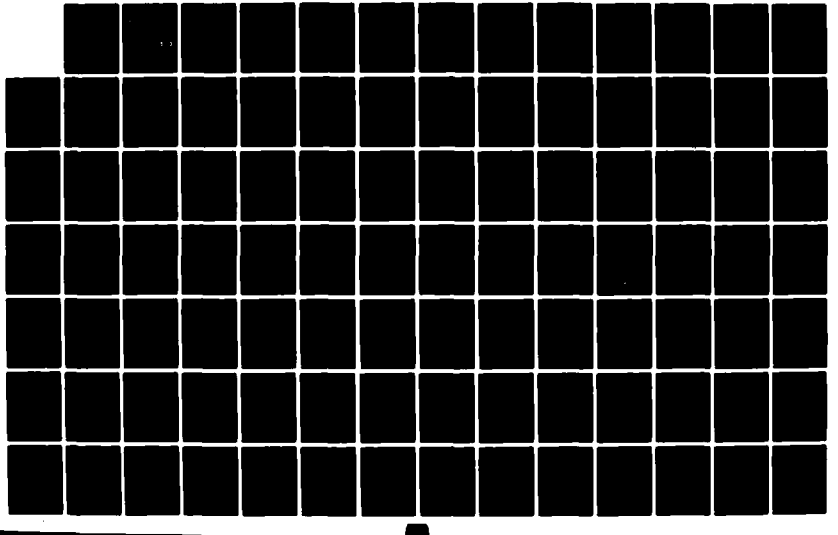

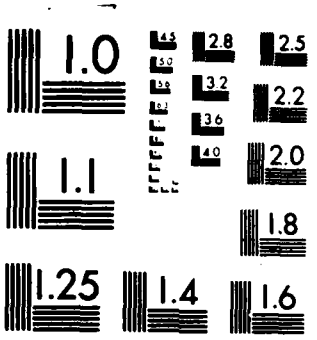

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EVALUATION OF THE TRI-SERVICE RADIOLOGY SYSTEM AT THE NAVAL HOSPITAL, BETHESDA

Final Report for Period 10/26/81-02/11/83

ARTHUR D. LITTLE, INC.
Acorn Park
Cambridge, Massachusetts 02140

Prepared for

TRIMIS Program Office
5401 Westbard Avenue
Bethesda, Maryland 20816

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Arthur D Little Inc

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Results of the evaluation of the implementation of the Tri-Service Radiology System at the Naval Hospital, Bethesda. The purpose of the study was to provide information for use in decision-making about the future use of automation in other military health care facilities.

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SUMMARY OF FINDINGS

A. INTRODUCTION

The Tri-Service Medical Information Systems (TRIMIS) Program Office (TPO) has installed four initial stand-alone computer systems for support of radiology operations in Medical Treatment Facilities (MTFs). The system, known as the Tri-Service Radiology System (or TRIRAD), provides automated support to patient management, scheduling, film management, administrative reporting and statistics, teaching and research, and reporting assistance to radiologists. The experience with the implementation of this system in the Radiology Department at the Naval Hospital, Bethesda (NHB), has been evaluated in order to provide information for use in decision-making about the future use of automation in radiology departments in other MTFs.

The evaluation was based upon a comparison of processes and data on operations collected in November of 1981 before the system was installed at NHB (baseline) with similar information collected after the system was in routine use (post-implementation) in November of 1982. This information was supplemented by information gained during five visits to the site to monitor the status of system implementation.

During the baseline and post-implementation data collection periods, quantitative studies were conducted concerning the most likely major impacts of TRIRAD on the operation of the Radiology Department:

- turnaround time for radiology reports,
- labor and process times for segments of the process of providing radiology services, and
- film file availability.

More intensive studies were performed in Main Radiology and the Imaging sections, which accounted for the major share (74% in FY81, and 83% in FY82) of the Department workload. Other impacts were studied by observation and by use of surveys and interviews, including satisfaction of Radiology Department staff and attending physicians

with radiology services, perceptions of staff concerning changes resulting from TRIRAD, and staff acceptance of the system. Information on costs was also obtained from Department budgets and TRIRAD contract documents.

The information gained has been analyzed and is summarized below as it relates to the goals and objectives established by the Medical Review Group for TRIRAD, the experience with computer assistance to reading and reporting functions, and staff acceptance of the system.

B. SYSTEM GOALS AND OBJECTIVES

1. Goal 1: To Provide Accurate, Timely Radiology Reports

Quantitative studies, survey results, and interviews all indicated that there were substantial improvements in the timeliness of radiology reports from the baseline to the post-implementation period.

During the implementation period, the backlog of examinations for which no report had been distributed (incomplete reports) decreased steadily, as the timeliness of completion of reports improved. In Main Radiology, for example, the turnaround time from patient arrival in the Department until a typed or printed report was available for distribution was reduced from 16 days in the baseline to 6 days. The proportion of the volume that was handwritten final reports in Main Radiology also dropped from 95% to 6%. In Orthopedic Radiology handwritten reports were prepared for all interpretations.

Bar-coded-reporting assistance was used for 20% of all reports prepared in the Department, and appears to have contributed to the decrease in turnaround time; 17% of these required no transcription while 3% of the reports were prepared from a combination of bar-coding and dictation. In other sections of the Department, all reports were transcribed from dictation in the baseline and printed by TRIRAD after system implementation. Associated baseline mean turnaround times in the range of 15-43 days had been reduced to 5-14 days by the time post-implementation data were collected.

Satisfaction of both Radiology Department staff and attending physicians with the timeliness of interpretation reports increased.

Both groups reported that access to information concerning patient examination status and reports stored in the TRIRAD system was one of the most significant benefits. Attending physicians noted that they were more likely to find radiology reports in patient records than before TRIRAD was implemented; however, they also reported that TRIRAD had not eliminated all problems with report availability. (As TRIRAD is a stand-alone system and installed only within the Radiology Department, its influence on certain segments of the process and on distribution and filing of reports in patient records outside of the Department may only be indirect.)

The reasons for the reduction experienced in report turnaround time are believed due primarily to a commitment on the part of Radiology management to make some changes in operations and staffing in order to improve turnaround time rather than due solely to TRIRAD. The most important change was in bringing transcription services within the Department by adding two transcriptionists to the Radiology Department staff rather than using outside services.

Both Radiology Department staff and attending physicians were satisfied with the accuracy of the interpretations in radiology reports in the baseline period. This level of satisfaction did not change during the post-implementation study. A few staff felt that TRIRAD had affected accuracy, but this appears to be related to the increased accuracy of information contained on the printed report, e.g., patient identification or examination date, and not due to the accuracy of the interpretation per se.

2. Goal 2: To Collect Management and Workload Data for Use in Optimizing Radiology Resources

At the time of the post-implementation study, the Administrative Reporting and Statistics module of TRIRAD was in the process of being installed. Therefore, the experience with management information was extremely limited. When this module is implemented, it is expected to reduce the effort required to prepare required management reports and to make available management information that was infeasible to compile by manual methods.

3. Goal 3: To Improve Availability of Patient-Specific Historical Radiological Reports and Films

In the baseline process, reports and films were filed together in the film file libraries. During the post-implementation period reports were stored in the TRIRAD system, whereas, only the record-keeping concerning the location of film files was automated and the hardcopy film storage and film-library procedures remained essentially unchanged. The benefits associated with changes in availability of reports were thus quite different than for films.

The staff surveys and quantitative studies indicate that the result of these changes was greatly improved availability of historical reports. The reason is that once a report was entered into the system, it was retrievable at any time on demand. Thus reports could be accessed more easily and in a more timely manner. Both Radiology staff and attending physicians reported increased access to reports to be a major benefit of TRIRAD.

Availability of historical film files showed minimal or no improvement. Though staff reported that the ease of obtaining film files had improved, the availability of a film file still depended upon manual filing and retrieval in the film library. As the patient data base on reports, film file records and examination history continues to grow, availability of this information when needed should continue to improve.

4. Goal 4: To Make Maximum Use of Resources, Equipment, and Staff Through Efficient Scheduling

At the time of the post-implementation study, the automated scheduling function of TRIRAD was not fully operational; the optimal scheduling module did not function due to software errors. Nevertheless, the remainder of the scheduling module was in use in all sections of the Radiology Department. Sixty percent of Department staff who responded to the post-implementation survey felt that TRIRAD had improved scheduling, and only 11% believed that there had been no improvements (the remainder were neutral).

Staff time devoted to scheduling/reception functions increased somewhat. However, during the scheduling and registration processes in the post-implementation period, the patient data base was created or updated. The increases in staff time were thus believed to have been due to entering the additional data required to meet the increased information needs for the patient examination history, rather than due to a decrease in the efficiency of scheduling.

The post-implementation staff survey included questions concerning the effect of TRIRAD on the efficiency and economy of the Department. A large percentage of the respondents believed that TRIRAD had made their work more efficient and that the system saved them time. However, respondents were also largely in agreement that neither personnel requirements in the Department nor the costs of providing radiology services had been reduced. This perception was consistent with the results of an analysis of Department budgets and a marginal cost analysis, which demonstrated some shifts in resources, but no actual resource reductions during the first year of TRIRAD operation.

The combined experience with respect to scheduling and resource utilization indicates that scheduling was improved and that some efficiencies have been gained in work performed in the Department. However, the anticipated relationship between these two changes, as specified in the Medical Review Group goals, has not been demonstrated.

5. Goal 5: To Reduce Patient Waiting and Processing Time due to Better Scheduling

Quantitative studies included measurement of the elapsed time between patient arrival in the Department for examination and patient departure. The data indicate that this time increased somewhat in five sections and decreased in three others. However, the increases are believed to have resulted from changes in procedures for requisitioning files, changes in the mix of examinations and changes in staffing rather than from improved scheduling or other direct effect of TRIRAD. Thus, the experience with patient waiting and

examination time was mixed and appears to have been determined for the most part by factors unrelated to TRIRAD scheduling functions.

6. Goal 6: To Reduce the Number of Repeat Exams as a Result of Improved Film File Accessibility

Film file accessibility was evaluated both by quantitative studies and surveys and interviews. Survey results suggest some improvements in accessibility of current films (recent films for outpatients or films for inpatients) as a result of the film-file-tracking functions of TRIRAD. Staff in the Department and attending physicians also reported that the ease of obtaining films had increased. However, quantitative studies of film file availability in reading rooms and surveys and interviews consistently indicated minimal or no improvement in the accessibility of historical films. As the film-file-data base continues to grow, accessibility to these films may improve. The lack of a discernible improvement is attributable to the fact that, though TRIRAD automated the bookkeeping functions of film-file management, the films themselves were still filed in "hard copy." Until new technology is available to store images digitally on the system, problems with the availability of films will not be totally solved by any radiology management system.

The issue of repeat examinations was included in the post-implementation survey of Radiology department staff. Thirty-eight percent of respondents reported that fewer repeat examinations were required (38% were neutral, 24% felt no impact had occurred). Given the lack of discernible change in accessibility of historical film files, reduced turnaround time for reports (discussed under Goal 1) and/or increased access to patient information (discussed under Goal 3) are more plausible as the causes of the reduced need to repeat examinations reported by some department staff than film-file accessibility.

7. Goal 7: To Reduce Personnel Time Spent in Clerical Transcription

One of the most significant impacts that resulted from the introduction of TRIRAD and accompanying management changes was the increase in printed (rather than handwritten) interpretation reports from 5% in the baseline period to 94%. Some of these, 17% of the

Department volume, were prepared directly by the radiologist using a bar-code reader and averted the need for transcription. The overall increase in transcribed reports amounts to nearly 30% of the examination volume (35% were transcribed during the baseline and 65% were transcribed during post-implementation). On this basis, time devoted to transcription increased.

However, the efficiency of transcription clearly improved. Following the introduction of TRIRAD, two typists were added to the Department staff and all transcriptions were performed within the Department rather than by the hospital's Central Transcription service and an outside typing service. (Department staff felt that typing efficiency was probably increased due to the increased use of pre-defined text. While pre-defined text was available prior to TRIRAD, its use appeared quite limited during the baseline study.) The elapsed time for the transcription segment of the process was reduced from 7 to 21 days to less than 1 day, a reduction that contributed significantly to the reduction noted in turnaround time for reports.

C. READING ASSISTANCE

Before TRIRAD was introduced in the Radiology Department at NHB, radiology reports were either handwritten by the radiologist on the request form or the interpretations were dictated and typed by outside transcription services. TRIRAD gave the staff radiologist and radiology residents the ability to produce printed interpretation reports directly from input via a bar-coding system or an optical mark reader (OMR).

By the end of the first year of system use, the bar-coding system was being used by a small number of radiologists in two sections of the Department. Although measured radiologist-reading and report-preparation times when using this method appeared to be somewhat shorter, bar-coding appeared to be used selectively for certain simple interpretations. Reductions in radiologist's labor for reporting appear not to have occurred. Computer-assisted reporting appears to have reduced turnaround time and eliminated the need for

transcription. This results in less labor devoted to transcription (an average of 2 minutes per report in the post-implementation period) and decreased turnaround time for results since the interpretation report can be verified immediately and printed for distribution.

In the first few months after TRIRAD was installed, the radiologists made greater use of bar-coding. The motivation appears to have been to reduce the backlog of reports in transcription and produce reports in a more timely manner. As these aspects of the process improved, use of bar-coding was observed to decline.

D. . SYSTEM ACCEPTANCE BY RADIOLOGY STAFF

Fifty-nine percent of respondents to the post-implementation survey of Radiology Department staff indicated that overall they were satisfied with TRIRAD, and only 6% considered themselves dissatisfied.

Many Department staff felt that there had been benefits to patient care. In particular, they cited the improved access to patient information as a significant contributor to their ability to provide information on examination status, reports and current films. As a consequence, they believed that the Department assisted attending physicians in providing better patient care and the attending physicians were more satisfied with radiology services. Most (79%) of respondents to the survey felt that TRIRAD was easy to learn, and many (59%) believed that overall the benefits outweighed the disadvantages. Seventy-five percent of the survey respondents further believed that the benefits from TRIRAD would continue to increase in the future.

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I. INTRODUCTION

A. OVERVIEW

The Tri-Service Medical Information Systems (TRIMIS) Program Office (TPO) has installed four initial stand-alone computer systems for support of radiology operations (Tri-Service Radiology System or TRIRAD) in Medical Treatment Facilities (MTFs). The experience with TRIRAD at the third installation site--the Naval Hospital, Bethesda (NHB)[1] in Bethesda, MD--has been evaluated in order to provide information for use in decision-making about the future use of automation in radiology departments in other military health care facilities and to identify system and operational changes that might lead to realization of additional benefits at NHB or at other sites.

This evaluation has been conducted in several phases. Intensive data were collected concerning aspects of radiology operations at NHB before the system was installed (baseline or X Period in November of 1981). The implementation of the TRIRAD system was monitored periodically from November of 1981 to October of 1982. The third phase was a second period of intensive data collection concerning the computer (post-implementation or Y Period in October of 1982) mode of operation once the TRIRAD system had been implemented and was in routine use. This report presents the results of all of these evaluation activities.

B. THE SETTING

The Naval Hospital, Bethesda is a very large and modern medical center located in Bethesda, MD, near the Uniformed Services University of the Health Sciences, with which it is closely allied. As a major teaching hospital, it provides post-graduate training in all clinical

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[1] As of September 1982, the name was changed from the National Naval Medical Center (NNMC) to Naval Hospital, Bethesda. The latter is used throughout this report, though the facility was known as NNMC when the evaluation was begun.

areas. A variety of patient care and research programs are conducted in collaboration with Walter Reed Army Medical Center and the National Institutes of Health.

NHB serves a local catchment population in the Washington, D.C. region and also serves as a regional tertiary referral center. The normal authorized operating capacity of 474 inpatient beds dropped briefly during the evaluation period (summer of 1982) to 211 beds, but had been restored to a more nearly normal level of 420 beds by the time post-implementation data were collected. The outpatient volume in the numerous clinics at the facility averages more than 1500 per day.

The Radiology Department supporting this patient load is sizable. Occupying an area of about 13,600 square feet, the various sections of the Department are dispersed throughout several floors of the facility. The full range of specialized radiology services offered is reflected in the nine individual sections operating within the Department: Main Radiology, Gastro-Intestinal (GI) Radiology, Orthopedic Radiology, Urologic Radiology, Special Procedures, Nuclear Medicine, Computerized Tomography, Ultrasound, and Radiation Oncology. Staffed by 24 radiologists and residents, 70 technicians, 3 physicists and 15 clerical and support staff, the nine sections performed 100,300 examinations/treatments (equivalent to 532,000 weighted work units[2]) in FY 1981 and 102,000 examinations/treatments (852,770 weighted work units[3]) in FY 1982.

C. INTRODUCTION TO RADIOLOGY SERVICES

For the reader not familiar with the typical workflow involved in providing radiology services in a military MTF with complete radiology services, the following is a brief overview of a typical manual

[2]For purposes of manpower planning, examinations are assigned a weight on the basis of complexity (e.g. a standard chest X-ray = 3 and an angiogram = 28).

[3]In FY82, the Nuclear Medicine Section of Radiology at NHB adopted a major change in procedures for computing weighted work units; a nuclear medicine examination averaged 10 work units per examination in FY81 and 57 work units per examination in FY82.

process and the changes commonly made to that process when the Radiology Department is automated.

1. Manual

The process of a radiology department begins with the arrival of a patient for examination. In some departments, some or all patient examinations are scheduled in advance; typically, only the more complex procedures are scheduled, with the routine diagnostic X-ray examinations performed on a walk-in basis. Patient check-in usually involves checking the written request for X-ray examinations (often a multi-part form) and in some cases also entering pertinent patient information into a log.

For patients who have been examined previously in the department, the film file is pulled; often a separate file is maintained documenting each patient's examination history. If no file is located, a new one is prepared. Check-in is completed with the preparation of a flashcard, which contains pertinent patient information and is used to identify the X-ray film.

After the X-ray examination has been performed, the film is processed, matched with the X-ray request form and film file folder, and given to a radiologist for reading. Departments usually have a process for expediting STAT (emergency) and ASAP (urgent) examinations and for providing a wet-reading (urgent interpretation and report). The radiologist may compare the present film(s) with any available prior films from the film file folder, as appropriate, before arriving at an interpretation and generally prepares the written report in one of two ways:

- by handwritten interpretation on the request form; or
- by dictation for transcription.

Transcribed reports are generally returned to the radiologist for verification and signature. The process is completed when the various copies of the request form, including the typed or handwritten radiologist's reading, are separated, the file copy filed in the film file folder with the film, and one or two copies are distributed to

the patient's record and/or the provider who requested the examination.

2. Automated Process

When this process is automated with a state-of-the-art system such as TRIRAD, the major changes occur in the reception/accession phase, in report preparation, and in file management.

At patient check-in, instead of working with the logs and hard-copy files typically found in a manual process, the receptionist consults the video display terminal (VDT) and enters patient registration information for a patient being examined for the first time or updates the examination history information for a returning patient. For previously scheduled patients, the accession process amounts to verifying the patient's arrival and entering the information into the system at the terminal. The system generates flashcards and/or film-file labels as needed.

The radiologist reading the X-ray film has increased options for preparing the interpretation report, such as the ability to select predefined standard report statements for generation of a printed report without need of transcription. Word-processing capabilities are included in order to facilitate the transcription process, with verification, editing and approval by the radiologist performed at a terminal.

Once entered into the system, the patient's examination history, including interpreted reports, is stored automatically, with the information available at any time via the terminal. This reduces the need for paper copies of X-ray reports in the film file; hard copies of the report are distributed for the requesting provider and the patient's medical record.

D. INTRODUCTION TO TRIRAD

The Tri-Services Radiology System (known as TRIRAD), was purchased from National Computer Systems of Minneapolis, MN. It provides state-of-the-art automated capabilities as described briefly below:

Patient Management--a patient data base including patient identification and demographic data, examination history, and diagnostic reports; label generation; and film-file tracking.

Scheduling--scheduling of single and multiple, same-day examinations; generation of film-file pull lists and administrative reports.

Film Management--film-file location tracking, including film-folder transfers, loans, returns, and overdue loans; film transfers accomplished via terminal or bar-code reader.

Administrative Reporting and Statistics--generation of reports concerning workload, including cancellation list, day logs, incomplete (exam status) list, schedule and film-file pull lists, and film inventory report.

Special Interest/Teaching Files--the capability for creating teaching or research files from the patient data base.

Reporting Assistance--direct generation of interpretation reports by radiologists by use of an Optical Mark Recognition (OMR) scanner or Stored Radiological Text (SRT) via a terminal or bar-code reader; text-processing support to transcription.

These six modules of TRIRAD were implemented in a phased fashion, beginning in November of 1981. By the time post-implementation data were collected in October of 1982, the system had been implemented throughout the Radiology Department, with the following exceptions:

- the management/statistics module had only been partially implemented;
- the scheduling module had been partially implemented and the optimal scheduling module was not functioning; and
- the implementation in Radiation Therapy had been deferred pending the development of computer algorithms

to support the specific scheduling and reporting requirements in this section.

E. GOALS AND OBJECTIVES FOR TRIRAD

In 1978, the Medical Review Group of the TRIMIS Program Office established seven goals and objectives for TRIRAD as follows:[1]

- To provide accurate, timely radiology reports
- To collect management and workload data for use in optimizing radiology resources
- To improve availability of patient specific historical radiological reports and films
- To make maximum use of resources, equipment and staff through efficient scheduling
- To reduce the number of repeat exams as a result of improved film-file accessibility
- To reduce patient waiting and processing time due to better scheduling
- To reduce personnel time spent in clerical transcriptions.

The Medical Review Group stated additional goals that it believed would be more difficult to quantify, including improved capability for clinical research and improved availability of information on patient allergies.

These goals and objectives determined the content of the evaluation of TRIRAD at NHB.

F. ORGANIZATION OF THE REPORT

The body of this evaluation report is presented in four chapters. Chapter II describes the methodology used, Chapter III documents the Department workload during the study period, summarizes the baseline work flow in the Radiology Department and describes changes that were made when the system was introduced. In Chapter IV, the results of data collection activities are described. Chapter V discusses the results in the context of the system goals and objectives, reading assistance for radiologists, and staff acceptance. Detailed supporting data appendices are included at the end of this volume.

II. METHODOLOGY

A. APPROACH

The basic analytic framework for the evaluation was a study of key aspects of the operation of the Radiology Department at NHB before and after the TRIRAD system was installed. This was supplemented by periodic monitoring of system implementation as it progressed in each of the various sections of the Department. Implementation monitoring served the dual purpose of documenting system status with respect to timing the post-implementation study and providing an opportunity to observe other changes, unrelated to TRIRAD, that affect radiology services (in effect, the confounding variables in the study).

B. EVALUATION OBJECTIVES AND SELECTION OF AREAS FOR STUDY

The overall objectives of the evaluation were to document the experience with TRIRAD at NHB and to ascertain to what extent the goals and objectives for the system were met. The most likely major system impacts were selected for more intensive, quantitative study:

- turnaround time for radiology services (elapsed time from patient arrival for examination to availability of interpretation report),
- elapsed time and labor devoted to segments of the work flow for processing patients, examinations and reports, and
- film file availability.

Other impacts were evaluated qualitatively by observation, and by use of interviews and staff surveys rather than by original data collection:

- staff satisfaction with radiology services,
- staff perceptions of changes resulting from TRIRAD, and
- staff acceptance of TRIRAD.

Available data concerning Department workload and budget were also assembled from management reports and TRIRAD contract documents.

Turnaround time for the written report was viewed as the most significant potential impact of TRIRAD on radiology services. In

order to provide a basis for assessing the significance of changes in turnaround time, evaluation staff discussed with staff radiologists at NHB what turnaround times they would consider as acceptable for different types of examinations and what turnaround times they would consider as preferred (giving the attending physician the maximum benefit from radiology information in clinical decision-making). The consensus opinions are given in Appendix A for 21 types of radiology examinations.

The decision to designate NHB as a major evaluation site for TRIRAD only preceded the installation of the system by a few weeks. In order to complete data collection activities within the available time and still evaluate the baseline operations in all sections of the Department, a decision was made to focus the more intensive data collection activities on Main Radiology and the three imaging sections (Nuclear Medicine, Ultrasound, and Computerized Tomography), which together produced 73% of the weighted workload in the Department. Smaller samples of data were obtained in the other sections. The TRIRAD system itself made some data easier to obtain in the post-implementation study, particularly data on the timing of events in the radiology-examination-to-report cycle. This made it feasible to collect larger numbers of observations than in the baseline.

The evaluation measures and techniques are summarized in Table 1. Further detail concerning the scope of, and procedures followed in, evaluation activities are contained in the evaluation plan.[3]

C. DATA COLLECTION

Baseline data were collected during the period November 9 to December 4, 1981. A total of 45 man-days were spent on-site observing, collecting data and interviewing facility staff. Implementation monitoring visits were conducted to NHB on January 20, February 16, March 23, August 5, and October 5, 1982. Activities during these visits included observation, interviews, and focused collection of data on department workload and other data compiled and reported by TRIRAD. Post-implementation data were collected during

TABLE 1

SUMMARY OF METHODOLOGY FOR EVALUATION OF THE TRI-SERVICE RADIOLOGY SYSTEM AT NAVAL HOSPITAL, BETHESDA

Impact Area	Evaluation Measure	Department Sections	Measurement Technique: Baseline	Measurement Technique: Post-Implementation	Sample Size
Quantitative					
Turnaround time for Radiology reports	Elapsed time from patient arrival in Department until completed report available for distribution		Capture of request forms/reports at different stages in cycle; comparison of present date/time with date/time noted for previous events; derivation of mean elapsed time for each segment and total cycle	Use of computer-generated report supplemented by observations for various segments of the cycle; comparison of present date at mailbox with date of examination and report printing	Baseline[a] Post-Imp: 1,326
	a. Handwritten	Main Radiology, Orthopedic Radiology			
	b. Typed/Printed	Main Radiology, GI Radiology, Orthopedic Radiology, Urologic Radiology, Special Procedures, Nuclear Medicine, Computerized Tomography, Ultrasonography			
	Volume of examinations for which no final interpretation report has been printed (incomplete) over time	All	---	Use of computer-generated reports listing the number of incomplete reports and date of examination	Total sample of status as of March 23, 1982; August 5, 1982; October 5, 1982; and November 5, 1982
Labor and process times	Time devoted to scheduling/reception in reception areas	Main Radiology, Imaging	Work sampling	Work sampling	*Baseline:* 549 *Post-Imp:* 889
	Elapsed time from patient arrival for examination to departure	All	Observation of patient arrival and departure times	Use of computer-generated reports supplemented by observation	Baseline: 224[b] Post-Imp: 256
	Time to process film file requests	Main Radiology	---	Timed observations	Baseline: n/a Post-Imp: 52
	Radiologist time devoted to interpreting films and preparing reports	All	Timed observations	Timed observations	Baseline: 236 Post-Imp: 357
	Elapsed time and labor time devoted to report transcription	All	---	Timed observations	Baseline: n/a Post-Imp: 311

[a]Means and ranges for individual process segments given in Appendix B.

[b]Includes 110 estimated observations for Main Radiology and 114 observations for all other Radiology sections.

TABLE 1 (Continued)

SUMMARY OF METHODOLOGY FOR EVALUATION OF THE TRI-SERVICE RADIOLOGY SYSTEM AT NAVAL HOSPITAL, BETHESDA

Impact Area	Evaluation Measure	Department Sections	Measurement Technique		Sample Size
			Baseline	Post-Implementation	
Quantitative					
Film file availability	Availability of prior film files during radiologist interpretation	Main Radiology GI Radiology Orthopedic Radiology Nuclear Medicine Computerized Tomography Ultrasonography	Observation during interpretation	Observation during interpretation	Baseline: 252 Post-Imp: 343
Costs					
Cost of Radiology services	Annual radiology budget and costs of TRIRAD equipment and operation		Department records, interviews	Department records, interviews	Department records, TRIRAD contract, interviews
Qualitative					
Radiology Department staff satisfaction with operations and services provided	Attitudes concerning satisfaction with aspects of services relating to efficiency/economy and quality of services	All	Self-administered questionnaire	Self-administered questionnaire	Baseline: 65 Post-Imp: 53
Attending physician satisfaction with radiology services	Perceptions of those aspects of radiology services most likely to be affected by TRIRAD, changes in those aspects, significance of changes to overall satisfaction with radiology services	Clinical services that are heavy users of radiology services	Interviews	Interviews	Baseline: 10 Post-Imp: 10

the period October 18 to November 5, 1982; a total of 57 man-days were spent on-site at this time.

During the baseline study, a total of 78 questionnaires was distributed and 65 (83%) were completed and returned. .This represents a 58% sample of the staff working in the Department at the time. In the post-implementation study, questionnaire administration was the responsibility of the Department; 95 questionnaires were distributed and 53 (56%) completed questionnaires were available for analysis. This sample represents approximately 47% of the staff at the time.

III. RADIOLOGY PROCESS, VOLUME AND EQUIPMENT

A. INTRODUCTION

This chapter discusses the process followed in delivery of Radiology services, including the processing of patients, examinations and reports. The volume of examinations performed annually in each section, as well as a list of TRIRAD equipment within the Department, is also presented.

The workflow for providing Radiology services, while varying in detail, generally followed a consistent process in all sections. Two generalized flow diagrams have been prepared - one each for the baseline period (Figure 1) and for the post-implementation period (Figure 2). This discussion is organized according to the major steps in the process: scheduling and reception, film file retrieval, film processing and control, interpretation and reporting, transcription, and report approval and distribution. Under each of these subheadings the generalized procedure is presented, variations followed in each section are described, and differences between the baseline and post-implementation periods are discussed. The volume of examinations and the corresponding weighted work units are shown at the end of this Chapter in Table 2 for both the baseline and post-implementation periods, and the peripheral equipment for TRIRAD located in each area of the Department are shown in a matrix format in Table 3.

B. SCHEDULING AND RECEPTION

The Radiology process began with the scheduling and reception functions. There were five reception areas in the Department:

- Main Radiology reception provided scheduling and registration for Main Radiology and GI Radiology;
- Imaging reception provided scheduling and reception for Nuclear Medicine, Computerized Tomography, and Ultrasonography;
- Urology outpatient clinic reception served Urologic Radiology;

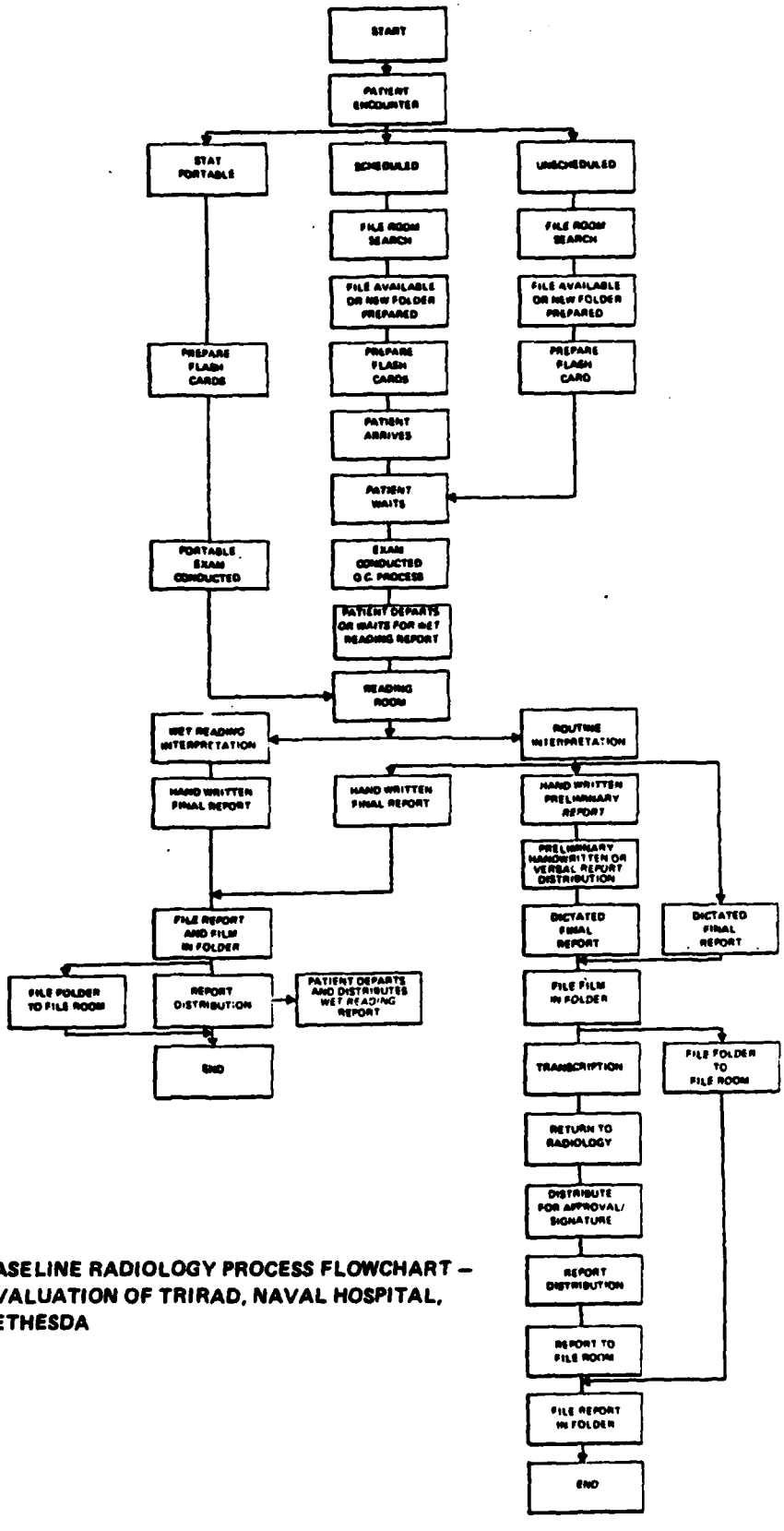


FIGURE 1 BASELINE RADIOLOGY PROCESS FLOWCHART – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

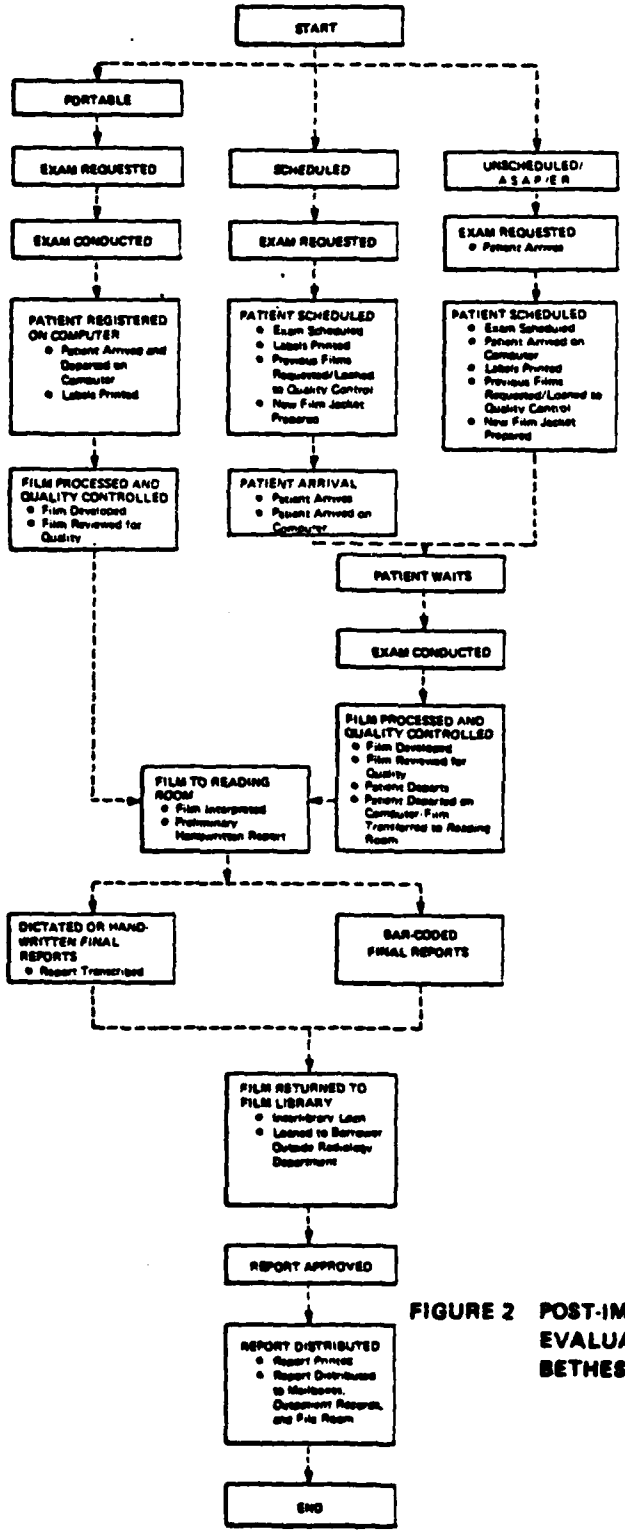


FIGURE 2 POST-IMPLEMENTATION PROCESS FLOWCHART – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

- Orthopedic outpatient clinic reception served Orthopedic Radiology; and
- The Special Procedures section scheduled and received patients, but did not need a reception desk, as such, due to the low volume of patients (three per day on average).

During the post-implementation period all patients were scheduled on the TRIRAD system; some patients were scheduled in advance while others were scheduled on arrival for examination. During the baseline period many patients were scheduled in advance; scheduling information was recorded in notebooks identified for that purpose.

In Main Radiology patients were either scheduled for examination in advance or examined on a walk-in basis. Advanced scheduling was done for mammograms by the mammography technician. The receptionists scheduled other examinations in advance for inpatients and for outpatients in cases when the receptionists predicted that an outpatient would need to wait too long for examination. Most standard examinations were taken on a walk-in basis. Portable examinations were taken on non-ambulatory patients. In GI Radiology all patients were scheduled in advance by the GI technicians.

Imaging examinations were scheduled by both the receptionists and technicians. In Urologic Radiology the technicians scheduled all examinations. Orthopedic Radiology provided all examinations on a walk-in basis. In the Special Procedures section examinations were usually arranged by the radiologist in consultation with the attending physician; scheduling itself was usually done by the technician.

The TRIRAD system was intended to have two scheduling options: optimal and manual scheduling. The optimal mode, which was not operational before or during the post-implementation study, was designed to identify for the scheduler the next available appointment, and potential conflicts with other examinations and overall to assist the scheduler in developing an optimal schedule. The optimal scheduling module was designed to prevent overbooking, scheduling examinations outside normal hours, and scheduling examinations in rooms where the examination was not approved to occur.

The manual system of scheduling with TRIRAD was in use in all sections of Radiology. The manual mode (which is an inappropriate label for this automated scheduling function) differed somewhat from the optimal mode. Examination times were chosen by the scheduler from available room schedules shown on the video display terminal. The system informed the operator of duplicate or similar examinations, conflicts due to contrast media, and conflicts within the patient's own schedule. In the manual mode, in contrast to the optimal mode, the scheduler could choose to schedule an examination in spite of duplicates or conflicts. Overbooking the room schedule, the patient's schedule and scheduling outside of the established hours were also available in the manual mode.

When a patient arrived at reception the arrival time was recorded on the system or in a logbook during the baseline period. If the patient was scheduled in advance, the prior film file or a new file jacket and all identifying labels were waiting at the reception desk. For unscheduled patients, the patient was registered and added to the schedule and the prior film file was requested from the film library by submitting either a printed file label or a written note. The printed labels replaced much of the handwriting required of receptionists during the baseline.

Inpatients and outpatients were processed similarly, except that unscheduled inpatients were called from the ward for examination during low workload periods so that waiting time was kept to a minimum. Portable examinations were used for non-ambulatory inpatients, such as those in the Intensive Care Unit. Usually patient registration and other processing were done after the examination in order to speed up the taking of the film, especially for emergencies.

After registration the patient was asked to wait. For certain emergencies, preparatory procedures were done at this time, e.g., removing a cast prior to a bone examination.

The differences between the baseline and post-implementation processes were in the use of the terminals to register and schedule patients, the automated printing of labels and lists of scheduled

examinations, and the increased amount of patient information obtained and the automated identification of possible examination conflicts and duplicates.

C. FILM FILE RETRIEVAL

There were four film libraries: Main Radiology, Imaging, Orthopedics, and Urology. The former two were large and contained films for a wide variety of examination types that were needed by a large number of physicians. The latter two were small and contained specialized images that were of interest to a smaller group of physicians.

Films were requested from the film libraries in two ways. For scheduled patients, a list of patients was submitted to the file clerk during the afternoon or evening prior to examination. The film files were delivered to the reception area to be held until patient arrival or a new file jacket was prepared. For unscheduled patients, individual requests or a small group of requests were submitted. In Main Radiology these requests were submitted on a dumbwaiter to the film library on the floor below reception and the film files were returned in the same manner. The TRIRAD functions that would allow file requests to be printed in the film libraries were not used (until the final day of post-implementation data collection).

With TRIRAD, when a film could not be located, data on the location of the file were obtained and this information was returned to the requestor. Prior to releasing the film, the file clerk signed out the file to the requesting location.

D. FILM PROCESSING AND CONTROL

After a film was taken, it was processed and matched with its requisition and film file jacket on the quality control desk. If the prior films had not been received from the film library, the current films remained on the control desk until they were matched (during post-implementation) or were sent to the reading rooms for interpretation (during the baseline or for emergency patients during the post-implementation period).

Once matched, films were reviewed for quality of the images and, if acceptable, transferred to the reading room. Occasionally repeat examinations or additional views were necessary to improve the quality of the examinations. In some sections films were also reviewed by the radiologist in order to ensure that the films clearly showed the diagnostic information needed. In some sections the radiologist also conducted or participated in the examination.

After films had been accepted for quality, patients were released, and, during post-implementation "departed" on the TRIRAD terminal. Films were transferred to a reading room. If a wet reading (urgent interpretation) was required, the patient waited for the report.

E. INTERPRETATION AND REPORTING

Interpretation and reporting varied in each section of Radiology and in some sections differed between baseline and post-implementation periods.

Main Radiology had three reading areas - the Wet Reading Room, the Inpatient Reading Room, and the CCU Reading Room. During the baseline period, the Wet Reading Room processed most of the volume in this section. Reports for both inpatients and outpatients were handwritten on the requisition and signed as official final reports. Not all films required wet readings, but all were handwritten in order to avoid long delays associated with the transcription of dictated reports. In the post-implementation period only outpatient examinations and inpatient examinations requiring wet readings were interpreted in this reading room and nearly all reports were dictated for transcription or were prepared using bar-coded reporting assistance. When a wet reading report was required, a preliminary handwritten report was prepared and a copy was given to the patient for distribution to the requesting provider. During the baseline period, the Wet Reading Room was used substantially for teaching Radiology residents, but this was not the case during the post-implementation period.

The Inpatient Reading Room served two functions - as a reading room and as an active storage area for viewing current inpatient films; films were mounted and available for viewing throughout the patient's stay. During the baseline period, this room served primarily as a film viewing room as only a small volume of films were interpreted here; these reports were all dictated for transcription. During the post-implementation period, nearly all inpatient films were interpreted in this area; reports were all dictated for transcription.

The CCU Reading Room operated similarly to the Inpatient Reading Room; however, a smaller volume of films were interpreted in this area.

In GI Radiology the films for each morning's examinations were mounted on a film viewer and interpreted during the early part of each afternoon. The films were left for viewing for 1 day. Reading sessions were also teaching sessions for residents. During these sessions the residents took handwritten notes, which were written as preliminary reports in a notebook; the preliminary reports were available to providers when they came to view the GI films. The residents dictated the final interpretation for transcription. The process was the same in both study periods.

In Orthopedic Radiology, all reports were treated as wet readings; a final handwritten interpretation was available within minutes after the films were processed. These reports were distributed immediately to the orthopedic surgeons. During the post-implementation period, this practice continued, but reports were also entered into the system to create the historical file; a small volume was entered by bar coding and the major share of the volume by transcription from the handwritten reports.

In Urologic Radiology, Special Procedures, Nuclear Medicine and Computerized Tomography all films were dictated for transcription during both periods. Nuclear Medicine began a practice of direct dictation to a transcriptionist for simultaneous typing in the middle of the post-implementation data collection period. In Ultrasonography reports were dictated for transcription during the baseline period and

these reports were interpreted in reading sessions. During the post-implementation period, reports were interpreted immediately on completion of the examination and these handwritten reports were sent to transcription.

F. TRANSCRIPTION

During the baseline period, dictated final reports and the related requisitions were sent by Main Radiology, GI Radiology, Urologic Radiology and Special Procedures to the hospital's Central Transcription service located in Patient Affairs. In Patient Affairs, the envelopes were delivered to the one transcriptionist assigned to Radiology transcription. This transcriptionist recorded the date received on the envelope and added it to the queue of work to be processed.

The transcriptionist typed the dictated reports from the cassette onto the requisitions that were included with the cassette. Completed reports were inserted back into the envelope and set aside. At day's end all the envelopes containing the completed typed dictations were put in the outgoing mail for delivery back to Radiology.

The process of selecting the order in which the envelopes are processed appeared to be made without regard to date of receipt or date of examination. The shorter reports were generally typed first, especially chest X-ray reports.

Patient Affairs contracted with an outside private transcription service to supplement the staff at hand. As the queue of incomplete dictations grew so did the likelihood that they would be sent to the outside service. Long reports, especially angiograms, were more likely to be sent out to a contract typing service. The outside transcription service typed the dictated final report onto the included requisitions and returned them to Patient Affairs, which distributed them to Radiology, as described above.

On receipt of the typed reports, Radiology distributed them for signature. The signed reports were separated and the copies were sent to the requesting physician, the outpatient clinic or inpatient ward, and the film file folder that contained the patients' X-rays.

The Imaging sections of Radiology did not use the Patient Affairs transcription services so the processing of final dictated reports differed from that described above for the other sections of Radiology. Both in-house and contract typing services were used.

Dictated Nuclear Medicine reports were delivered to the Nuclear Medicine secretary for transcription. Because of the relatively low volume of reports, this secretary was able to complete the reports in addition to her other departmental responsibilities. Completed reports were distributed for signature and, at weekly intervals, were distributed to requesting physicians, to clinics and wards and to file.

Dictated reports for Ultrasonography and Computerized Tomography were delivered to the Nuclear Medicine secretary for processing. Because the Nuclear Medicine secretary only typed the Nuclear Medicine reports and the Patient Affairs transcription services had a lengthy turnaround time, an alternative transcription service was sought.

In August 1981 the backlog of untyped Ultrasonography and CT reports had become considerable. After bidding and contractual terms were arranged, several hundred reports were sent out for transcription. During the baseline data collection period of November 1981, the same contract services were used based on the previously established terms. The transcription process for Ultrasound and CT reports was apparently being changed and in transition at the time of data collection.

Typed reports were returned to the Radiology supply officer and distributed for signature through the office of the Nuclear Medicine secretary. Signed reports were separated and copies were sent to the requesting physician, the patient clinic or inpatient location and to the file.

In the post-implementation period, the transcription process was completely revised and all transcribed reports were entered into the computer. Two transcriptionists were added to the Radiology staff, and typing of Radiology reports was no longer done by Central Transcription or contract typing services. The Nuclear Medicine

secretary usually transcribed reports from that section and did both transcription from direct dictation and from dictation tape. In Orthopedic Radiology and Ultrasonography reports were transcribed from handwritten preliminary reports. For all other sections, reports were transcribed from dictation tape. The pre-defined text feature of TRIRAD was used with the goal to increase the efficiency of both interpretation and transcription. Using this feature, the radiologist dictated a code for an interpretation statement which was pre-defined and stored. The transcriptionist then retrieved this statement by typing only the code on the video display terminal. Once the reports had been entered into the system, they were available for radiologists' approval.

G. REPORT APPROVAL AND DISTRIBUTION

During the baseline period, handwritten final reports were signed and distributed immediately. For wet readings, a copy was given to the patient for distribution to the provider. For routine reports, the distribution copies were decollated and inserted into the mailbox for distribution to medical records, attending physicians and to the film files. Typed reports were delivered to the radiologists for review and signature and then these were decollated and inserted into the mailbox for distribution.

During the post-implementation period, handwritten reports were signed and distributed immediately. Reports entered into the system by bar coding or by transcription were approved by radiologists using electronic signature. After reviewing the report and editing the text as needed using an intelligent video display terminal, the radiologist approved the report with a unique signature code. These reports were then transferred to a print queue. Several times each day a designated technician printed all reports in this queue. The reports were accumulated and then later decollated and inserted in the mailbox for distribution to the ward or clinic, medical record, the attending physician and to the film file.

H. TRIRAD PERIPHERAL EQUIPMENT

A matrix of the TRIRAD peripheral equipment units that are located in each area of Radiology is shown in Table 2. These units include video display terminals, bar-code readers and printers as indicated, but not the mainframe equipment and software. The numbers in the columns refer to the numbers of each unit located in each area of Radiology. For example, there are three video display terminals in the Main Radiology reception area. For additional information on the mainframe and software, refer to the section on Costs in Chapter IV and to Appendix E.

I. VOLUMES AND WEIGHTED WORKLOAD

The annual FY81 and FY82 volumes of examinations performed by each of the Radiology sections are presented in Table 3. The percent of the total volume in each section has also been computed. Radiation Therapy treatments were not included since this section did not use TRIRAD as of November of 1982. Volumes for FY81 have been used as baseline values since it was the last full year prior to the installation of TRIRAD. Similarly, FY82 volumes have been used for post-implementation since the first year of TRIRAD operations began in the second quarter of FY82, although TRIRAD was actually used for only 9 months of FY82.

Also presented in Table 3 are the annual workload values reported as weighted volumes for FY81 and FY82. Again, the percentage of total workload attributable to each section is provided. The weighted value is a quantitative method used to account for the differences in resources required for each type of examination. For example, a simple chest X-ray has a weighted value of 3 whereas an angiogram, which requires a number of physicians and technicians, a well-equipped special procedures room and costly supplies, has a weighted value of 28. All examinations have an average weighted value of 5.3. It should be noted that the method for computing weighted workload values for Nuclear Medicine changed in FY82. During the baseline period each examination was assigned an average weighted value of 10; during the post-implementation period the average weighted value was 57.

TABLE 2

PERIPHERAL EQUIPMENT CONFIGURATION
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

	Number of Devices					
	VDT	IVDT	BCR	BCP	PTR	OMR
Hospital Main Computer Room	1			1[a]		
Main Radiology						
Reception	3			1		
Quality Control	1		1			
ICU/CCU Readiong Room			1			
Wet Reading Room		1	2		1	1
Inpatient Reading Room	1		5			
Administrative Offices	1	1	2		2	
Main Film Library	1		2	1		
GI Radiology						
Quality Control	1		1			
Reading Room			1			
Imaging Radiology						
Reception	2			1	1	
Reading Room		1	2			
CT Image Processing Room			1			
Administrative Offices	2	1			1	
File Room			1			
Orthopedic Radiology						
Reading Room			1		1	
File Room	1		1	1		
Urologic Radiology						
Reception	1		1	1		
Reading Room	1		1			
File Room						
Special Procedures						
Reading Room	1		1	1		
Total	17	4	24	7	6	1

[a]One bar-code printer, originally assigned to Radiation Therapy, is used as back-up to substitute when one is being maintained or repaired.

Legend:
VDT - video display terminal
IVDT - intelligent video display terminal
BCR - bar-code reader
BCP bar-code printer
PTR - printer
OMR - optical-mark reader

TABLE 3

COMPARISON OF BASELINE AND POST-IMPLEMENTATION ANNUAL RADIOLOGY VOLUMES AND WEIGHTED WORKLOAD VALUES — EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

	Baseline (FY81)				Post-Implementation (FY82)			
	Examinations	% of Total Examinations	Workload (Weighted[a] Values)	% of Total Workload (Weighted[a] Values)	Examinations	% of Total Examinations	Workload (Weighted[a] Values)	% of Total Workload (Weighted[a] Values)
Main Radiology	47,273	55.7%	168,381	34.2%	60,422	65.1%	213,752	27.6%
GI Radiology	3,532	4.0	31,311	6.3	3,278	3.5	28,859	3.7
Orthopedic Radiology	17,520	20.6	62,278	12.7	12,292	13.3	43,395	5.6
Urologic Radiology	2,376	2.7	19,008	3.8	2,298	2.5	18,144	2.3
Special Procedures	2,084	3.5	51,962	10.5	820	0.9	20,290	2.6
Nuclear Medicine[b]	3,965	4.5	38,134[b]	7.7	5,784	6.2	332,168[b]	42.8
Computerized Tomography	5,169	6.0	87,873	17.9	4,371	4.7	73,802	9.5
Ultrasonography	2,655	3.0	34,515	6.9	3,551	3.8	45,857	5.9
Total	84,574	100.0%	493,462[b]	100.0%	92,816	100.0%	776,267[b]	100.0%

[a] In Radiology it is a standard practice to assign a weight to each examination according to the level of effort required to administer the examination. For example a chest x-ray is assigned 3 weighted value units while an intensive angiography procedure is assigned as 28. The weighted value is used for budgeting purposes and for intra- and inter-site comparisons of workload.

[b] In Nuclear Medicine the method for computing weighted workload value changed. Whereas during the baseline period each examination was assigned an average weighted value of 10, during the post-implementation period the average weighted value was 57.

The workload figures that are displayed in Table 3 were obtained from data provided by Uniform Chart of Accounts (UCA) reports, Radiology department records, and interviews with members of the Radiology staff and staff in the NHB Comptroller's office. The apparent increase in the total number of examinations from FY81 to FY82 (FY81 - 84,574; FY82 - 92,816) may be due at least partially to Radiology's increased capability to capture and record examinations by using the TRIRAD system and may not fully represent an actual increase in volume. (Staff in the Department believed that the Wet Reading Room in Main Radiology, where a large volume of handwritten reports was processed during the baseline period, had experienced difficulties in tracking completed examinations and that this was a major contributor to the apparent differences in reported volume.) The change in weighted workload is due in part to the increase in examination volume and to the change in weighting procedures as discussed above.

The incomplete reports data presented in Chapter IV present supporting data to further evaluate the validity of the changes in volume observed. For a more detailed view of post-implementation volumes, see Appendix F which presents the daily examination volumes for each Department section.

IV. RESULTS

A. INTRODUCTION

This chapter presents the results of the various evaluation activities. Results of quantitative studies are presented first, organized by the impacts studied as follows:

- report turnaround time;
- patient process time;
- labor to process patients, reports, films; and
- film file availability.

The next section contains the information gathered from Department records, TRIRAD contract documents, and interviews concerning the costs of radiology services. The final section first analyzes the results of baseline and post-implementation surveys of Radiology Department staff and then summarizes the information gained from baseline and post-implementation interviews with attending physicians. Chapter V contains a discussion of results combining the results of quantitative and qualitative studies, and interprets these results in reference to system goals and evaluation objectives.

B. QUANTITATIVE STUDIES

1. Turnaround Time for Radiology Reports

a. Introduction

Two types of data were collected regarding the turnaround time for radiology reports. The first was a measure of the elapsed time for the complete processing of patient examinations from the time the patient arrived in the Department for the examination until the interpretation results were available for distribution to the attending physician and/or the patient record. The second measured the ability of the Department to produce reports through the process by examining the backlog of examinations for which interpretation reports had not been completed (incomplete reports).

b. Elapsed Time Analysis

i. Data Considerations

The elapsed time was measured from the time of patient arrival for the examination until the interpretation report was available for distribution via the department mailbox or (for wet readings) by hand delivery by the patient. Interpretation reports were distributed in several different forms. In the baseline, handwritten reports and reports typed from dictation were prepared. In the post-implementation process, most reports were printed; however, handwritten reports were also prepared for those examinations for which a wet reading had been requested. Elapsed times were evaluated for all of these report types. In addition, in Main Radiology, the process after the implementation of TRIRAD differed for inpatients and outpatients and both of these were evaluated separately.

Elapsed times were studied for the whole process and for different segments of the process.

For typed reports in the baseline period, five time segments were either measured or estimated as follow:

- time segment from examination to completion of dictation;
- time segment from dictation to delivery of the dictation tape to transcription;
- time segment from delivery to transcription until completion of typing;
- time segment from completion of typing until report returned to Radiology; and
- time segment from arrival in Radiology until report approved and distributed.

For printed reports in the post-implementation period, two time segments were measured as follow:

- time segment from examination through generation of the computer report (this interval contained dictation and transcription, or bar coding, as well as report approval); and
- time segment from report printing through distribution

into the mailbox.

For handwritten reports, report turnaround time was measured in two segments as follow:

- time segment from patient arrival in Radiology, through examination and patient departure; and
- the time segment spent in reading the film and preparing the report.

Data were collected in a different manner in the baseline and post-implementation studies. In the baseline, data were difficult to obtain on the entire cycle because the elapsed time for many reports exceeded the length of the data-collection period and data were captured by a variety of techniques for different segments of the cycle, with the total elapsed time derived from the available data. In the post-implementation period, many of the data which needed to be derived in the baseline study could be obtained from the TRIRAD system, and this made it possible to obtain more observations and with greater consistency across sections of the department and process segments and to track individual examinations to completion. Hence, there is necessarily greater confidence in the reliability of post-implementation data concerning this impact.

ii. Results

A comparison of measured report turnaround times is contained in Table 4. In every section of the Department turnaround time for typed reports improved in the post-implementation period as compared with baseline observations. For handwritten reports, turnaround time increased slightly.

The turnaround time in Main Radiology decreased from an estimated 16 days in the baseline period for typed reports to 4 days for printed reports on both inpatients and outpatients in the post-implementation period. For a limited sample of four bar-coded reports, turnaround time was measured as 2 days. In the baseline, turnaround for handwritten reports averaged 46 minutes. During post-implementation handwritten reports were prepared, in addition to the printed reports,

TABLE 4

COMPARISON OF BASELINE AND POST-IMPLEMENTATION REPORT TURNAROUND TIME
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

			Report Turnaround Time						
			Baseline			Post-Implementation			
			Daily Volume			Daily Volume			
Department Section	Type of Report	Type of Patient	#	% Total	Average	#	% Total	Average	Standard Deviation
Main Radiology	Handwritten[b]	In/outpatients	158	53.2%	46 min.[a]				
	Typed	Inpatients			16 days[a]				
	Printed	Outpatients				127	41.1%	4 days	2.98 days
	Printed	Inpatients				60	19.4	4 days	2.86 days
	Handwritten[b]	In/outpatients				8	2.5	63 min.	
GI Radiology	Typed	In/outpatients	14	4.7	18 days[a]				
	Printed	In/outpatients				12	3.9	5 days	1.85 days
Orthopedic Radiology	Handwritten[b]	In/outpatients	67	22.6	39 min.[a]				
	Handwritten[b]	In/outpatients				45	14.6	56 min.	
	Printed	In/outpatients						4 days	3.17 days
Urologic Radiology	Typed	In/outpatients	9	3.0	18 days[a]				
	Printed	In/outpatients				9	2.9	5 days	--
Special Procedures	Typed	In/outpatients	4	1.3	25 days[a]				
	Printed	In/outpatients				3	1.0	14 days	5.03 days
Nuclear Medicine	Typed	In/outpatients	15	5.1	15 days[a]				
	Printed	In/outpatients				16	5.2	12 days	9.40 days
Computerized Tomography	Typed	In/outpatients	20	6.7	43 days[a]				
	Printed	In/outpatients				16	5.2	14 days	4.78 days
Ultrasonography	Typed	In/outpatients	10	3.4	34 days[a]				
	Printed	In/outpatients				13	4.2	6 days	0.97 days
			297	100.0%		309	100.0%		

[a]Derived from limited observations of each of the process segments and estimates where needed. Means and ranges for individual process segments given in Appendix B.

[b]Handwritten reports are distributed immediately either by giving it to the patient or to the attending physician or by inserting it into the mailbox.

for examinations on which a "wet reading" was requested; turnaround time for these reports averaged 63 minutes.

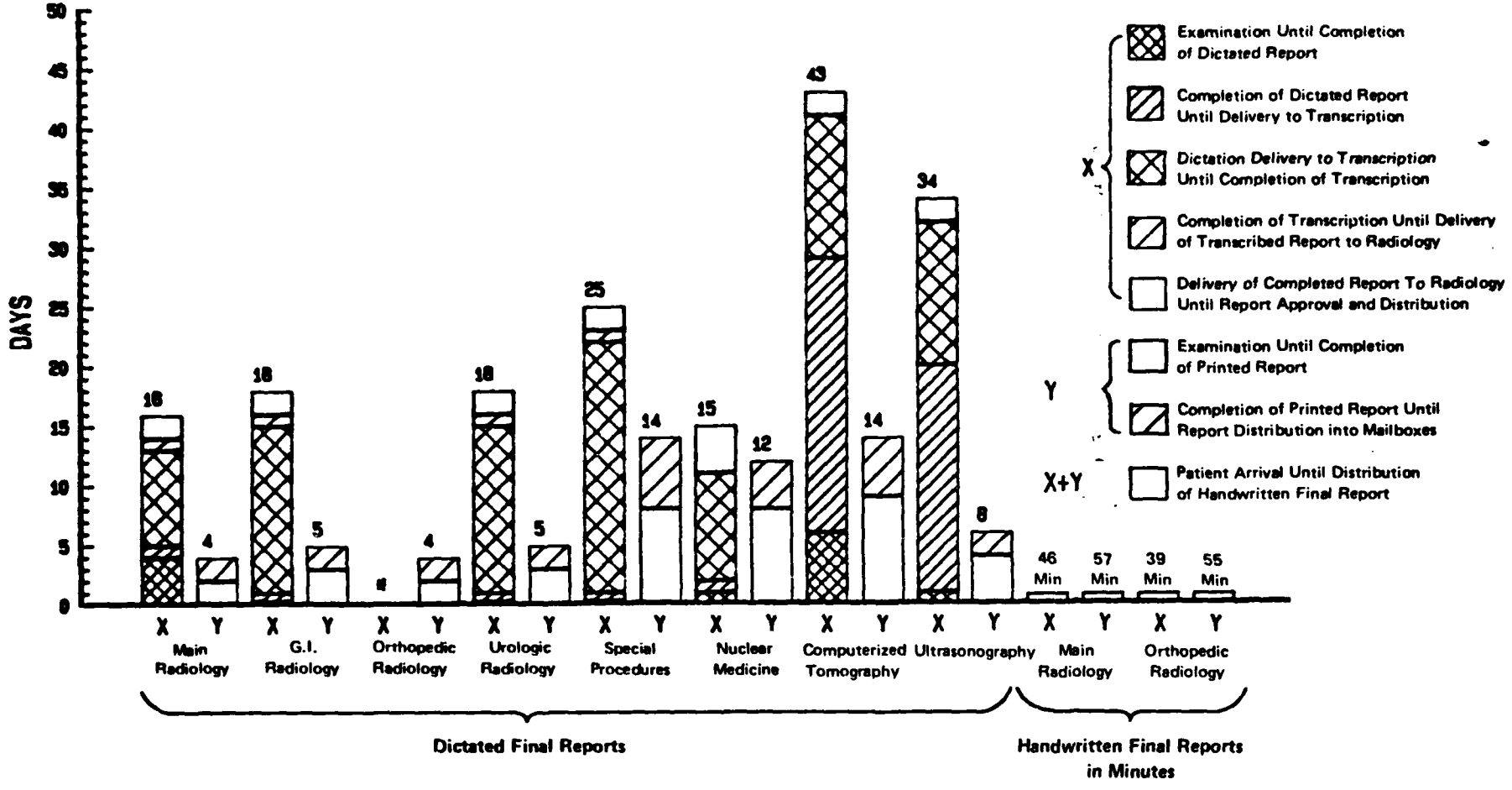
The proportion of reports prepared in handwritten versus typed/printed form changed significantly between the baseline and post-implementation periods. Table 4 combines data on volume changes and elapsed time for report turnaround. As shown, nearly all (approximately 95%) of reports produced in the baseline period were handwritten, whereas in the post-implementation period, relatively few handwritten reports were prepared, with many of these serving as preliminary reports for wet reading examinations.

The reports for GI Radiology were dictated and typed and distributed during the baseline period in an average time of 18 days. This time was reduced to an average of 5 days for computer-printed reports.

In Orthopedic Radiology all reports were handwritten during the baseline period and distributed in an average time of 39 minutes. During the post-implementation period, handwritten reports were prepared in the same manner in an average time of 56 minutes. In addition a copy of the report was delivered to transcription to be entered into the TRIRAD system. The printed report was distributed in an average of 4 days from the date of examination.

Decreased turnaround times were measured in all other sections (Table 4). In Urologic Radiology, report turnaround time decreased from an estimated 18 days to 5 days (measured on a very small sample of reports). In Special Procedures turnaround time was reduced from an estimated 25 days to 14 days; in Nuclear Medicine from 15 days to 12 days; in Computerized Tomography from 43 days to 14 days; and in Ultrasonography from 34 days to 6 days.

Figure 3 illustrates the relative contribution of individual process segments to total turnaround time. In the baseline period the time segment in transcription contributed to delays in all sections, except in Orthopedic Radiology where only handwritten reports were prepared. Other major delays were also observed in Computerized Tomography for time segments from examination through dictation, and



Reports Not Dictated or Typed.

FIGURE 3 COMPARISON OF CONTRIBUTION OF PROCESS SEGMENTS TO TOTAL TURNAROUND TIME FOR RADIOLOGY REPORTS IN BASELINE (X) AND POST-IMPLEMENTATION (Y) PERIODS – TRIRAD EVALUATION AT NAVAL HOSPITAL, BETHESDA

from dictation through delivery to transcription. In Ultrasonography, delays were noted in the time segment from dictation through delivery to transcription.

In the post-implementation period, the time segment from examination to report averaged 3.5 days, the time segment from report printing to distribution in the mail averaged 2.5 days, and the total time across all sections averaged 6 days. (For a limited sample of four bar-coded reports, each report was printed on the same day as the examination and distributed to the mailbox in 2 days, resulting in a report turnaround time of 2 days.)

During the post-implementation period, in order to evaluate better the implications of a 6-day turnaround time for official Radiology reports on inpatient care, a determination was made of the number of inpatients still in-house when Radiology reports were distributed. As part of the data-collection procedures for measuring turnaround time at the mailbox, patient-identification data were also obtained. When reports were picked up for distribution to inpatient wards, a comparison was made by patient-ID with the inpatient census. The number of patients still in-house on the day of distribution was found to be 33%. Since some patients also check out of the hospital on that day and the report might not be examined prior to patient departure, the census on the following day was also compared; it was found that 26% of inpatients were still in-house on the day following report distribution. A similar study was not performed during the baseline period.

c. Complete and Incomplete Reports

i. Data Considerations

The numbers of complete and incomplete reports were analyzed from management reports generated by the TRIRAD system. A complete report is one that has been entered into the system, approved by the radiologist, and then printed. An incomplete report is one that has not completed this cycle; thus a dictated report that has been entered onto the system by the transcriptionist but has not yet been approved is considered incomplete.

The incomplete-report analysis was conducted in order to supplement the analysis of elapsed time to report distribution. Turnaround time, having been measured at the distribution mailbox, tracks those reports that complete the cycle and does not indicate the backlog of examinations for which a report has not been generated. The incomplete report analysis was made possible by TRIRAD for each section of the Radiology Department, the total number of procedures conducted on each day and the distribution of complete and incomplete reports for each day.

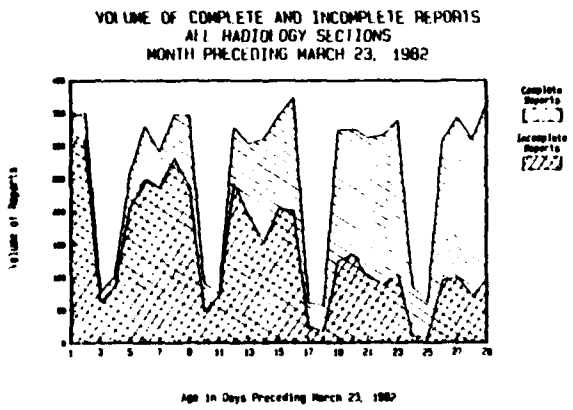
The computer reports, from which these data were obtained, were generated on four different dates; three during site visits to monitor the progress of implementation on March 23, August 5 and October 5 and a fourth at the conclusion of post-implementation data collection on November 5, 1982. A comparison reveals trends in the report backlog of the Department and the individual sections.

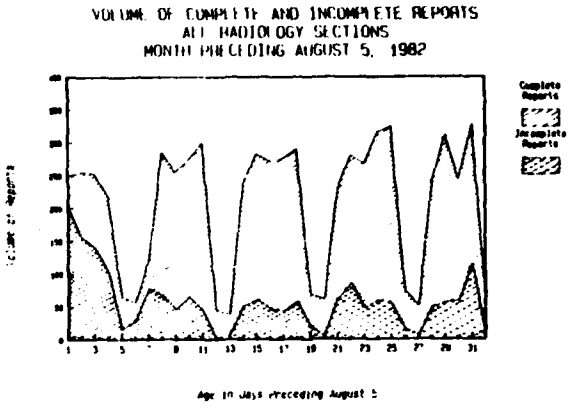
Information on the status of report completion was not available in the baseline nor was it feasible to collect such information. However, the first sampling date of March 23 was only 2 months after the installation of TRIRAD, when the Department was still in the preliminary stages of implementing the system into routine operations. Furthermore, the information on report completion for that date indicates a mean report completion time of approximately 16 days. Since this is consistent with the measured mean elapsed time for baseline report turnaround, report completion information for that sampling data would appear to represent a reasonable analog to the baseline.

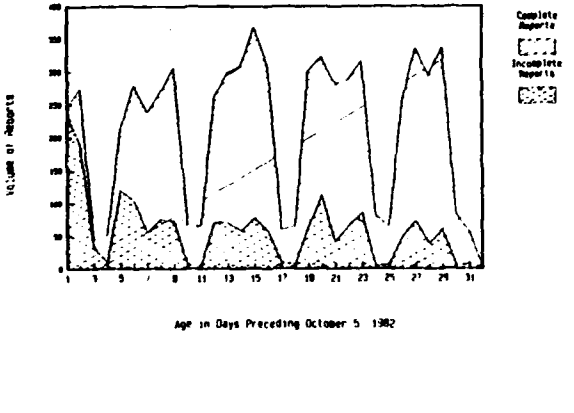
ii. Results

Figure 4 illustrates the status of complete and incomplete reports for all Radiology sections combined as of each of the sampling dates. The low-volume periods or the "valleys" occur on weekend days and the high-volume periods or "peaks" occur on weekdays.

The following example explains how to interpret these graphs. On March 23, a printout was obtained indicating the status of reports for the month preceding that day. On the preceding day, March 22,







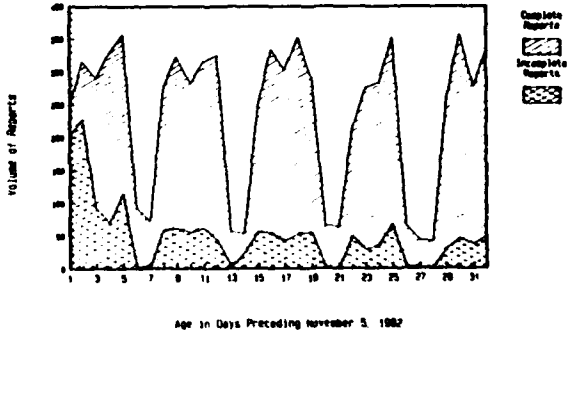


FIGURE 4 POST-IMPLEMENTATION RADIOLOGY REPORT COMPLETION TRENDS, ALL RADIOLOGY SECTIONS – MONTH PRECEDING MARCH 23, 1982, AUGUST 5, 1982, OCTOBER 5, 1982 AND NOVEMBER 5, 1982 – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

approximately 350 examinations were completed. Approximately 320 of these were incomplete and 30 were completed by March 23. Sixteen days prior to March 23, on March 7, there were approximately 350 examinations and of these 200 reports were incomplete and 150 reports were complete on March 23. As more days pass, more reports have been completed for examinations on a given date.

Comparing March 23 with November 5, substantial changes are noted in the Department's ability to complete reports. In the November 5 data, of approximately 290 examinations performed on preceding day 3, 200 of these were completed by November 5; this finding is consistent with the average elapsed time of 3 days cited above for the time segment between examination and report printing. Though most reports were completed within several days, there still remained approximately 50 incomplete reports for each weekday, i.e., 15 percent of the total volume of examinations, even a month later. A certain portion of these were never meant to have official reports, e.g., procedures performed as part of a research study. Another explanation is that some examinations were reported by methods other than by using the TRIRAD system.

Graphs of complete and incomplete reports for each of the individual sections are contained in Figures 5 through 11. The data for Main Radiology (Figure 5) reveal a similar pattern of improvement between March and November as was described above for the total department. (Note that these graphs of Main Radiology also contain GI studies.)

The data for Orthopedic Radiology (Figure 6) have to be interpreted differently from those for the other sections. Since all examinations were treated as wet readings, handwritten reports were prepared for immediate distribution. Reports were also entered into the system in order to maintain an historic report file on each patient. In March very few reports were entered, whereas in November most reports were entered and completed within 2 days of the examination date.

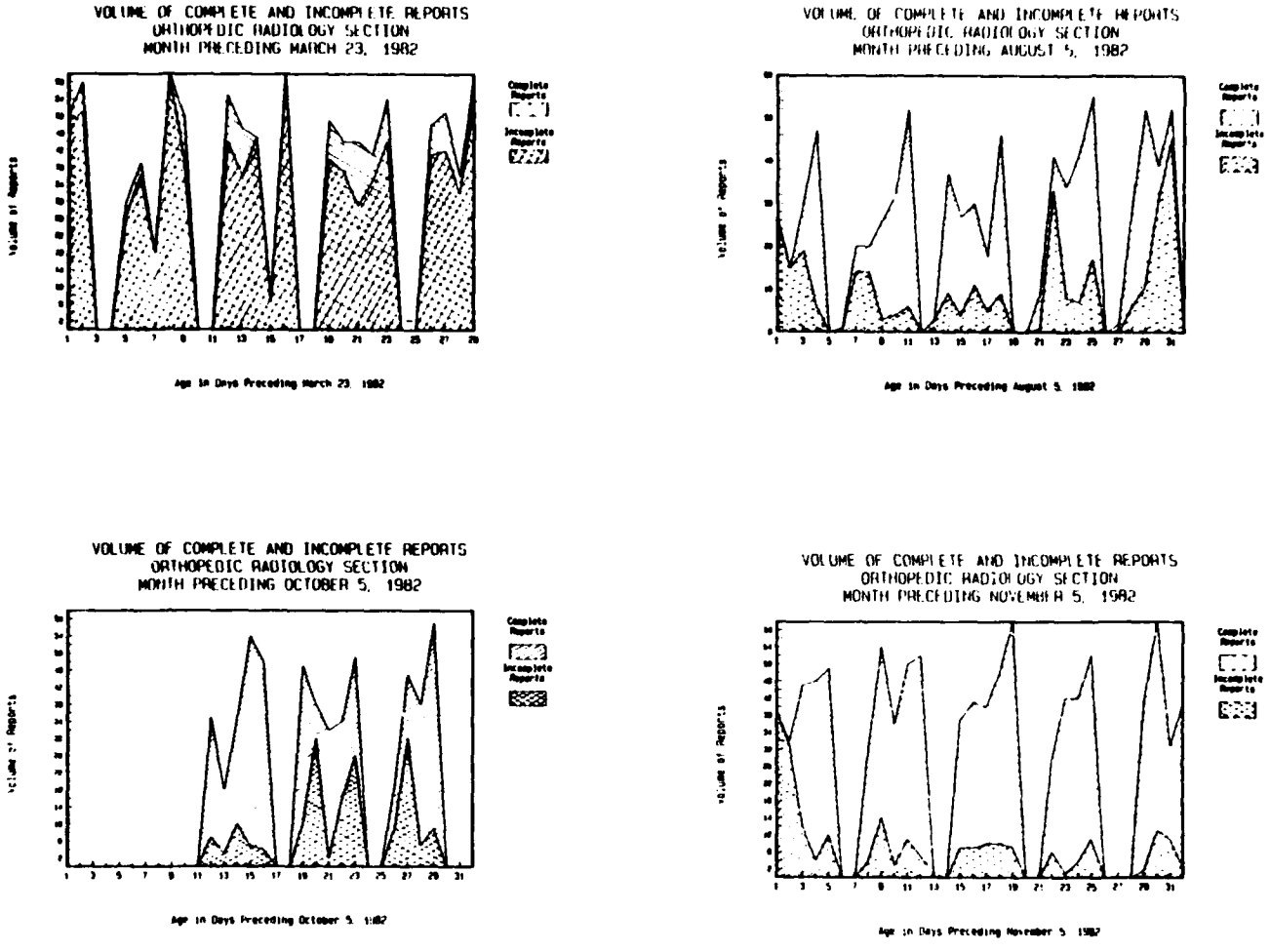


FIGURE 5 POST-IMPLEMENTATION RADIOLOGY REPORT COMPLETION TRENDS, ORTHOPEDIC RADIOLOGY SECTION – MONTH PRECEDING MARCH 23, 1982, AUGUST 5, 1982, OCTOBER 5, 1982 AND NOVEMBER 5, 1982 – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

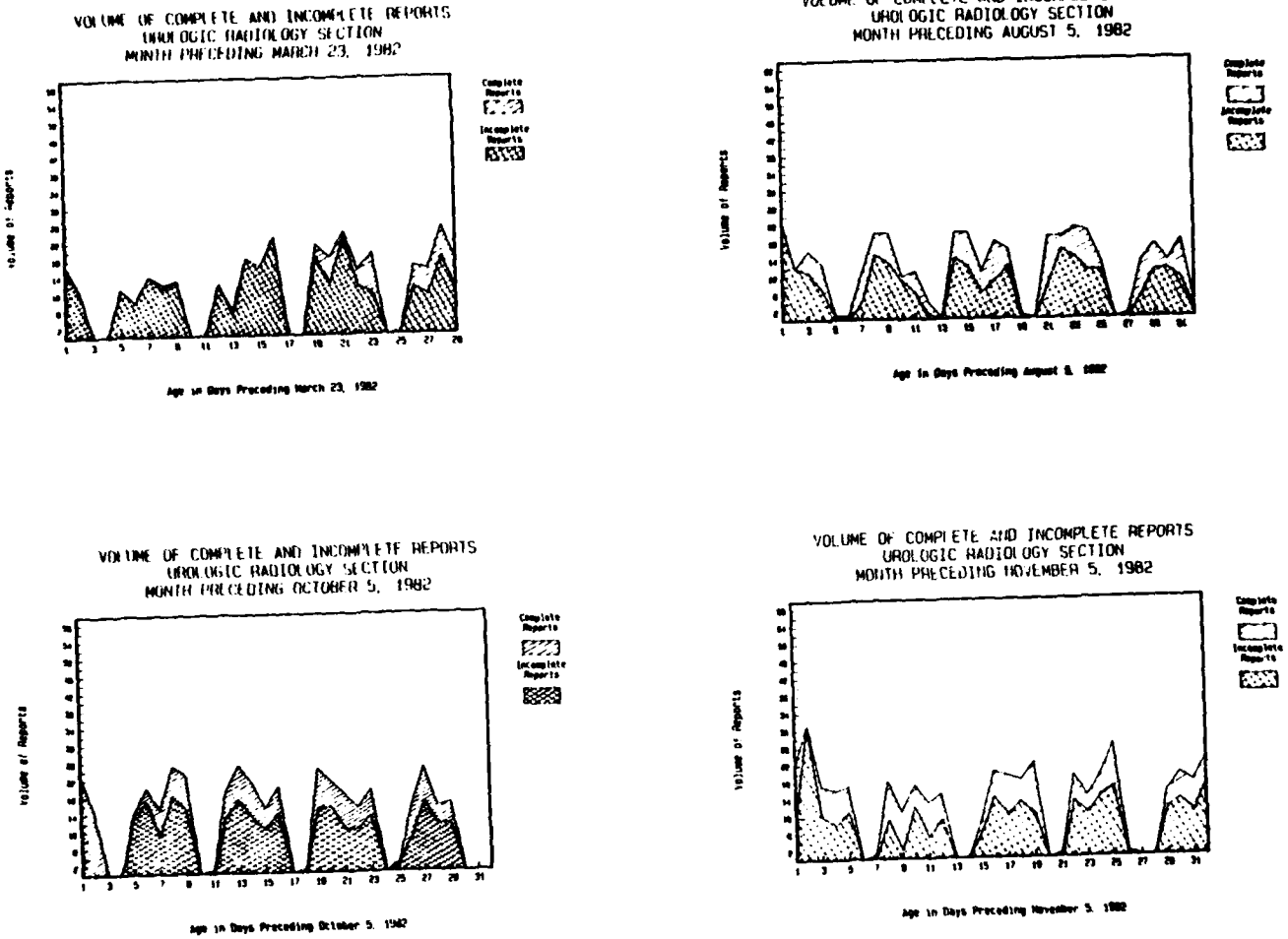


FIGURE 6 POST-IMPLEMENTATION RADIOLOGY REPORT COMPLETION TRENDS, UROLOGIC RADIOLOGY SECTION – MONTH PRECEDING MARCH 23, 1982, AUGUST 5, 1982, OCTOBER 5, 1982 AND NOVEMBER 5, 1982 – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

In Urologic Radiology (Figure 7), all procedures were logged on the TRIRAD system, despite the fact that a portion of them were not radiologic procedures and not intended to have radiologic reports. Hence, improvements in completing reports are apparent, but not to the degree measured in other sections.

The low volume in Special Procedures (Figure 8) makes changes difficult to appreciate. Rapid completion of reports was observed in August, worsened somewhat in October, but improved again in November which appeared to be consistent with staffing changes.

Nuclear Medicine (Figure 9) remained fairly constant in completing reports, worsening slightly in October and recovering again in November. Computerized Tomography (Figure 10) substantially decreased the time to complete reports between March and August, increased in October, and had made gains in November. Ultrasonography (Figure 11) steadily improved from August to October to November.

2. Labor and Process Time

a. Introduction

Data were collected in both baseline and post-implementation periods pertaining to Radiology Department staff time required to carry out specific functions and elapsed times for selected segments of the process. Labor times were measured for the following functions:

- Time devoted to scheduling/reception activities in reception areas;
- Time devoted to radiologist interpretation and reporting; and
- Time devoted to transcribing reports.

Elapsed times were measured for selected segments of the process as follow:

- Patient waiting and examination time;
- Elapsed time for film file requests; and
- Elapsed time from dictation until completion in transcription.

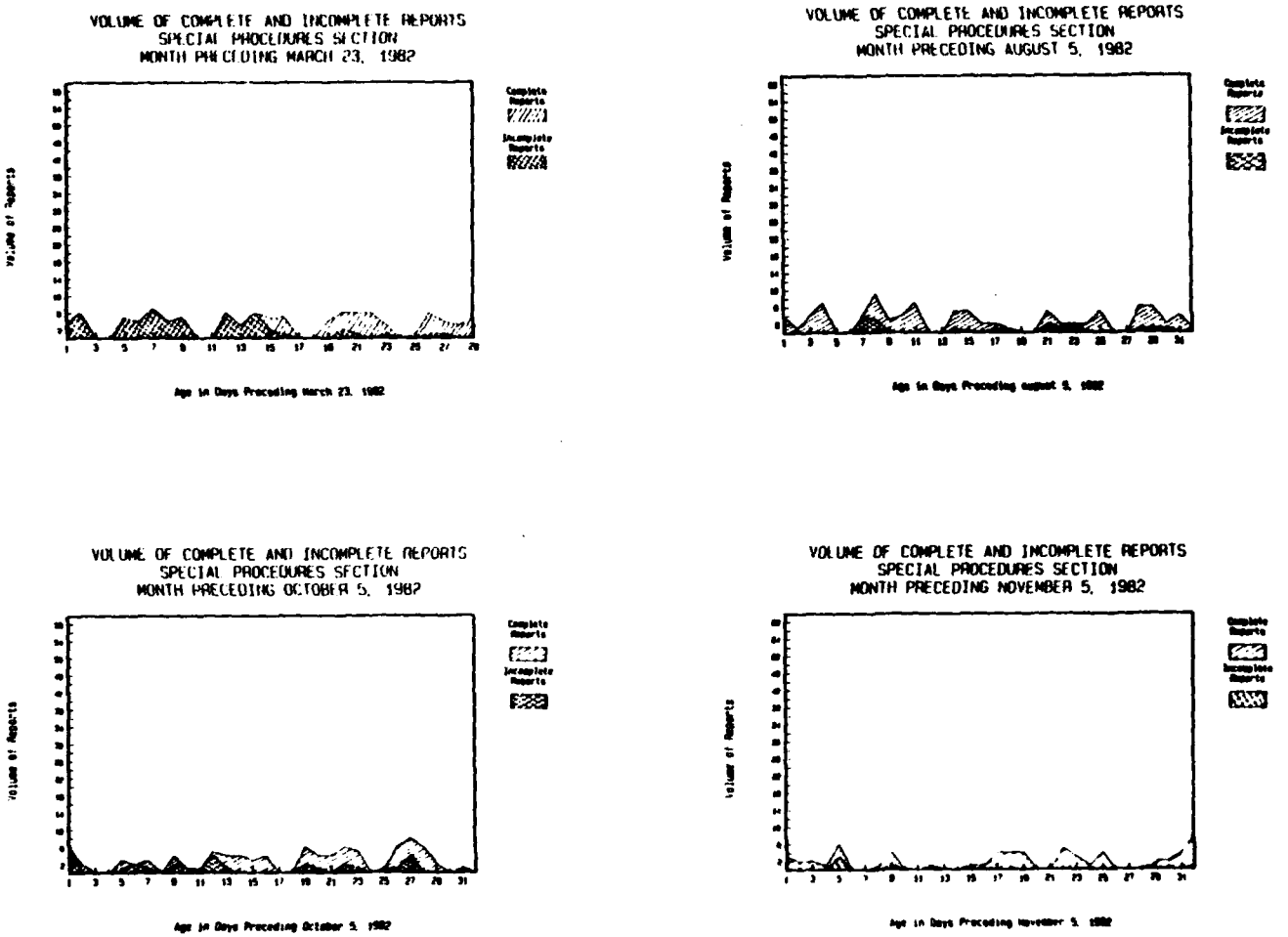


FIGURE 7 POST-IMPLEMENTATION RADIOLOGY REPORT COMPLETION TRENDS, SPECIAL PROCEDURES SECTION – MONTH PRECEDING MARCH 23, 1982, AUGUST 5, 1982, OCTOBER 5, 1982 AND NOVEMBER 5, 1982 – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

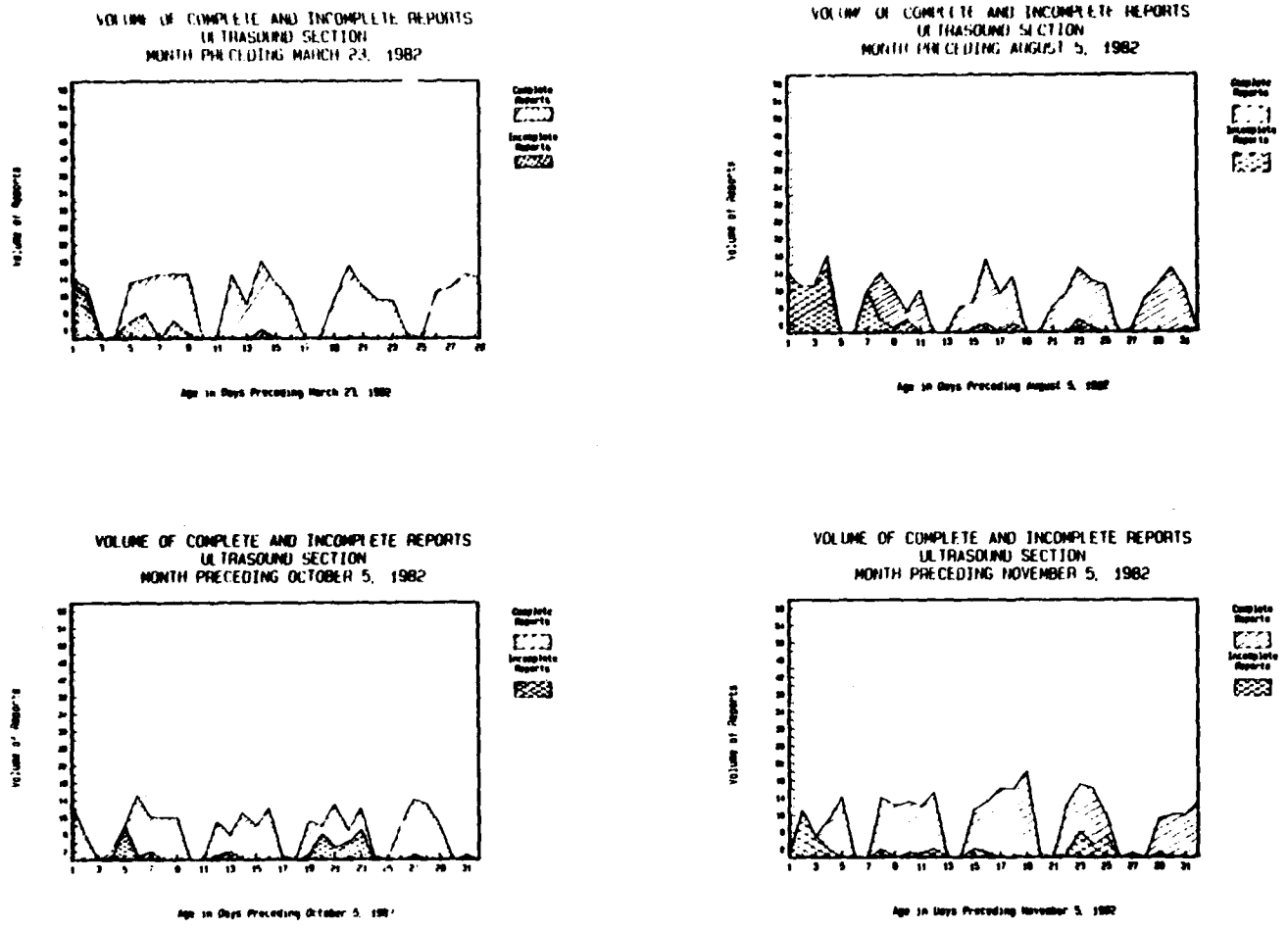


FIGURE 8 POST-IMPLEMENTATION RADIOLOGY REPORT COMPLETION TRENDS, ULTRASONOGRAPHY SECTION – MONTH PRECEDING MARCH 23, 1982, AUGUST 5, 1982, OCTOBER 5, 1982 AND NOVEMBER 5, 1982 – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

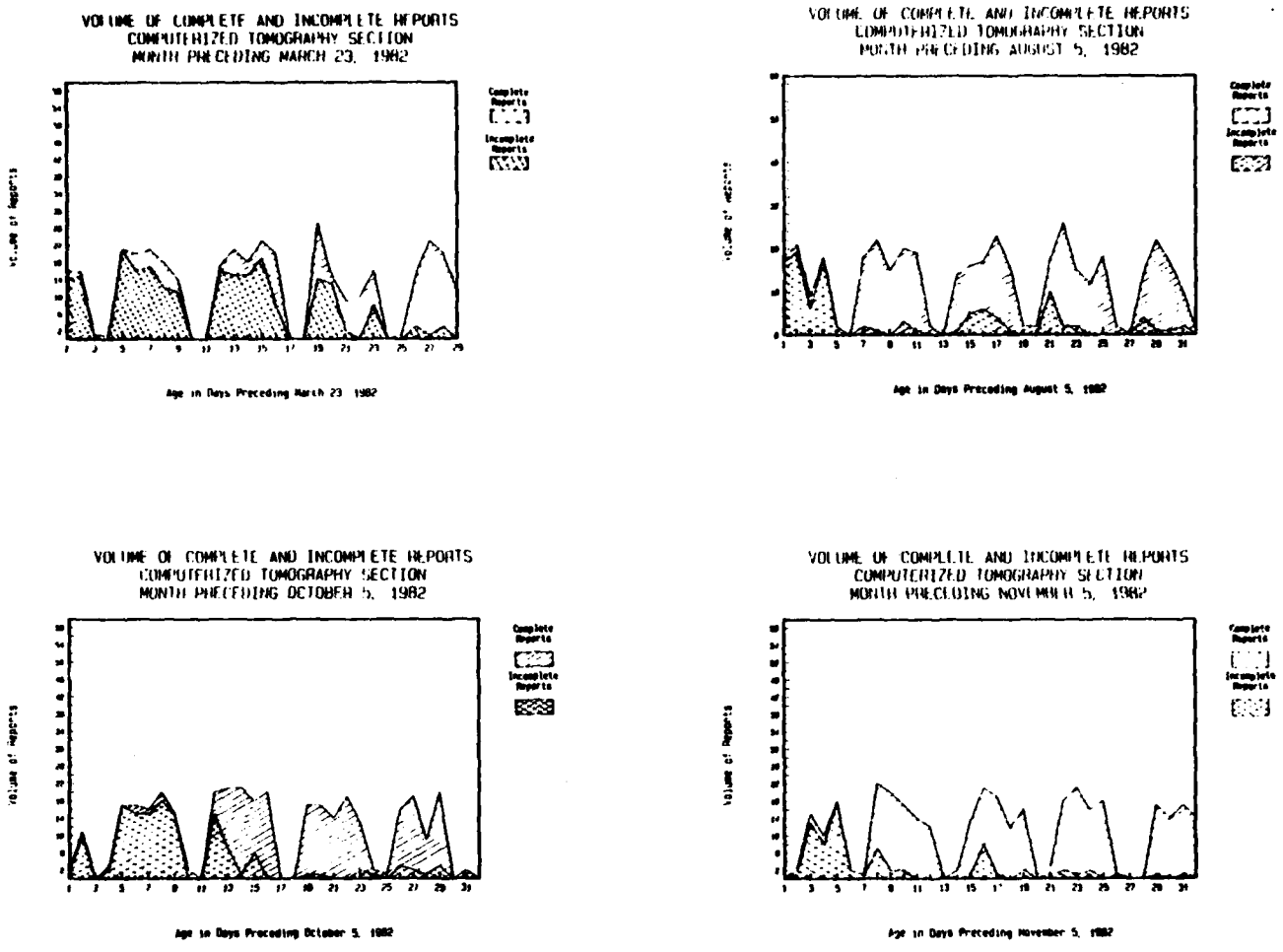


FIGURE 9 POST-IMPLEMENTATION RADIOLOGY REPORT COMPLETION TRENDS, COMPUTERIZED TOMOGRAPHY SECTION – MONTH PRECEDING MARCH 23, 1982, AUGUST 5, 1982, OCTOBER 5, 1982 AND NOVEMBER 5, 1982 – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

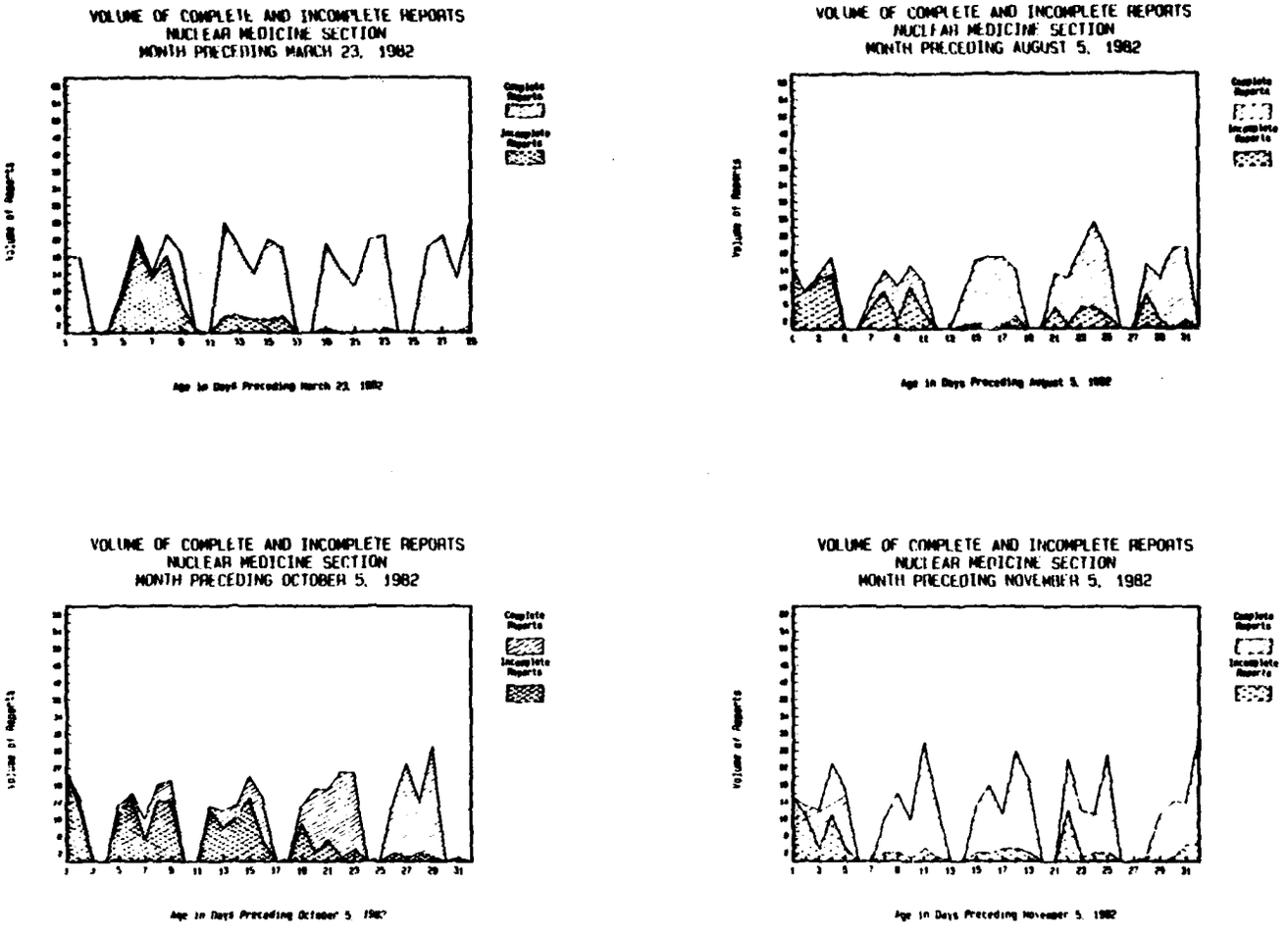


FIGURE 10 POST-IMPLEMENTATION RADIOLOGY REPORT COMPLETION TRENDS, NUCLEAR MEDICINE SECTION – MONTH PRECEDING MARCH 23, 1982, AUGUST 5, 1982, OCTOBER 5, 1982 AND NOVEMBER 5, 1982 – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

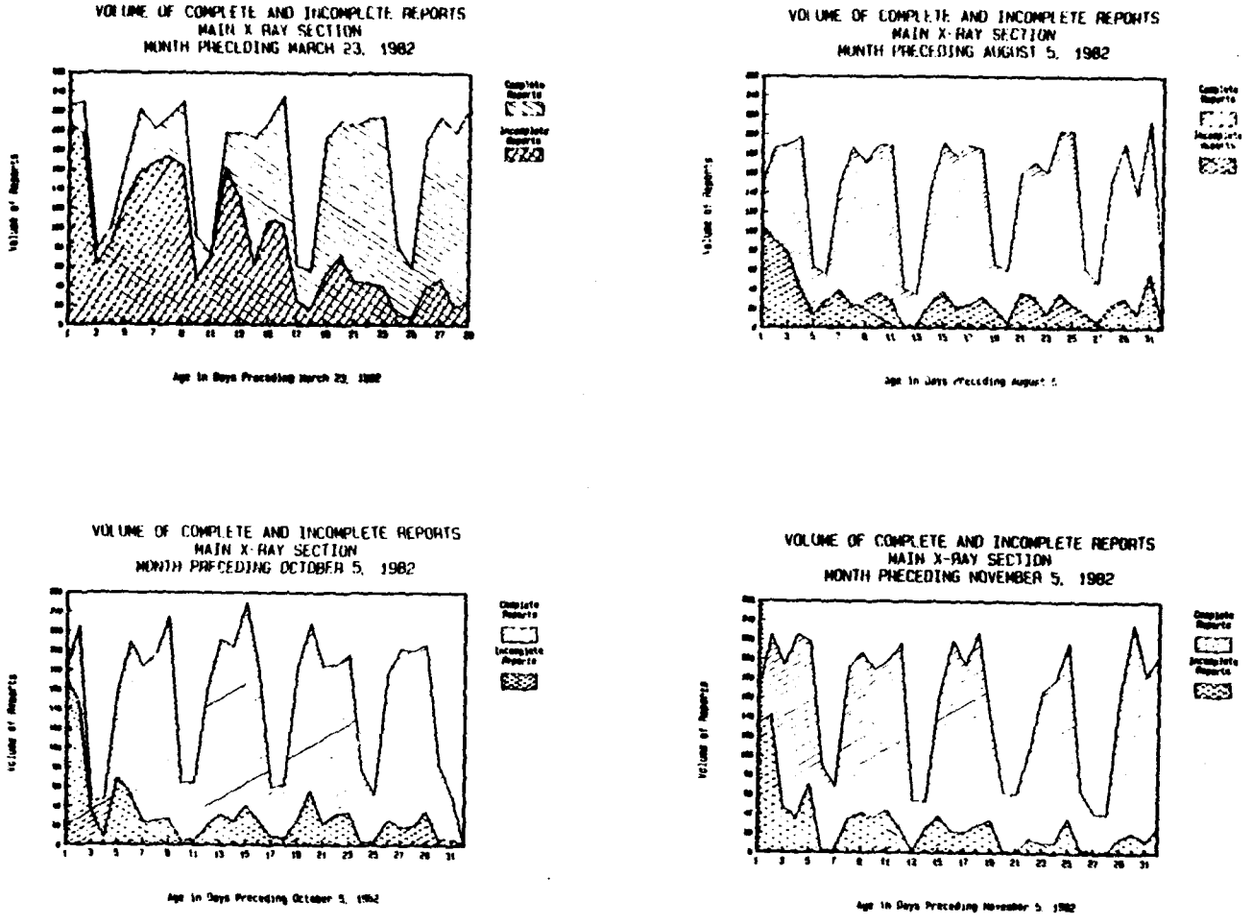


FIGURE 11 POST-IMPLEMENTATION RADIOLOGY REPORT COMPLETION TRENDS, MAIN X-RAY SECTION – MONTH PRECEDING MARCH 23, 1982, AUGUST 5, 1982, OCTOBER 5, 1982 AND NOVEMBER 5, 1982 – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

The results of these are discussed below in the order that the steps occur in the Radiology process.

b. Time Devoted to Scheduling/Reception

i. Data Considerations

Work sampling was conducted during baseline and post-implementation periods in the reception areas of Main Radiology and Imaging. The specific activities sampled were those pertaining to scheduling and check-in functions, with the purpose of ascertaining any change in the proportion of staff time devoted to these activities. The activities observed varied substantially because of the changes introduced by TRIRAD.

ii. Results

The results of work sampling are shown in Tables 5 and 6 for the baseline and post-implementation periods, respectively. Comparison of the two periods shows some major changes in the activities observed. There has been an increase in the proportion of time spent in working directly on scheduling and reception functions, noted as a decrease in "other" time at both reception areas. In Imaging "other" time decreased from 40.2% in the baseline period to 7.3% during the post-implementation study. In Main Radiology "other" time changed from 47.1% down to 30.0%.

During post-implementation, computer functions occupied 32.1% of the receptionist's time in Imaging and 28.2% of the time in Main Radiology. The percent of time devoted to scheduling and receiving patients was similar in both sections during the baseline period -- 16.2% in Imaging and 16.0% in Main Radiology. During the post-implementation study, scheduling activities and receiving activities were observed separately. Receiving occupied 5.9% of the time in Imaging and 5.8% in Main Radiology; scheduling occupied 15.4% of the time in Imaging and 16.0% in Main Radiology. If these two functions are summed for each section, Imaging receptionists spent 21.3% of their time and Main Radiology receptionists spent 21.8% of their time devoted to scheduling and receiving patients.

TABLE 5

SUMMARY OF BASELINE WORK SAMPLING IN SCHEDULING AND RECEPTION AREAS --
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

	Imaging		Main	
Activity Category	Obser-vations	Percent of Total	Obser-vations	Percent of Total
Receive and/or schedule patients	33	16.2%	34	16.0%
Prepare flash cards	--	--	5	2.3
Type onto daily log	2	1.0	3	1.4
Answer in-person inquiries from patients	--	--	15	7.0
Answer telephone inquiries	20	9.8	8	3.8
Make telephone inquiries	7	3.4	4	1.9
Distribute 519s	1	0.5	--	--
Refile patient cards	6	2.9	--	--
Check exam schedule	7	3.4	14	6.6
Inspect 519s	2	1.0	--	--
Inspect 519s against worksheet	--	--	1	0.4
Talk to hospital staff	14	6.9	11	5.2
Request files	--	--	2	0.9
Prepare file folder	2	1.0	1	0.4
Other productive work	28	13.7	15	7.0
Other (personal, away from area)	82	40.2	100	47.1
TOTAL	204	100.0%	213	100.0%

TABLE 6

SUMMARY OF POST-IMPLEMENTATION WORK SAMPLING IN SCHEDULING AND RECEPTION AREAS -- EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

Activity Category	Imaging Observations	Imaging Percent of Total[a]	Main Observations	Main Percent of Total
At Reception Area				
Receive Patients	21	5.9%	31	5.8%
Answer inpatient inquiries from patients	18	5.1	34	6.4
Instruct patients in treatment preparation	1	0.3	-	-
Answer in-person inquiries from physicians	9	2.5	4	0.8
Answer telephone inquiries re: test results	6	1.7	1	0.2
Answer other telephone inquiries	33	9.3	32	6.0
Make telephone inquiries	22	6.2	4	0.8
Talk to hospital staff	33	9.3	8	1.5
Wait for terminal	1	0.3	-	-
Clerical				
Check exam schedule	4	1.1	1	0.2
Prepare file jackets	25	7.0	50	9.4
File reports	13	3.7	-	-
Type	-	-	-	-
Request films	-	-	5	0.9
Computer Functions				
Register patients	12	3.4	-	-
Schedule/cancel exams	55	15.4	86	16.0
Log in patient arrival/departure	21	5.9	30	5.6
Retrieve patient studies/schedule/data	16	4.5	7	1.3
Edit file	-	-	-	-
Record studies	1	0.3	1	0.2
Print labels	5	1.4	26	4.9
Retrieve day log/schedule	3	0.8	-	-
Identify film location	-	-	1	0.2
Print report	2	0.6	-	-
Review report	-	-	-	-
Merge files	-	-	-	-
Away From Reception Area				
Search for physician/technician	5	1.4	-	-
Distribute reports	-	-	-	-
Locate/pick up patient files	-	-	1	0.2
Escort patient	-	-	1	0.2
Other duties away from area	24	6.7	50	9.4
Other				
Meal Break	25	7.0	53	9.9
Personal	1	0.3	40	7.5
Inactive	-	-	67	12.6
TOTAL	356	100.0%	533	100.0%

[a]Percentages may not add to 100% due to rounding.

In both sections there was an increase in answering telephone inquiries -- 9.8% to 11.0% in Imaging and 3.8% to 6.2% in Main Radiology.

The proportion of time spent in preparing file jackets increased from 1.0% to 7.0% in Imaging and from 0.4% to 9.4% in Main Radiology. This apparent increase is due to a change in procedures. Formerly, file jackets were prepared by file room personnel. Since bar-code labels for the file jacket were printed at the reception area during the post-implementation period, this activity shifted with regards to the location. This measured increase is not believed to be a real increase but merely a change in process.

c. Patient Waiting and Examination Time

i. Data Considerations

The time from patient arrival, through examination, until patient departure was measured in the baseline and post-implementation periods.

During the baseline period, the progress of actual patients was followed by data collectors in order to obtain arrival and departure times. In Urologic Radiology and Special Procedures, these times were derived from limited observations and from interviews with Radiology staff to verify that these observations were typical of normal operations.

During the post-implementation data collection, the computer-generated daily log report, which contains patient arrival and departure times, was used whenever possible. In each section, a small sample of patients were followed in order to verify the accuracy of the computer log. In cases where discrepancies were identified, patient-waiting-time data were collected by tracking patients directly in a manner similar to that used for baseline data collection.

ii. Results

The data for the baseline and post-implementation periods are given in Table 7. Patient waiting and examination times increased in five sections of the Department and decreased in three sections. The reasons for the increases appear to be due to: (1) longer examination

TABLE 7

COMPARISON OF BASELINE AND POST-IMPLEMENTATION
PATIENT WAITING AND EXAMINATION TIME
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

	Patient Waiting and Examination Time			
	Baseline		Post-Implementation	
Department Section	Average	Sta. Dev.	Average	Sta. Dev.
Main Radiology	40 min.	30 min.[a]	54 min.	49 min.
GI Radiology	66 min.	22 min.	115 min.	73 min.
Orthopedic Radiology	34 min.	16 min.	50 min.	26 min.
Urologic Radiology	120 min.[a]	--	71 min.	40 min.
Special Procedures	120 min.[a]	--	107 min.[b]	64 min.
Nuclear Medicine	96 min.	43 min.	176 min.	126 min.
Computerized Tomography	60 min.	28 min.	83 min.	41 min.
Ultrasonography	125 min.	37 min.	49 min.	17 min.

[a]Derived from limited observations and estimates where needed.

[b]Small sample size, however, for Special Procedures this represents a full day's volume.

times in GI Radiology and Nuclear Medicine due to changes in patient mix; (2) increased elapsed time to obtain prior film files in Main Radiology; (3) increased processing time due to TRIRAD data requirements and changes in clinic procedures in Orthopedic Radiology; and (4) a change in scheduling procedures, independent of TRIRAD in Computerized Tomography.

The reasons for decreases in processing times appear due to: (1) a change in radiologist and procedures in Ultrasonography; and (2) a possible change in mix of examinations and non-representative mean process times derived from limited observations during the baseline period for Urologic Radiology and Special Procedures.

The interpretation of these changes is discussed further in Chapter V.

d. Time for Film File Requests

i. Data Considerations

During the baseline period, requests for prior films were not recognized as a problem nor was it believed that TRIRAD would impact this segment of the process. However, during the post-implementation period increases in patient process time were noted in Main Radiology. During interviews with staff to identify possible reasons for this increase, requests for film files were believed to be a major cause of delays. Accordingly, data were collected on this segment of the process.

ii. Results

The measured data are tabulated in Table 8. File requests were made by the receptionists. The patient's file-jacket labels were sent to the film library on a small elevator, known as a dumbwaiter. The average time that elapsed between placing the labels (which was understood as a request for prior films) in the dumbwaiter until the requests were received in the film library was 14 minutes. The average time that elapsed before a film or note indicating "not in file" was returned to reception was 21 minutes. The average combined time in reception from request to return from film library was

TABLE 8

ANALYSIS OF POST-IMPLEMENTATION FILE REQUESTS IN MAIN RADIOLOGY
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

Date of Sample	11/2/82	11/3/82	Both Samples
Request in Dumbwaiter Until Down to Film Library			
No. of samples	9	30	39
Total time (minutes)	102	435	537 minutes
Average time (minutes)	11	15	14 minutes
Standard deviation (minutes)			9 minutes
Request Down to Film Library Until Up From Film Library			
No. of samples	19	33	52
Total time (minutes)	333	753	1086 minutes
Average time (minutes)	17	23	21 minutes
Standard deviation (minutes)			11 minutes
Request in Dumbwaiter Until Up From Film Library			
No. of samples	9	29	38
Total time (minutes)	273	1079	1352 minutes
Average time (minutes)	30	37	36 minutes
Standard deviation (minutes)			17 minutes
Requisition on Control Desk Until Jacket/Note on Control Desk			
No. of samples	22	27	49
Total time (minutes)	574	912	1486 minutes
Average time (minutes)	26	34	30 minutes
Standard deviation (minutes)			14 minutes

measured as 36 minutes (approximately the sum of the two segments of the process).

After the prior file jacket was received in reception it was brought to the quality control desk. Also, when the examination had been completed, the requisition for the examination was placed on the control desk. After the films were developed, they were matched with the requisition and the prior film. The elapsed time from the placing of the requisition on the control desk until the placing of prior films, or supplemental note, on the control desk was measured and found to average 30 minutes.

e. Radiologist Time Devoted to Interpreting Films

i. Data Considerations

Reading time was evaluated in all eight sections of the Radiology Department. During the baseline studies, reading times in Urologic Radiology and Special Procedures were derived from limited observations and interviews with the radiologists to determine whether these observations were typical of normal operations.

ii. Results

A comparison of the results of the baseline and post-implementation periods is shown in Table 9 and Figures 12 and 13. In Main Radiology, Nuclear Medicine and Computerized Tomography, a measured decrease in reading time was noted from baseline to post-implementation. A decrease was also noted in Urologic Radiology and Special Procedures from a reading time which was derived from limited observations in the baseline period to a measured reading time during the post-implementation period. Reading time remained constant in Orthopedic Radiology and Ultrasonography. A slight increase in reading time was measured in GI Radiology.

Concurrent with the implementation of TRIRAD, substantial changes in Radiology staffing and procedures were introduced. In Chapter 5, Discussion of Results, the interpretation of these changes is discussed in detail.

In most sections, a consistent method of reading films was followed throughout the study period. However, in the Main Radiology

TABLE 9

COMPARISON OF BASELINE AND POST-IMPLEMENTATION READING TIMES
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

	Reading Times			
	Baseline		Post-Implementation	
Department Section	Average	Sta. Dev.	Average	Sta. Dev.
Main Radiology	6 min.[a,b]	4 min.	3 min.[a]	3 min.
GI Radiology	10 min.	8 min.	11 min.	4 min.
Orthopedic Radiology	5 min.	3 min.	5 min.	3 min.
Urologic Radiology	10 min.[c]	—	7 min.	2 min.
Special Procedures	15 min.[c]	—	10 min.	5 min.
Nuclear Medicine	5 min.	3 min.	5 min.	3 min.
Computerized Tomography	12 min.	7 min.	7 min.	7 min.
Ultrasonography	6 min.	6 min.	7 min.	4 min.

[a]Analysis of changes in reading times suggest that differences may be due, in part, to staffing and procedural changes and, in part, to TRIRAD.

[b]Baseline figures are for handwritten reports only.

[c]Refer to Chapter 5, Discussion of Results, for detail.

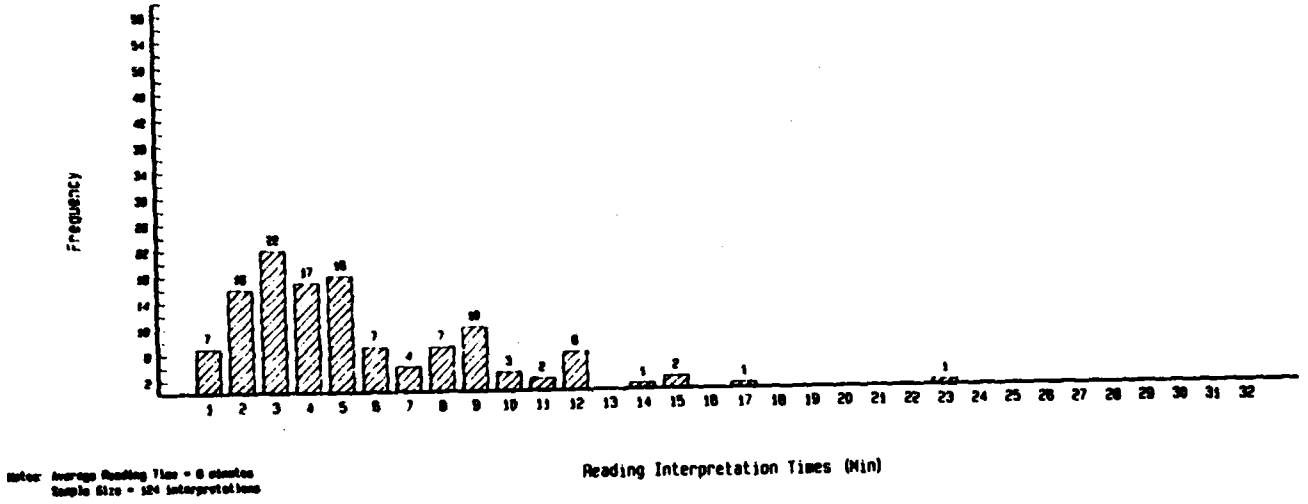
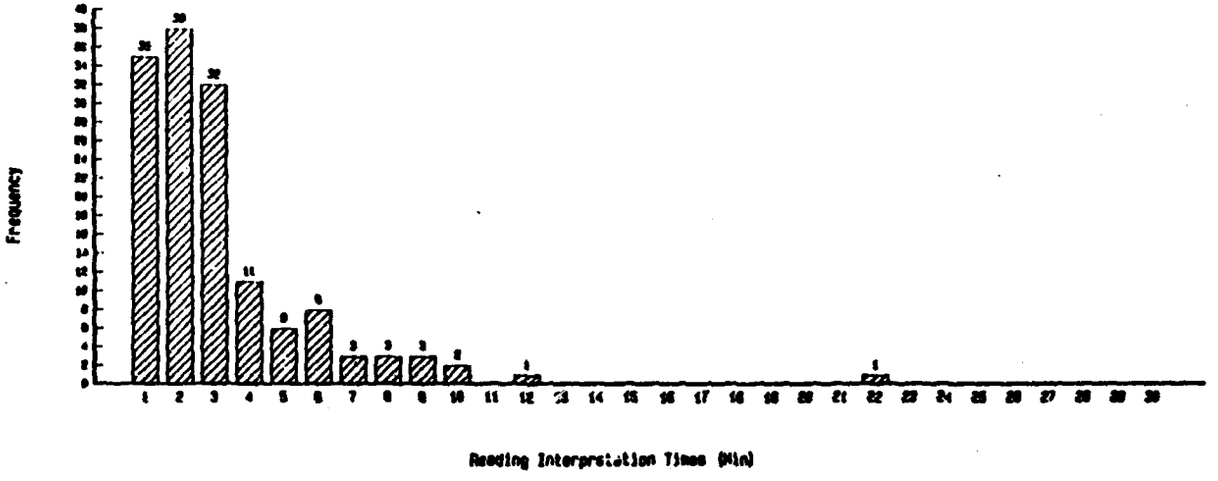


FIGURE 12 DISTRIBUTION OF BASELINE READING TIMES FOR HANDWRITTEN REPORTS IN MAIN RADIOLOGY – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA



Note: Average Reading Time = 5 minutes
Sample Size = 140 Interpretations.

FIGURE 13 DISTRIBUTION OF POST-IMPLEMENTATION READING TIMES FOR REPORTS IN MAIN RADIOLOGY – EVALUATION OF TRIRAD, NAVAL HOSPITAL, BETHESDA

Wet Reading Room seven different methods, or combinations of methods, were employed in the post-implementation period. The times associated with each method varied as can be seen in Table 10. The data are grouped by reporting method with and without computer assistance. For 40% of the volume observed in the Wet Reading Room, bar-coded reporting was used for part or all of the report preparation. The reading time for these computer-assisted reports averaged 2.0 minutes. The 60% of the reports, that were prepared without computer assistance, took 3.0 minutes to interpret and report.

A comparison of these two values with and without computer assistance appears to indicate that bar coding speeds up interpreting and reporting of films and to suggest that widespread use of bar coding might result in an overall reduction in reading time. This comparison is not valid to make with these data because the mix of examinations was different in the two groups. Bar coding was used to create simpler reports of less complex interpretations. Dictation was used for more complex reports for which bar-coded statements were not available or were awkward to use. Bar coding may or may not reduce reporting time but it is not possible to draw definitive conclusions with the confounding variables in these data.

f. Time For Report Transcription

i. Data Considerations

The time spent transcribing reports was measured in the post-implementation period but not in the baseline period for two reasons: (1) transcription was done in another department (Patient Affairs) and authorization was not obtained to collect these data; and (2) much of the transcription was provided by a contract typing service whose control was outside of the hospital and the scope of this study. Though transcription labor time spent per report could not be evaluated quantitatively during the baseline period, and though a direct comparison of change could not be made, transcription labor was measured during the post-implementation study.

The elapsed time between arrival of the radiologists' dictation until transcription was complete was studied during both periods.

TABLE 10

ANALYSIS OF POST-IMPLEMENTATION READING TIMES BY REPORTING METHOD
IN THE MAIN RADIOLOGY WET READING ROOM
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

Reporting Method	No. of Observations[a]	Average Reading Time
No Computer Assistance--60%		
Final Handwritten	5 (6%)	3.2 minutes
Dictated	23 (28%)	2.8 minutes
Preliminary Handwritten and Dictated	20 (25%)	3.1 minutes
With Computer Assistance--40%		
Bar Coded	23 (28%)	1.7 minutes
Preliminary Handwritten and Bar Coded	5 (6%)	2.2 minutes
Dictated and Bar Coded	4 (5%)	2.3 minutes
Preliminary Handwritten, Dictated and Bar Coded	1 (1%)	6.0 minutes
Overall	81 (100%)	2.6 minutes

[a]Percentages may not add to 100% due to rounding.

During the baseline period the elapsed time segment in transcription was studied because this part of the process was reported by Radiology staff to contribute to delays in turnaround time for reports. During the post-implementation period this was observed to no longer be the case. During the post-implementation period the examination date and transcription date were recorded and compared.

ii. Results

Data on post-implementation transcription times are shown on Table 11, which contains the number of observations, the average time and the standard deviation by section. The table also contains an estimate of the number of reports that could be transcribed per hour. Average transcription times (and reports per hour) ranged from a low of 53 seconds (60 per hour) in Ultrasonography and 1 minute, 8 seconds (60 per hour) in Orthopedic Radiology to a high of 4 minutes, 10 seconds (15 per hour) in Computerized Tomography and an even longer report in Special Procedures. In Ultrasonography, reports were typed from handwritten notes according to a "screen" or framework of pre-defined statements that permitted rapid typing. In Orthopedic Radiology reports were typed from handwritten notes and the reports tended to be either brief or used pre-defined statement codes, thus explaining the short transcription time. In Computerized Tomography the reports were lengthy and complex. Reports for Special Procedures probably required more transcription time than other reports; however, this is difficult to evaluate based on measured data, as only one such report was observed. (Though an actual comparison of labor time for transcription is precluded by the absence of baseline data, Radiology staff believed that the power typing capabilities of TRIRAD had increased the efficiency of transcriptionists.)

Mean elapsed time in transcription during the baseline period varied between 7 and 21 days for different sections of Radiology, substantially adding to the delays in report turnaround time (data for this time segment by section are contained in Appendix B). During post-implementation observations this segment was found to average less than one day. (A more precise value was not possible because the

TABLE 11

POST-IMPLEMENTATION TRANSCRIPTION TIME
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

Department Section	Number of Observations	Average	Standard Deviation	Number of Reports Transcribed per Hour
Main Radiology	118	2 min. 11 sec.	85 sec.	30
GI Radiology	30	2 min. 3 sec.	67 sec.	30
Orthopedic Radiology	65	1 min. 18 sec.	43 sec.	60
Urologic Radiology	11	3 min. 26 sec.	73 sec.	20
Special Procedures	1	19 min. 0 sec.	N/A	N/A
Nuclear Medicine	33[a]	3 min. 38 sec.	132 sec.	27
Computerized Tomography	23	3 min. 13 sec.	127 sec.	15
Ultrasonography	30	1 min. 37 sec.	54 sec.	60

[a]Includes 23 direct-dictation-to-transcriptionist observations (average 2 min. 56 sec.) and 10 dictation-tape-to-transcriptionist observations (average 3 min. 18 sec.).

delivery of dictation types to transcription could not be reliably determined.) The elapsed time for this segment has decreased substantially since the baseline period with a resultant decrease in report turnaround time.

3. Film File Availability

i. Data Considerations

Data concerning film-file availability were collected during observation of radiologists in the reading rooms. It was believed that the impact of improved file availability would be greatest in the reading rooms since the largest volume of prior films were pulled expressly for comparisons in the reading rooms. Also, it was believed that changes in file availability in the reading rooms could have a direct impact on the quality of patient care. For each reading observed, the presence or absence of prior films was noted.

ii. Results

Tables 12 and 13 show the results concerning file availability in the baseline and post-implementation periods, respectively. The upper half of each table shows the number of prior films that were or were not present in the reading room; "don't know" was indicated by the data collector when it could not be determined whether a prior film was available or not. The lower half of the table shows, for prior films in the reading room, whether they were in fact used in the interpretation. Note that in GI Radiology it was more difficult to determine whether prior films were used.

Examination of the results of the total of all sections indicates that during the baseline period 41% of all interpretations had a prior file available, 42% did not, and in 17% of the cases the availability of prior films could not be determined. By comparison, during the post-implementation period 32% of the interpretations had a prior film available, 50% did not and for 18% the availability of prior films could not be determined. A comparison of the total volumes shows that 9% fewer interpretations during the post-implementation period had a prior film available for comparison. It is important to recognize, in interpreting these results, that no distinction was made as to the

TABLE 12

ANALYSIS OF BASELINE AVAILABILITY OF PRIOR FILMS DURING INTERPRETATION
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

	Department Section															
	Main Radiology															
	Wet Reading Room		Inpatient Reading Room--Not Evaluated		GI Radiology		Orthopedic Radiology		Nuclear Medicine		Computerized Tomography		Ultra-Sonography		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
No. of Prior Films in Reading Room	52	40%	-	-	19	50%	18	60%	8	40%	7	33%	--	--	104	41%
No. of Prior Films Not in Reading Room	53	41%	-	-	17	45%	10	33%	11	55%	9	43%	6	46%	106	42%
Don't Know	25	19%	-	-	2	5%	2	7%	1	5%	5	24%	7	54%	42	17%
Total No. of Observations	130	100%	-	-	38	100%	30	100%	20	100%	21	100%	13	100%	252	100%
Prior Films in Reading Room Used	39	75%	-	-	5[a]	26%[a]	14	78%	8	100%	7	100%			73[b]	70%
Prior Films in Reading Room Not Used	13	25%	-	-	14[a]	74%[a]	4	22%	--		--				31	30%
Total No. of Prior Films in Reading Room	52	100%	-	-	19	100%	18	100%	8	100%	7	100%			104	100%

[a] In GI Radiology, radiologists usually participate in taking the examination. Before the offical reading session, prior films may be reviewed. The numbers reflected here indicate only the use of prior films in the observed reading section.

[b] Represents 29% of all 252 observations.

TABLE 13

ANALYSIS OF POST-IMPLEMENTATION AVAILABILITY OF PRIOR FILMS DURING INTERPRETATION
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

	Department Section																	
	Main Radiology																	
	Wet Reading Room		Inpatient Reading Room		GI Radiology		Orthopedic Radiology		Nuclear Medicine		Computerized Tomography		Ultra-sonography		Total	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
No. of Prior Films in Reading Room	11	14%	34	55%	11	30%	25	46%	19	47%	4	10%	5	18%	109	32%
No. of Prior Films Not in Reading Room	70	86%	—	--	26	70%	29	54%	12	29%	25	63%	11	39%	173	50%
Don't Know	--	--	28	45%	--	--	--	--	10	24%	11	27%	12	43%	61	18%
Total No. of Observations	81	100%	62	100%	37	100%	54	100%	41	100%	40	100%	28	100%	343	100%
Prior Films in Reading Room Used	10	91%	23	68%	2	18%	22	88%	18	95%	3	75%	4	80%	82[b]	75%
Prior Films in Reading Rooms Not Used	1	9%	11	32%	4[a]	36%[a]	3	12%	1	5%	1	25%	1	20%	22	20%
Don't Know	--	--	--	--	5[a]	46%[a]	--	--	--	--	--	--	--	--	5	5%
Total No. of Prior Films in Reading Room	11	100%	34	100%	11	100%	25	100%	19	100%	4	100%	5	100%	109	100%

[a] In GI Radiology, radiologists usually participate in taking the examination. Before the official reading session, prior films may be reviewed. The numbers reflected here indicate only the use of prior films in the observed reading section.

[b] Represents 24% of all 343 observations.

type of patient or to the reason why a prior film might not have been present. The purpose of this study focused on the availability of prior films to the radiologist at the time of the official reading. Thus these data were collected in the reading room. It was not possible to assess which current films should have had a prior film in either the baseline or post-implementation period. Accordingly, films for first time patients and films out on loan were both recorded as "not available" to the radiologist during the official reading. This methodology was consistently followed in both study periods.

In the Radiology Wet Reading Room, the percentage of available films decreased from 40% in the baseline period to 14%; observations were not made in the Inpatient Reading Room during the baseline period so a comparison is not possible; in GI Radiology a decrease from 50% to 30% was measured; in Orthopedic Radiology a decrease from 60% to 46%; and in Computerized Tomography from 33% in the baseline down to 10% during post-implementation. Improvements were measured in Nuclear Medicine (from 40% to 47%) and in Ultrasonography (from 0% to 18%).

Comparison of the number of available prior films that were, in fact, used in the interpretation shows an increase from 70% in the baseline period to 75% during the post-implementation period. A calculation of the total number of prior films used divided by the total number of observations shows that for 29% (73 of 252 observations) of all interpretations a prior film was actually used during the baseline period and for 24% (82 of 343 observations) of all interpretations a prior film was actually used during the post-implementation period, or a net reduction of 5% of the total volume.

C. COSTS OF RADIOLOGY SERVICES AND TRIRAD EQUIPMENT

Information on costs of Radiology services was obtained from budgeting figures contained in the Uniform Chart of Accounts (UCA) reports provided by the Comptroller of NHB. The reader should be aware that the budgeting figures should be used as a general reference only and for overall comparison with the costs of TRIRAD equipment and operation.

Table 14 shows the cost figures for both FY81 (last full year prior to TRIRAD installation) and FY82 (TRIRAD was installed during the second quarter of FY82); for the following cost elements:

- Direct expenses - including labor, supplies, utilities, etc.;
- Indirect expenses - reported as support costs by UCA;
- Radiology equipment - major capital equipment, not including TRIRAD;
- Maintenance and repair; for major capital equipment, not including TRIRAD; and
- TRIRAD operating expenses - for FY82 only, includes the operating expenses, attributable to TRIRAD, for the hospital's main computer room.

In FY81 Radiology services cost $5,677,107 and for FY82 costs were $6,416,925. (Note carefully the extensive footnotes on Table 14 that discuss assumptions and methods used in preparing these cost figures.) In FY81 the volume of examinations totaled 84,574[4] and the workload totaled 493,462[5] weighted work units. In FY81 the cost per examination was $67.13 and the cost per work unit was $11.50. In FY82 the volume of examinations totaled 92,816[4] and the workload totaled 776,267[5] weighted work units. In FY82 the cost per examination was $69.13 and the cost per work unit was $8.27 (not including the cost of TRIRAD).

The changes in the Radiology costs from FY81 to FY82 appear to have been due to several identifiable factors and were probably due, in part, to other factors that have not been identified. The operating cost of the TRIRAD mainframe has been added. The two

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[4] Note that the apparent increase in volume between FY81 and FY82 may be due, entirely or in part, to the improved capability with TRIRAD to record and account for each procedure performed.

[5] Note that the apparent increase in workload as recorded in weighted work units is due primarily to the changes in the Nuclear Medicine section for assigning weights to each examination.

TABLE 14

ANNUAL BUDGET FOR RADIOLOGY SERVICES[a] IN FY81 AND FY82 --
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

Cost Element	FY81[b] Baseline	FY82[b] Post-Implementation
Direct expenses (includes labor, supplies, utilities, etc.)	$2,797,082	$3,384,030[c]
Indirect expenses	645,740	748,789[c]
Radiology equipment[d]	1,714,285[d]	1,714,285[d]
Maintenance and repair[e]	520,000[e]	520,000[e]
TRIRAD operating expenses[f]	--	49,821[f]
	$5,677,107	$6,416,925

[a]Includes Diagnostic Radiology and Nuclear Medicine sections, but does not include Radiation Therapy since this section does not use TRIRAD.

[b]FY81 figures used as baseline values since last full year prior to TRIRAD installation. FY82 figures used for post-implementation values since first year of TRIRAD operation although TRIRAD was installed during second quarter of FY82.

[c]Values projected by multiplying first three quarters of FY82 by 1.33 since values for fourth quarter are not yet available.

[d]Radiology equipment includes major capital equipment, but not TRIRAD equipment. Value of equipment determined to equal $12 million, allocated over 7 years, i.e., $12 million ÷ 7 years = $1,714,285. Value determined from Radiology equipment records and interviews with staff. Value assumed to be the same in FY81 and FY82 since no major equipment purchases were made.

[e]Maintenance and repair on major capital equipment but not TRIRAD. Based upon maintenance contracts of $420,000 and estimate of in-house maintenance of $100,000. Value assumed to be the same in FY81 and FY82 since no major change in equipment to be maintained.

[f]TRIRAD operating expenses based upon third quarter of FY82 includes the operation of the main frame in the hospital's main computer room. Since TRIRAD was installed from second through fourth quarters, and since data for the third quarter are believed to be most reliable, FY82 values were determined by multiplying third quarter expenses times three, i.e., $16,607 x 3 = $49,821. (NHB Comptroller staff felt that second quarter data were unreliable due to failure to capture all costs incurred during the start-up period.)

transcriptionists hired to work within Radiology during FY82 replaced the transcriptionist from Central Transcription and the outside typing services used in FY81; on the Radiology budget transcription was included as a direct expense in FY82 whereas it was listed as an indirect expense in FY81. It appears that there may be no net change in total cost as a result of this management change. Inflation in salaries, supplies, utilities and other expenses account for a portion of the change. The increase in volume of examinations requires a corresponding increase in supplies, including direct and indirect expenses for these supplies.

The list of TRIRAD equipment costs for FY82 is contained in Table 15 and totals $232,161. TRIRAD costs include hardware lease, hardware maintenance, software lease and maintenance and one-time charges. Table 15 lists each component of the TRIRAD system installed at NHB, the number of units, the monthly cost per item and the cost contributed by each component during FY82. For example, the four intelligent KVDT's were leased at a rate of $125 per month and were installed for 8.77 months during FY82; as a result, the hardware cost for these terminals is found to be $4,383 (4 units x $125 per month x 8.77 months). In succeeding years the annual cost figure will be calculated for 12 months.

The one-time charges of $110,650 include such items as training, installation and documentation. These one-time charges, as the term suggests, have only occurred during the first year of the contract and will not be incurred again. Thus in succeeding years, if software and hardware costs remain constant, the annual cost figure is expected to be lower, e.g., in FY83 an annual figure of $176,000 has been predicted. Appendix E contains details of TRIRAD equipment costs for succeeding years through March 1989 and a detailed table of one-time charges.

A comparison of TRIRAD equipment and operating costs with FY82 budget figures shows that TRIRAD represents 4.4% of the FY82 budget [($232,161 + 49,821) ÷ ($6,416,925 x 100 = 4.4%)]. With the expected increases in the Radiology budget during each succeeding year and the

TABLE 15

COSTS OF TRIRAD SYSTEM FOR FY82[1] HARDWARE, SOFTWARE AND MAINTENANCE —
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

	No.	Monthly Cost Per Item[2]	FY82[2]
Hardware Lease			
8-Channel Expander	6	$ 70.00	$ 3,682
Bar Code Printer	7	295.00	18,103
Bar Code Reader	24	45.00	9,468
KVDT Basic	17	55.00	8,197
KVDT Intelligent	4	125.00	4,383
MAXIFILE System	1	2,390.00	20,952
Modem Short Haul	53	10.00	4,646
Modem Short Haul[1]	1	10.00	37
Optical Scanner	1	525.00	1,960
Printer 150CPS	6	120.00	6,312
Subtotal			$77,740
Hardware Maintenance			
8-Channel Expander	6	$ 20.00	$ 1,105
Bar Code Printer	7	130.00	8,377
Bar Code Reader	24	25.00	5,523
KVDT Basic	17	25.00	3,912
KVDT Intelligent	4	35.00	1,289
MAXIFILE System	1	1,400.00	12,887
Modem Short Haul	3	10.00	4,879
Modem Short Haul[1]	1	10.00	39
Optical Scanner	1	150.00	588
Printer 150CPS	6	50.00	2,762
Subtotal			$41,361
Software Lease and Maintenance			
Film File Management	1	$ 50.00	$ 438
Patient Record File	1	50.00	438
Scheduling Feature	1	50.00	438
Raport II-A Module	1	75.00	658
Raport II-B Module	1	75.00	225[3]
Statistical Package	1	50.00	—[4]
Teaching File	1	75.00	213
Subtotal			$2,410
Equipment Lease and Maintenance Costs			$119,101
Software Lease and Maintenance Costs			$ 2,410
One-Time Costs[5]			$110,650
TOTAL COSTS			$232,161

[1] Dollars spent or committed to be spent by TRIMIS Program Office during FY82
[2] FY82 costs can only be calculated from monthly costs if date of installation for each item is known. Installation of equipment and software components were staggered between January and September, 1982
[3] Delivery delayed
[4] Installed FY83
[5] For breakdown of one-time costs, refer to Appendix E

lower annual cost of TRIRAD equipment (since one-time charges will not be incurred), it is anticipated that the percentage of annual Radiology costs due to TRIRAD equipment will be lower than the 4.4% calculated for FY82.

The cost of Radiology services per examination was shown above to be $69.13 in FY82. If the costs of TRIRAD equipment are added to the Radiology budget then the cost per examination increases to $71.64.

D. QUALITATIVE FINDINGS

1. Questionnaire Results

a. Characteristics of Respondent Sample

The respondents to the baseline survey included 65 Radiology Department staff: 13 radiologists, eight residents, 37 technicians, and seven classified as other (clerical staff and physicists). Thirty of the respondents were working in Diagnostic Radiology, 15 were assigned to one of the imaging sections (3 in Computerized Tomography, 10 in Nuclear Medicine, and 2 in Ultrasound), and 15 were assigned to other sections (11 from Radiation Therapy, 2 from Special Procedures, and 2 from Orthopedic Radiology). Five respondents worked on a rotating basis in two or more sections.

Respondents to the post-implementation survey included 53 staff: 10 each of radiologists and residents, 22 technicians, and 11 staff classified as other. Of these 20 were assigned to Diagnostic Radiology, 23 were assigned to one of the imaging sections, and seven were assigned to Special Procedures (3), Orthopedics (2), and Urology (2). Three other respondents -- a radiologist, a resident, and one technician -- worked on a rotating basis in three or four sections. Nearly 75% of the respondents had been on the staff of the Radiology Department prior to the installation of the TRIRAD system.

b. Satisfaction with Radiology Department Operations

i. Introduction

Both the baseline and post-implementation surveys solicited satisfaction ratings for various aspects of the operation of the Radiology Department without specific reference to the TRIRAD system. Table 16 compares weighted mean satisfaction ratings in the baseline

TABLE 16

COMPARISON OF BASELINE AND POST-IMPLEMENTATION SATISFACTION OF RADIOLOGY DEPARTMENT STAFF WITH DEPARTMENT OPERATIONS — RESPONDENTS TO STAFF SURVEYS AT NAVAL HOSPITAL, BETHESDA

Aspect of Operations	Period	Weighted Mean Satisfaction Response[a]				
		Radiologist	Resident	Technician	Other	Total
Timely availability of films, records, reports:						
current records - routine	Baseline	-1.1	-0.7	+0.1	+0.4	-0.2
test results - routine	Baseline	-1.4	-0.7	-0.3	+0.1	-0.5
historical records - routine	Baseline	-0.9	-1.1	-0.1	+0.3	-0.3
current films	Post-implementation	-0.2	+0.1	+0.5	0	+0.2
current reports	Post-implementation	+0.2	+0.4	+0.5	+0.6	+0.5
historical films	Post-implementation	-0.5	-0.7	+0.2	-0.3	-0.2
historical reports	Post-implementation	-0.2	-0.1	+0.7	+0.1	+0.2
Ease of obtaining information:						
current records	Baseline	-0.8	-0.9	-0.1	+0.1	-0.3
historical records	Baseline	-0.9	-0.9	-0.1	-0.4	-0.4
test results - inpatients	Baseline	-1.0	-0.6	-0.2	0	-0.4
test results - telephone inquiries	Baseline	-1.2	-0.2	-0.7	-0.6	-0.7
films	Post-implementation	-0.5	0	+0.3	+0.1	+0.1
reports	Post-implementation	+0.8	+0.4	+1.0	+0.6	+0.8
getting access to terminal	Post-implementation	-0.3	-0.4	+0.6	+1.1	+0.3
Completeness of information:						
patient records - tests ordered, test results	Baseline	-1.1	-0.9	-0.6	+0.1	-0.7
department files	Baseline	-1.5	-1.1	-0.7	-0.6	-0.9
patient exam history - tests ordered, test results	Post-implementation	+0.6	+0.5	+0.6	-0.2	+0.4
department files	Post-implementation	-0.8	-0.4	+0.3	-0.2	-0.2

[a]A weighted mean satisfaction response was obtained by assigning a value of +2 to responses of "very satisfied," +1 to "somewhat satisfied," 0 to undecided, -1 to "somewhat dissatisfied" and -2 to "very dissatisfied"; summing these values; and dividing the sum by the number of respondents who answered the question. Thus a positive result indicates a mean level of satisfaction overall and a negative result indicates an overall mean level of dissatisfaction.

TABLE 16 (Continued)

COMPARISON OF BASELINE AND POST-IMPLEMENTATION SATISFACTION OF RADIOLOGY DEPARTMENT STAFF WITH DEPARTMENT OPERATIONS
RESPONDENTS TO STAFF SURVEYS AT NAVAL HOSPITAL, BETHESDA

Aspect of Operations	Period	Weighted Mean Satisfaction Response[a]				
		Radiologist	Resident	Technician	Other	Total
Accuracy of information:						
patient records	Baseline	-0.8	-0.4	-0.2	+0.4	-0.3
patient records stored on computer	Post-implementation	+0.8	+0.6	+0.8	+0.4	+0.7

[a]A weighted mean satisfaction response was obtained by assigning a value of +2 to responses of "very satisfied," +1 to "somewhat satisfied," 0 to undecided, -1 to "somewhat dissatisfied" and -2 to "very dissatisfied"; summing these values; and dividing the sum by the number of respondents who answered the question. Thus a positive result indicates a mean level of satisfaction overall and a negative result indicates an overall mean level of dissatisfaction.

and post-implementation surveys. Because of process changes brought about by TRIRAD, the relevant aspects of operations for each area for the baseline were not identical to those for the post-implementation operation. Therefore, specific aspects relating to areas of service effectiveness have been grouped into categories (e.g., ease of obtaining information, completeness of information). Within each category, the survey items for baseline service aspects are listed first, followed by the relevant, parallel aspects for the post-implementation process. A similar table (Table 17) gives the distribution of responses of radiologists and residents into the different satisfaction/dissatisfaction categories on the questionnaire.

ii. Timely Availability of Films, Records, and Reports

As shown in Table 16, baseline responses of radiologists and residents regarding timely availability of films, records, and test results indicated they were somewhat dissatisfied. For radiologists, the lowest mean rating was for test results for routine cases. Overall, staff radiologists appeared to be more dissatisfied with these aspects of department operations than were residents. For residents, the availability of historical records was the least satisfactory aspect. Overall, both technicians and other staff appeared to be essentially neutral.

In the post-implementation period, X-ray films were still filed, but the filed copies of reports were no longer the only record, because they were also stored by the TRIRAD system. As noted in Table 16, satisfaction ratings for availability of reports/records seem to have increased from a level of somewhat dissatisfied to neutral. The ratings for timely availability of films in the post-implementation survey were essentially neutral for current films, but indicating some dissatisfaction for historical films. (The data base of stored reports and film file records should continue to increase the longer the TRIRAD system is in use.) Technicians and other staff appeared overall to be somewhat more satisfied with these aspects of operations in the post-implementation survey.

TABLE 17

COMPARISON OF DISTRIBUTION OF RESPONSES OF RADIOLOGISTS AND RESIDENTS REGARDING SATISFACTION WITH DEPARTMENT OPERATIONS -- BASELINE AND POST-IMPLEMENTATION STAFF SURVEYS, NAVAL HOSPITAL, BETHESDA

Aspect of Operations	Period	Distribution(%)[a] Radiologist[b] Very Dissat.	2	3	4	Very Sat.	Resident[c] Very Dissat.	2	3	4	Very Sat.
Timely availability of films, records, reports:											
current records - routine	Baseline	46%	31%	8%	15%	0	25%	37%	25%	13%	0
test results - routine	Baseline	46	46	8	0	0	25	25	50	0	0
historical records - routine	Baseline	33	33	25	8	0	50	12	38	0	0
current films	Post-implementation	0	50	30	10	10	0	30	30	40	0
current reports	Post-implementation	0	30	30	30	10	0	10	50	30	10
historical films	Post-implementation	10	50	30	0	10	10	50	30	0	10
historical reports	Post-implementation	10	30	30	30	0	22	22	11	33	11
Ease of obtaining information:											
current records	Baseline	31	39	15	15	0	25	37	38	0	0
historical records	Baseline	31	38	23	8	0	37	13	50	0	0
test results - inpatients	Baseline	31	38	31	0	0	12	38	50	0	0
test results - telephone inquiries	Baseline	46	31	15	8	0	12	12	63	13	0
films	Post-implementation	10	50	30	0	10	0	20	60	20	0
reports	Post-implementation	0	20	20	30	30	0	20	30	40	10
getting access to terminal	Post-implementation	30	20	10	30	10	11	44	22	22	0

[a] Percentages are based on the number of responses to each question (i.e., excluding no answers). The respondent base for radiologists consists of 13 radiologists and 8 residents in the baseline survey and 10 radiologists and 10 residents in the post-implementation survey.

[b] Thirteen radiologists responded to the baseline survey and 10 responded to the post-implementation survey; percentages are based on the number of respondents who answered the question.

[c] Eight residents responded to the baseline survey and 10 responded to the post-implementation survey; percentages are based on the number of respondents who answered the question.

TABLE 17 (Continued)

COMPARISON OF DISTRIBUTION OF RESPONSES OF RADIOLOGISTS AND RESIDENTS REGARDING SATISFACTION WITH DEPARTMENT OPERATIONS -- BASELINE AND POST-IMPLEMENTATION STAFF SURVEYS, NAVAL HOSPITAL, BETHESDA

		Distribution (%)[a]									
		Radiologist[b]					Resident[c]				
Aspect of Operations	Period	Very Dissat.	2	3	4	Very Sat.	Very Dissat.	2	3	4	Very Sat.
Completeness of information:											
patient records - tests ordered, test results	Baseline	31%	46%	23%	0%	0%	37%	13%	50%	0%	0%
department files	Baseline	54	38	8	0	0	50	37	0	0	13
patient exam history - tests ordered, test results	Post-implementation	0	10	20	70	0	10	0	30	50	10
department files	Post-implementation	30	30	30	10	0	11	22	66	0	0
Accuracy of information:											
patient records	Baseline	23	46	23	8	0	12	13	75	0	0
patient records stored on computer	Post-implementation	10	0	10	60	20	10	10	10	50	20

[a]Percentages are based on the number of responses to each question (i.e., excluding no answers). The respondent base for radiologists consists of 13 radiologists and 8 residents in the baseline survey and 10 radiologists and 10 residents in the post-implementation survey.

[b]Thirteen radiologists responded to the baseline survey and 10 responded to the post-implementation survey; percentages are based on the number of respondents who answered the question.

[c]Eight residents responded to the baseline survey and 10 responded to the post-implementation survey; percentages are based on the number of respondents who answered the question.

The increasing satisfaction of radiologists and residents with availability of films and reports/records is also apparent in the distribution of responses, (Table 17). In the baseline survey, from 66% to 92% of all radiologists surveyed expressed some dissatisfaction with these aspects (including those who were somewhat and very dissatisfied). No respondents indicated they were "very dissatisfied" with the availability of current records and films in the post-implementation survey and 40% of radiologists and 42% of residents registered some dissatisfaction with availability of historical films.

iii. Ease of Obtaining Information

Baseline satisfaction with the ease of obtaining records and test results indicates that radiologists and residents were quite consistently "somewhat dissatisfied" (Table 16). Technicians and other staff, however, tended to be neutral or somewhat satisfied.

In the post-implementation survey, though all respondents appeared to be only somewhat more satisfied with the ease of obtaining films, they appeared to be substantially more satisfied with the ease of obtaining reports. As noted in Table 17, only 20% of radiologists and a similar percentage of residents were still dissatisfied (versus 70% of radiologists and about 50% of residents in the baseline survey). A comparison of survey responses for technicians and other staff likewise indicates a shift from overall dissatisfaction to a level of "somewhat satisfied" (Table 16).

The post-implementation satisfaction expressed by both groups of physician respondents with access to terminals was lower than that indicated by technicians and other staff; this difference is believed to have resulted from the fact that radiologists and residents needed intelligent CRT terminals (these intelligent terminals are needed for editing and approving reports). There were only four such terminals i the entire Department, and all transcription had to be done at these same terminals as well. Other staff, however, had access to 24 terminals, all capable of performing the other necessary computer functions.

iv. Completeness of Information

Baseline responses regarding completeness of patient records and department files indicate a consistent level of dissatisfaction for all staff types (Table 16). The post-implementation data reveal a substantial shift toward greater satisfaction with the completeness of the patient exam history (tests conducted, test results), which was stored by TRIRAD in addition to the paper record on the file film jacket. Whereas no physician respondents to the baseline survey indicated satisfaction with the completeness of the exam history, 90% of radiologists and 60% of residents did so in the post-implementation survey (Table 17). Overall satisfaction of technicians increased in a similar manner, while that of other staff remained essentially unchanged (Table 16).

The post-implementation results for completeness of patient files indicate more satisfaction than in the baseline survey for both physician groups, though overall, radiologists were still somewhat dissatisfied and residents dissatisfied. Technicians and other staff, who were overall more satisfied with file completeness in the baseline survey, likewise indicated a higher level of satisfaction than physicians in their post-implementation responses, though they shifted from slight dissatisfaction to an essentially neutral position.

v. Accuracy of Information

The baseline survey asked for satisfaction ratings for the accuracy of information on the paper patient record. Radiologists overall were the least satisfied (Table 16); as noted in Table 17, only 8% of those surveyed were satisfied with accuracy of information. Residents, on the other hand, were largely neutral.

The post-implementation responses of these two groups clearly show greater confidence in the accuracy of the information when stored on the computer (Table 17), with 80% of the radiologists and 70% of the residents surveyed reporting that they were "somewhat" or "very satisfied."

c. Overall Satisfaction with TRIRAD

The post-implementation survey asked Radiology Department staff to rate their overall satisfaction with TRIRAD. Of the 49 survey respondents who answered the question, six were very satisfied, 23 were somewhat satisfied, 17 were neutral, three were somewhat dissatisfied, and none were very dissatisfied. The distribution of responses by staff type was as follows:

	Very Satisfied	Somewhat Satisfied	Neutral	Somewhat Dissatisfied
Radiologists	2	3	4	1
Residents	0	7	3	0
Technicians	1	10	7	2
Other Staff	3	3	3	0

d. Benefits of TRIRAD

i. Expectations

The baseline survey solicited opinions regarding the likely benefits of a radiology management system in the department. The results are given in Tables 18 and 19 for two categories of benefits: those affecting primarily the efficiency and/or economy of operations and those affecting the quality of services provided. Results are shown by staff type and for the 63 survey respondents in total.

As shown in Table 18, survey respondents expected some beneficial effects on efficiency/economy in almost every impact area. The notable exception is reduction in the staffing requirements. Overall, radiologists appeared to have higher expectations regarding beneficial impacts than the other staff surveyed. Those impacts rated as most likely to occur included making the patient's current record more easily accessible and available more quickly, improving the scheduling of patients, and reducing the number of telephone inquiries. Respondents overall were unconvinced that a system would decrease the cost of services.

The results concerning expectations for possible impacts relating to the quality of service are shown in Table 19. Respondents appeared to expect improvements in file maintenance, record completeness, and

TABLE 18

EXPECTATIONS OF RADIOLOGY DEPARTMENT STAFF OF DIFFERENT STAFF TYPES REGARDING THE BENEFITS OF A COMPUTERIZED RADIOLOGY MANAGEMENT SYSTEM FOR EFFICIENCY AND ECONOMY -- BASELINE STAFF SURVEY AT NAVAL HOSPITAL, BETHESDA

Impact	Weighted Mean Response[a,b]				
	Radiologist	Resident	Technician	Other	Total
Reduce time to produce a written report	1.6	1.4	1.7	1.6	0.9
Make patient current records more easily accessible	1.5	1.0	0.9	1.9	1.2
Make patient historical records more easily accessible	1.5	0.8	0.7	1.6	1.0
Make patient current records available more quickly	1.4	0.9	0.9	1.6	1.1
Make patient historical records available more quickly	1.3	0.4	0.8	1.6	1.0
Make Radiology function more smoothly	0.8	0.5	0.6	1.3	0.7
Decrease the time spent looking for records/test results	1.7	1.3	1.2	1.6	1.3
Improve scheduling of patients	1.2	0.9	1.0	1.3	1.1
Decrease the cost of radiology services	-0.2	0	0.2	1.0	0.1
Improve the way things are done	1.2	0.6	0.5	1.4	0.7
Reduce the number of people needed to work	-0.2	-0.6	-1.1	-0.4	-0.8
Reduce the number of telephone inquiries for test results	1.5	0.9	0.9	1.7	1.1

[a]A weighted mean response was obtained by assigning values of +2, +1, 0, -1, and -2 to the five possible answers ranging from "definitely will" to "definitely not" and by dividing the sum of these by the number of responses. Thus a positive mean value indicates that overall a computerized radiology management system is expected to have the stated impact.

[b]Respondent base included 13 radiologists, eight residents, 37 technicians, and seven other staff; mean is based on the number of actual responses to each question (i.e., excluding no-answer responses).

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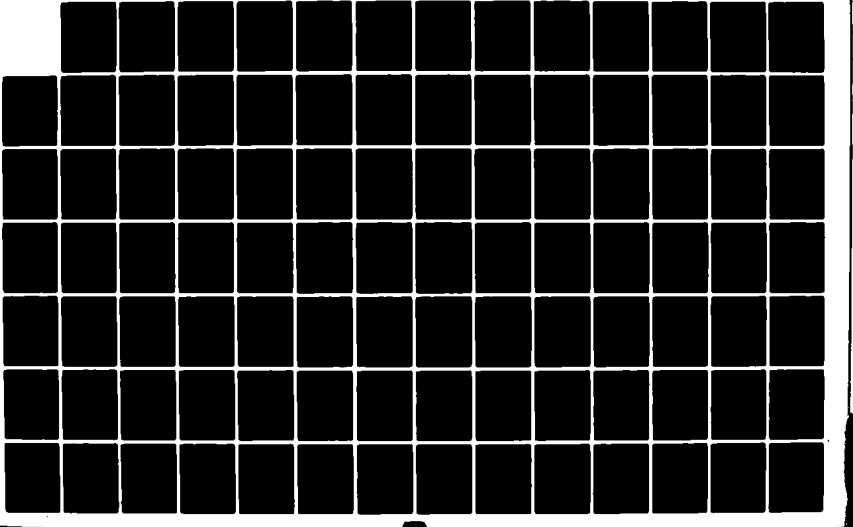

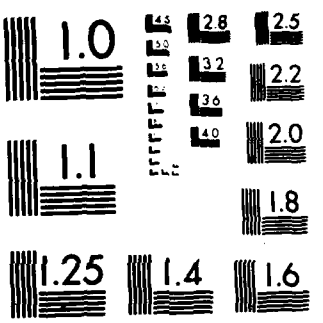

TABLE 19

EXPECTATIONS OF RADIOLOGY DEPARTMENT STAFF OF DIFFERENT STAFF TYPES REGARDING THE BENEFITS OF COMPUTERIZED RADIOLOGY MANAGEMENT SYSTEMS FOR THE QUALITY OF SERVICE-- BASELINE STAFF SURVEY AT NAVAL HOSPITAL, BETHESDA

Impact	Weighted Mean Response[a,b]				
	Radiologist	Resident	Technician	Other	Total
Reduce the number of lost files	1.4	0.9	0.8	1.7	1.0
Result in more complete patient records	1.5	0.8	0.9	1.9	1.1
Reduce the number of errors in patient records	0.9	0	0.4	1.3	0.5
Allow better patient care	0.9	0.6	0.3	1.3	0.6
Make reports easier to read	1.5	0.9	0.9	1.7	1.1

[a]A weighted mean response was obtained by assigning values of +2, +1, 0, -1, and -2 to the five possible answers ranging from "definitely will" to "definitely not" and by dividing the sum of these by the number of responses. Thus a positive mean value indicates that overall a computerized radiology management system is expected to have the stated impact.

[b]Respondent base included 13 radiologists, eight residents, 37 technicians, and seven other staff; mean is based on the number of actual responses to each question (i.e., excluding no-answer responses).

report legibility with greater certainty than improvements in record accuracy and patient care. Again, radiologists were more certain that benefits would be realized.

The results for the same series of questions regarding expected benefits are given in Tables 20 and 21, which show the responses according to level of experience or familiarity with computerized radiology management systems.

Responses to the survey question of familiarity are shown in Table 22. As noted, a small number of respondents (all of whom were technicians) reported prior experience in actually using a system, and a large number (30-40% of the respondent sample) reported no prior familiarity or experience. For use in the analysis of expected benefits in Tables 20 and 21, responses have been pooled to include both experience with TRIRAD and experience with any other radiology management system and respondents have been counted only once, within the highest experience category they indicated.

Survey respondents with the least prior familiarity/experience had the lowest expectations regarding benefits, and those with some direct experience (having used a system) appeared to be somewhat more cautious than those who had only read or heard about computerized radiology management systems or seen them demonstrated.

ii. Realized Benefits

The results of the post-implementation survey concerning staff perceptions of realized benefits to efficiency/economy are given in Table 23. A large number of the respondents reported beneficial changes for most impacts affecting efficiency/economy. Individual benefits reported by 50% or more of the respondent base (27 of 53) included:

- reduced time to produce a written report;
- more timely availability of patient historical records;
- decreased time spent looking for records/test results; and
- improved scheduling.

Two areas of efficiency/economy were viewed as not having been improved by TRIRAD. Respondents felt that TRIRAD had not reduced

TABLE 20

EXPECTATIONS OF RADIOLOGY DEPARTMENT STAFF WITH DIFFERENT LEVELS OF PRIOR SYSTEM EXPERIENCE OR FAMILIARITY REGARDING THE BENEFITS OF A COMPUTERIZED RADIOLOGY MANAGEMENT SYSTEM FOR EFFICIENCY AND ECONOMY OF OPERATIONS--BASELINE STAFF SURVEY AT NAVAL HOSPITAL, BETHESDA

	Weighted Mean Response[a,b]				
Impact	None	Read/ Heard Only	Saw Demon- strated	Saw Used	Used
Reduce time to produce a written report	0.3	1.4	1.8	1.3	0.5
Make patient current records more easily accessible	0.7	1.4	1.5	1.6	1.1
Make patient historical records more easily accessible	0.6	1.0	1.5	1.6	0.9
Make patient current records available more quickly	0.5	1.4	1.7	1.6	0.9
Make patient historical records available more quickly	0.5	1.1	1.5	1.4	0.9
Make Radiology function more smoothly	0.8	0.7	0.8	0.6	0.8
Decrease time spent looking for records/test results	1.3	1.5	1.5	1.6	1.0
Improve scheduling of patients	0.8	1.3	1.0	1.0	1.0
Decrease the cost of radiology services	0.3	0.3	0.6	-0.9	-0.1
Improve the way things are done	0.7	0.7	1.0	1.1	0.5
Reduce the number of people needed to work	-0.5	-1.0	-1.0	-0.7	-0.7
Reduce the number of telephone inquiries for test results	0.8	1.2	1.7	1.6	1.1

[a]A weighted mean response was obtained by assigning values of +2, +1, 0, -1, and -2 to the five possible answers ranging from "definitely will" to "definitely not" and by dividing the sum of these by the number of responses. Thus a positive mean value indicates that overall a computerized radiology management system is expected to have the stated impact.

[b]Responses have been pooled to include experience with TRIRAD or other systems; each respondent is counted only once, within the highest level of experience. See Table 22.

TABLE 21

EXPECTATIONS OF RADIOLOGY DEPARTMENT STAFF WITH DIFFERENT LEVELS OF SYSTEMS FAMILIARITY/EXPERIENCE REGARDING THE BENEFITS OF A COMPUTERIZED RADIOLOGY MANAGEMENT SYSTEM FOR THE QUALITY OF SERVICE -- BASELINE STAFF SURVEY AT NAVAL HOSPITAL, BETHESDA

	Weighted Mean Response[a,b]				
Impact	None	Read/ Heard Only	Saw Demon-strated	Saw Used	Used
Reduce the number of lost files	0.8	1.5	1.3	1.0	0.1
Result in more complete patient records	0.9	1.2	1.5	1.6	0.6
Reduce the number of errors in patient records	0.4	0.8	0.8	0.4	0.5
Allow better patient care	0.4	0.9	1.2	0.3	0
Make reports easier to read	0.8	1.2	1.7	1.6	1.1

[a]A weighted mean response was obtained by assigning values of +2, +1, 0, -1, and -2 to the five possible answers ranging from "definitely will" to "definitely not" and by dividing the sum of these by the number of responses. Thus a positive mean value indicates that overall a computerized radiology management system is expected to have the stated impact.

[b]Responses have been pooled to include experience with TRIRAD or other systems; each respondent is counted only once, within the highest level of experience. See Table 22.

TABLE 22

LEVEL OF EXPERIENCE/FAMILIARITY WITH TRIRAD OR OTHER COMPUTERIZED RADIOLOGY MANAGEMENT SYSTEMS -- RESPONDENTS TO BASELINE STAFF SURVEY AT NAVAL HOSPITAL, BETHESDA

	Number of Respondents[a]				
Staff Type:	Radiologist	Resident	Technician	Other	Total
Level of Familiarity					
No familiarity					
TRIRAD	3	5	16	4	28
Other System	4	4	11	2	21
Read/heard about but not seen or used					
TRIRAD	4	3	13	2	22
Other System	1	1	10	0	12
Seen demonstrated					
TRIRAD	3	0	1	2	6
Other System	3	0	2	0	5
Seen used					
TRIRAD	2	0	1	1	4
Other System	3	1	3	0	7
Used/tried					
TRIRAD	0	0	0	0	0
Other System	0	0	8	0	8

[a]Total responses add to more than the respondent base of 65 because many respondents noted several answers.

TABLE 23

OPINIONS OF RADIOLOGY DEPARTMENT STAFF CONCERNING THE BENEFITS OF THE TRIRAD SYSTEM FOR EFFICIENCY AND ECONOMY--RESPONDENTS TO POST IMPLEMENTATION STAFF SURVEY AT NAVAL HOSPITAL, BETHESDA

	Number of Respondents[a]							
	Radiologist		Resident		Technician and Other		Total	
Impact on Operations	Benefit	No Benefit	Benefit	No Benefit	Benefit	No Benefit	Benefit	No Benefit[b]
Reduced time to produce written report	6	3	8	1	22	7	36	11
Increased accessibility of patient historical records	4	0	3	0	11	4	18	4
Speeded up availability of patient historical records	10	0	7	0	20	5	37	5
Made radiology function more smoothly	5	1	5	0	13	8	23	9
Decreased time spent looking for records/test results	8	1	9	0	26	6	43	7
Improved scheduling	6	2	6	1	20	3	32	6
Decreased cost of radiology services	2	5	1	2	5	6	8	13
Reduced personnel requirements	1	9	2	5	5	16	8	36
Reduced telephone inquiries/improved turnaround	4	4	7	0	11	10	22	14

[a]Responses of "benefit" include those indicating TRIRAD had definitely had the impact and those indicating TRIRAD had had some effect; responses of "no benefit" likewise include responses indicating strong disagreements that the impact had occurred or some disagreement. Neutral responses are not shown.

[b]Respondent base included 53 questionnaires: 10 radiologists, 10 residents, 22 technicians, and 11 other staff. Responses shown in table do not always correspond to total respondents for staff category due to no answers and neutral responses.

personnel requirements (36 reporting no benefit and eight reporting a benefit). A large number of respondents gave a neutral response regarding any effect on the cost of radiology services; of those who were not neutral, however, 13 reported no benefit and eight reported a benefit.

A comparison of the responses regarding expectations from the baseline survey (Table 18) with the responses in Table 23 suggests that expectations that costs of services and personnel requirements would not be reduced were consistent with reported experience with TRIRAD. Other expectations regarding improvements in accessibility of records (both ease and speed of obtaining records) and time spent looking for record/test results also appear to have been met for many staff.

Responses regarding realized benefits to the quality of services are given in Table 24. For most impacts, a large number of respondents reported a benefit. Benefits reported by more than 50% of respondents included:

- increased completeness of patient records;
- improved patient care; and
- improved ease of reading reports.

Responses regarding changes in the number of lost files and errors in patient records were mixed. When the responses regarding realized benefits to the quality of service are compared with expectations as expressed in the baseline survey (Table 21), it appears that the expectations regarding improved record completeness and ease of reading reports were met. Staff in the baseline survey were somewhat less confident that the number of errors in patient records would decline, and this appears to have been confirmed by the somewhat mixed responses concerning this benefit in the post-implementation survey. The one area in which there was an obvious discrepancy between expectations and reported experience is the number of lost files. Baseline responses indicate that overall staff of all types were expecting a decrease in the number of lost files, with radiologists the most convinced. The post-implementation data in Table 24 reveal

TABLE 24

OPINIONS OF RADIOLOGY DEPARTMENT STAFF CONCERNING THE BENEFITS OF TRIRAD FOR THE QUALITY OF RADIOLOGY SERVICES--RESPONDENTS TO POST-IMPLEMENTATION STAFF SURVEY AT NAVAL HOSPITAL , BETHESDA

	Number of Respondents[a]							
	Radiologist		Resident		Technician and Other		Total	
Service Benefit	Benefit	No Benefit	Benefit	No Benefit	Benefit	No Benefit	Benefit	No Benefit[b]
Reduced number of lost files	4	4	2	3	10	10	16	17
Increased completeness of patient records	8	0	7	1	19	3	34	4
Reduced errors in patient records	2	2	3	1	11	8	16	11
Improved patient care	4	3	8	1	15	8	27	12
Increased ease of reading reports	7	0	8	0	30	1	45	1
Reduced unnecessary repeat examinations	3	4	1	3	16	6	20	13
Increased satisfaction of attending physician with radiology service	6	3	4	0	15	1	25	5
Increased accuracy of radiology reports	2	7	4	1	19	2	25	10

[a]Responses of "benefit" include those indicating TRIRAD had definitely had the impact and those indicating TRIRAD had had some effect; responses of "no benefit" likewise include responses indicating strong disagreements that the impact had occurred or some disagreement. Neutral responses are not shown.

[b]Respondent base included 53 questionnaires: 10 radiologists, 10 residents, 22 technicians, and 11 other staff. Responses shown in table do not always correspond to total respondents for staff category due to no answers and neutral responses.

that a large number (20 or 38% of the 53) of respondents gave a neutral response; the remainder were evenly divided as to whether this impact had been realized or not.

iii. Effect of TRIRAD on the Work of Department Staff

The post-implementation survey asked respondents to agree or disagree with a series of questions concerning the effect of TRIRAD on their work. Results are shown in Table 25 for the physician respondents in the same (radiologists and residents), for technicians and other staff, and for the respondent base as a whole. On the questionnaire, positive and negative statements concerning TRIRAD were intermingled. In the table they have been reordered so that negative statements appear together at the end of the list.

Of the positive statements, 50% or more of the respondents (27 of 53) agreed with the following:

- it was easy to learn to use the system;
- it has made my work more efficient;
- it has made recordkeeping easier for me;
- the benefits have outweighed the disadvantages; and
- I expect the benefits to increase in the future.

The maximum number of respondents expressing disagreement with a positive statement was 16 (30%) for the statement concerning the challenge of work.

Results for the four negative statements indicate very few respondents felt that the system had had the stated effect. A large number (23) of respondents gave a neutral response regarding loss of flexibility in their work. For the three other statements, 50% or more of the respondents disagreed that such an effect had occurred:

- I do not trust the information I obtain;
- I personally use it as little as possible; and
- some decision-making has been taken away from me.

Of the physician respondents, 87% disagreed with or gave a neutral response to the first statement, and 94% disagreed with or gave a neutral response to the second.

TABLE 25

OPINIONS OF RADIOLOGY DEPARTMENT STAFF CONCERNING THE EFFECT OF TRIRAD ON THEIR WORK --
RESPONDENTS TO POST-IMPLEMENTATION STAFF SURVEY AT NAVAL HOSPITAL, BETHESDA

Effect of TRIRAD[b]	Number of Respondents[a]								
	Radiologists and Residents			Technicians and Others			Total		
	Agree	Neutral	Disagree	Agree	Neutral	Disagree	Agree	Neutral	Disagree
a. It was easy for me to learn to use the radiology system	13	4	3	29	4	0	42	8	3
b. It has made my work more efficient	9	8	3	18	12	3	27	20	6
d. It has made record keeping easier for me	11	5	4	18	9	6	29	14	10
f. It has made my work more challenging	6	8	6	7	16	10	13	24	16
g. The benefits to me have outweighed the disadvantages of the system	12	4	3	18	8	6	30	12	9
h. It has significantly altered the way I do my work	9	5	5	13	10	10	22	15	15
i. I have been able to provide better service to my patients	11	6	2	9	19	7	20	23	9
l. The system saves me time	11	5	3	12	9	12	23	14	15
m. I expect that benefits from this system will increase in the future	15	4	1	25	5	3	40	9	4
c. I do not trust the information I obtain	1	2	17	6	5	21	7	7	38
e. I personally try to use it as little as possible	2	2	16	1	4	26	3	6	44
j. I have had less flexibility because operations are more routinized	3	6	10	6	13	13	9	19	23
k. Some decision making has been taken away from me	1	6	12	5	11	16	6	17	28

[a]Respondents counted as agreeing with statement include those who indicated strong agreement ("5" on survey) and some agreement ("4"); those counted as disagreeing similarly included those noting strong disagreement ("1")or some disagreement ("2"); those counted as neutral noted "3". Respondent base included 53: 10 radiologists, 10 residents, and 33 technicians and other staff; responses for each category may not add to total because of no answers.

[b]The order in which the statements are listed has been modified so that positive ones precede negative ones; the alphabetical labels, however, correspond to those on the actual survey instrument and provide a means of matching these data with questionnaire results in Appendix D.

2. Interviews with Attending Physicians

Ten attending physicians were interviewed, in both the baseline and post-implementation periods, regarding their satisfaction with those aspects of Radiology services that might be affected, directly or indirectly, by TRIRAD. All physicians were frequent users of Radiology services, depended upon Radiology for diagnostic information and expressed strong interest in the quality of services being delivered. The physicians were from varied medical and surgical specialties, anesthesiology and emergency medicine. The issues addressed were timeliness of reports, access to current and prior films, accuracy of reports, access to Radiology consultations, [illegible] of ordering routine and STAT examinations, the presence of reports [illegible] the inpatient and outpatient medical records, and the features of [illegible]D that were most useful to physicians outside of Radiology.

a. Timeliness and Filing of Radiology Reports

During the baseline period, all physicians were very dissatisfied with report turnaround time. All physicians interviewed agreed that Radiology reports were more timely following the implementation of TRIRAD. Despite improvements, however, many reports for inpatients were still not back in the chart by the time the patient was discharged. The physicians interviewed considered this situation unacceptable.

In responding to questions about the timeliness and filing of interpretation reports for outpatients, most physicians agreed that there have been noticeable improvements in both areas since TRIRAD was implemented. They believed that official Radiology reports for examinations ordered during the previous encounters were available more often at the next encounter. However, they all agreed that further improvements were desirable.

Several physicians described their own independent systems for obtaining and recording timely Radiology information for outpatients. These systems were in use in the baseline period and have continued to be used during post-implementation. One physician described a process he had developed whereby the outpatient mails a postcard to him the

day of the examination and this serves as a reminder to the physician to go to Radiology to view the film. Another physician reported that he obtains Radiology results on outpatients by going to the Radiology Department and reading the film himself and/or discussing the film with a radiologist. (Though this practice is quite usual for inpatients, these physicians had adopted it for outpatients as well.) Both physicians summarized the findings themselves in the notes of the patient encounter.

Several physicians described specific cases where patient care could have been adversely affected by the physician's inability to locate films and/or interpretation reports, or the lack of distribution copies available to physicians or in the patient record. They felt that, despite improvements, TRIRAD had not totally eliminated these occurrences.

The timeliness of reports to the Emergency Room was also explored through interviews. During the baseline period, ER staff reported turnaround time to be satisfactory. During July 1982, six months post-installation, in an effort to improve service, the ER staff had conducted a study of the time from patient departure from the ER to Radiology to the return of patient and handwritten X-ray report to the ER and compared results with two civilian teaching hospitals in Washington. The study showed an average turnaround time of 78 minutes in contrast to average times of 30 minutes and 54 minutes at the other two hospitals. The ER staff identified two factors contributing to delays in Radiology: that ER patients did not receive priority in having examinations taken and that the time to retrieve prior films from the film library had increased since the baseline. The latter resulted from procedures for departing patients on TRIRAD that required matching new films and prior films before departing the patient and sending the films to the reading room. By October, nine months post-installation, both situations had changed, with the result that ER staff were considerably more satisfied with turnaround time.

Surgeons and an anesthesiologist cited difficulties in both the baseline and post-implementation periods for obtaining pre-operative

results sufficiently in advance to resolve questions raised by the Radiology report. They described instances of having to cancel surgery because of Radiology reports read and/or delivered the morning of surgery, rather than during the late afternoon on the day before, when there was still time to call in a consultant and resolve any questions.

Attending physicians in all areas noted that they often obtained reports from the TRIRAD CRT terminal. They reported using this means to obtain reports, to locate files, or to ascertain the status of patient examinations not yet reported. The interviewees believed that access to reports and report status via TRIRAD was proving to be one of the major benefits of the system to attending physicians.

b. Film Access and Borrowing

On questions relating to film access and borrowing, the physicians interviewed indicated that they were somewhat dissatisfied in the post-implementation period, whereas in the baseline period they indicated that they were very dissatisfied. Their increase in satisfaction (or decrease in dissatisfaction) is related to the improvement in locating current films in the department, aided by the file tracking features of TRIRAD.

Interviewees indicated a desire for some improvements in procedures for borrowing films that were instituted with the installation of TRIRAD. They cited difficulties checking out a large number of films (e.g., for a teaching conference). They reported that the bar-code readers did not always accept the inputs and multiple strokes of the light pen were required for each input, resulting in lengthy check-out procedures. TRIRAD was designed to identify delinquent borrowers. However, when films were returned to Radiology, the return was not being credited to the physician's borrowing queue (due to a software error). As a result, the original plan to use this queue to notify borrowers which films were delinquent, e.g., more than one week overdue, could not be carried out.

A further source of dissatisfaction with the loan system during post-implementation was that loans could only be made to physicians

and not to clinics or wards. This approach was instituted so that an individual would be responsible for the films. However, typically, the day before a clinic was held, films were checked out for all the patients to be seen on the following day. This could amount to dozens of files for patients seeing ten different physicians. Since signing out each film to the actual physician was found to be cumbersome, some clinics adopted the practice of signing out all films for the clinic to one of the physicians. This practice was decreasing the Department's ability to track films loaned out and to attribute outstanding loans to an individual.

The staff in the ER expressed particular dissatisfaction in both study periods about their access to films. This stems from the requirement that the ER staff come to Radiology to sign out each file individually. These policies have been in effect since the baseline period.

c. Other Issues

The attending physicians interviewed felt that the quality of the films and the accuracy of the Radiology reports were equal in baseline and post-implementation periods; satisfaction in both cases was considered good and the quality of service consistent with other teaching facilities where Radiology residents are responsible for some of the reading.

Access to Radiology consultations was generally felt to be useful and a satisfactory component of the overall Radiology Service.

On questions relating to ease of ordering examinations, interviewees were generally satisfied with the process for both routine and STAT examinations.

Attending physicians noted an increase in patient waiting time, particularly in Main Radiology. These increases had become evident to them largely from patient complaints, especially when patients had to wait for wet-reading reports. Patient waiting time was not felt to be a general problem during the baseline period.

V. DISCUSSION OF RESULTS

A. INTRODUCTION

This chapter reviews the results of quantitative studies, surveys, and interviews and discusses the information gained from the experience with TRIRAD at NHB from several perspectives. First, each of the goals and objectives established by the TRIMIS Medical Review Group is examined. Actual pertinent experience documented in the evaluation is reviewed and the influence of TRIRAD and the significance of changes are discussed. Following the discussion of system goals and objectives, two other topics are addressed: the experience with reporting assistance for radiologists and staff acceptance of TRIRAD.

B. GOALS AND OBJECTIVES

1. Goal 1: To Provide Accurate, Timely Radiology Reports

Timeliness of interpretation reports was an acknowledged problem at NHB before the installation of TRIRAD. When surveyed during the baseline period, staff expressed high expectations for TRIRAD in reducing the time to produce a report. In fact, respondents rated their expectations for this change at a higher level than for any other change. Because of this and the importance of timeliness to radiology services, considerable effort in the evaluation was devoted to documenting changes in report turnaround time in the various sections of the Radiology Department. Staff perceptions regarding changes and the role of TRIRAD in these changes were also solicited.

Since the installation of TRIRAD, the turnaround time, as measured between patient arrival in Radiology until the final written report is available for distribution, has decreased substantially in many sections of the department. Additionally, whereas during the baseline study many final reports were handwritten, nearly all reports are now printed, which results in more legible reports. These two changes must be considered together in order to interpret the significance of improved timeliness.

Main Radiology films were interpreted in either the Wet Reading Room or the Inpatient Reading Room. In the Wet Reading Room, reports were all handwritten during the baseline period and turnaround time averaged 46 minutes. A portion of these reports required a wet reading; however, many routine reports were also interpreted in this room in order to take advantage of the faster turnaround time to be gained from handwritten reporting. Approximately 95% of all reports in Main Radiology were processed in this manner. A small number of reports, 5%, were interpreted in the Inpatient Reading Room. These reports were dictated and transcribed and required an average of 16 days for completion.

During the post-implementation period, only 6% of the final reports in the Wet Reading Room were handwritten. All other reports were printed and, of these, 32% also received a preliminary handwritten report. In Main Radiology, the turnaround time for printed reports averaged 4 days and handwritten reports averaged 63 minutes.

In Orthopedic Radiology, where all reports were handled as "wet reads," final handwritten reports continued to serve as the principal report, and turnaround time increased from 39 minutes to 56 minutes. Following implementation of TRIRAD, reports were also entered into the computer, 6% by bar coding and 94% by transcription from the handwritten report. These printed reports were distributed within 4 days on average.

In the baseline period, reports in all other sections were dictated and typed and this practice continued into the post-implementation period. Average turnaround time in these areas was reduced from a range of 15-43 days in the baseline period to 5-14 days in the post-implementation period.

The analysis of incomplete reports between March, August, October and November, 1982 (2, 7, 9, and 10 months post-installation) clearly shows the progression of improvement in the Department's ability to reduce the backlog of reports and to improve the timeliness of report completion. For all Radiology sections summed together, the length of

time required to complete reports for more than 50% of the procedures for a given day has steadily decreased. In March, approximately 16 days elapsed before 50% of the reports were completed. (During this month, Orthopedic Radiology was just beginning to enter reports into the system; previously these were only handwritten.) In August, reports were produced for 50% of the procedures within 4 days. In October and November, this time was reduced to 3.5 days. These figures correlate with an average turnaround time from examination until report printing of 3.5 days.

The Radiology Department staff were surveyed regarding their satisfaction with the timely availability of reports and test results. Ninety-two percent of radiologists were dissatisfied and half of these responded as "very dissatisfied" concerning a baseline question on the timely availability of test results; 50% of all residents were dissatisfied and half of these were "very dissatisfied". The remaining radiologists and residents answered that they were "neutral," and no staff indicated that they were satisfied in the baseline period. In responding to the post-implementation survey, 40% of radiologists and 40% of residents indicated satisfaction with the timely availability of current reports and no staff indicated dissatisfaction.

Results of interviews with attending physicians further support these findings. These physicians were very dissatisfied with the timeliness of reports during the baseline period for both inpatients and outpatients. During post-implementation interviews, they noted a decrease in report turnaround time and indicated that reports were more often found in both inpatient and outpatient records when needed.

Attending physicians felt that more improvements in report timeliness were needed. Quantitative data show that, for inpatient reports, only 33% of the patients were still in-house on the day that the hard-copy report was distributed. Attending physicians noted a continued reliance on informal mechanisms (such as going to the Radiology Department) for obtaining the information contained in a Radiology report. They felt that the access to reports on the TRIRAD

terminal was particularly beneficial for retrieving report results by either telephone inquiry or going to the department personally. As soon as they were entered into the system, results became accessible, even prior to radiologist's approval or printing and distribution.

The reasons for the reduction experienced in report turnaround time are believed due primarily to a commitment on the part of Radiology management to make some changes in operating and staffing in order to improve turnaround time rather than due solely to TRIRAD. The most important change was in bringing transcription services within the Department by adding two transcriptionists to the Radiology Department staff rather than using outside services. This change speeded up individual segments in the report turnaround cycle.

During the baseline period, reports were dictated approximately 4 days after examination. One day of the total turnaround time was spent sending dictation tapes to transcription and one day was spent returning the typed reports to Radiology; these times were substantially longer when transcriptions were done by an outside typing service. Once the transcriptionists were located within Radiology, reports tended to be dictated the same day and radiologists often hand-delivered dictation tapes of handwritten notes to the transcriptionists. Also when the transcriptionist entered the reports directly into the system, they were available immediately for approval and signature.

In addition to improved transcription, a reduction in the volume of Radiology examinations during the summer of 1982 helped the transcriptionists to catch up on the backlog.

Aside from management changes that coincided with the implementation of TRIRAD, the specific contribution of the system to improved report timeliness appears to lie in eliminating the need for transcription. The 17% of reports that were bar-coded reduced the volume of reports to be typed. Bar-coded reports in Main Radiology were created immediately on the system and may have contributed to lowering the average turnaround time in Main Radiology if they were also approved, printed and distributed quickly.

In interpreting the significance of changes in report timeliness, it is important to consider the mix in types of reports prepared in the baseline and post-implementation periods. In Main Radiology most reports were handwritten during the baseline period in order to avoid the lengthy turnaround time to prepare a typed report; nearly all reports in Main Radiology during the post-implementation period were printed. In Orthopedic Radiology all reports were handwritten in both periods because of the need for immediate results. Using the TRIRAD system, many of these were also entered into the system so that the report could be printed for the medical record and could be retrieved from the system at a later time; of these, a few were entered by bar coding whereas most were transcribed from the handwritten report. Thus, in these two sections there was a shift in the type of report being prepared and in the type of service offered, along with a change in timeliness.

The improvement in timeliness of interpretation reports noted in studies conducted within the Radiology Department was confirmed by the attending physicians interviewed. They reported that they were more likely to find interpretation reports in patient records, though ideally they desired further improvements. A comparison of report turnaround time criteria (representing a consensus of Radiology staff) with the data from the baseline and post-implementation periods add further support to these findings. These criteria suggest that Radiology staff considered that a turnaround time of 24-48 hours was acceptable depending upon the type of examination; a time period of 8-24 hours was preferred. Since turnaround time for typed/printed reports was decreased to an average of 5 days in the post-implementation period, an increase in satisfaction among Radiology staff and attending physicians is consistent with this positive change. However, with the gap between 5 days and the criterion of one or two days, it is understandable that staff would like to see further improvements.

Written reports are not the only means whereby attending physicians receive radiology results. In the Inpatient Reading Room,

for example, films are stored on multi-film viewers throughout the patient's stay. Several clinical services conduct Radiology rounds at these viewers and may review all films taken on that day on their patients. Attending physicians also discuss the interpretation of films with radiologists and retrieve reports from the TRIRAD system. Improvements in these informal mechanisms for reporting, especially the increase in ease and timely availability of retrieving reports, were considered by attending physicians to be the most significant benefit to staff outside of Radiology.

With respect to report availability in records, the attending physician is, however, somewhat removed from the part of the radiology process affected by TRIRAD. The processes for (1) radiology report distribution, (2) delivery to the appropriate ward, clinic, or record room, and (3) filing in the appropriate record, were only indirectly affected by TRIRAD, and, therefore, more timely availability of the report for distribution from the Radiology Department alone would not be expected to address delays in these other segments of the total turnaround cycle.

The analysis of complete and incomplete reports shows a continuous progression of improvement in the Department's ability to complete reports more quickly. This steady improvement from March through November, 1982 appears likely to continue since changes were still being made during the post-implementation data-collection period. For example, in Nuclear Medicine radiologists changed from dictation on tape (for later transcription), to direct dictation where the transcriptionist entered the report immediately. In Computerized Tomography, the radiologists established a schedule for interpretation and reporting to replace the unscheduled reading sessions. In both of these sections, these changes resulted in a decrease in turnaround time from the beginning to the end of the 3-week data collection period.

When surveyed during the post-implementation period, Radiology staff felt strongly that benefits would continue to accrue in the future. Radiology staff, when surveyed during the post-implementation

period, reported that telephone inquiries for reports had decreased. This appears to be a reflection of the fact that attending physicians had to obtain fewer reports by telephone because they received formal printed reports in a more timely manner and were provided with increased access to reports via the TRIRAD terminals in the Department.

Information regarding accuracy of interpretation reports was gained by survey and interviews. Radiology Department staff were asked in the post-implementation questionnaire whether TRIRAD had increased the accuracy of Radiology reports. Though two radiologists surveyed felt that accuracy had increased, the remainder were neutral (3) or felt that accuracy had not been affected (7). Residents who responded to the survey believed four to one that accuracy had increased. Interviews with attending physicians indicated that they viewed the accuracy of reports as satisfactory both before and after TRIRAD installation and no changes were noted.

The difference in responses between radiologists and residents is interesting. The two groups, or individual physicians within each group, may in fact be responding to different interpretations of this question. TRIRAD does not directly contribute to the accuracy of the interpretation itself, i.e., TRIRAD does not aid the radiologist in seeing more abnormalities nor in interpreting their significance. If the question of accuracy is interpreted in this way a response of "no benefit" or "neutral" appears a consistent response. TRIRAD can, however, contribute to the completeness of the printed report, and to the accuracy of the information contained in the printed report, e.g., the correct date, examination type, patient identification, clinical information, and patient location. Together these contribute to increased accuracy of the information contained in the report.

2. Goal 2: To Collect Management and Workload Data for Use in Optimizing Radiology Resources

The Administrative Reporting and Statistics module was intended to provide access to information from the patient data base for a variety of management purposes. At the time of the post-implemen-

tation study, this module of TRIRAD was in the process of being installed, and, therefore, the experience with management information was extremely limited.

The basic data for radiology management reports were captured from schedules. They were supplemented with information entered into the system at patient check-in, the time of examination, the date of reporting, etc. By the time of the post-implementation study, these data elements were all available in the system and some information based on these elements (e.g., report-completion status) could be reported on demand. However, because the ability to manipulate data and produce specialized reports (e.g., list incomplete reports transcribed but awaiting approval) was limited, use of the information available from TRIRAD for management purposes was at a very preliminary stage.

Some management reports were available as part of TRIRAD functions that had already been implemented. However, these reports were not designed to be assembled and printed in a concise format. For example, during several implementation monitoring visits and during post-implementation data collection, daily logs were printed in order to obtain the data needed to prepare the graphs of complete and incomplete reports presented in Chapter IV. The daily totals of complete and incomplete reports were all that were needed. However, in order to obtain these numbers, a complete listing of all patients examined was obtained and then a manual count was made. Printing these reports for 1 month of day logs, approximately 7000 examinations, required 2 hours. So while this information was quite valuable once obtained, it required substantial effort to produce and analyze and thus was not used routinely in the Department as a management tool.

When the management information capabilities are fully implemented, TRIRAD is expected to provide much of the information needed to complete management reports prepared in the Department such as for the Uniform Chart of Accounts. Use of computer-tabulated workload data in place of information compiled manually from paper

records should increase the accuracy of the data and reduce the time required to perform these reporting functions. TRIRAD is also expected to make available management information that was infeasible to compile by manual methods (e.g., producing a list of files to be purged from the film library on patients who have not had an examination in the Department for 5 years).

3. Goal 3: To Improve Availability of Patient-Specific Historical Radiological Reports and Films

In the baseline process, interpretation reports and films were filed together in the film file folder. Therefore, the availability of both reports and films depended upon the ability of the Department to manage its files. Once TRIRAD had been implemented, interpretation reports were stored on the system, and the copy of the interpretation report filed with the film was no longer the only record available in the Department. Film file management practices were also changed by the introduction of the film file tracking features of TRIRAD, which partially automated the recordkeeping aspects of file management. Therefore, whereas the issues relating to report availability and film availability were the same in the baseline study, the TRIRAD functions affecting the availability of these two types of historical information were different and the impacts on availability need to be considered separately.

Report and film availability were included in the surveys of Radiology Department staff and were explored in interviews with attending physicians. In addition, data concerning film availability were collected in all reading rooms where radiologists were observed (Main Radiology, GI Radiology, Orthopedic Radiology, Nuclear Medicine, Computerized Tomography and Ultrasonography).

Survey questions relating to historical reports and films addressed two components of availability: timeliness of availability and ease of obtaining the information. The baseline survey indicated that Radiology Department staff overall were slightly dissatisfied with both the timeliness of historical record availability (film and report filed together) and the ease of obtaining historical records.

Radiologists as a group indicated that they were less satisfied with both aspects (with an overall mean rating indicating they were "somewhat dissatisfied").

In the post-implementation survey, overall satisfaction of staff with timely availability of historical records was improved. Radiologists, though still less satisfied than other staff, also appeared to be slightly more satisfied than during the baseline period. This change is believed to result from the capability to retrieve interpretation reports via the system. Attending physicians noted that this capability was the single most important benefit of TRIRAD.

Surveys, interviews, and quantitative studies all indicated less improvement in the availabiity of historical films. Staff satisfaction with availability of films remained essentially unchanged between the baseline and post-implementation surveys, though their satisfaction with the ease of obtaining them increased somewhat.

Analysis of the number of prior film files that were available in the reading room for use by the radiologist in interpretation showed that there was a prior file for 41% of the interpretations in the baseline period and for 32% in the post-implementation period. There was also a sizeable portion of the readings for which the data collector was not able to determine whether there was a prior film (17% in the baseline and 18% in the post-implementation period). The conclusion is that availability of prior films did not change significantly. So that while satisfaction had increased slightly, no more historical film files were actually present during reading. These findings support the conclusion that obtaining films was slightly easier, but no more films were available for comparison.

The extent to which TRIRAD functions replaced manual processes differed for historical films and reports, and this is the likely explanation for the different impacts on availability. Film management functions, such as file tracking and label generation, were automated but films were still filed and retrieved manually in the film library.

Further improvements to be gained through automated retrieval of historical films await the development of new technologies that will eliminate the need for film-file libraries. One such technology is digital radiography, which promises to obtain and store radiographic images digitally. With this technology, films would no longer be used and radiologists would view images on video display terminals. These technologies already exist but are not yet in widespread use due, in part, to the high cost of the hardware and the high cost of the storage necessary to file the images.

4. Goal 4: To Make Maximum Use of Resources, Equipment and Staff Through Efficient Scheduling

This goal, as formulated by the Medical Review Group, includes inter-related improvements in the efficiency of scheduling and the ability of the Department to utilize its resources.

Scheduling/reception functions were included in the staff surveys conducted before and after TRIRAD installation.

The baseline survey included a question regarding expected changes in scheduling. All groups of staff expected that TRIRAD would improve scheduling. At the time post-implementation data were collected, the optimal scheduling function of TRIRAD was not fully operational due to software problems. The manual scheduling module functioned well and was used in all sections of Radiology. This meant that the system was producing schedules and performing functions such as checking for conflicts in scheduled examinations and displaying schedule rosters in order to allow the scheduler to select an available appointment. When surveyed during the post-implementation period, Radiology staff felt that the use of TRIRAD had, in fact, resulted in improved scheduling. Thirty-two staff felt that there had been benefits to scheduling while only six felt that no benefits had been realized. The distribution of responses was similar among radiologists, residents and technicians and other staff.

Work sampling was conducted at the reception areas in Main Radiology and Imaging. The percentage of time devoted to each reception activity or function was calculated. In both Main Radiology

and Imaging the percentage of time spent on scheduling and receiving of patients increased from 16% in the baseline period to 21% during the post-implementation period. This increase appears to be due directly to the time spent entering additional patient data in order to develop more complete patient examination histories and data files. This information was then available to all other users of the system.

A positive change in scheduling, due directly to TRIRAD, appears certain to have occurred. However, evidence for an influence of this change on resource utilization appears mixed.

The post-implementation survey of Radiology Department staff included questions related to the impact of TRIRAD on the efficiency and economy of delivering radiology services. A large number of staff (27 or 51% of the respondent sample) reported that TRIRAD had made their work more efficient and that TRIRAD saved time (23 or 43% of the respondent sample). The conclusion, based on this information, seems to be that increased efficiency was realized.

However, the staff surveyed did not believe that TRIRAD had reduced overall personnel requirements nor the cost of radiology services. (This was consistent with their expectations concerning personnel requirements and costs.) The examination of Department budgets also indicated no substantial shifts in staffing or other resources due to TRIRAD, at least during the first year of system operation. Thus the impact of TRIRAD on resource utilization appears to have been in some improvements in efficiency, but these efficiencies were not of a magnitude that the economy of service delivery could be measurably improved.

The specific role of TRIRAD scheduling functions in increasing the efficiency of operations should have been reflected in decreased patient waiting and examination time. As discussed in the subsequent section dealing with the goal related to this issue, the evidence is also somewhat mixed.

In five sections of the Department, these times were found to increase somewhat. In the three sections where time reductions were

noted, it appears that these reductions were due to reasons other than improved scheduling.

Thus though it would appear that scheduling did improve, and that Department efficiency was enhanced in some areas, the relationship between these two changes, as anticipated by the Medical Record Review Group has not been demonstrated. (A possible, though not well-substantiated benefit, of patient registration and scheduling using TRIRAD is more reliable capture of workload performed in the Department.)

5. Goal 5: To Reduce Patient Waiting and Processing Time Due to Better Scheduling

As was the case for Goal 4, the Medical Review Group anticipated that improved scheduling would result in other changes, in this case a reduction in the elapsed time from patient arrival in the Department until completion of the examination and departure of the patient.

Quantitative studies conducted during the evaluation included measurements of changes in patient waiting and processing time. The data indicate that these times increased somewhat in five sections and decreased in three other sections of the Department. As discussed previously (Goal 4), the TRIRAD scheduling functions had not been fully implemented when post-implementation data were collected. Nevertheless, staff in the Department believed that scheduling had improved. In order to elucidate any relationship between this improvement and patient waiting and examination time, it is necessary to consider the experience in the individual sections of the Radiology Department.

In Main Radiology, the increase in time appears to be related to the increase in elapsed time to request prior film files and match these historical records to the current films prior to reading.

In GI Radiology, it appears that the examinations performed during the post-implementation period required more time to complete on average than those during the baseline and does not appear to be due to changes in other parts of the process.

In Orthopedic Radiology, the increase in patient waiting and examination time appears due in part of slower processing of patients due both to entering the additional data required by TRIRAD and to changes in the Orthopedic Clinic independent of the X-ray functions.

In Urologic Radiology and Special Procedures, process time appears to have decreased. There were no observed changes in the process to account for these changes. Possibly the mix of examination times changed or the limited observations from the baseline period were not representative of the average times.

In Nuclear Medicine, the mix of examinations changed. During the post-implementation study period 56% of the patients tracked had either liver scans or bone scans which have very long examination times. These two examinations represented a much smaller proportion of the baseline sample.

In Computerized Tomography, unscheduled patients were added to the schedule more often in the post-implementation period. For example, if an outpatient who was scheduled for a CT scan in advance was late for the appointment, CT staff filled the apparent opening in the schedule by substituting an examination on an inpatient. On several occasions the inpatient was sent to the CT section and the late outpatient also arrived. This resulted, in effect, with two patients scheduled for the same time period, and thus increased waiting time for one of these patients.

In Ultrasonography, the decrease in waiting time appears due to a change in radiologist staffing. The radiologist during the baseline period preferred to be involved in taking the examination, often obtaining additional views after the technician completed the routine views, resulting in increased waiting and examination time for the patients. The radiologist during post-implementation preferred that the technicians perform the complete study. It is believed that these changes in staffing and procedures account for the measured differences in process time.

Overall, only in Computerized Tomography did the actual procedures for scheduling change substantially in the post-implementation

period, and in this case, the changes were not due to TRIRAD. These observations, combined with quantitative data to support the reasons for changes, reduce the confidence that the apparent increases or decreases in patient processing time are due, to a measurable degree, to scheduling improvements.

6. Goal 6: To Reduce the Number of Repeat Exams as a Result of Improved Film File Accessibility

Others have reported that stand-alone computer support to radiology departments reduced the number of repeat exams[3]. As stated by the Medical Review Group, this goal of reduced repeat examinations was expected to result from improved accessibility of film files.

When surveyed in the baseline period, staff expected that TRIRAD would have a definite impact on access to current films. Indeed, access to current films appears to have increased. The film-tracking functions of TRIRAD have made it easier to obtain films from outpatients taken during the past day or two or from inpatients taken during the present hospitalization period. Regarding the ease of obtaining current films the weighted mean response improved slightly from -0.3 to +0.1 from the baseline to post-implementation periods, respectively. To a somewhat lesser extent, TRIRAD reduced the time to locate these films. On questions relating to the timely availability of current films, survey respondents gave a weighted mean response of -0.2 (slight dissatisfaction) during the baseline and +0.2 (slight satisfaction) during the post-implementation period.

However, though film file accessibility appears to have improved somewhat for current films, accessibility appears unchanged for historic films. When staff were surveyed on satisfaction with the timely availability of historic films, respondents indicated a nearly comparable level of slight dissatisfaction in both the baseline (-0.3) and post-implementation (-0.2) periods. Quantitative data collected during observations of radiologists during reading showed a slight decrease in the number of prior files available, from 41% in the baseline and 32% in the post-implementation period. Note that this

study focused on the availability of prior films at the time of the official reading. No attempt was made to determine which current films should have had a prior film. Accordingly, data were collected during observations of radiologists while reading and no distinction was made for first-time examinations for patients and for examinations for which prior films were out on loan. This methodology was consistently followed in both study periods.

Staff gave mixed responses on whether TRIRAD had reduced the number of lost files; 16 respondents to the survey felt that there was a benefit while 17 felt there was no benefit. In contrast to these findings, when surveyed during the baseline period regarding their expectations for TRIRAD, all staff groups, and in particular radiologists and other staff, felt strongly that TRIRAD would have a definite impact on reducing lost files. The reasons for the lack of change in availability of historic films appear to be two-fold. First, file retrieval depends to a significant extent on film-library management. TRIRAD performed record-keeping functions, and this appears to have improved the process for obtaining films from the library. The need for manual filing and retrieval of the file folder was not eliminated and consequently, the availability of historical film files did not change, although the availability of current films may have increased. Second, TRIRAD had only been operational for nine months at the time of the post-implementation study. Nine months may not have been a sufficient period of time to establish an adequate historical data base. (Department staff felt that 18 months would have been better.)

Questions regarding repeat examinations were included in post-implementation surveys of Radiology Department staff. Twenty (38% of survey respondents) staff members felt that TRIRAD had reduced the number of unnecessary repeat examinations, a large number (18) were neutral, and only 13 (24%) felt that no change had occurred. These responses suggest that there was a reduction, at least experienced by some of the staff.

Given the lack of discernible change in film-file accessibility, there are other possible bases for expecting a reduced need for repeat examinations. The turnaround time for reports decreased overall in the Department (discussed previously under Goal 1). Perhaps even more significant was the increased availability of patient information reported by both Department staff and attending physicians (discussed previously under Goal 3). This included both access to completed reports stored in the system and the ability to ascertain the status of examinations not yet reported out of the Department. An association between these improvements and reduced repeat examinations seems quite likely.

7. Goal 7: To Reduce Personnel Time Spent in Clerical Transcriptions

During the baseline period, transcription of radiology reports was performed outside of the Radiology Department, both in the hospital's Central Transcription section and by a typing service outside the hospital. Observations during the baseline period indicated that this process was very inefficient and contributed significantly to the long turnaround time for typed reports. As a result, radiologists made extensive use of handwritten reports, which they viewed as less desirable but a more efficient way to prepare reports for distribution in a timely manner.

Following TRIRAD installation, the transcription service was changed; two typists were added to the Radiology Department staff and policy was established that all transcription would be done within the Department. The result has been reduced turnaround time for reports, accompanied by increased satisfaction of both Radiology Department staff and attending physicians.

The most significant aspect of the improved transcription services is that the Department is now able to produce most interpretations in printed rather than handwritten form. Whereas in the baseline 65% were handwritten, only 35% were handwritten during post-implementation. The ability to improve services in this manner and produce timely reports clearly resulted from the changes in the efficiency of transcription services that accompanied TRIRAD.

Because of the shift toward printed reports, more staff time is being devoted to transcription. However, the efficiency of the transcription segment of the process has clearly been improved. (Though an actual comparison of labor time for transcription is precluded by the absence of baseline data, Radiology staff believed that the power typing capabilities of TRIRAD had increased the efficiency of transcriptionists.)

Another influence of TRIRAD on the transcription process has been the added capability for radiologists to produce an interpretation report directly and without transcription. Observations of reporting methods indicate the 17% of all reports prepared in the Department used bar coding, thus averting the need for transcription. By projecting this volume of reports to the annual workload it was calculated that nearly 500 hours of transcription labor per year might be averted through the use of bar coding. The experience at NHB with this computer assistance to radiologist reading and report preparation is discussed in the following section.

C. READING ASSISTANCE

1. Introduction

TRIRAD gave the staff radiologists and radiology residents at NHB the ability to produce printed interpretation reports directly from input via a bar-coding system or an optical mark reader (OMR). This section first discusses the utilization and staff acceptance of these reading and reporting-assistance functions at NHB and then explores the potential significance of this type of computer assistance in reducing the turnaround time for typed/printed interpretation reports.

2. Bar-Coding System

During observations of radiologists in the reading rooms the method of reporting and, in the post-implementation period, the use of computer assistance was recorded. Use of this TRIRAD function was observed in Main Radiology and Orthopedic Radiology.

In the Main Radiology Wet Reading Room, bar coding was used to prepare all or part of 40% of the interpretation reports in the observation sample. All of these bar-coded reports were prepared by a

single radiologist, one of the two radiologists who developed the bar-coding system being used at NHB and an enthusiastic advocate of this TRIRAD feature.

Bar coding was also used to a more limited extent, 6% of all reports observed, in Orthopedic Radiology. First, a handwritten report was prepared and then, for selected, simple interpretations, the report was entered by bar coding. The remaining handwritten reports were delivered to transcription to be entered into the system. The staff radiologist in this section and the staff radiologist in GI Radiology both have indicated that they would use bar coding for nearly all of their reports if intelligent video display terminals were installed in these reading rooms. Bar coding was not used in any of the the other reading rooms.

The data obtained on radiologist reading times suggest that the preparation of bar-coded reports in Main Radiology required less radiologist time than did dictated reports. Interpretation of this finding is made difficult by the fact that bar coding appeared to be used generally for simpler reports and dictation for more complex reports. Since the mix of examinations in the observations of reading times is different for each method, the apparent time differences measured cannot be readily interpreted.

3. Optical Mark Reader

The optical mark reader (OMR), also known as Raport II, was not used during the post-implementation data collection period. The OMR capability was made available at NHB 5 months after the beginning of TRIRAD installation. At that time bar coding was being used, and this decreased the interest in an additional method of computer assistance.

Observations and discussion with radiologists suggest several reasons why this feature was not integrated into routine reporting. First, the OMR did not have an advocate (as did bar coding) to encourage the use of the method within the Department among the staff. Second, the OMR forms, when read by the scanner, generated an immediate report without going through the radiologist's approval queue; radiologist's signature was made by marking a code on the form.

Radiologists were very reluctant to release interpretation reports in this manner, particularly since a slight error in marking the form could lead to an incorrect report. The verification process for bar-coded and dictated-and-transcribed reports gave them an opportunity to review the report via terminal prior to release. (It is believed that OMR-generated reports could be added to the approval queue with a minor change in software.)

The OMR was also felt to be more limiting than the bar-coding system and required a greater change in how radiologists read films. The bar-coding system used at NHB was specifically organized to follow a well-accepted approach. Finally, the OMR presented an additional system to learn without enough apparent advantages to motivate radiologists to become fluent in the use of the mark-sense forms.

4. Significance

The real significance to radiologists of computer assistance in reading films/images and preparing interpretation reports may be that it eliminates the need for transcription and the attendant delays in reporting the interpretation out of the department. Observations of report turnaround time show that the transcription segment contributed 1 to 3 weeks to the total time in the baseline and less than one day to the time for transcribed reports in the post-implementation study. By contrast, in Main Radiology, bar-coded reports were prepared, verified and printed within 1 day, with 2-3 days more required for report distribution.

In fact, initially radiologists at NHB made greater use of bar coding. Their motivation appears to have been to reduce the backlog of reports in transcription and produce reports in a more timely manner. In August 1982, 7 months after installation of TRIRAD, 92% of the 24 reports observed in the Wet Reading Room were prepared with use of bar coding. The interest in the use of computer assistance appeared to decrease as transcription services improved and the report backlog decreased. The transcriptionists, while excellent typists, were initially unfamiliar with medical terminology when first hired. Over several months, as they gained increasing experience,

radiologists noted increased quality of transcribed reports. Further, a reduction in daily volume in the summer of 1982 permitted the transcriptionists to reduce the back-log of incomplete reports. The resulting improvement in timeliness for reports seems to have been a factor in encouraging radiologists to rely increasingly on dictation and transcription, thus reducing the need for computer-assisted reporting.

D. STAFF ACCEPTANCE

Of 49 respondents to the post-implementation survey of Radiology Department staff, 29 staff (59% of all respondents) were satisfied overall with TRIRAD while only three staff (6%) were dissatisfied and the remaining 35% were neutral. The weighted mean response of all staff was +0.7, indicating a satisfaction level of slightly less than "somewhat satisfied" (+1.0).

A review was made of responses to particular survey questions concerning satisfaction with TRIRAD. A comparison was also made of baseline and post-implementation levels of satisfaction with Radiology services in general. These provided further insight into the reasons behind this overall level of satisfaction.

Regarding the accuracy of information, 69% of radiologists were dissatisfied and only 8% were satisfied with the accuracy of patient records during the baseline period. By comparison, only 10% of radiologists were dissatisfied and 80% were satisfied with the accuracy of patient records stored on the computer. For all staff surveyed, the weighted mean response on these questions improved from -0.3 to +0.7. Satisfaction with the completeness of patient records improved from -0.7 to +0.4.

Overall, staff agreed that information was easier to obtain with TRIRAD. On survey questions concerning the ease of obtaining reports using TRIRAD, a weighted mean score of +0.8 was computed for the post-implementation survey, whereas in the baseline period the mean staff responses were -0.4 for ease of obtaining historical records and -0.3 for current records. In the post-implementation survey, 25 Radiology staff felt that attending physicians' satisfaction with

Radiology services had increased as a result of TRIRAD. This is believed to be due in large part to the ability to ascertain exam status and to obtain interpretation reports from the system instead of searching for paper records. Interviews with attending physicians confirmed that they had noted substantial gains in access to patient information. (It is important to note that at the time of the post-implementation study, the historical data base of patient exam history and records consisted of less than one year's volume; as this data base continues to grow, the need to consult paper records maintained prior to TRIRAD should decrease accordingly.)

Overall, the Department staff surveyed believed that TRIRAD had improved patient care; 27 staff felt that there were benefits to patient care while 12 staff felt that there was no benefit; residents felt most strongly on this issue (eight felt there were benefits while one felt there was no benefit).

Interviews with Radiology staff supported the survey findings on improvements in patient care. Staff felt that the ability to retrieve reports from the TRIRAD system in a more timely manner gave providers the information that they needed at the time when they needed it. When the patient returned for a follow-up outpatient visit, the official report was more likely to be contained in the patient's chart. Staff felt that the increased ability to determine the status of a report, e.g., the report had been entered by the transcriptionist but not yet approved for signature, was a benefit. This gave the provider the information to decide whether to come to the Department to discuss the film or to wait for the report to be distributed through normal channels. Also, staff felt that the increased ability to locate current films also improved patient care. Often, an attending physician will need to view a film whether he has the report or not. This is common practice in GI Radiology. A surgeon may want to borrow pre-operative X-rays for use during the operative procedure. The ability to locate these films more easily and more quickly, through the use of the film-tracking functions, was believed to have directly contributed to improved patient care. Attending physicians

also reported to Radiology staff that they felt that the provider's ability to care for patients had improved because of improvements in Radiology services.

On several questions, Radiology staff showed a substantial level of agreement concerning the effect of TRIRAD in their work. Staff felt that TRIRAD made their work more efficient (51% agreed, 38% were neutral, 11% disagreed). Record keeping was considered easier (55% agreed, 26% were neutral, 19% disagreed). TRIRAD was easy to learn (79% agreed, 15% neutral, 6% disagreed). Overall, staff felt that the benefits of TRIRAD outweighed the disadvantages (59% agreed, 24% neutral, 17% disagreed). Seventy-five percent of Radiology staff believe that benefits from TRIRAD would continue to increase in the future.

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1. Medical Review Group, TRIMIS Program Office, Goals and Objectives for the Tri-Service Radiology System, Bethesda, MD, 1978.

2. Arthur D. Little, Inc., Plan for the Evaluation of the Tri-Service Radiology System at the Naval Hospital, Bethesda, Contract MDA903-81-C-0209, Report to the TRIMIS Program Office, Bethesda, MD, December, 1982.

3. Mischelevich, D.J., W.G. Gipe, J.R. Roberts, C. Denny, A.D. Stern, and M.W. Day, "Cost-Benefit Analysis of a Computer-Based Hospital Information System," In Proceedings of the Third Annual Symposium in Computer Applications in Medical Care.

APPENDIX A

EFFECTIVE RADIOLOGY SERVICES
TURNAROUND TIME

	ROUTINE REPORTS	
	Acceptable	Preferred
MAIN RADIOLOGY		
• STANDARD EXAMS		
- Chest	48 Hours	24 Hours
- Skull	48 Hours	24 Hours
- Spine	48 Hours	24 Hours
- Extremities	48 Hours	24 Hours
• GI		
- UGI	48 Hours	24 Hours
- LGI	48 Hours	24 Hours
- BE	48 Hours	24 Hours
IMAGING		
• CT/HEAD		
- no contrast	48 Hours	24 Hours
- contrast	48 Hours	24 Hours
- contrast & no contrast	48 Hours	24 Hours
• CT/TOTAL BODY		
- no contrast	48 Hours	24 Hours
- contrast	48 Hours	24 Hours
- contrast & no contrast	48 Hours	24 Hours
• NUCLEAR MEDICINE		
- Bone Scan	24 Hours	8 Hours
- Cardiac Renal Imaging (Computer Aided)	48 Hours	24 Hours
- Lung Scan	24 Hours	8 Hours
- Liver, Brain etc.	24 Hours	8 Hours
- Thyroid	48 Hours	24 Hours
• ULTRASOUND	48 Hours	24 Hours
ORTHOPEDICS	24 Hours	8 Hours
SPECIAL PROCEDURES	48 Hours	24 Hours

APPENDIX B. TURNAROUND TIME FOR REPORTS

Tables B-1 through B-4 summarize the data obtained concerning turnaround time for reports in the eight sections of the Radiology Department at NHB in which the TRIRAD system was implemented.

TABLE B-1

SUMMARY OF DATA OBTAINED ON REPORT TURNAROUND TIME FOR MAIN RADIOLOGY AND G.I. RADIOLOGY

	Main Radiology				G.I. Radiology			
	No. OBS	Mean	Range	Std. Dev.	No. OBS	Mean	Range	Std. Dev.
DICTATED FINAL REPORTS (DAYS)								
Baseline								
Examination until completion of dictated report	-[1]	4[1]	-[1]	-[1]				
Patient waiting and examination time		40 min	6-127	-[3]	37	66 min	35-139 min	22.29
Preliminary handwritten report available	-[3]	-[3]	-[3]		38	130 min	6-281 min	73.34
Reading time	-[1]	2 min	-[1]	-[1]	31	10 min	3-32 min	7.65
Dictated report completed	-[1]	4[1]	-[1]	-[1]		4 hrs[1]		
Completion of dictated report until delivery to transcription	-[1]	1[1]	-[1]	-[1]	-[1]	-[1]	-[1]	-[1]
Dictation delivery to transcription until completion of transcription	143	8	1-21		-[1]	14[1]	-[1]	-[1]
Completion of transcription until delivery of transcribed report to Radiology	-[1]	1[1]	-[1]	-[1]	-[1]	1[1]	-[1]	-[1]
Delivery of completed report to Radiology until report approval and distribution	-[1]	2[1]	-[1]	-[1]	-[1]	2[1]	-[1]	-[1]
Total		16 days[2]	9-36 days[2]			18 days[2]		
Post-Implementation (days)								
Examination until completion of printed report	638	2	0-21	2.47	62	3	0-6	1.66
Completion of printed report until report distribution into mailboxes	638	2	0-16	1.56	62	2	1-7	0.98
Total	638	4 days	1-22	2.93	62	5 days	2-9	1.85
HANDWRITTEN FINAL REPORTS (MIN.)								
Baseline								
Patient waiting time and examination time		40	6-127					
Radiologist observation time	124	6	1-23	4		FINAL REPORTS		
Patient arrival until distribution of handwritten final reports		46 min[2]	7-150[2]			NOT		
Post-Implementation (min)								
Patient waiting and examination time	79	54	9-417	49		HANDWRITTEN		
Radiologist observation time	143	3	1-22	3				
Patient arrival until distribution of handwritten final reports		57 min[2]						

[1] Based on observations of limited sample of request forms and/or logs and direct observation.

[2] Data derived from summation of segments.

[3] Preliminary handwritten reports not prepared.

TABLE B-2

SUMMARY OF DATA OBTAINED ON REPORT TURNAROUND TIME FOR COMPUTERIZED TOMOGRAPHY AND ULTRASONOGRAPHY

	Computerized Tomography				Ultrasonography			
	No. OBS	Mean	Range	Std. Dev.	No. OBS	Mean	Range	Std. Dev.
DICTATED FINAL REPORTS (DAYS)								
Baseline								
Examination until completion of dictated report	203	6 days	0-56 days		19	1 day	0-4 days	1.45
Patient waiting and examination time		60 min	17-150 min			125 min	79-183 min	
Preliminary handwritten report available	-[3]	-[3]	-[3]	-[3]		5 min[1]		
Reading time	19	12 min	1-26 min		9	7 min	1-18 min	
Dictated report completed		6 days	0-56 days		19	1 day	0-4 days	1.45
Completion of dictated report until delivery to transcription	195	23	2-41	10.30	17	19	2-32	11.10
Dictation delivery to transcription until completion of transcription	-[1]	12	-[1]	1[1]	-[1]	12[1]	-[1]	-[1]
Completion of transcription until delivery of transcribed report to Radiology	-[4]	-[4]	-[4]	-[4]	-[4]	-[4]	-[4]	-[4]
Delivery of completed report to Radiology until report approval and distribution	-[1]	2[1]	-[1]	-[1]	-[1]	2[1]	-[1]	-[1]
Total		43 *days*[2]	17-56 *days*[2]			34 *days*[2]	18-64 *days*[2]	
Post-Implementation (days)								
Examination until completion of printed report	34	9	3-22	4.23	16	4	3-6	0.81
Completion of printed report until report distribution into mailboxes	34	5	1-8	2.40	16	2	1-3	0.60
Total	34	14 days	7-25 days	4.78	16	6 days	4-8 days	0.97
HANDWRITTEN FINAL REPORTS (MIN.)								
Baseline								
Patient waiting time and examination time								
Radiologist observation time								
Patient arrival until distribution of handwritten final reports		FINAL REPORTS				FINAL REPORTS		
Post-Implementation (min)								
Patient waiting and examination time		NOT				NOT		
Radiologist observation time								
Patient arrival until distribution of handwritten final reports		HANDWRITTEN				HANDWRITTEN		

[1] Based on observations of limited sample of request forms and/or logs and direct observation.

[2] Data derived from summation of segments.

[3] Preliminary handwritten reports not prepared.

[4] Reports transcribed in department.

TABLE B-3

SUMMARY OF DATA OBTAINED ON REPORT TURNAROUND TIME FOR SPECIAL PROCEDURES AND NUCLEAR MEDICINE

	Special Procedures				Nuclear Medicine			
	No. OBS	Mean	Range	Std. Dev.	No. OBS	Mean	Range	Std. Dev.
DICTATED FINAL REPORTS (DAYS)								
Baseline								
Examination until completion of dictated report					-[1]	1[1]	-[1]	1[1]
Patient waiting and examination time	-[1]	120 min[1]	-[1]	-[1]		96 min[1]	35-169 min	
Preliminary handwritten report available	-[1]	15 min[1]	-[1]	-[1]	-[1]	5 min[1]	-[1]	-[1]
Reading time	-[1]	15 min[1]	-[1]	-[1]	23	5 min	1-13 min	
Dictated report completed	-[1]	4 hrs	-[1]	-[1]	-[1]	1 day[1]	-[1]	-[1]
Completion of dictated report until delivery to transcription	-[1]	1 day[1]	-[1]	-[1]	-[1]	1 day[1]	-[1]	-[1]
Dictation delivery to transcription until completion of transcription	-[1]	21[1]	-[1]	-[1]		9	1-39	
Completion of transcription until delivery of transcribed report to Radiology	-[1]	1[1]	-[1]	-[1]	-[4]	-[4]	-[4]	-[4]
Delivery of completed report to Radiology until report approval and distribution	-[1]	2[1]	-[1]	-[1]	-[1]	4[1]	-[1]	-[1]
Total		25 days				15 days[2]	7-45 days[2]	
Post-Implementation (days)								
Examination until completion of printed report	27	8	2-19	4.38	177	8	0-52	8.75
Completion of printed report until report distribution into mailboxes	27	6	1-15	6.09	177	4	1-35	3.62
Total	27	14	7-21	5.03	177	12	2-56	9.40
HANDWRITTEN FINAL REPORTS (MIN.)								
Baseline								
Patient waiting time and examination time								
Radiologist observation time								
Patient arrival until distribution of handwritten final reports		FINAL REPORTS				FINAL REPORTS		
Post-Implementation (min)								
Patient waiting and examination time		NOT				NOT		
Radiologist observation time								
Patient arrival until distribution of handwritten final reports		HANDWRITTEN				HANDWRITTEN		

[1] Based on observations of limited sample of request forms and/or logs and direct observation.

[2] Data derived from summation of segments.

[3] Preliminary handwritten reports not prepared.

[4] Reports transcribed in department.

TABLE B-4

SUMMARY OF DATA OBTAINED ON REPORT TURNAROUND TIME FOR ORTHOPEDIC RADIOLOGY AND UROLOGIC RADIOLOGY

	Orthopedic Radiology				Urologic Radiology			
	No. OBS	Mean	Range	Std. Dev.	No. OBS	Mean	Range	Std. Dev.
DICTATED FINAL REPORTS (DAYS)								
Baseline								
Examination until completion of dictated report		FINAL REPORTS NOT						
Patient waiting and examination time					-[1]	120[1] min	-[1]	-[1]
Preliminary handwritten report available		DICTATED OR TYPED			3	-[3]	-[3]	-[3]
Reading time					-[1]	10 min	-[1]	-[1]
Dictated report completed		IN BASELINE PERIOD			-[1]	4 hrs	-[1]	-[1]
Completion of dictated report until delivery to transcription					-[1]	1 day	-[1]	-[1]
Dictation delivery to transcription until completion of transcription					-[1]	14[1]	-[1]	-[1]
Completion of transcription until delivery of transcribed report to Radiology					-[1]	2[1]	-[1]	-[1]
Delivery of completed report to Radiology until report approval and distribution					-[1]	1[1]	-[1]	-[1]
Total						18[2] days		
Post-Implementation (days)								
Examination until completion of printed report	370	2	0-39	2.54	2	3	3	-
Completion of printed report until report distribution into mailboxes	370	2	0-7	1.98	2	2	2	-
Total	370	4	1-40	3.17	2	5	5	-
HANDWRITTEN FINAL REPORTS (MIN.)								
Baseline								
Patient waiting time and examination time	25	34	11-83	16				
Radiologist observation time	30	5	1-14	3				
Patient arrival until distribution of handwritten final reports		39 min	19-88 min			FINAL REPORTS		
Post-Implementation (min)								
Patient waiting and examination time	37	50	14-113	26		NOT		
Radiologist observation time	53	5	1-16	3				
Patient arrival until distribution of handwritten final reports		55 min				HANDWRITTEN		

[1] Based on observations of limited sample of request forms and/or logs and direct observation.

[2] Data derived from summation of segments.

[3] Preliminary handwritten reports not prepared.

APPENDIX C. INCOMPLETE REPORT ANALYSIS

The following pages present distribution graphs of the incomplete report information obtained from the TRIRAD system during four site visits, three of which were to monitor the status of system implementation and the last of which coincided with the post-implementation data collection.

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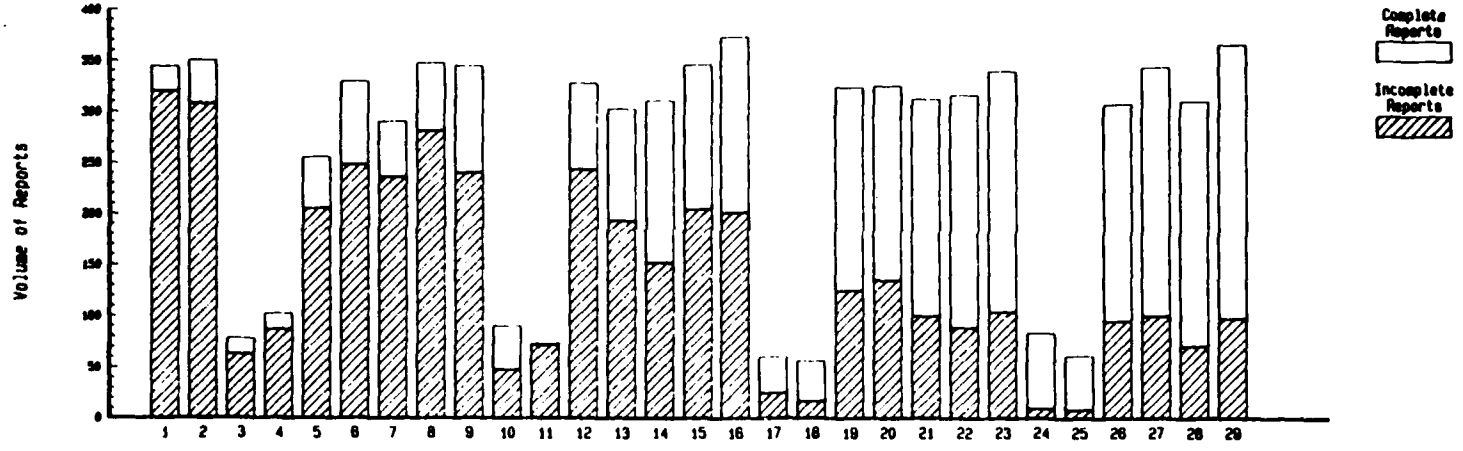

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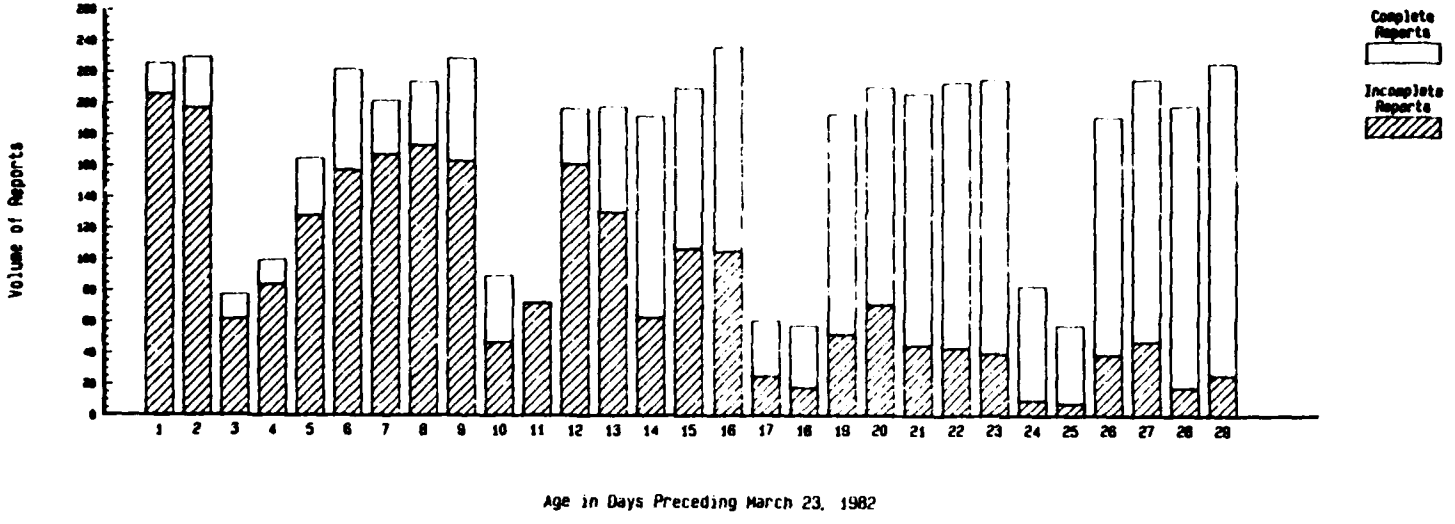

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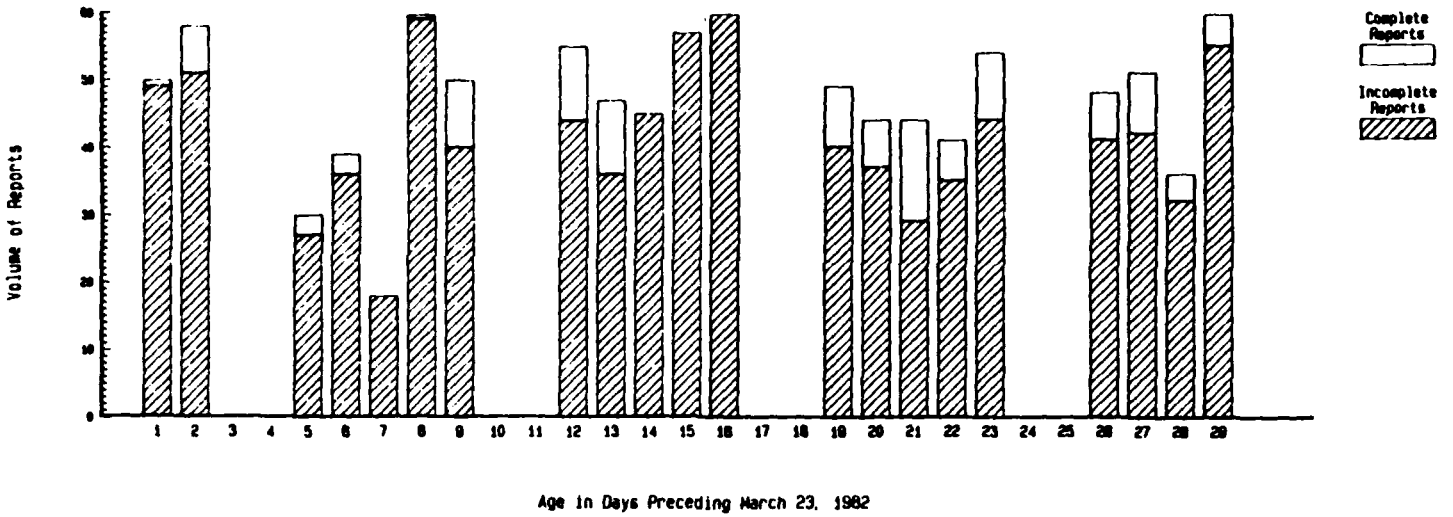

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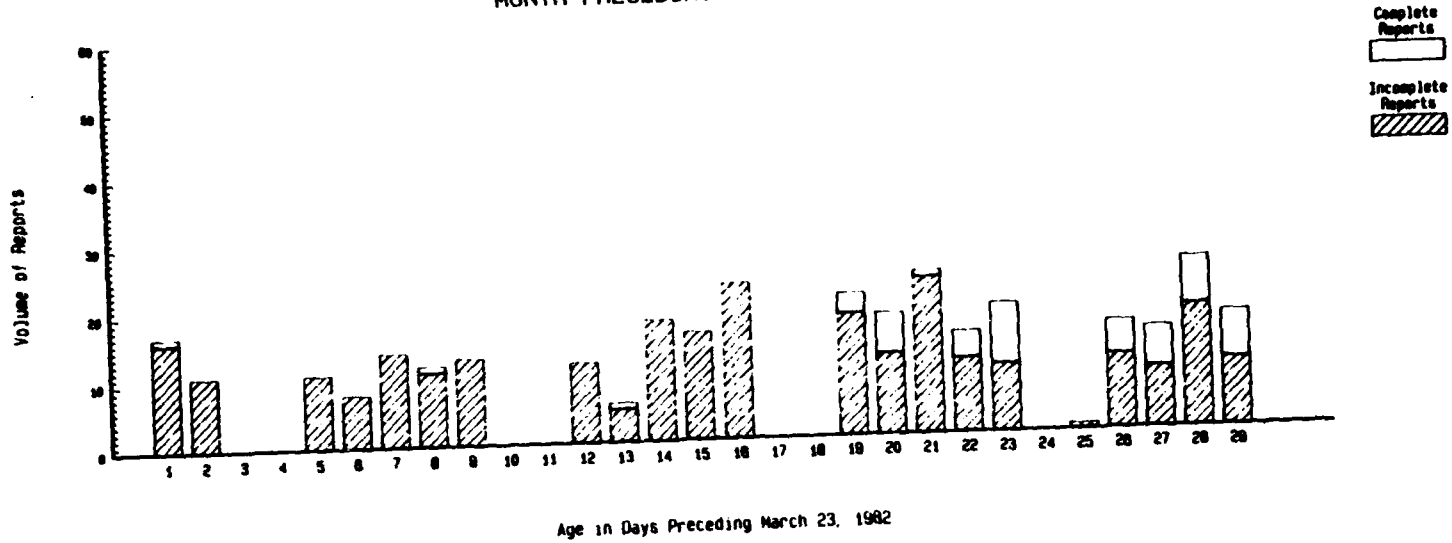

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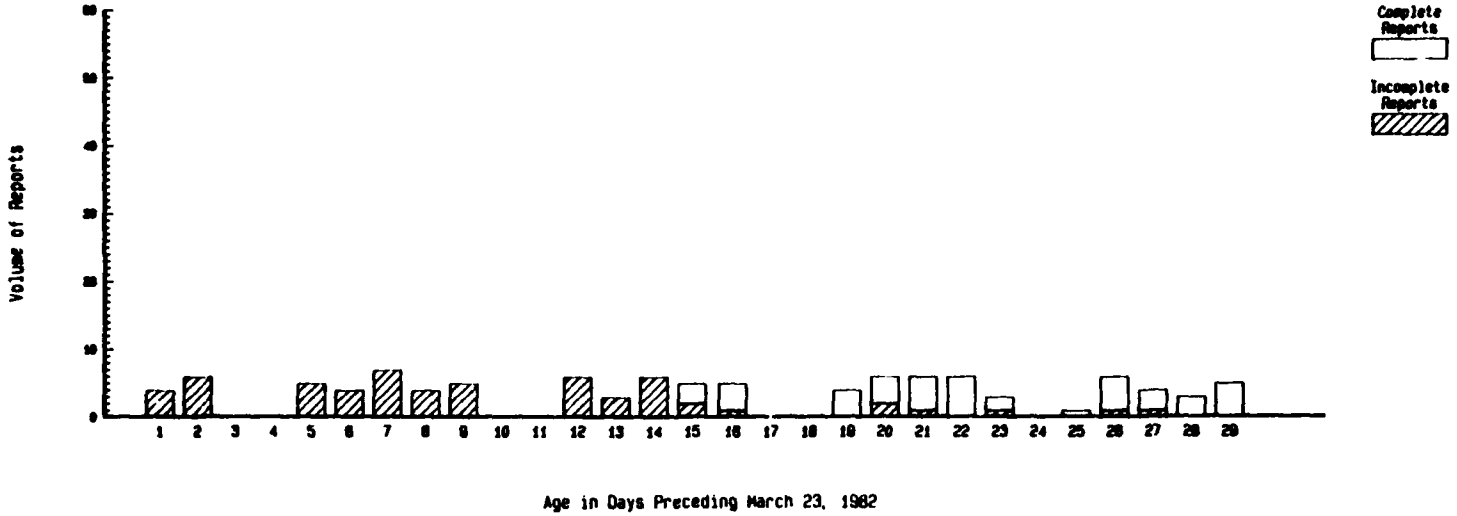

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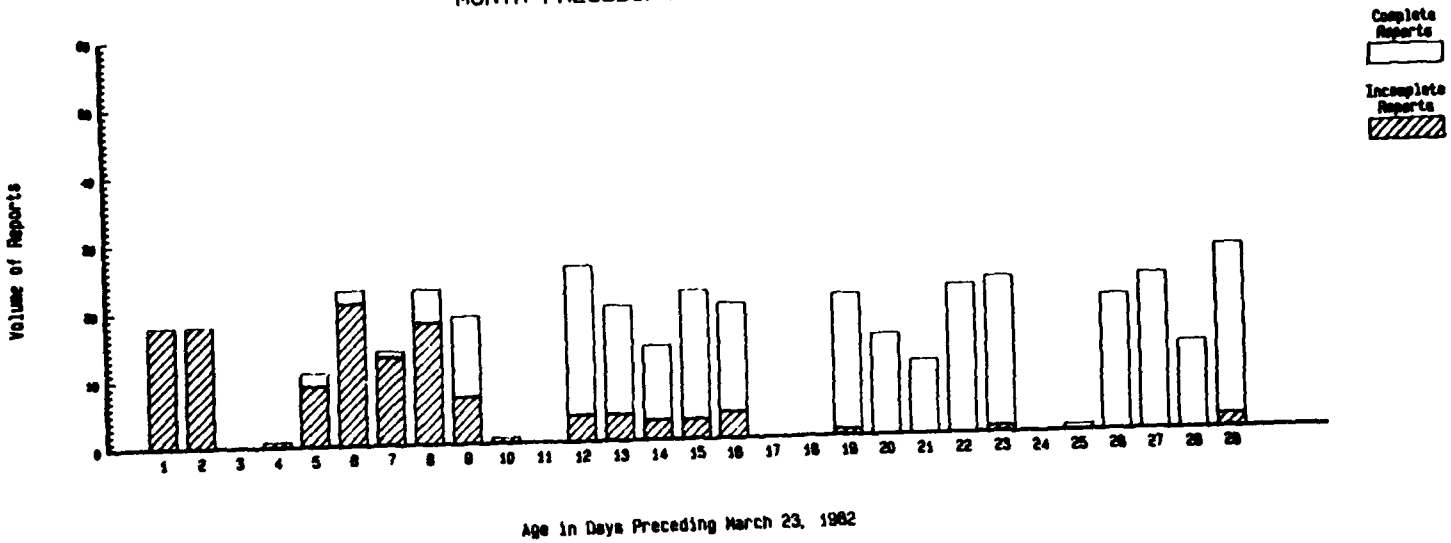

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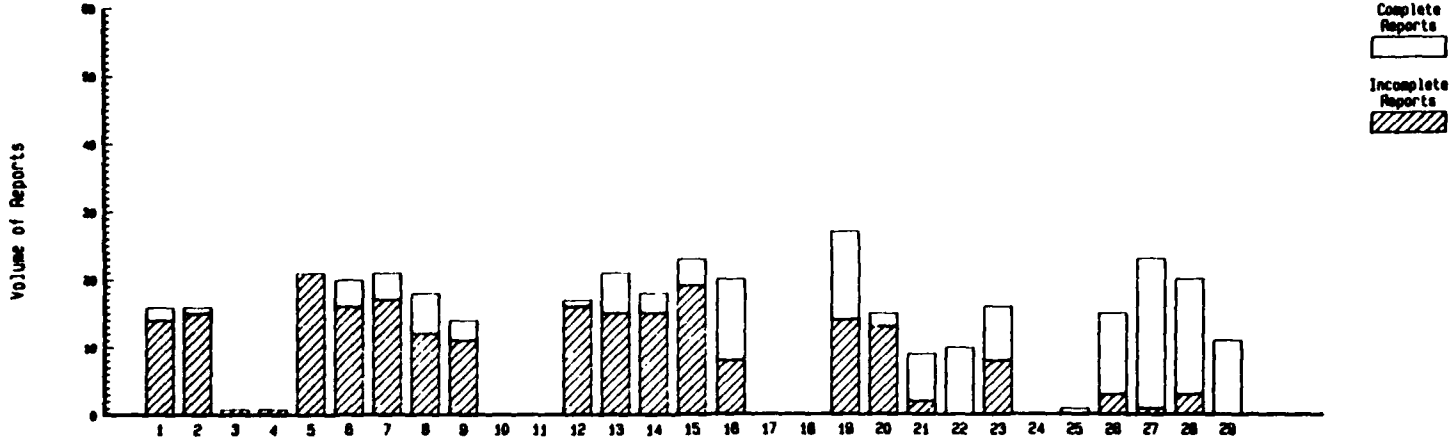

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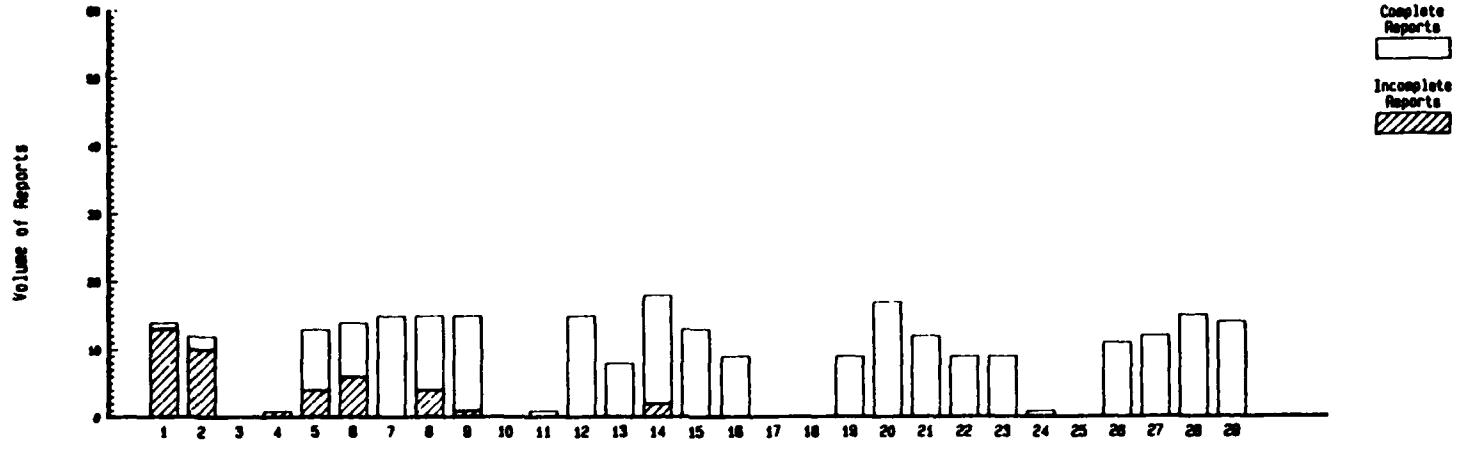

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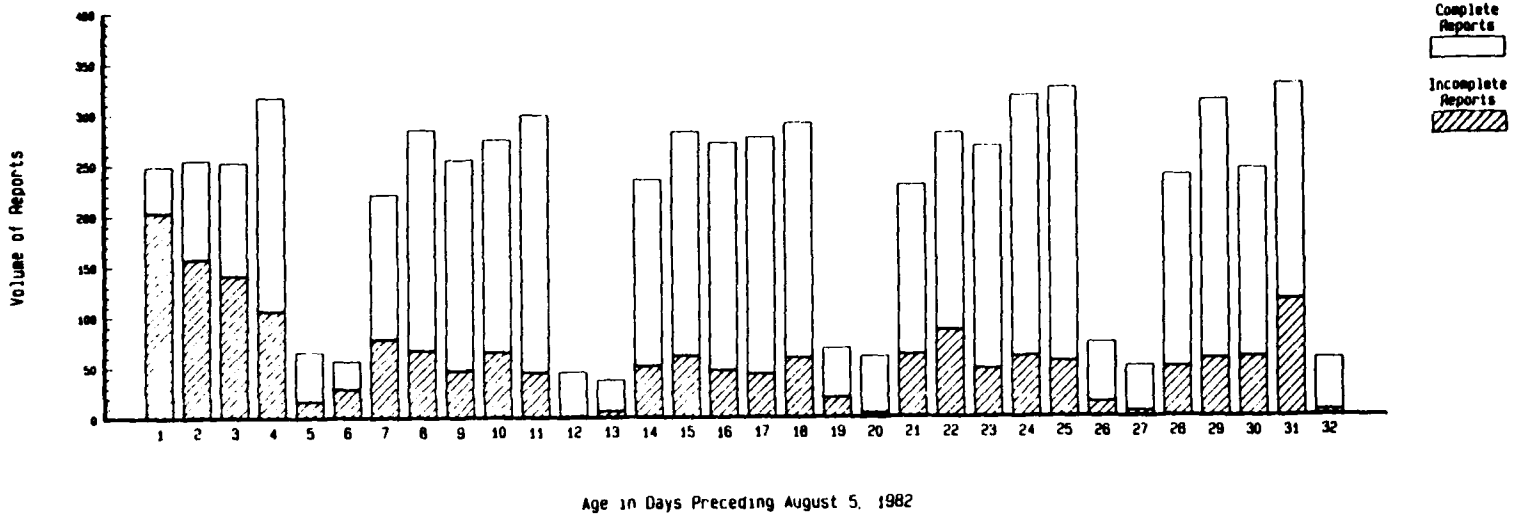

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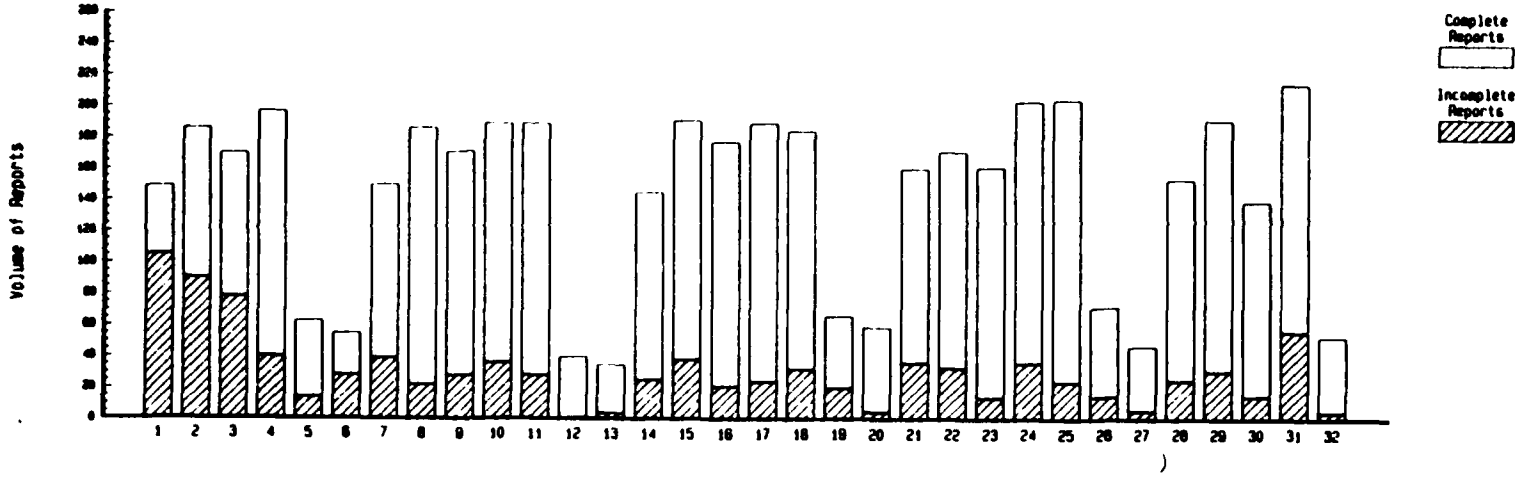

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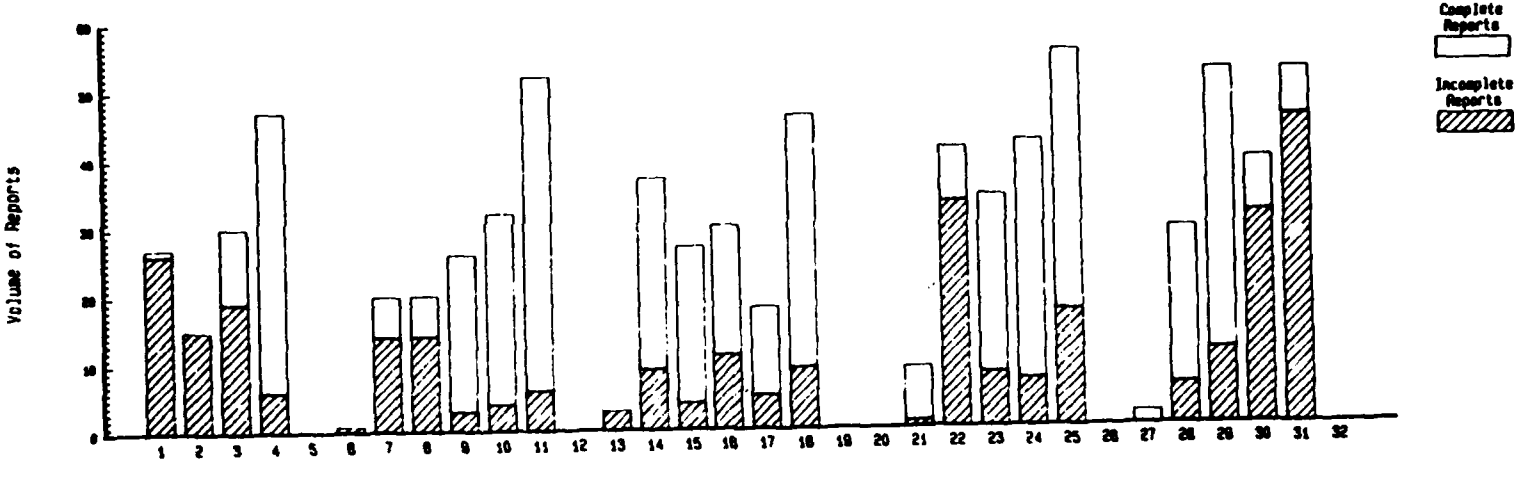

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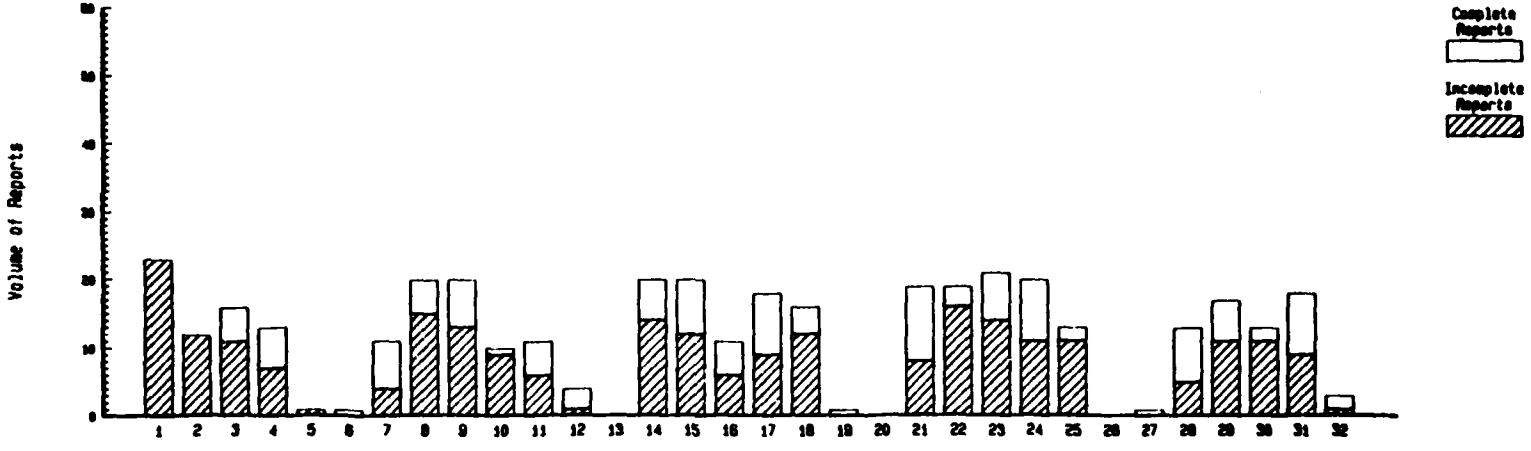

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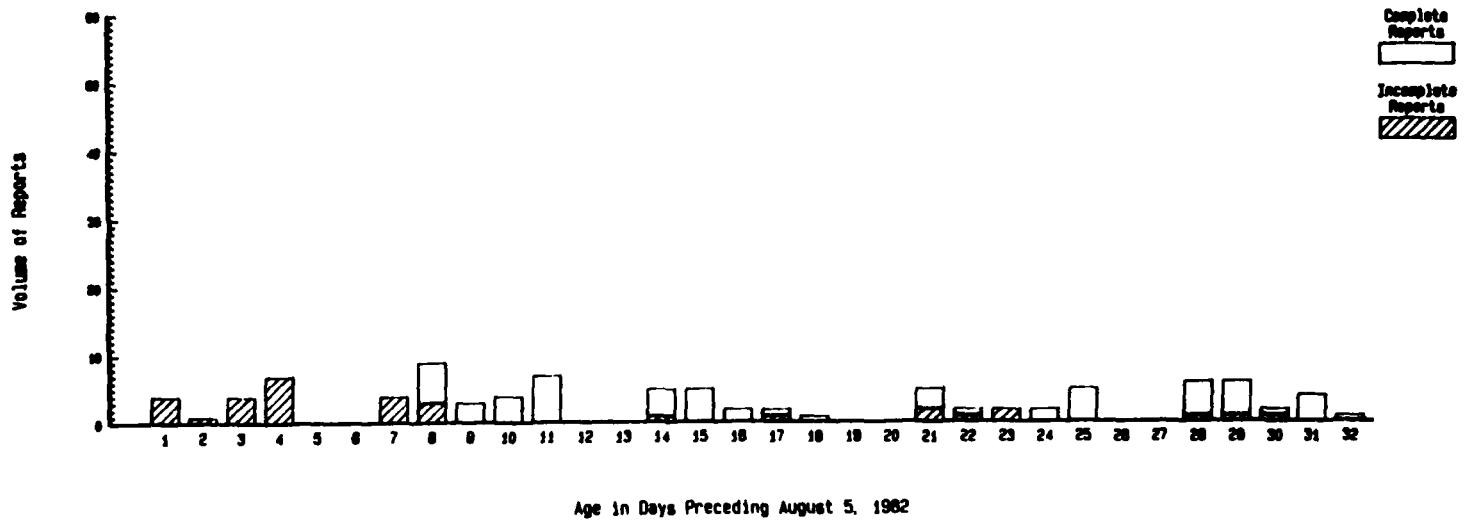

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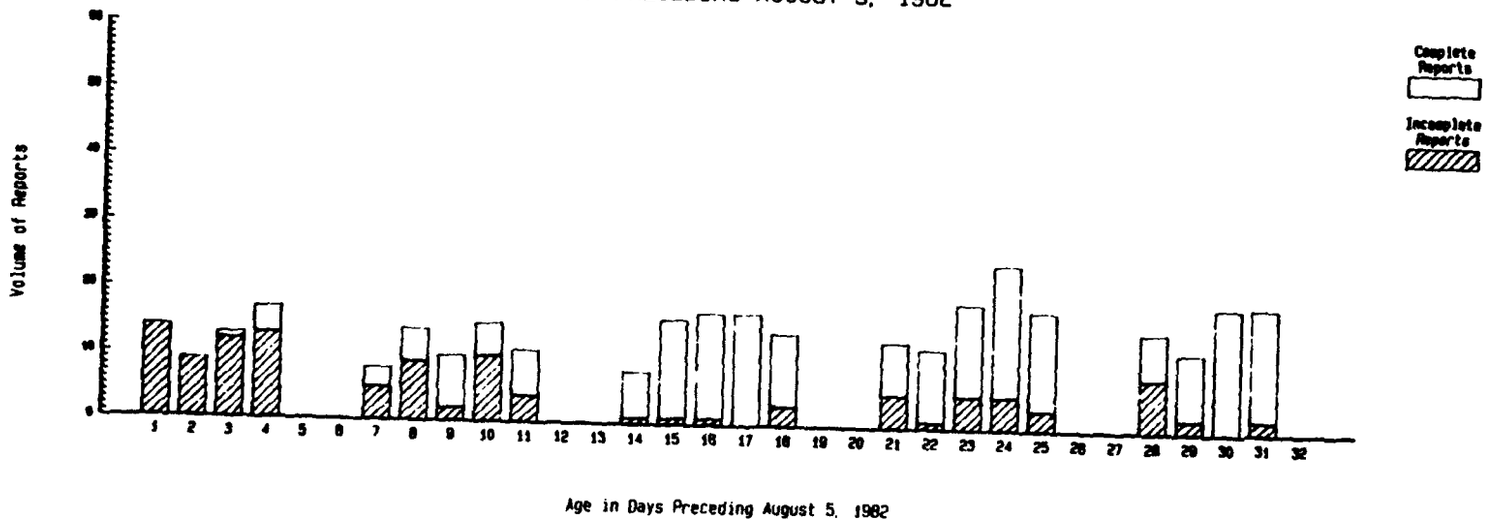

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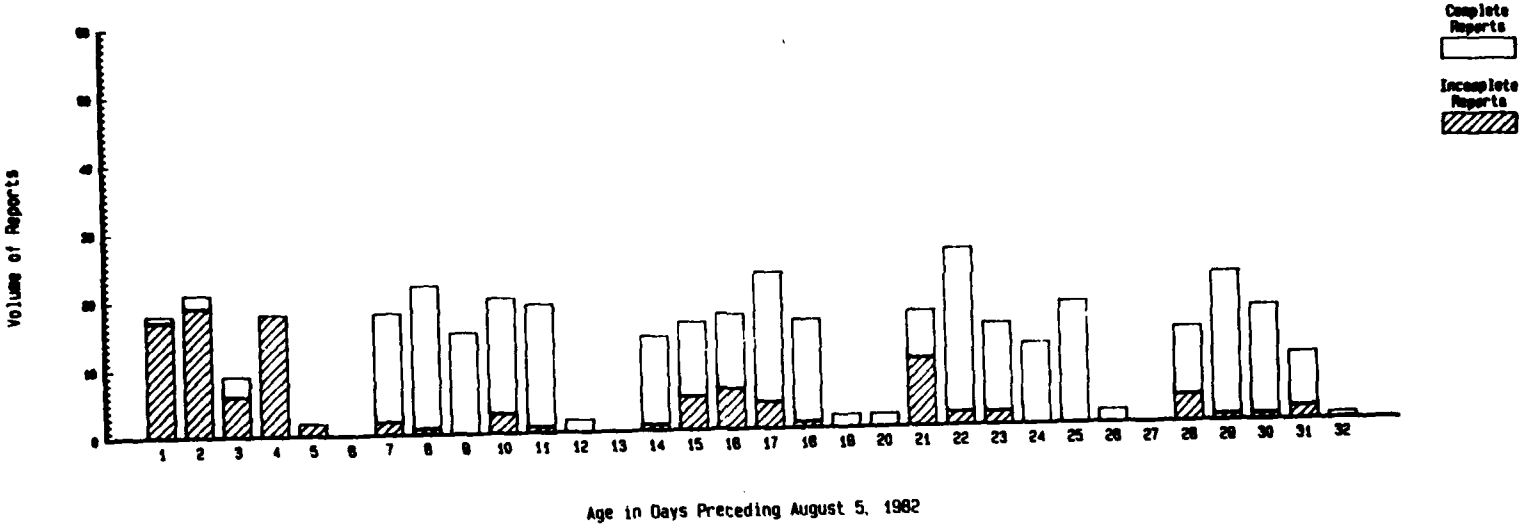

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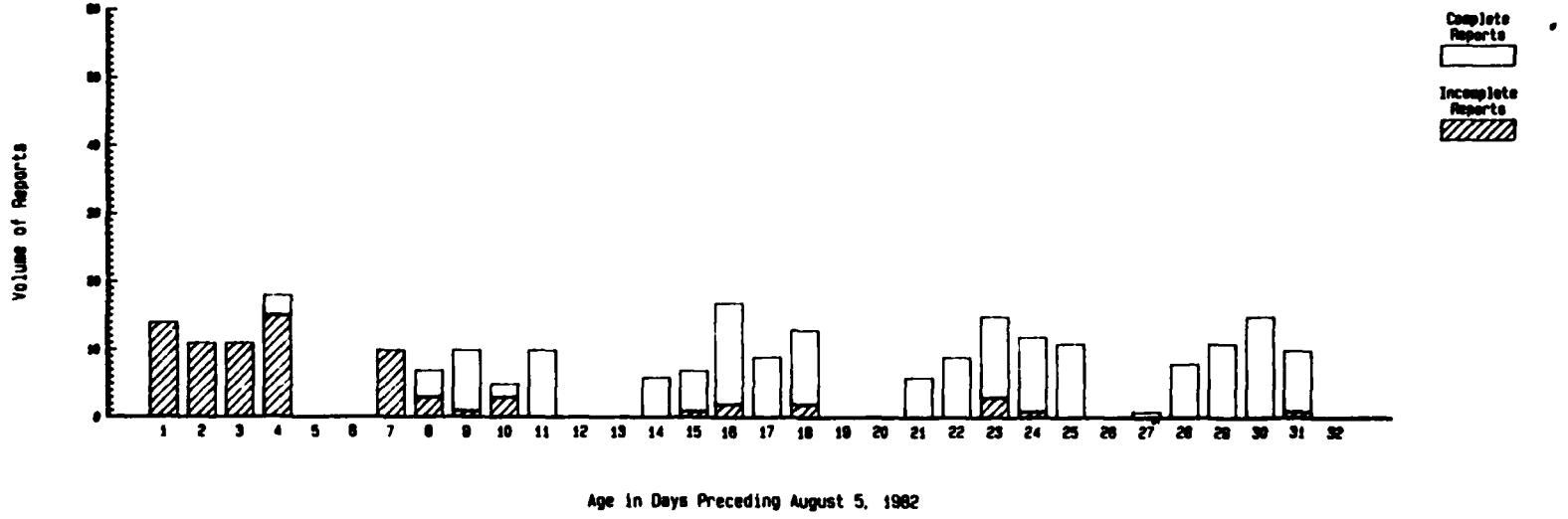

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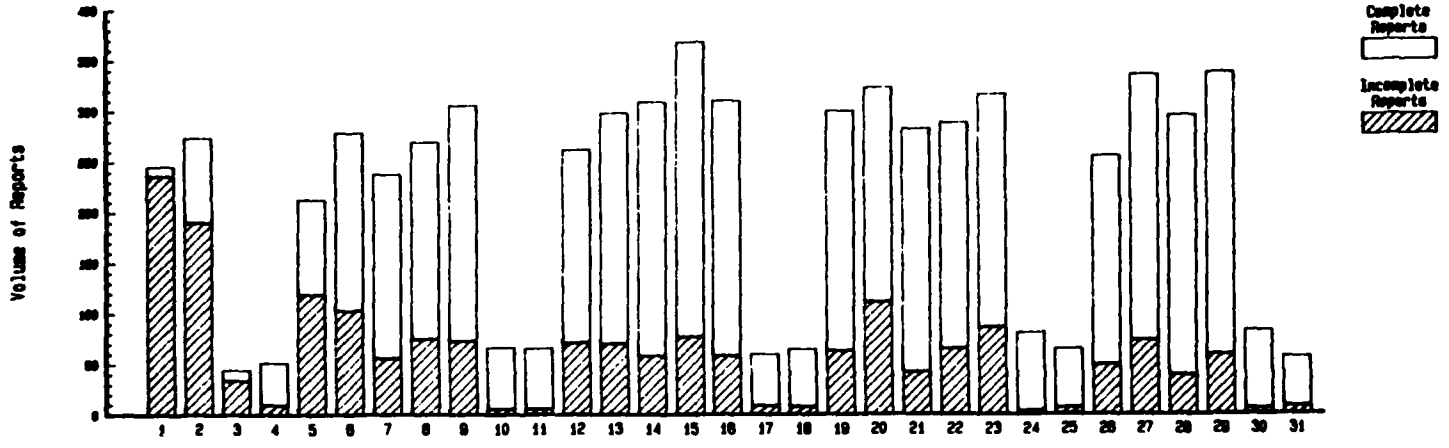

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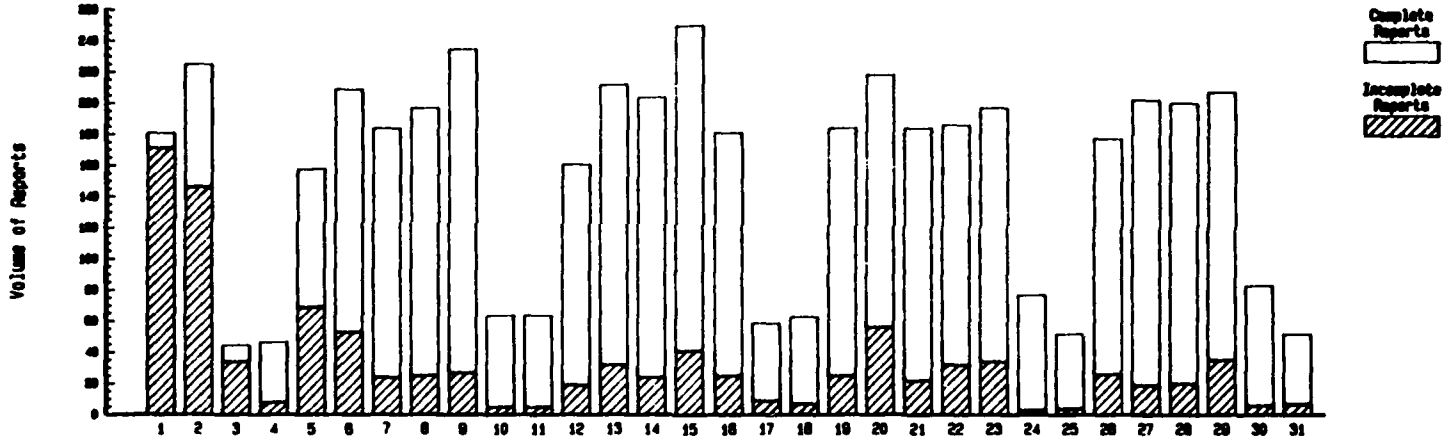
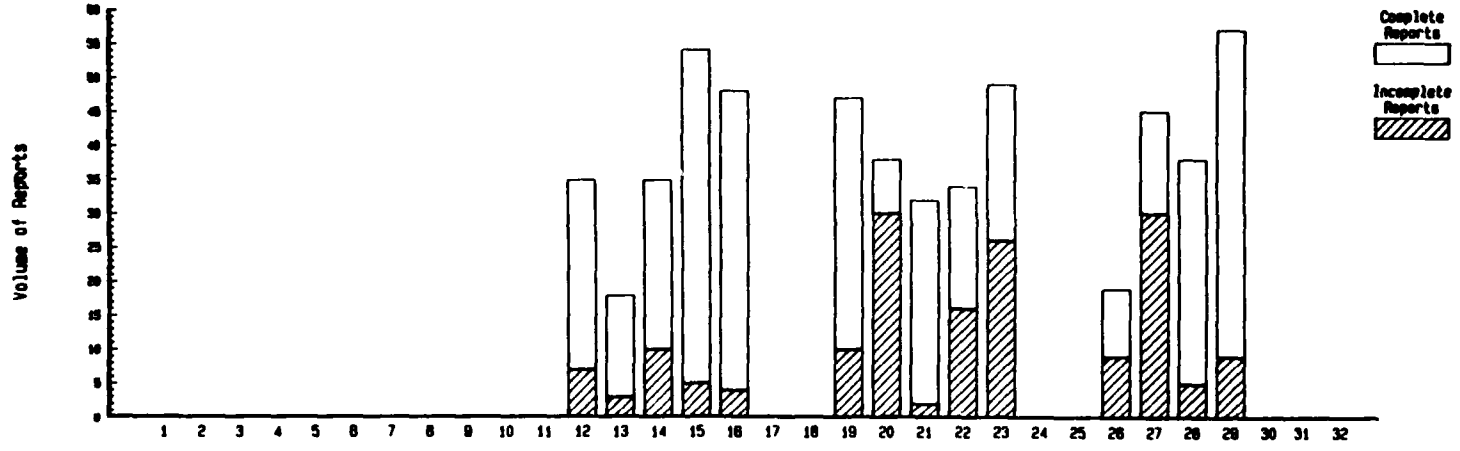
VOLUME OF COMPLETE AND INCOMPLETE REPORTS
MAIN X-RAY SECTION
MONTH PRECEDING OCTOBER 5, 1982



Age in Days Preceding October 5, 1982

VOLUME OF COMPLETE AND INCOMPLETE REPORTS
ORTHOPEDIC RADIOLOGY SECTION
MONTH PRECEDING OCTOBER 5, 1982



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VOLUME OF COMPLETE AND INCOMPLETE REPORTS
UROLOGIC RADIOLOGY SECTION
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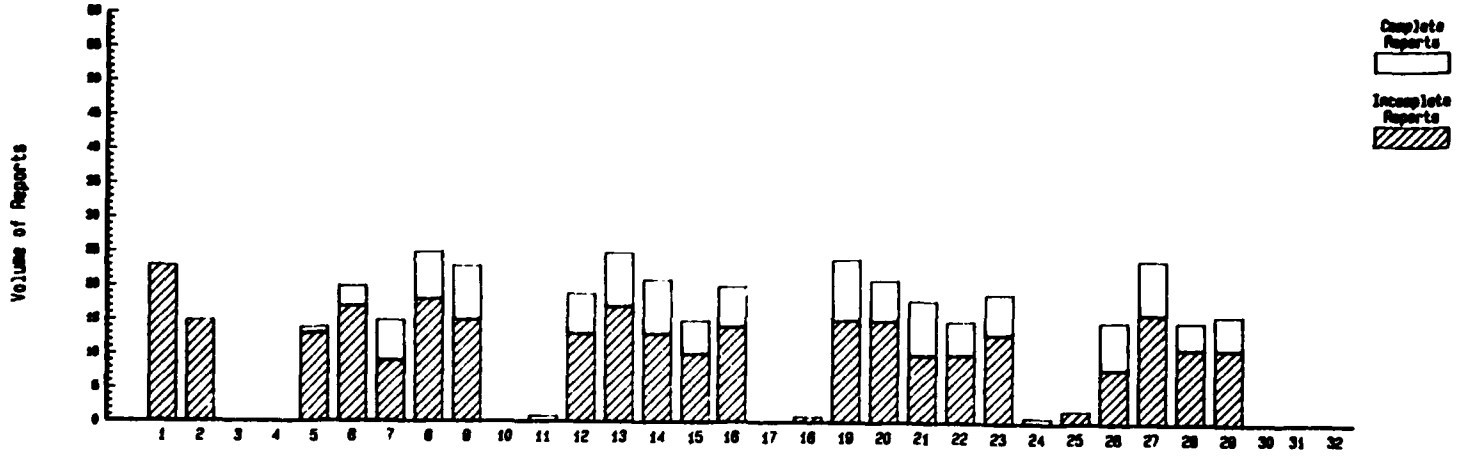

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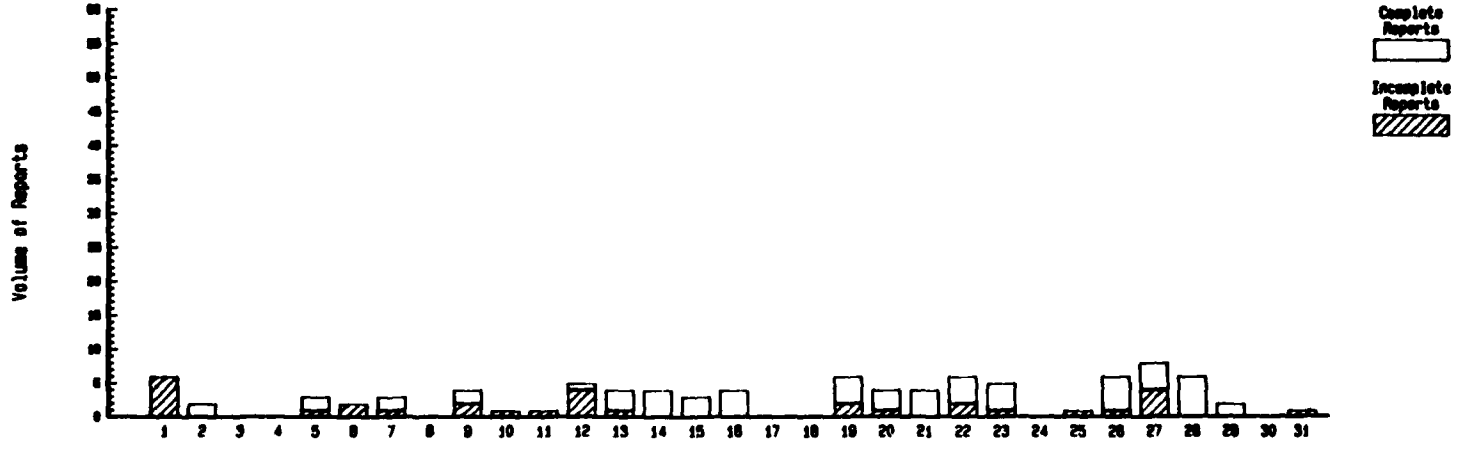
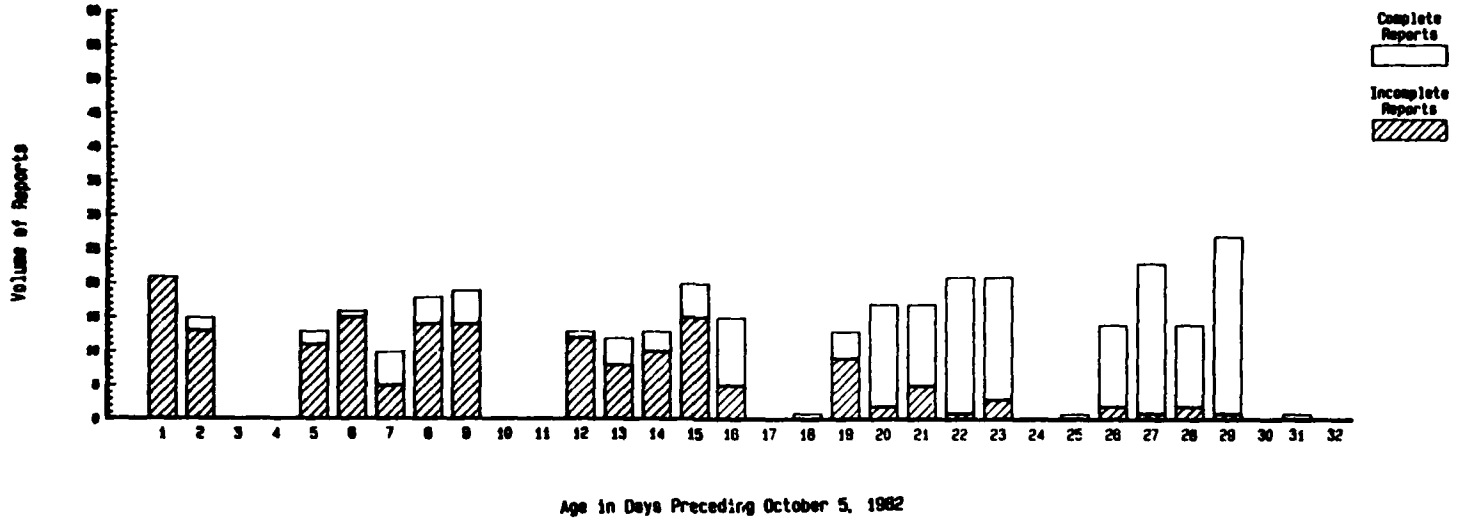
VOLUME OF COMPLETE AND INCOMPLETE REPORTS
SPECIAL PROCEDURES SECTION
MONTH PRECEDING OCTOBER 5, 1982



Age in Days Preceding October 5, 1982

VOLUME OF COMPLETE AND INCOMPLETE REPORTS
NUCLEAR MEDICINE SECTION
MONTH PRECEDING OCTOBER 5, 1982



VOLUME OF COMPLETE AND INCOMPLETE REPORTS
COMPUTERIZED TOMOGRAPHY SECTION
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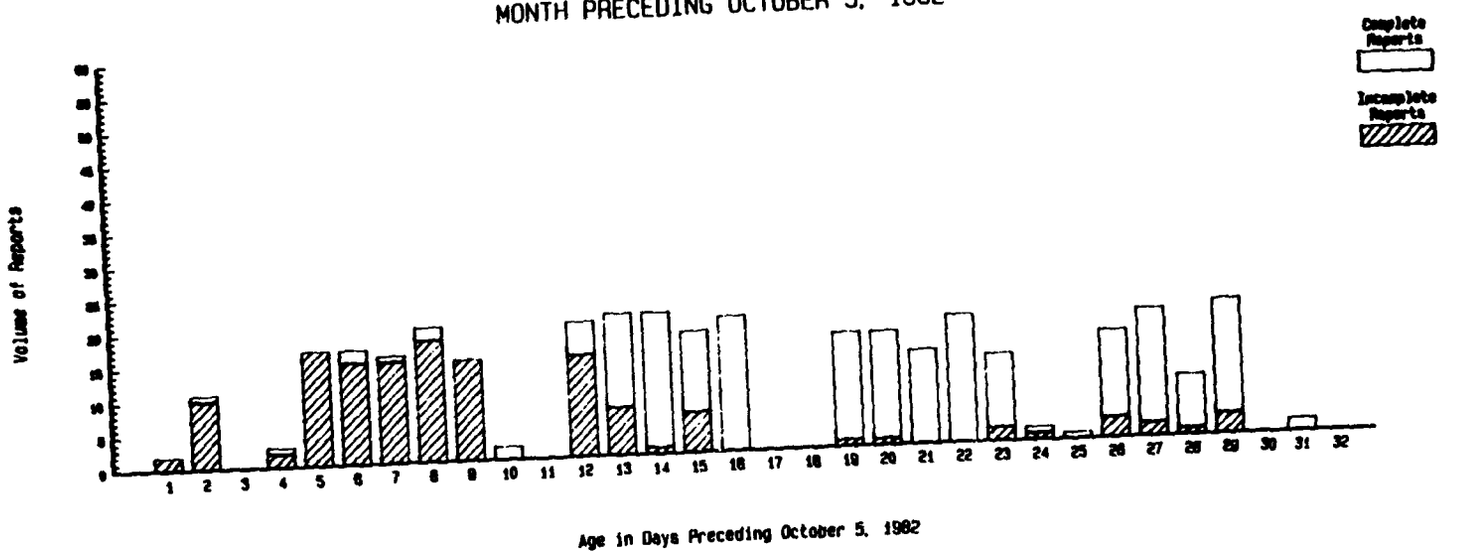

VOLUME OF COMPLETE AND INCOMPLETE REPORTS
ULTRASOUND SECTION
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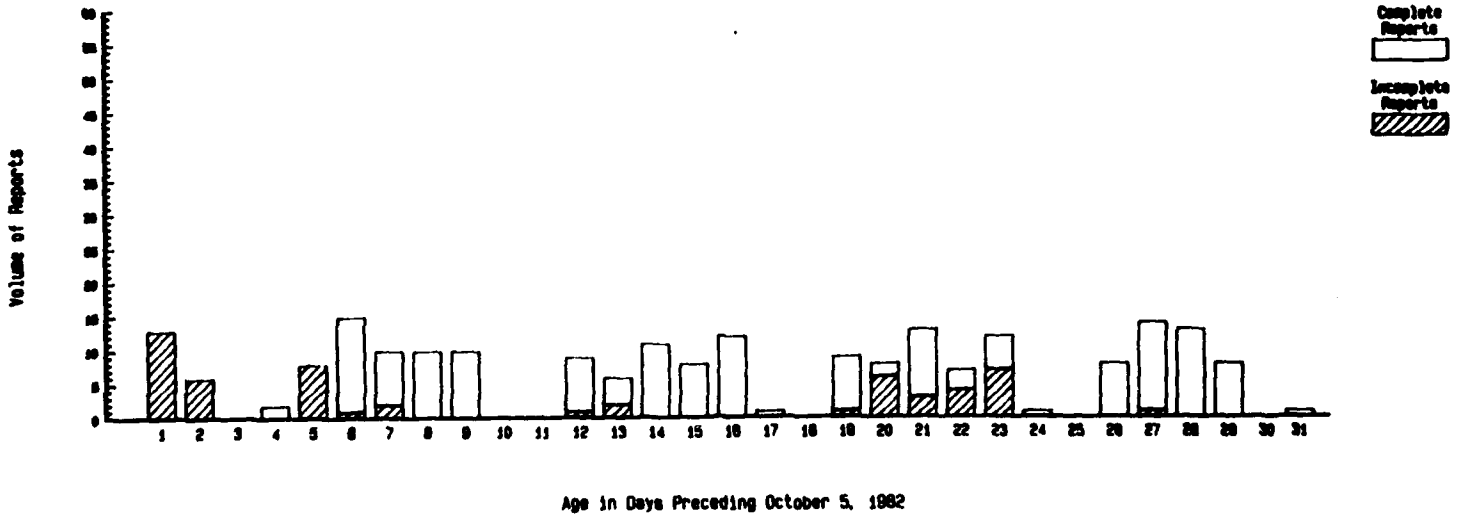

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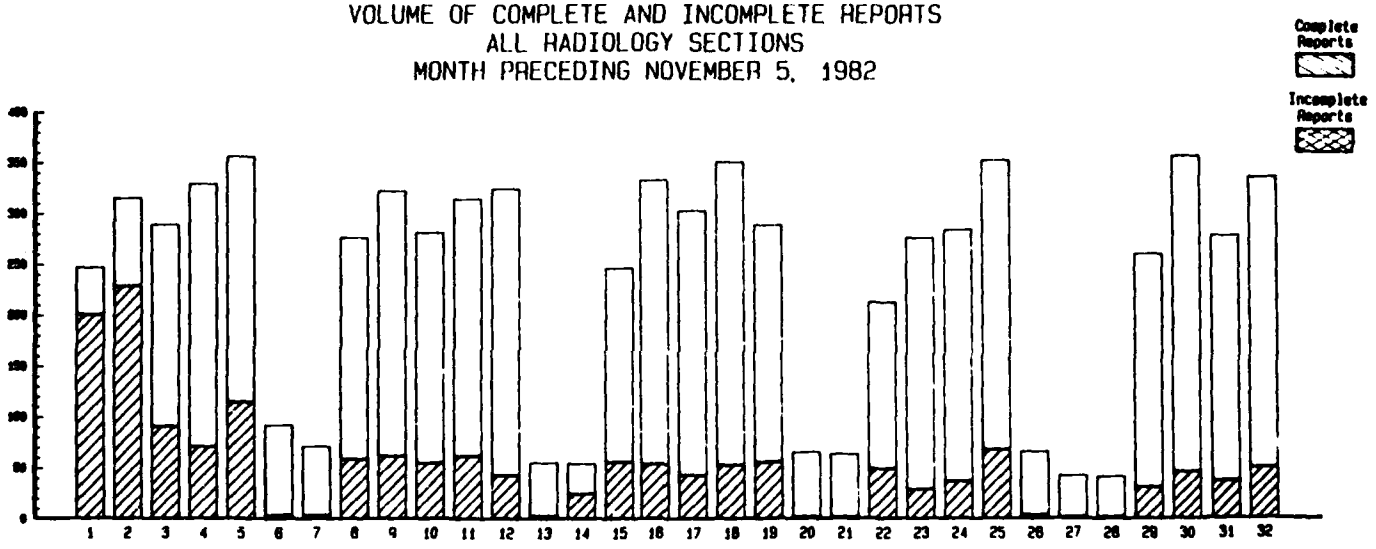

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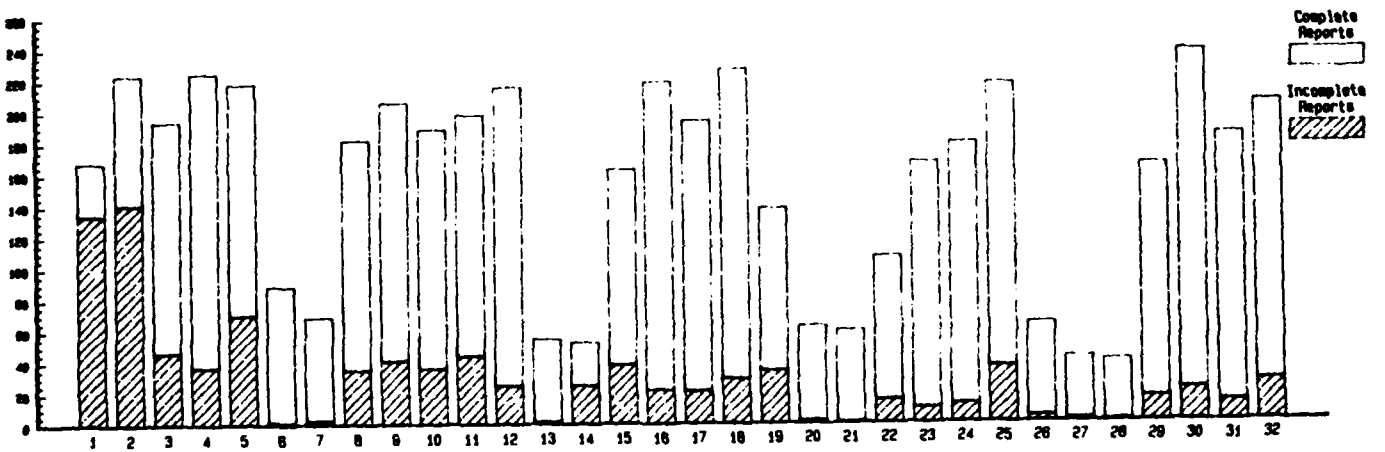

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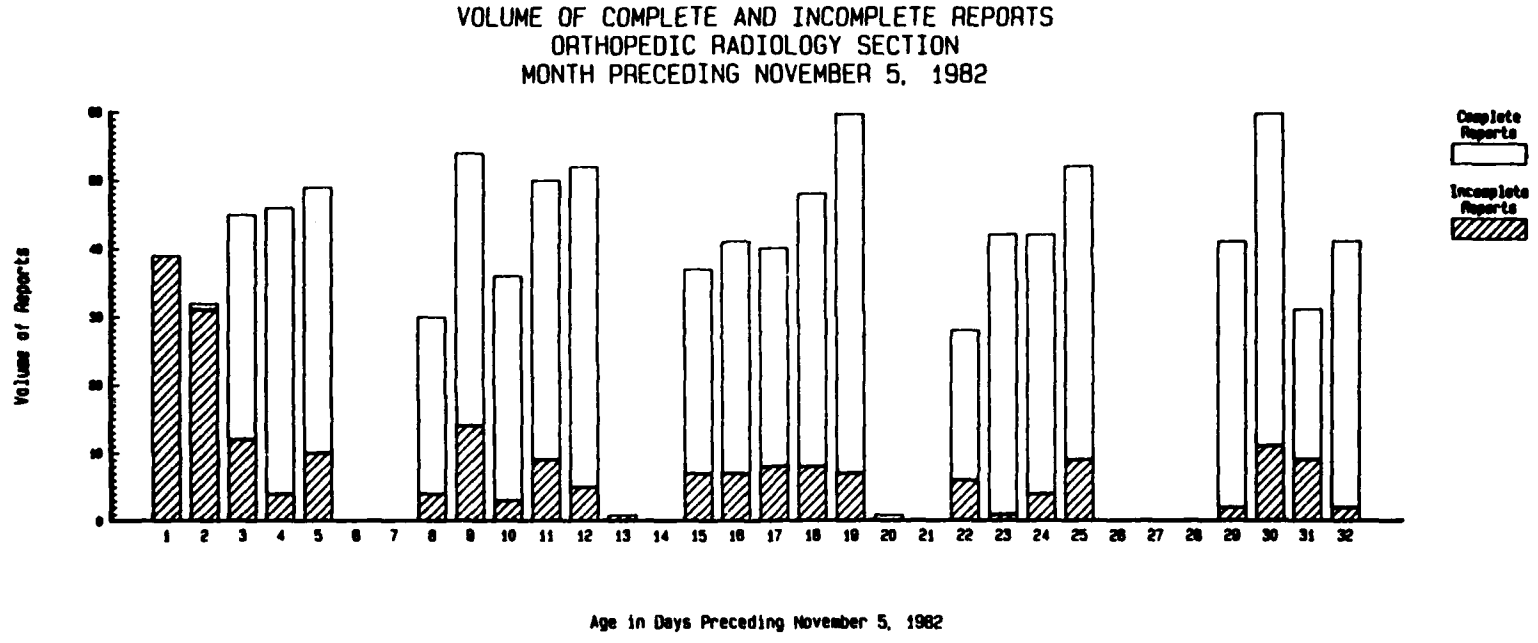
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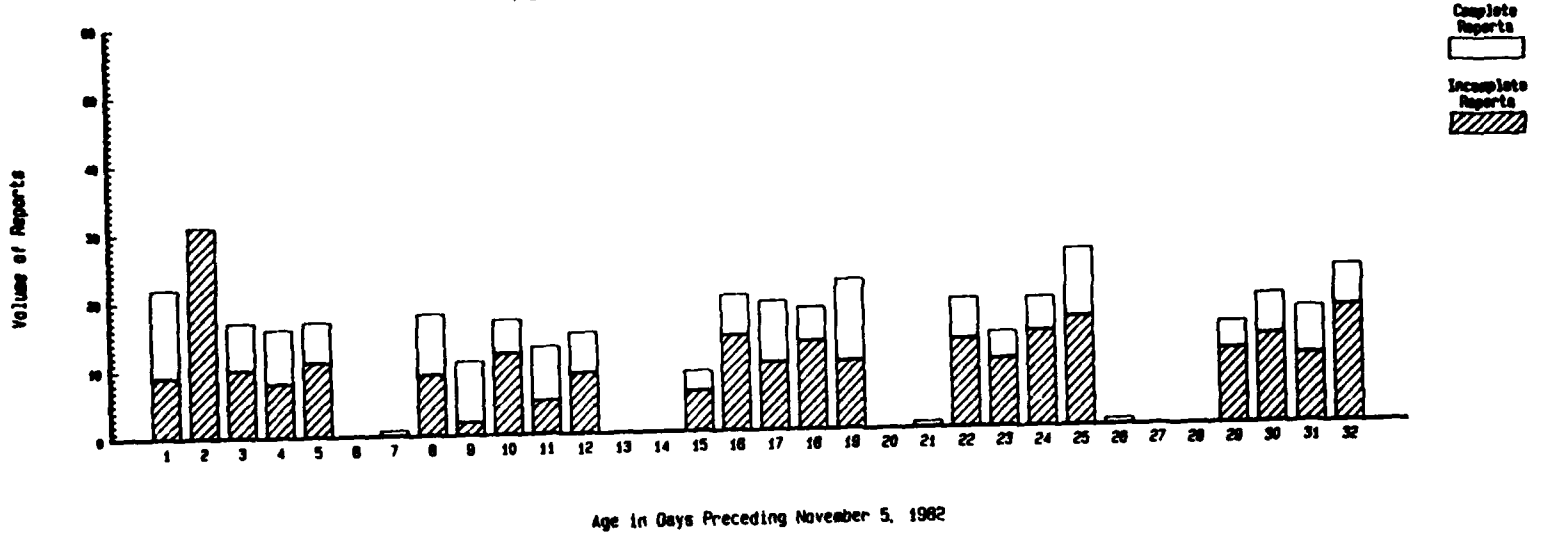
ORTHOPEDIC RADIOLOGY SECTION
MONTH PRECEDING NOVEMBER 5, 1982
Volume of Reports
Complete Reports
Incomplete Reports
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
Age in Days Preceding November 5, 1982

VOLUME OF COMPLETE AND INCOMPLETE REPORTS
UROLOGIC RADIOLOGY SECTION
MONTH PRECEDING NOVEMBER 5, 1982



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SPECIAL PROCEDURES SECTION
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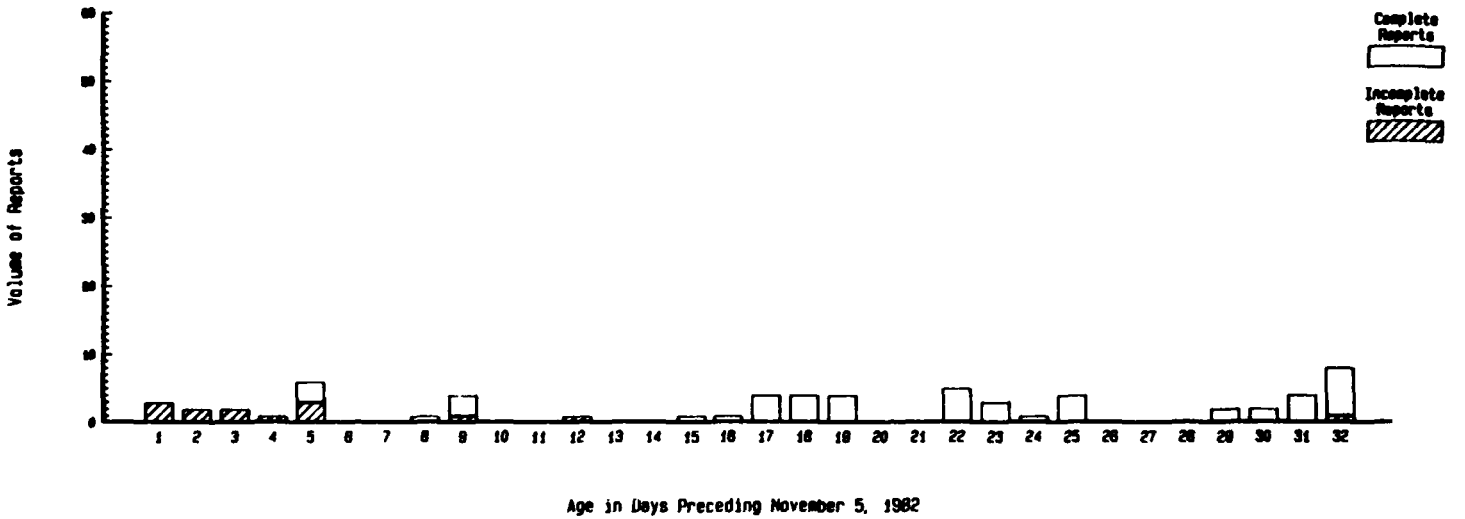

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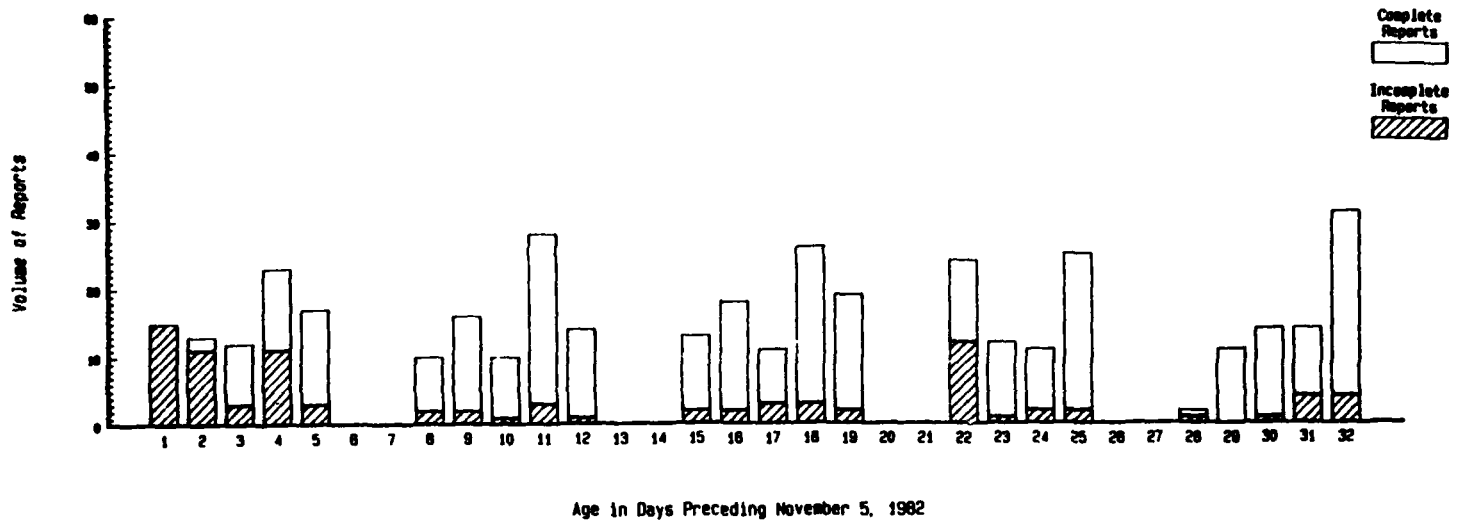
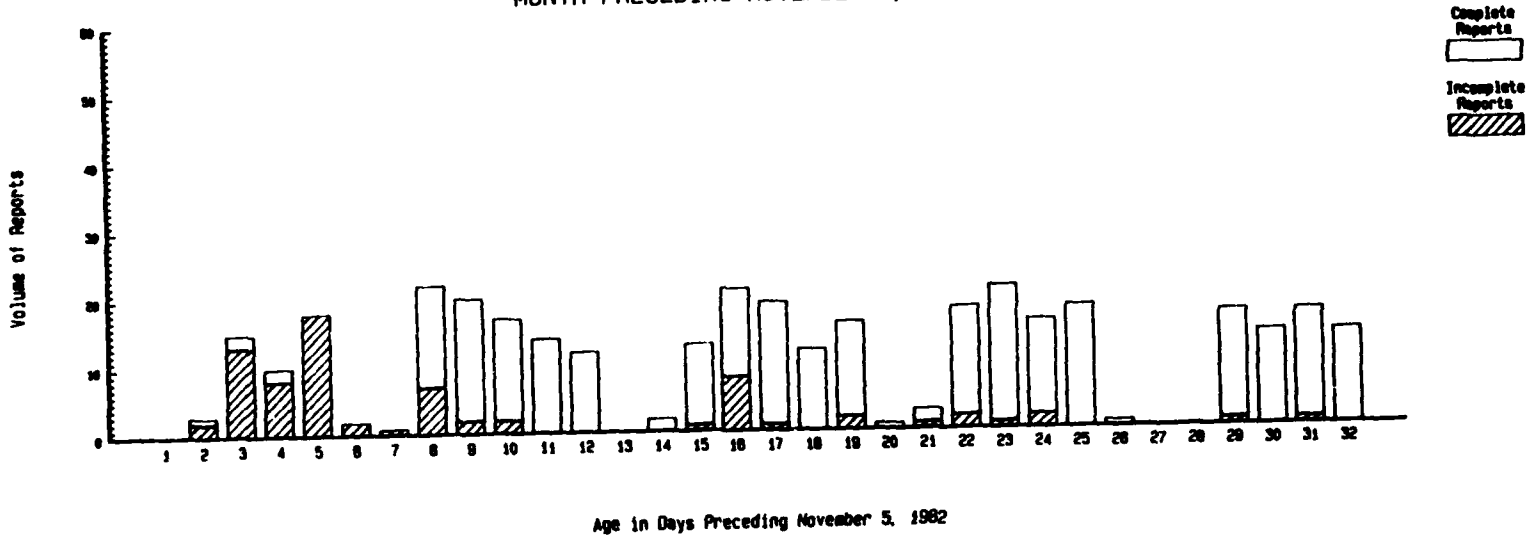


VOLUME OF COMPLETE AND INCOMPLETE REPORTS
COMPUTERIZED TOMOGRAPHY SECTION
MONTH PRECEDING NOVEMBER 5, 1982



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ULTRASOUND SECTION
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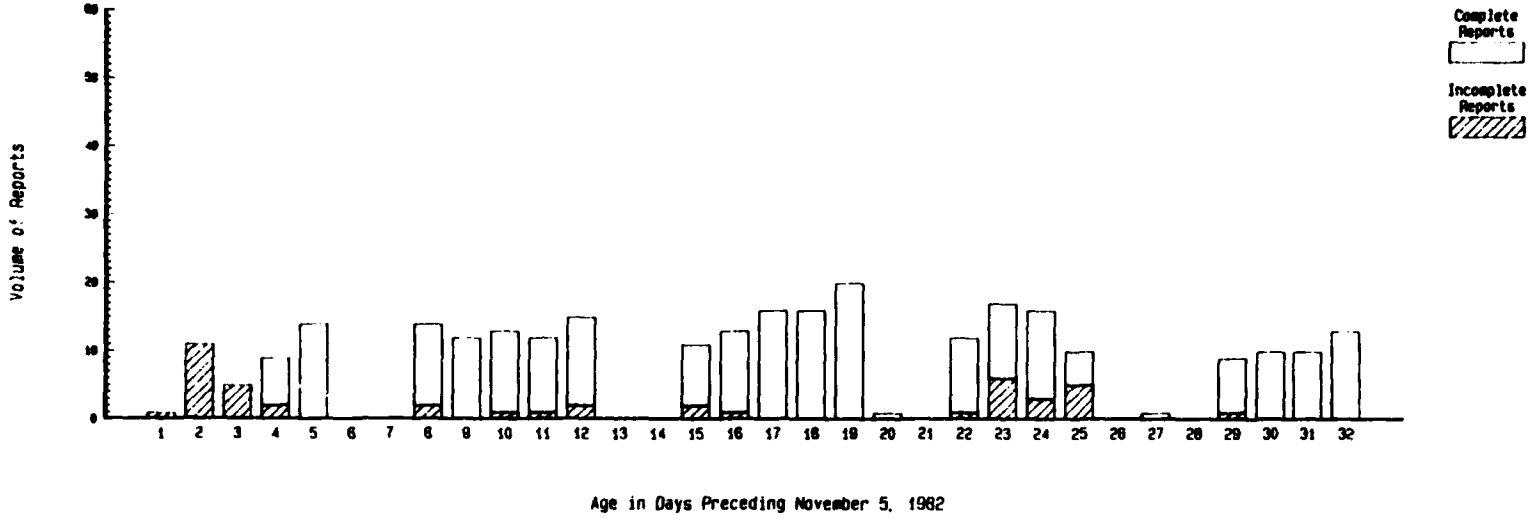

APPENDIX D. QUESTIONNAIRE RESULTS

On the following pages, copies of the baseline and post-implementation questionnaires are given. Tabulated responses of the Radiology Department staff who completed questionnaires in each survey have been included; percentage of respondents giving each answer is provided, along with a weighted mean computed by use of a weighting scale of +2, +1, 0, -1, and -2. Following the post-implementation questionnaire, is a series of tables showing responses to questions regarding TRIRAD on the post-implementation survey. Responses are shown for the individual staff types (radiologist, resident, technician, and other) and for the individual sections of the Radiology Department.

BASELINE QUESTIONNAIRE

1. Listed below are general characteristics of radiology department operations related to information handling. Please indicate how satisfied you are with existing operations by rating each item listed below on a scale of "1" to "5" where "1" represents very dissatisfied and "5" is very satisfied.

	Very Dissatisfied 1	2	3	4	Very Satisfied 5	No Response 6	Mean
a. Timely availability of patients' current records--STAT cases	9%	34%	28%	15%	6%	8%	-0.3
b. Timely availability of patients' current records--routine cases	19%	20%	29%	17%	9%	6%	-0.2
c. Timely availability of patients' historical records--STAT cases	18%	37%	23%	8%	3%	11%	-0.7
d. Timely availability of patients' historical records--routine cases	17%	21%	31%	15%	5%	11%	-0.3
e. Ease of obtaining patients' current records	17%	23%	31%	18%	5%	6%	-0.3
f. Ease of obtaining patients' historical records	17%	25%	32%	14%	3%	9%	-0.4
g. Timely availability of patients' test results--STAT cases	11%	31%	31%	18%	6%	3%	-0.2
h. Timely availability of patients' test results--routine cases	23%	28%	28%	15%	3%	3%	-0.5
i. Ease of obtaining patients' test results--in--patients	14%	28%	40%	12%	1%	5%	-0.4
j. Ease of obtaining patients' test results--telephone inquiries	25%	35%	21%	11%	3%	5%	-0.7
k. Completeness of patients' records: tests ordered, test results	23%	26%	35%	8%	2%	6%	-0.7
l. Accuracy of patients" records	12%	21%	48%	9%	5%	5%	-0.3
m. Legibility/ease of reading patients' records	28%	28%	26%	11%	4%	3%	-0.7
n. Amount of paperwork/ time required for writing patients' orders	14%	19%	32%	18%	3%	14%	-0.2
o. Completeness of department files, i.e.,number of lost files	31%	37%	17%	8%	3%	4%	-0.9
p. Time available for patient care	6%	26%	31%	28%	1%	8%	-0.1

2. The following statements describe how an individual may react to a computerized radiology management system. Please indicate to what extent each statement describes how you personally feel. The more you agree with a statement, the higher the number you should give it.

		Strongly Disagree 1	2	3	4	Strongly Agree 5	No Response	Mean
a.	It will be time-consuming for me to learn	15%	22%	35%	17%	8%	3%	-0.2
b.	It will be difficult for me to use the terminal	40%	34%	17%	3%	3%	3%	-1.1
c.	It will make my work more efficient	5%	6%	35%	22%	29%	3%	0.7
d.	I will not trust the information I obtain	46%	31%	17%	3%	0%	3%	-1.2
e.	It will make record keeping more difficult for me	32%	39%	23%	3%	0%	3%	-1.0
f.	I personally will use it as little as possible	46%	23%	18%	5%	5%	3%	-1.0
g.	It will make my work more challenging	11%	24%	34%	11%	15%	5%	0.0
h.	The whole idea of a radiology management system turns me off	66%	14%	11%	3%	1%	5%	-1.5
i.	The benefits to me will outweigh the trouble of learning to use the system	3%	5%	22%	29%	38%	3%	1.0
j.	It will significantly alter the way I do my work	9%	12%	37%	22%	15%	5%	0.2
k.	It will make writing orders for my patients easier/less time-consuming	6%	9%	35%	17%	5%	28%	0.1
l.	It will be difficult for me to read the CRT terminal screen	51%	21%	14%	3%	3%	8%	-1.2
m.	I will be able to provide better service to my patients	2%	6%	25%	40%	21%	6%	0.8
n.	I will have less flexibility because operations will be more routinized	28%	25%	32%	9%	1%	5%	-0.7
o.	Some decision-making will be taken away from me	29%	31%	21	9%	5%	5%	-0.7
p.	I will have more time for direct patient care	6%	14%	40%	20%	6%	14%	0.1

3. As you may know, a radiology management system can incorporate a number of different functions. For each of the functions listed below, please indicate how important or desirable it is to you to have that function or capability in the radiology management system in this department. Rate each function on a scale of "1" to "5", where "1" represents not at all important and "5" is very important.

	Not At All Important 1	2	3	4	Very Important 5	No Response	Mean
a. Scheduling of in-patient tests	5%	6%	11%	23%	55%	0%	1.2
b. Scheduling of out-patient tests	5%	5%	15%	26%	48%	1%	1.1
c. Patient registration	3%	5%	17%	21%	51%	3%	1.2
d. Record/track to whom/where patient x-ray file folders signed out	1%	0%	5%	3%	91%	0%	1.8
e. Place test orders	3%	14%	27%	17%	31%	8%	0.6
f. Record test results	0%	11%	14%	20%	52%	3%	1.2
g. Correlate test results with previous tests/other data	2%	6%	17%	23%	49%	3%	1.2
h. Record radiologist's/other physician's evaluations	3%	3%	9%	23%	60%	2%	1.4
i. Maintain patient records on current hospital stay (tests ordered, test results/evaluations)	2%	3%	15%	35%	43%	2%	1.2
j. Maintain ongoing data file on each patient -- registration data	2%	3%	17%	32%	43%	3%	1.2
k. Maintain ongoing data file on each patient--medical data (historical record of visits, test results, treatments, etc.)	1%	5%	21%	31%	40%	2%	1.0
l. Maintain/generate radiology department statistics (number of patients, number of tests, time per test, etc.)	0%	3%	20%	26%	48%	3%	1.2

4. Listed below are possible benefits a computerized radiology management system might have. For each of these, please indicate to what extent you believe that benefit will be seen in the radiology department operations of this hospital when the radiology management system is installed. The more likely you think it is that benefit will come about, the higher the number you should give it.

A computerized radiology management system will...	Definitely Will Not 1	2	3	4	Definitely Will 5	No Response	Mean
a. Reduce the time required to produce a written report	3%	9%	16%	34%	35%	3%	0.9
b. Reduce the number of lost files	2%	9%	17%	31%	41%	0%	1.0
c. Result in more complete patient records	0%	5%	17%	41%	37%	0%	1.1
d. Make patients' current records more easily accessible	2%	3%	12%	45%	38%	0%	1.2
e. Make patients' historical records more easily accessible	0%	6%	23%	39%	32%	0%	1.0
f. Make patients' current records available more quickly	0%	5%	18%	43%	34%	0%	1.1
g. Make patients' historical records available more quickly	0%	8%	22%	38%	32%	0%	1.0
h. Reduce the number of errors in patient records	3%	11%	38%	21%	25%	2%	0.5
i. Make radiology function more smoothly	1%	6%	34%	34%	25%	0%	0.7
j. Allow better patient care	5%	11%	32%	28%	24%	0%	0.6
k. Decrease the time spent looking for patient records/test results	0%	0%	14%	38%	48%	0%	1.3
l. Improve scheduling of patients	0%	3%	23%	39%	35%	0%	1.1
m. Decrease the cost of radiology services	9%	14%	38%	25%	11%	3%	0.1
n. Improve the way things are done here	5%	6%	29%	31%	29%	0%	0.7
o. Reduce the number of people needed to work here	34%	25%	29%	11%	1%	0%	-0.8
p. Make reports easier to read	2%	0%	23%	37%	38%	0%	1.1
q. Reduce the number of telephone inquiries for test results due to improved turnaround	1%	9%	25%	28%	37%	0%	0.9

5. How familiar are you with TRIRAD or other radiology management systems? (Please circle all that apply.)

0%	1	Have personally used or tried TRIRAD in other hospital
12%	2	Have personally used or tried other radiology management system in other hospital
6%	3	Have seen TRIRAD in use in other hospital, but have not personally used
11%	4	Have seen other radiology management system in use in other hospital, but have not personally used
9%	5	Have seen TRIRAD demonstrated
8%	6	Have seen other radiology management system demonstrated
34%	7	Have read or heard about TRIRAD but have not seen demonstrated or used
18%	8	Have read or heard about other radiology management system but have not seen demonstrated or used
43%	9	No familiarity or experience with TRIRAD
32%	10	No familiarity or experience with other radiology management system
2%	11	No Response

Finally, for background purposes, please specify the following:

6. Your specialty:

20%	1	Staff radiologist
6%	2	Radiology resident - 1st year
5%	3	Radiology resident - 2nd year
1%	4	Radiology resident - 3rd year
57%	5	Radiology technologist
11%	6	Other
0%	7	No Response

7. Your section in this hospital:[a]

49%	1	Diagnostic Radiology
12%	2	Imaging/CT
20%	3	Imaging/Nuclear Medicine
11%	4	Imaging/Ultrasound
18%	5	Radiation Therapy
5%	6	Special Procedures
5%	7	Orthopedics
0%	8	Urology[b]
2%	9	Refused/No Response

a. The percentage of staffing in each section total to more than 100% since some staff work in more than one section and thus selected more than one response.

b. Questionnaires were not distributed to Urology staff.

POST-IMPLEMENTATION QUESTIONNAIRE

1. Listed below are general characteristics of radiology department operations related to information handling. Please indicated how satisfied you are now with current operations by rating each item listed below on a scale of "1" to "5" where "1" represents very dissatisfied and "5" is very satisfied.

	Very Dissatisfied 1	2	3	4	Very Satisfied 5	No Response	Mean
a. Timely availability of patients' current films	6%	17%	36%	34%	7%	0%	.21
b. Timely availability of patients' current reports	4	15	32	28	21	0	.47
c. Timely availability of patients' historical films	17	15	41	23	4	0	-.19
d. Timely availability of patients' historical reports	11	15	25	28	17	4	.25
e. Ease of obtaining films	6	22	34	36	2	0	.06
f. Ease of obtaining reports	4	9	19	42	26	0	.77
g. Completeness of patients' exam history: tests ordered, test results	10	10	28	37	15	0	.40
h. Accuracy of patients' records stored on computer	6	4	22	51	17	0	.70
i. Ease of getting access to terminal	9	21	15	32	19	4	.31
j. Completeness of department files, i.e., number of lost files	11	23	36	26	2	2	-.15

2. Now that the TRIRAD radiology management system has been in place for nine months, how would you describe your overall satisfaction with the system?

5	Very satisfied	11%
4	Fairly satisfied	43
3	Mixed	32
2	Fairly dissatisfied	6
1	Very dissatisfied	0
	No response	8

3. Now that you have had the opportunity to work with the TRIRAD system, you are in a position to judge the benefits a computerized radiology management system might or might not have over a manual system. For each of these, please indicated to what extent you believe that benefit has been seen in the radiology department operations of this hospital now that the TRIRAD system is operational. The more convinced you are that each benefit has come about, the higher the number you should give it.

The TRIRAD computerized radiology management system has . . .	Definitely Has Not 1	2	3	4	Definitely Has 5	No Response	Mean
a. Reduced the time required to produce a written report	9%	11%	9%	27%	42%	2%	.81
b. Reduced the number of lost files	13	19	36	26	4	2	-.12
c. Resulted in more complete patient records	0	8	24	43	21	4	.80
d. Made patients' historical records more easily accessible	2	6	24	34	34	0	.92
e. Made patient' historical records available more quickly	0	9	21	38	32	0	.92
f. Reduced the number of errors in patient records	9	11	47	25	6	2	.06
g. Made radiology function more smoothly	11	6	38	34	9	2	.25
h. Improved patient care	11	11	26	44	8	0	.25
i. Decreased the time spent looking for patient records/test results	4	9	4	53	28	2	.94
j. Improved scheduling of patients	8	4	22	38	22	6	.68
k. Decreased the cost of radiology services	11	13	46	13	2	15	-.22
l. Reduced the number of people needed to work here	43	25	15	11	4	2	-.94
m. Made reports easier to read	0	2	13	26	59	0	1.42
n. Reduced the number of telephone inquiries for test results due to improved turnaround	13	13	28	34	8	4	.10
o. Reduced the number of unnecessary repeat examinations	4	21	34	28	9	4	.20
p. Increased satisfaction level of attending physicians with radiology service	4	6	36	36	11	7	.49
q. Increased the accuracy of radiology reports	8	11	28	30	17	6	.40

4. Please indicate to what extent each statement describes how you personally were affected by the computerized radiology management system. The more you agree with a statement, the higher the number you should give it.

	Strongly Disagree 1	2	3	4	Strongly Agree 5	No Response	Mean
a. It was easy for me to learn to use the radiology system	2%	4%	15%	24%	55%	0%	1.26
b. It has made my work more efficient	2	9	38	30	21	0	.58
c. I do not trust the information I obtain	44	28	13	9	4	2	1.00
d. It has made record keeping easier for me	9	9	27	51	4	0	.30
e. I personally try to use it as little as possible	58	25	11	2	4	0	1.32
f. It has made my work more challenging	15	15	45	10	15	0	- .06
g. The benefits to me have outweighed the disadvantages of the system	11	6	22	38	19	4	.49
h. It has significantly altered the way I do my work	8	21	28	26	15	2	.21
i. I have been able to provide better service to my patients	8	9	44	26	11	2	.25
j. I have had less flexibility because operations are more routinized	15	28	36	9	8	4	.35
k. Some decision-making has been taken away from me	22	30	32	6	6	4	.61
l. The system saves me time	15	13	26	25	19	2	.19
m. I expect that benefits from this system will increase in the future	6	2	17	36	39	0	1.02

5. Indicate which functions of the computer you use most often.

6. Add any further comments, positive or negative, about the system itself or the way in which it is used. Please elaborate further or address questions which we did not ask.

Finally, for background purposes, please specify the following:

7. Your specialty:

1.	Staff radiologist	19%
2.	Radiology resident - 1st year	11
3.	Radiology resident - 2nd year	4
4.	Radiology resident - 3rd year	4
5.	Radiology technologist	41
6.	Other (please specify): _____	21

8. Your section in this hospital:

1.	Diagnostic Radiology	42%	
2.	Imaging/CT	15	45%*
3.	Imaging/Nuclear Medicine	30	
4.	Imaging/Ultrasound	9	
5.	Special Procedures	6	13%
6.	Orthopedics	4	
7.	Urology	4	

9. Were you employed in this hospital before January 1982 when the TRIRAD system was installed?

1.	Yes	74%
2.	No	26
	No Response	0

*Note - Staff in imaging tend to rotate through the various imaging sections, therefore the individual percentiles reflect their interaction with each section; the 45% indicates their representation in the total 53 respondents.

If you were employed here before the TRIRAD system was installed, please answer:

10. Has your job function or title changed since the TRIRAD system was installed?

1. Yes	36%
2. No	64
No Response	0

If your job function or title has changed, please answer Qs. 11 and 12:

11. Please explain what your function and title was before.

12. Was the change in your job function or title directly related to the implementation of the computerized management system?

1. Yes	7%
2. No	86
No Response	7

13. Your name:_____

Thank you for your time and effort.

TABLE 2

OVERALL SATISFACTION WITH TRIRAD RADIOLOGY MANAGEMENT SYSTEM

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	4 7.5	- -	- -	2 9.1	2 18.2	1 4.5	1 12.5	2 12.5	- -	3 12.5	- -	- -	- -	- -
LOW NET	3 5.7	1 10.0	- -	2 9.1	- -	2 9.1	- -	1 6.3	- -	1 4.2	- -	- -	- -	- -
1 VERY DISSATISFIED	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
2	3 5.7	1 10.0	- -	2 9.1	- -	2 9.1	- -	1 6.3	- -	1 4.2	- -	- -	- -	- -
3	17 32.1	4 40.0	3 30.0	7 31.8	3 27.3	6 27.3	6 75.0	3 18.8	3 60.0	8 33.3	2 66.7	1 50.0	- -	3 42.9
4	23 43.4	3 30.0	7 70.0	10 45.5	3 27.3	11 50.0	1 12.5	6 37.5	2 40.0	8 33.3	1 33.3	1 50.0	2 100.0	4 57.1
5 VERY SATISFIED	6 11.3	2 20.0	- -	1 4.5	3 27.3	2 9.1	- -	4 25.0	- -	4 16.7	- -	- -	- -	- -
HIGH NET	29 54.7	5 50.0	7 70.0	11 50.0	6 54.5	13 59.1	1 12.5	10 62.5	2 40.0	12 50.0	1 33.3	1 50.0	2 100.0	4 57.1
MEAN	.65	.60	.70	.50	1.00	.62	.14	.93	.40	.71	.33	.50	1.00	.57
STD ERR	.11	.31	.15	.17	.29	.18	.14	.25	.24	.18	.33	.50	-	.20

TABLE 3 A

HAS THE FOLLOWING BENEFIT COME ABOUT: REDUCED THE TIME REQUIRED TO PRODUCE A WRITTEN REPORT

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53	10	10	22	11	22	8	16	5	24	3	2	2	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
NO ANSWER	1	-	-	-	1	-	-	1	-	1	-	-	-	-
	1.9	-	-	-	9.1	-	-	6.2	-	4.2	-	-	-	-
LOW NET	11	3	1	6	1	5	1	2	-	3	2	1	-	3
	20.8	30.0	10.0	27.3	9.1	22.7	12.5	12.5	-	12.5	66.7	50.0	-	42.9
1 DEFINITELY HAS NOT	5	2	-	2	1	2	1	-	-	1	1	1	-	2
	9.4	20.0	-	9.1	9.1	9.1	12.5	-	-	4.2	33.3	50.0	-	28.6
2	6	1	1	4	-	3	-	2	-	2	1	-	-	1
	11.3	10.0	10.0	18.2	-	13.6	-	12.5	-	8.3	33.3	-	-	14.3
3	5	1	1	3	-	-	2	1	2	5	-	-	-	-
	9.4	10.0	10.0	13.6	-	-	25.0	6.3	40.0	20.8	-	-	-	-
4	14	2	3	6	3	5	3	5	2	7	1	-	1	2
	26.4	20.0	30.0	27.3	27.3	22.7	37.5	31.3	40.0	29.2	33.3	-	50.0	28.6
5 DEFINITELY HAS	22	4	5	7	6	12	2	7	1	8	-	1	1	2
	41.5	40.0	50.0	31.8	54.5	54.5	25.0	43.8	20.0	33.3	-	50.0	50.0	28.6
HIGH NET	36	6	8	13	9	17	5	12	3	15	1	1	2	4
	67.9	60.0	80.0	59.1	81.8	77.3	62.5	75.0	60.0	62.5	33.3	50.0	100.0	57.1
MEAN	.81	.50	1.20	.55	1.30	1.00	.63	1.13	.80	.83	-.67	-	1.50	.14
STD ERR	.19	.52	.33	.29	.40	.30	.46	.27	.37	.24	.88	2.00	.50	.67

TABLE 3 B

HAS THE FOLLOWING BENEFIT COME ABOUT: REDUCED THE NUMBER OF LOST FILES

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	1 1.9	- -	- -	- -	1 9.1	- -	- -	1 6.2	- -	1 4.2	- -	- -	- -	- -
LOW NET	17 32.1	4 40.0	3 30.0	7 31.8	3 27.3	8 36.4	2 25.0	5 31.3	2 40.0	7 29.2	2 66.7	- -	- -	2 28.6
1 DEFINITELY HAS NOT	7 13.2	2 20.0	1 10.0	2 9.1	2 18.2	4 18.2	1 12.5	2 12.5	1 20.0	2 8.3	1 33.3	- -	- -	1 14.3
2	10 18.9	2 20.0	2 20.0	5 22.7	1 9.1	4 18.2	1 12.5	3 18.8	1 20.0	5 20.8	1 33.3	- -	- -	1 14.3
3	19 35.8	2 20.0	5 50.0	8 36.4	4 36.4	9 40.9	3 37.5	5 31.3	2 40.0	8 33.3	- -	1 50.0	1 50.0	2 28.6
4	14 26.4	2 20.0	2 20.0	7 31.8	3 27.3	4 18.2	3 37.5	4 25.0	1 20.0	7 29.2	1 33.3	1 50.0	1 50.0	3 42.9
5 DEFINITELY HAS	2 3.8	2 20.0	- -	- -	- -	1 4.5	- -	1 6.3	- -	1 4.2	- -	- -	- -	- -
HIGH NET	16 30.2	4 40.0	2 20.0	7 31.8	3 27.3	5 22.7	3 37.5	5 31.3	1 20.0	8 33.3	1 33.3	1 50.0	1 50.0	3 42.9
MEAN	-.12	-	-.20	-.09	-.20	-.27	-	-.07	-.40	-	-.67	.50	.50	-
STD ERR	.15	.47	.29	.21	.38	.24	.38	.30	.51	.22	.88	.50	.50	.44

TABLE 3 C

HAS THE FOLLOWING BENEFIT COME ABOUT: RESULTED IN MORE COMPLETE PATIENT RECORDS

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	2 3.8	- -	- -	1 4.5	1 9.1	- -	- -	2 12.5	- -	2 8.3	- -	- -	- -	- -
LOW NET	4 7.5	- -	1 10.0	3 13.6	- -	2 9.1	- -	1 6.3	- -	1 4.2	1 33.3	- -	- -	1 14.3
1 DEFINITELY HAS NOT	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
2	4 7.5	- -	1 10.0	3 13.6	- -	2 9.1	- -	1 6.3	- -	1 4.2	1 33.3	- -	- -	1 14.3
3	13 24.5	2 20.0	2 20.0	7 31.8	2 18.2	6 27.3	1 12.5	2 12.5	1 20.0	4 16.7	1 33.3	1 50.0	1 50.0	3 42.9
4	23 43.4	5 50.0	6 60.0	7 31.8	5 45.5	9 40.9	5 62.5	6 37.5	3 60.0	11 45.8	1 33.3	1 50.0	1 50.0	3 42.9
5 DEFINITELY HAS	11 20.8	3 30.0	1 10.0	4 18.2	3 27.3	5 22.7	2 25.0	5 31.3	1 20.0	6 25.0	- -	- -	- -	- -
HIGH NET	34 64.2	8 80.0	7 70.0	11 50.0	8 72.7	14 63.6	7 87.5	11 68.8	4 80.0	17 70.8	1 33.3	1 50.0	1 50.0	3 42.9
MEAN	.80	1.10	.70	.57	1.10	.77	1.13	1.07	1.00	1.00	-	.50	.50	.29
STD ERR	.12	.23	.26	.21	.23	.20	.23	.25	.32	.17	.58	.50	.50	.29

TABLE 3 D

HAS THE FOLLOWING BENEFIT COME ABOUT: MADE PATIENTS' HISTORICAL RECORDS MORE EASILY ACCESSIBLE

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	4 7.5	- -	- -	2 9.1	2 18.2	- -	3 37.5	2 12.5	2 40.0	3 12.5	1 33.3	- -	- -	1 14.3
1 DEFINITELY HAS NOT	1 1.9	- -	- -	- -	1 9.1	- -	1 12.5	1 6.3	1 20.0	1 4.2	- -	- -	- -	- -
2	3 5.7	- -	- -	2 9.1	1 9.1	- -	2 25.0	1 6.3	1 20.0	2 8.3	1 33.3	- -	- -	1 14.3
3	13 24.5	2 20.0	2 20.0	6 27.3	3 27.3	5 22.7	1 12.5	3 18.8	1 20.0	5 20.8	- -	2 100.0	1 50.0	3 42.9
4	18 34.0	4 40.0	5 50.0	7 31.8	2 18.2	8 36.4	2 25.0	5 31.3	2 40.0	8 33.3	1 33.3	- -	1 50.0	2 28.6
5 DEFINITELY HAS	18 34.0	4 40.0	3 30.0	7 31.8	4 36.4	9 40.9	2 25.0	6 37.5	- -	8 33.3	1 33.3	- -	- -	1 14.3
HIGH NET	36 67.9	8 80.0	8 80.0	14 63.6	6 54.5	17 77.3	4 50.0	11 68.8	2 40.0	16 66.7	2 66.7	- -	1 50.0	3 42.9
MEAN	.92	1.20	1.10	.86	.64	1.18	.25	.88	-.20	.83	.67	-	.50	.43
STD ERR	.14	.25	.23	.21	.41	.17	.53	.30	.58	.23	.88	-	.50	.37

TABLE 3 E

HAS THE FOLLOWING BENEFIT COME ABOUT: MADE PATIENT HISTORICAL RECORDS AVAILABLE MORE QUICKLY

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	5 9.4	- -	- -	4 18.2	1 9.1	- -	1 12.5	4 25.0	1 20.0	4 16.7	1 33.3	- -	- -	1 14.3
1 DEFINITELY HAS NOT	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
2	5 9.4	- -	- -	4 18.2	1 9.1	- -	1 12.5	4 25.0	1 20.0	4 16.7	1 33.3	- -	- -	1 14.3
3	11 20.8	- -	3 30.0	6 27.3	2 18.2	6 27.3	2 25.0	- -	1 20.0	3 12.5	- -	1 50.0	1 50.0	2 28.6
4	20 37.7	8 80.0	5 50.0	5 22.7	4 36.4	7 31.8	2 25.0	7 43.8	2 40.0	10 41.7	1 33.3	1 50.0	1 50.0	3 42.9
5 DEFINITELY HAS	17 32.1	4 40.0	2 20.0	7 31.8	4 36.4	9 40.9	3 37.5	5 31.3	1 20.0	7 29.2	1 33.3	- -	- -	1 14.3
HIGH NET	37 69.8	10 100.0	7 70.0	12 54.5	8 72.7	16 72.7	5 62.5	12 75.0	3 60.0	17 70.8	2 66.7	1 50.0	1 50.0	4 57.1
MEAN	.92	1.40	.90	.68	1.00	1.14	.88	.81	.60	.83	.67	.50	.50	.57
STD ERR	.13	.16	.23	.24	.30	.18	.40	.29	.51	.21	.88	.50	.50	.37

TABLE 3 F

HAS THE FOLLOWING BENEFIT COME ABOUT: REDUCED THE NUMBER OF ERRORS IN PATIENT RECORDS

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53	10	10	22	11	22	8	16	5	24	3	2	2	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
NO ANSWER	1	-	-	-	1	-	-	1	-	1	-	-	-	-
	1.9	-	-	-	9.1	-	-	6.2	-	4.2	-	-	-	-
LOW NET	11	2	1	5	3	5	1	3	2	4	2	-	-	2
	20.8	20.0	10.0	22.7	27.3	22.7	12.5	18.8	40.0	16.7	66.7	-	-	28.6
1 DEFINITELY HAS NOT	5	1	1	1	2	3	1	1	1	1	1	-	-	1
	9.4	10.0	10.0	4.5	18.2	13.6	12.5	6.3	20.0	4.2	33.3	-	-	14.3
2	6	1	-	4	1	2	-	2	1	3	1	-	-	1
	11.3	10.0	-	18.2	9.1	9.1	-	12.5	20.0	12.5	33.3	-	-	14.3
3	25	6	6	9	4	12	5	5	2	10	-	2	1	3
	47.2	60.0	60.0	40.9	36.4	54.5	62.5	31.3	40.0	41.7	-	100.0	50.0	42.9
4	13	1	3	7	2	5	2	4	-	6	1	-	1	2
	24.5	10.0	30.0	31.8	18.2	22.7	25.0	25.0	-	25.0	33.3	-	50.0	28.6
5 DEFINITELY HAS	3	1	-	1	1	-	-	3	1	3	-	-	-	-
	5.7	10.0	-	4.5	9.1	-	-	18.8	20.0	12.5	-	-	-	-
HIGH NET	16	2	3	8	3	5	2	7	1	9	1	-	1	2
	30.2	20.0	30.0	36.4	27.3	22.7	25.0	43.8	20.0	37.5	33.3	-	50.0	28.6
MEAN	.06	-	.10	.14	-.10	-.14	-	.40	-.20	.30	-.67	-	.50	-.14
STD ERR	.14	.33	.28	.20	.41	.20	.33	.31	.66	.21	.88	-	.50	.40

TABLE 3 G

HAS THE FOLLOWING BENEFIT COME ABOUT: MADE RADIOLOGY FUNCTION MORE SMOOTHLY

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	1 1.9	-	-	-	1 9.1	-	-	1 6.2	-	1 4.2	-	-	-	-
LOW NET	9 17.0	1 10.0	- -	7 31.8	1 9.1	4 18.2	2 25.0	1 6.3	1 20.0	4 16.7	- -	- -	1 50.0	1 14.3
1 DEFINITELY HAS NOT	6 11.3	1 10.0	-	4 18.2	1 9.1	3 13.6	2 25.0	1 6.3	- -	3 12.5	- -	- -	- -	- -
2	3 5.7	- -	- -	3 13.6	- -	1 4.5	- -	- -	1 20.0	1 4.2	- -	- -	1 50.0	1 14.3
3	20 37.7	4 40.0	5 50.0	10 45.5	1 9.1	9 40.9	2 25.0	2 12.5	1 20.0	5 20.8	3 100.0	2 100.0	1 50.0	6 85.7
4	18 34.0	4 40.0	5 50.0	4 18.2	5 45.5	8 36.4	4 50.0	8 50.0	2 40.0	10 41.7	- -	- -	- -	- -
5 DEFINITELY HAS	5 9.4	1 10.0	- -	1 4.5	3 27.3	1 4.5	- -	4 25.0	1 20.0	4 16.7	- -	- -	- -	- -
HIGH NET	23 43.4	5 50.0	5 50.0	5 22.7	8 72.7	9 40.9	4 50.0	12 75.0	3 60.0	14 58.3	- -	- -	- -	- -
MEAN	.25	.40	.50	-.23	.90	.14	-	.93	.60	.48	-	-	-.50	-.14
STD ERR	.15	.34	.17	.24	.38	.23	.46	.27	.51	.26	-	-	.50	.14

AD-A128 776 EVALUATION OF THE TRI-SERVICE RADIOLOGY SYSTEM AT THE NAVAL HOSPITAL BETHESDA(U) LITTLE (ARTHUR D) INC CAMBRIDGE MA 11 FEB 83 ADL-0209-2-RAD-1-Y-FINAL

UNCLASSIFIED MDA903-81-C-0209 F/G 6/5 NL

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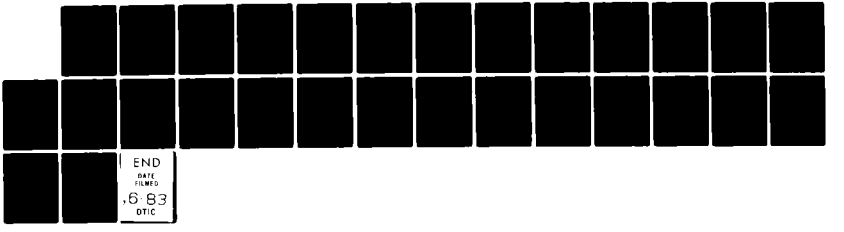

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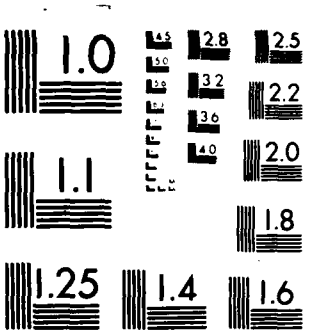


TABLE 3 H

HAS THE FOLLOWING BENEFIT COME ABOUT: IMPROVED PATEINT CARE

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53	10	10	22	11	22	8	16	5	24	3	2	2	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
NO ANSWER	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LOW NET	12	3	1	7	1	2	4	2	2	6	2	2	-	4
	22.6	30.0	10.0	31.8	9.1	9.1	50.0	12.5	40.0	25.0	66.7	100.0	-	57.1
1 DEFINITELY HAS NOT	6	1	1	4	-	1	1	-	1	2	2	1	-	3
	11.3	10.0	10.0	18.2	-	4.5	12.5	-	20.0	8.3	66.7	50.0	-	42.9
2	6	2	-	3	1	1	3	2	1	4	-	1	-	1
	11.3	20.0	-	13.6	9.1	4.5	37.5	12.5	20.0	16.7	-	50.0	-	14.3
3	14	3	1	7	3	8	2	2	-	4	1	-	1	2
	26.4	30.0	10.0	31.8	27.3	36.4	25.0	12.5	-	16.7	33.3	-	50.0	28.6
4	23	3	8	7	5	11	2	9	2	11	-	-	1	1
	43.4	30.0	80.0	31.8	45.5	50.0	25.0	56.3	40.0	45.8	-	-	50.0	14.3
5 DEFINITELY HAS	4	1	-	1	2	1	-	3	1	3	-	-	-	-
	7.5	10.0	-	4.5	18.2	4.5	-	18.8	20.0	12.5	-	-	-	-
HIGH NET	27	4	8	8	7	12	2	12	3	14	-	-	1	1
	50.9	40.0	80.0	36.4	63.6	54.5	25.0	75.0	60.0	58.3	-	-	50.0	14.3
MEAN	.25	.10	.60	-.09	.73	.45	-.38	.81	.20	.38	-1.33	-1.50	.50	-.86
STD ERR	.15	.38	.31	.25	.27	.18	.38	.23	.73	.24	.67	.50	.50	.48

TABLE 3 I

HAS THE FOLLOWING BENEFIT COME ABOUT: DECREASED THE TIME SPENT LOOKING FOR PATIENT RECORDS/TEST RESULTS

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	1 1.9	- -	1 10.0	- -	- -	1 4.5	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	7 13.2	1 10.0	- -	5 22.7	1 9.1	1 4.5	3 37.5	2 12.5	1 20.0	4 16.7	1 33.3	1 50.0	- -	2 28.6
1 DEFINITELY HAS NOT	2 3.8	- -	- -	1 4.5	1 9.1	1 4.5	1 12.5	1 6.3	1 20.0	1 4.2	- -	- -	- -	- -
2	5 9.4	1 10.0	- -	4 18.2	- -	- -	2 25.0	1 6.3	- -	3 12.5	1 33.3	1 50.0	- -	2 28.6
3	2 3.8	1 10.0	- -	- -	1 9.1	2 9.1	- -	- -	- -	- -	- -	- -	- -	- -
4	28 52.8	5 50.0	7 70.0	12 54.5	4 36.4	12 54.5	5 62.5	5 31.3	3 60.0	11 45.8	2 66.7	1 50.0	2 100.0	5 71.4
5 DEFINITELY HAS	15 28.3	3 30.0	2 20.0	5 22.7	5 45.5	6 27.3	- -	9 56.3	1 20.0	9 37.5	- -	- -	- -	- -
HIGH NET	43 81.1	8 80.0	9 90.0	17 77.3	9 81.8	18 81.8	5 62.5	14 87.5	4 80.0	20 83.3	2 66.7	1 50.0	2 100.0	5 71.4
MEAN	.94	1.00	1.22	.73	1.09	1.05	.13	1.25	.60	1.00	.33	-	1.00	.43
STD ERR	.14	.30	.15	.25	.37	.20	.44	.30	.68	.23	.67	1.00	-	.37

TABLE 3 J

HAS THE FOLLOWING BENEFIT COME ABOUT: IMPROVED SCHEDULING OF PATIENTS

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	3 5.7	- -	- -	2 9.1	1 9.1	2 9.1	- -	1 6.2	- -	1 4.2	- -	- -	- -	- -
LOW NET	6 11.3	2 20.0	1 10.0	3 13.6	- -	2 9.1	2 25.0	- -	- -	2 8.3	1 33.3	- -	1 50.0	2 28.6
1 DEFINITELY HAS NOT	4 7.5	1 10.0	1 10.0	2 9.1	- -	2 9.1	1 12.5	- -	- -	1 4.2	1 33.3	- -	- -	1 14.3
2	2 3.8	1 10.0	- -	1 4.5	- -	- -	1 12.5	- -	- -	1 4.2	- -	- -	1 50.0	1 14.3
3	12 22.6	2 20.0	3 30.0	5 22.7	2 18.2	6 27.3	1 12.5	3 18.8	2 40.0	4 16.7	1 33.3	1 50.0	- -	2 28.6
4	20 37.7	3 30.0	4 40.0	10 45.5	3 27.3	9 40.9	3 37.5	5 31.3	- -	8 33.3	1 33.3	1 50.0	1 50.0	3 42.9
5 DEFINITELY HAS	12 22.6	3 30.0	2 20.0	2 9.1	5 45.5	3 13.6	2 25.0	7 43.8	3 60.0	9 37.5	- -	- -	- -	- -
HIGH NET	32 60.4	6 60.0	6 60.0	12 54.5	8 72.7	12 54.5	5 62.5	12 75.0	3 60.0	17 70.8	1 33.3	1 50.0	1 50.0	3 42.9
MEAN	.68	.60	.60	.45	1.30	.55	.50	1.27	1.20	1.00	-.33	.50	-	-
STD ERR	.16	.43	.37	.25	.26	.25	.50	.21	.49	.23	.88	.50	1.00	.44

TABLE 3 K

HAS THE FOLLOWING BENEFIT COME ABOUT: DECREASED THE COST OF RADIOLOGY SERVICES

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53	10	10	22	11	22	8	16	5	24	3	2	2	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
NO ANSWER	8	-	1	3	4	5	1	2	1	2	1	-	-	1
	15.1	-	10.0	13.6	36.4	22.7	12.5	12.5	20.0	8.3	33.3	-	-	14.3
LOW NET	13	5	2	6	-	5	3	-	1	4	2	2	-	4
	24.5	50.0	20.0	27.3	-	22.7	37.5	-	20.0	16.7	66.7	100.0	-	57.1
1 DEFINITELY HAS NOT	6	3	-	3	-	1	2	-	1	3	1	1	-	2
	11.3	30.0	-	13.6	-	4.5	25.0	-	20.0	12.5	33.3	50.0	-	28.6
2	7	2	2	3	-	4	1	-	-	1	1	1	-	2
	13.2	20.0	20.0	13.6	-	18.2	12.5	-	-	4.2	33.3	50.0	-	28.6
3	24	3	6	11	4	11	4	8	2	12	-	-	1	1
	45.3	30.0	60.0	50.0	36.4	50.0	50.0	50.0	40.0	50.0	-	-	50.0	14.3
4	7	2	1	2	2	1	-	5	-	5	-	-	1	1
	13.2	20.0	10.0	9.1	18.2	4.5	-	31.3	-	20.8	-	-	50.0	14.3
5 DEFINITELY HAS	1	-	-	-	1	-	-	1	1	1	-	-	-	-
	1.9	-	-	-	9.1	-	-	6.3	20.0	4.2	-	-	-	-
HIGH NET	8	2	1	2	3	1	-	6	1	6	-	-	1	1
	15.1	20.0	10.0	9.1	27.3	4.5	-	37.5	20.0	25.0	-	-	50.0	14.3
MEAN	-.22	-.60	-.11	-.37	.57	-.29	-.71	.50	-	-	-1.50	-1.50	.50	-.83
STD ERR	.14	.37	.20	.21	.30	.17	.38	.17	.82	.22	.50	.50	.50	.48

TABLE 3 L

HAS THE FOLLOWING BENEFIT COME ABOUT: REDUCED THE NUMBER OF PEOPLE NEEDED TO WORK HERE

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	1 1.9	- -	- -	- -	1 9.1	- -	- -	1 6.2	- -	1 4.2	- -	- -	- -	- -
LOW NET	36 67.9	9 90.0	5 50.0	16 72.7	6 54.5	16 72.7	7 87.5	7 43.8	4 80.0	14 58.3	3 100.0	2 100.0	1 50.0	6 85.7
1 DEFINITELY HAS NOT	23 43.4	8 80.0	1 10.0	10 45.5	4 36.4	11 50.0	4 50.0	4 25.0	3 60.0	9 37.5	1 33.3	2 100.0	- -	3 42.9
2	13 24.5	1 10.0	4 40.0	6 27.3	2 18.2	5 22.7	3 37.5	3 18.8	1 20.0	5 20.8	2 66.7	- -	1 50.0	3 42.9
3	8 15.1	- -	3 30.0	4 18.2	1 9.1	4 18.2	1 12.5	3 18.8	- -	4 16.7	- -	- -	- -	- -
4	6 11.3	1 10.0	2 20.0	1 4.5	2 18.2	1 4.5	- -	4 25.0	1 20.0	4 16.7	- -	- -	1 50.0	1 14.3
5 DEFINITELY HAS	2 3.8	- -	- -	1 4.5	1 9.1	1 4.5	- -	1 6.3	- -	1 4.2	- -	- -	- -	- -
HIGH NET	8 15.1	1 10.0	2 20.0	2 9.1	3 27.3	2 9.1	- -	5 31.3	1 20.0	5 20.8	- -	- -	1 50.0	1 14.3
MEAN	-.94	-1.60	-.40	-1.05	-.60	-1.09	-1.38	-.33	-1.20	-.74	-1.33	-2.00	-	-1.14
STD ERR	.17	.31	.31	.24	.48	.25	.26	.35	.58	.27	.33	-	1.00	.40

TABLE 3 M

HAS THE FOLLOWING BENEFIT COME ABOUT: MADE REPORTS EASIER TO READ

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	1 1.9	- -	- -	1 4.5	- -	1 4.5	- -	- -	- -	- -	- -	- -	- -	- -
1 DEFINITELY HAS NOT	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
2	1 1.9	- -	- -	1 4.5	- -	1 4.5	- -	- -	- -	- -	- -	- -	- -	- -
3	7 13.2	3 30.0	2 20.0	1 4.5	1 9.1	5 22.7	- -	- -	1 20.0	1 4.2	- -	1 50.0	- -	1 14.3
4	14 26.4	4 40.0	3 30.0	6 27.3	1 9.1	3 13.6	4 50.0	4 25.0	- -	8 33.3	1 33.3	- -	2 100.0	3 42.9
5 DEFINITELY HAS	31 58.5	3 30.0	5 50.0	14 63.6	9 81.8	13 59.1	4 50.0	12 75.0	4 80.0	15 62.5	2 66.7	1 50.0	- -	3 42.9
HIGH NET	45 84.9	7 70.0	8 80.0	20 90.9	10 90.9	16 72.7	8 100.0	16 100.0	4 80.0	23 95.8	3 100.0	1 50.0	2 100.0	6 85.7
MEAN	1.42	1.00	1.30	1.50	1.73	1.27	1.50	1.75	1.60	1.58	1.67	1.00	1.00	1.29
STD ERR	.11	.26	.26	.17	.19	.21	.19	.11	.40	.12	.33	1.00	-	.29

TABLE 3 N

HAS THE FOLLOWING BENEFIT COME ABOUT: REDUCED THE NUMBER OF TELEPHONE INQUIRIES FOR TEST RESULTS DUE TO IMPROVED TURNAROUND

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	2 3.8	- -	- -	1 4.5	1 9.1	- -	- -	1 6.2	- -	1 4.2	1 33.3	- -	- -	1 14.3
LOW NET	14 26.4	4 40.0	- -	8 36.4	2 18.2	4 18.2	5 62.5	2 12.5	2 40.0	7 29.2	2 66.7	1 50.0	- -	3 42.9
1 DEFINITELY HAS NOT	7 13.2	2 20.0	- -	4 18.2	1 9.1	- -	4 50.0	2 12.5	2 40.0	6 25.0	1 33.3	- -	- -	1 14.3
2	7 13.2	2 20.0	- -	4 18.2	1 9.1	4 18.2	1 12.5	- -	- -	1 4.2	1 33.3	1 50.0	- -	2 28.6
3	15 28.3	2 20.0	3 30.0	7 31.8	3 27.3	5 22.7	3 37.5	6 37.5	1 20.0	8 33.3	- -	1 50.0	1 50.0	2 28.6
4	18 34.0	4 40.0	7 70.0	4 18.2	3 27.3	13 59.1	- -	4 25.0	1 20.0	5 20.8	- -	- -	- -	- -
5 DEFINITELY HAS	4 7.5	- -	- -	2 9.1	2 18.2	- -	- -	3 18.8	1 20.0	3 12.5	- -	- -	1 50.0	1 14.3
HIGH NET	22 41.5	4 40.0	7 70.0	6 27.3	5 45.5	13 59.1	- -	7 43.8	2 40.0	8 33.3	- -	- -	1 50.0	1 14.3
MEAN	.10	-.20	.70	-.19	.40	.41	-1.13	.40	-.20	-.09	-1.50	-.50	1.00	-.33
STD ERR	.16	.39	.15	.27	.40	.17	.35	.32	.80	.29	.50	.50	1.00	.58

TABLE 3 O

HAS THE FOLLOWING BENEFIT COME ABOUT: REDUCED THE NUMBER OF UNNECESSARY REPEAT EXAMINATIONS

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53	10	10	22	11	22	8	16	5	24	3	2	2	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
NO ANSWER	2	-	-	-	2	1	-	1	-	1	-	-	-	-
	3.8	-	-	-	18.2	4.5	-	6.2	-	4.2	-	-	-	-
LOW NET	13	4	3	6	-	5	1	3	-	4	2	2	-	4
	24.5	40.0	30.0	27.3	-	22.7	12.5	18.8	-	16.7	66.7	100.0	-	57.1
1 DEFINITELY HAS NOT	2	1	-	1	-	-	1	-	-	1	-	1	-	1
	3.8	10.0	-	4.5	-	-	12.5	-	-	4.2	-	50.0	-	14.3
2	11	3	3	5	-	5	-	3	-	3	2	1	-	3
	20.8	30.0	30.0	22.7	-	22.7	-	18.8	-	12.5	66.7	50.0	-	42.9
3	18	3	6	8	1	9	3	2	2	7	1	-	1	2
	34.0	30.0	60.0	36.4	9.1	40.9	37.5	12.5	40.0	29.2	33.3	-	50.0	28.6
4	15	2	-	6	7	5	4	8	3	10	-	-	-	-
	28.3	20.0	-	27.3	63.6	22.7	50.0	50.0	60.0	41.7	-	-	-	-
5 DEFINITELY HAS	5	1	1	2	1	2	-	2	-	2	-	-	1	1
	9.4	10.0	10.0	9.1	9.1	9.1	-	12.5	-	8.3	-	-	50.0	14.3
HIGH NET	20	3	1	8	8	7	4	10	3	12	-	-	1	1
	37.7	30.0	10.0	36.4	72.7	31.8	50.0	62.5	60.0	50.0	-	-	50.0	14.3
MEAN	.20	-.10	-.10	.14	1.00	.19	.25	.60	.60	.39	-.67	-1.50	1.00	-.43
STD ERR	.14	.38	.28	.22	.17	.20	.37	.25	.24	.21	.33	.50	1.00	.48

TABLE 3 P

HAS THE FOLLOWING BENEFIT COME ABOUT: INCREASED SATISFACTION LEVEL OF ATTENDING PHYSICIANS WITH RADIOLOGY SERVICE

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	4 7.5	- -	1 10.0	1 4.5	2 18.2	2 9.1	- -	1 6.2	- -	1 4.2	1 33.3	- -	- -	1 14.3
LOW NET	5 9.4	3 30.0	- -	1 4.5	1 9.1	3 13.6	1 12.5	- -	- -	1 4.2	- -	1 50.0	- -	1 14.3
1 DEFINITELY HAS NOT	2 3.8	1 10.0	- -	- -	1 9.1	1 4.5	- -	- -	- -	- -	- -	1 50.0	- -	1 14.3
2	3 5.7	2 20.0	- -	1 4.5	- -	2 9.1	1 12.5	- -	- -	1 4.2	- -	- -	- -	- -
3	19 35.8	1 10.0	5 50.0	10 45.5	3 27.3	8 36.4	4 50.0	5 31.3	2 40.0	9 37.5	1 33.3	1 50.0	- -	2 28.6
4	19 35.8	5 50.0	4 40.0	8 36.4	2 18.2	8 36.4	3 37.5	5 31.3	2 40.0	8 33.3	1 33.3	- -	2 100.0	3 42.9
5 DEFINITELY HAS	6 11.3	1 10.0	- -	2 9.1	3 27.3	1 4.5	- -	5 31.3	1 20.0	5 20.8	- -	- -	- -	- -
HIGH NET	25 47.2	6 60.0	4 40.0	10 45.5	5 45.5	9 40.9	3 37.5	10 62.5	3 60.0	13 54.2	1 33.3	- -	2 100.0	3 42.9
MEAN	.49	.30	.44	.52	.67	.30	.25	1.00	.80	.74	.50	-1.00	1.00	.17
STD ERR	.13	.40	.18	.16	.44	.21	.25	.22	.37	.18	.50	1.00	-	.48

TABLE 3 Q

HAS THE FOLLOWING BENEFIT COME ABOUT: INCREASED THE ACCURACY OF RADIOLOGY REPORTS

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	3 5.7	- -	1 10.0	1 4.5	1 9.1	2 9.1	- -	- -	- -	- -	1 33.3	- -	- -	1 14.3
LOW NET	10 18.9	7 70.0	1 10.0	2 9.1	- -	4 18.2	2 25.0	1 6.3	1 20.0	4 16.7	1 33.3	1 50.0	- -	2 28.6
1 DEFINITELY HAS NOT	4 7.5	3 30.0	1 10.0	- -	- -	1 4.5	2 25.0	- -	- -	2 8.3	- -	1 50.0	- -	1 14.3
2	6 11.3	4 40.0	- -	2 9.1	- -	3 13.6	- -	1 6.3	1 20.0	2 8.3	1 33.3	- -	- -	1 14.3
3	15 28.3	1 10.0	4 40.0	8 36.4	2 18.2	6 27.3	1 12.5	6 37.5	2 40.0	7 29.2	1 33.3	1 50.0	- -	2 28.6
4	16 30.2	1 10.0	4 40.0	8 36.4	3 27.3	7 31.8	4 50.0	4 25.0	- -	8 33.3	- -	- -	1 50.0	1 14.3
5 DEFINITELY HAS	9 17.0	1 10.0	- -	3 13.6	5 45.5	3 13.6	1 12.5	5 31.3	2 40.0	5 20.8	- -	- -	1 50.0	1 14.3
HIGH NET	25 47.2	2 20.0	4 40.0	11 50.0	8 72.7	10 45.5	5 62.5	9 56.3	2 40.0	13 54.2	- -	- -	2 100.0	2 28.6
MEAN	.40	-.70	.22	.57	1.30	.40	.25	.81	.60	.50	-.50	-1.00	1.50	-
STD ERR	.16	.42	.32	.19	.28	.24	.53	.25	.60	.24	.50	1.00	.50	.58

TABLE 4 A

RATING OF EFFECT OF TRIRAD SYSTEM: IT WAS EASY FOR ME TO LEARN TO USE THE RADIOLOGY SYSTEM

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	3 5.7	2 20.0	1 10.0	- -	- -	2 9.1	1 12.5	- -	- -	1 4.2	- -	- -	- -	- -
1 STRONGLY DISAGREE	1 1.9	1 10.0	- -	- -	- -	- -	1 12.5	- -	- -	1 4.2	- -	- -	- -	- -
2	2 3.8	1 10.0	1 10.0	- -	- -	2 9.1	- -	- -	- -	- -	- -	- -	- -	- -
3	8 15.1	2 20.0	2 20.0	2 9.1	2 18.2	3 13.6	2 25.0	2 12.5	- -	4 16.7	1 33.3	- -	- -	1 14.3
4	13 24.5	3 30.0	5 50.0	4 18.2	1 9.1	6 27.3	- -	4 25.0	1 20.0	4 16.7	1 33.3	- -	2 100.0	3 42.9
5 STRONGLY AGREE	29 54.7	3 30.0	2 20.0	16 72.7	8 72.7	11 50.0	5 62.5	10 62.5	4 80.0	15 62.5	1 33.3	2 100.0	- -	3 42.9
HIGH NET	42 79.2	6 60.0	7 70.0	20 90.9	9 81.8	17 77.3	5 62.5	14 87.5	5 100.0	19 79.2	2 66.7	2 100.0	2 100.0	6 85.7
MEAN	1.26	.60	.80	1.64	1.55	1.18	1.00	1.50	1.80	1.33	1.00	2.00	1.00	1.29
STD ERR	.14	.43	.29	.14	.25	.21	.53	.18	.20	.21	.58	-	-	.29

TABLE 4 B

RATING OF EFFECT OF TRIRAD SYSTEM: IT HAS MADE MY WORK MORE EFFICIENT

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	6 11.3	2 20.0	1 10.0	3 13.6	- -	3 13.6	- -	2 12.5	- -	2 8.3	- -	1 50.0	- -	1 14.3
1 STRONGLY DISAGREE	1 1.9	- -	- -	1 4.5	- -	- -	- -	1 6.3	- -	1 4.2	- -	- -	- -	- -
2	5 9.4	2 20.0	1 10.0	2 9.1	- -	3 13.6	- -	1 6.3	- -	1 4.2	- -	1 50.0	- -	1 14.3
3	20 37.7	5 50.0	3 30.0	11 50.0	1 9.1	8 36.4	3 37.5	4 25.0	1 20.0	8 33.3	1 33.3	1 50.0	2 100.0	4 57.1
4	16 30.2	1 10.0	4 40.0	7 31.8	4 36.4	6 27.3	4 50.0	4 25.0	2 40.0	8 33.3	2 66.7	- -	- -	2 28.6
5 STRONGLY AGREE	11 20.8	2 20.0	2 20.0	1 4.5	6 54.5	5 22.7	1 12.5	6 37.5	2 40.0	6 25.0	- -	- -	- -	- -
HIGH NET	27 50.9	3 30.0	6 60.0	8 36.4	10 90.9	11 50.0	5 62.5	10 62.5	4 80.0	14 58.3	2 66.7	- -	- -	2 28.6
MEAN	.58	.30	.70	.23	1.45	.59	.75	.81	1.20	.71	.67	-.50	-	.14
STD ERR	.14	.33	.30	.19	.21	.21	.25	.31	.37	.21	.33	.50	-	.26

TABLE 4 C

RATING OF EFFECT OF TRIRAD SYSTEM: IT HAS MADE RECORD KEEPING EASIER FOR ME

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	10 18.9	2 20.0	2 20.0	4 18.2	2 18.2	4 18.2	4 50.0	3 18.8	1 20.0	6 25.0	- -	- -	- -	- -
1 STRONGLY DISAGREE	5 9.4	1 10.0	- -	2 9.1	2 18.2	1 4.5	3 37.5	2 12.5	1 20.0	4 16.7	- -	- -	- -	- -
2	5 9.4	1 10.0	2 20.0	2 9.1	- -	3 13.6	1 12.5	1 6.3	- -	2 8.3	- -	- -	- -	- -
3	14 26.4	2 20.0	3 30.0	6 27.3	3 27.3	7 31.8	- -	2 12.5	1 20.0	3 12.5	1 33.3	1 50.0	2 100.0	4 57.1
4	27 50.9	5 50.0	5 50.0	12 54.5	5 45.5	11 50.0	4 50.0	9 56.3	2 40.0	13 54.2	2 66.7	1 50.0	- -	3 42.9
5 STRONGLY AGREE	2 3.8	1 10.0	- -	- -	1 9.1	- -	- -	2 12.5	1 20.0	2 8.3	- -	- -	- -	- -
HIGH NET	29 54.7	8 80.0	5 50.0	12 54.5	6 54.5	11 50.0	4 50.0	11 68.8	3 60.0	15 62.5	2 66.7	1 50.0	- -	3 42.9
MEAN	.30	.40	.30	.27	.27	.27	-.38	.50	.40	.29	.67	.50	-	.43
STD ERR	.14	.37	.26	.21	.38	.19	.53	.30	88	.26	.33	.50	-	.20

TABLE 4 D

RATING OF EFFECT OF TRIRAD SYSTEM: IT HAS MADE MY WORK MORE CHALLENGING

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	16 30.2	3 30.0	3 30.0	5 22.7	5 45.5	9 40.9	3 37.5	5 31.3	1 20.0	7 29.2	- -	- -	- -	- -
1 STRONGLY DISAGREE	8 15.1	2 20.0	1 10.0	2 9.1	3 27.3	6 27.3	2 25.0	1 6.3	1 20.0	2 8.3	- -	- -	- -	- -
2	8 15.1	1 10.0	2 20.0	3 13.6	2 18.2	3 13.6	1 12.5	4 25.0	- -	5 20.8	- -	- -	- -	- -
3	24 45.3	4 40.0	4 40.0	15 68.2	1 9.1	8 36.4	3 37.5	6 37.5	3 60.0	10 41.7	2 66.7	2 100.0	2 100.0	6 85.7
4	5 9.4	1 10.0	2 20.0	1 4.5	1 9.1	1 4.5	1 12.5	2 12.5	- -	3 12.5	1 33.3	- -	- -	1 14.3
5 STRONGLY AGREE	8 15.1	2 20.0	1 10.0	1 4.5	4 36.4	4 18.2	1 12.5	3 18.8	1 20.0	4 16.7	- -	- -	- -	- -
HIGH NET	13 24.5	3 30.0	3 30.0	2 9.1	5 45.5	5 22.7	2 25.0	5 31.3	1 20.0	7 29.2	1 33.3	- -	- -	1 14.3
MEAN	-.06	-	-	-.18	.09	-.27	-.25	.13	-	.08	.33	-	-	.14
STD ERR	.17	.45	.37	.18	.53	.30	.49	.30	.63	.24	.33	-	-	.14

TABLE 4 E

RATING OF EFFECT OF TRIRAD SYSTEM: THE BENEFITS TO ME HAVE OUTWEIGHED THE DISADVANTAGES OF THE SYSTEM

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	2 3.8	- -	1 10.0	- -	1 9.1	1 4.5	- -	1 6.2	- -	1 4.2	- -	- -	- -	- -
LOW NET	9 17.0	2 20.0	1 10.0	4 18.2	2 18.2	4 18.2	3 37.5	3 18.8	1 20.0	5 20.8	- -	- -	- -	- -
1 STRONGLY DISAGREE	6 11.3	1 10.0	1 10.0	3 13.6	1 9.1	2 9.1	3 37.5	2 12.5	1 20.0	4 16.7	- -	- -	- -	- -
2	3 5.7	1 10.0	- -	1 4.5	1 9.1	2 9.1	- -	1 6.3	- -	1 4.2	- -	- -	- -	- -
3	12 22.6	2 20.0	2 20.0	5 22.7	3 27.3	6 27.3	2 25.0	2 12.5	1 20.0	3 12.5	2 66.7	- -	1 50.0	3 42.9
4	20 37.7	4 40.0	5 50.0	11 50.0	- -	6 27.3	3 37.5	5 31.3	2 40.0	10 41.7	1 33.3	2 100.0	1 50.0	4 57.1
5 STRONGLY AGREE	10 18.9	2 20.0	1 10.0	2 9.1	5 45.5	5 22.7	- -	5 31.3	1 20.0	5 20.8	- -	- -	- -	- -
HIGH NET	30 56.6	6 60.0	6 60.0	13 59.1	5 45.5	11 50.0	3 37.5	10 62.5	3 60.0	15 62.5	1 33.3	2 100.0	1 50.0	4 57.1
MEAN	.49	.50	.56	.36	.70	.48	-.38	.67	.40	.48	.33	1.00	.50	.57
STD ERR	.17	.40	.38	.25	.47	.27	.50	.38	.68	.29	.33	-	.50	.20

TABLE 4 F

RATING OF EFFECT OF TRIRAD SYSTEM: IT HAS SIGNIFICANTLY ALTERED THE WAY I DO MY WORK

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53	10	10	22	11	22	8	18	5	24	3	2	2	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
NO ANSWER	1	-	1	-	-	1	-	-	-	-	-	-	-	-
	1.9	-	10.0	-	-	4.5	-	-	-	-	-	-	-	-
LOW NET	15	4	1	6	4	5	2	5	3	8	1	1	-	2
	28.3	40.0	10.0	27.3	36.4	22.7	25.0	31.3	60.0	33.3	33.3	50.0	-	28.6
1 STRONGLY DISAGREE	4	-	-	2	2	1	1	2	2	3	-	-	-	-
	7.5	-	-	9.1	18.2	4.5	12.5	12.5	40.0	12.5	-	-	-	-
2	11	4	1	4	2	4	1	3	1	5	1	1	-	2
	20.8	40.0	10.0	18.2	18.2	18.2	12.5	18.8	20.0	20.8	33.3	50.0	-	28.6
3	15	1	4	8	2	6	2	5	-	7	1	-	1	2
	28.3	10.0	40.0	36.4	18.2	27.3	25.0	31.3	-	29.2	33.3	-	50.0	28.6
4	14	4	3	5	2	5	3	4	1	6	1	1	1	3
	26.4	40.0	30.0	22.7	18.2	22.7	37.5	25.0	20.0	25.0	33.3	50.0	50.0	42.9
5 STRONGLY AGREE	8	1	1	3	3	5	1	2	1	3	-	-	-	-
	15.1	10.0	10.0	13.6	27.3	22.7	12.5	12.5	20.0	12.5	-	-	-	-
HIGH NET	22	5	4	8	5	10	4	8	2	9	1	1	1	3
	41.5	50.0	40.0	36.4	45.5	45.5	50.0	37.5	40.0	37.5	33.3	50.0	50.0	42.9
MEAN	.21	.20	.44	.14	.18	.43	.25	.06	-.40	.04	-	-	.50	.14
STD ERR	.16	.36	.29	.25	.46	.26	.45	.31	.81	.25	.58	1.00	.50	.34

TABLE 4 G

RATING OF EFFECT OF TRIRAD SYSTEM: I HAVE BEEN ABLE TO PROVIDE BETTER SERVICE TO MY PATIENTS

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53	10	10	22	11	22	8	18	5	24	3	2	2	7
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
NO ANSWER	1	-	1	-	-	1	-	-	-	-	-	-	-	-
	1.9	-	10.0	-	-	4.5	-	-	-	-	-	-	-	-
LOW NET	9	2	-	6	1	2	3	1	2	6	-	1	-	1
	17.0	20.0	-	27.3	9.1	9.1	37.5	6.3	40.0	25.0	-	50.0	-	14.3
1 STRONGLY DISAGREE	4	-	-	3	1	1	2	1	-	3	-	-	-	-
	7.5	-	-	13.6	9.1	4.5	25.0	6.3	-	12.5	-	-	-	-
2	5	2	-	3	-	1	1	-	2	3	-	1	-	1
	9.4	20.0	-	13.6	-	4.5	12.5	-	40.0	12.5	-	50.0	-	14.3
3	23	4	2	12	5	12	2	4	-	6	3	1	1	5
	43.4	40.0	20.0	54.5	45.5	54.5	25.0	25.0	-	25.0	100.0	50.0	50.0	71.4
4	14	1	7	3	3	6	2	6	1	7	-	-	1	1
	26.4	10.0	70.0	13.6	27.3	27.3	25.0	37.5	20.0	29.2	-	-	50.0	14.3
5 STRONGLY AGREE	6	3	-	1	2	1	1	5	2	5	-	-	-	-
	11.3	30.0	-	4.5	18.2	4.5	12.5	31.3	40.0	20.8	-	-	-	-
HIGH NET	20	4	7	4	5	7	3	11	3	12	-	-	1	1
	37.7	40.0	70.0	18.2	45.5	31.8	37.5	68.8	60.0	50.0	-	-	50.0	14.3
MEAN	.25	.50	.78	-.18	.45	.24	-.13	.88	.60	.33	-	-.50	.50	-
STD ERR	.14	.37	.15	.21	.34	.18	.52	.27	.68	.27	-	.50	.50	.22

TABLE 4 H

RATING OF EFFECT OF TRIRAD SYSTEM: THE SYSTEM SAVES ME TIME

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	1 1.9	- -	1 10.0	- -	- -	1 4.5	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	15 28.3	3 30.0	- -	11 50.0	1 9.1	6 27.3	3 37.5	2 12.5	1 20.0	6 25.0	1 33.3	1 50.0	1 50.0	3 42.9
1 STRONGLY DISAGREE	8 15.1	2 20.0	- -	5 22.7	1 9.1	3 13.6	3 37.5	- -	1 20.0	4 16.7	- -	1 50.0	- -	1 14.3
2	7 13.2	1 10.0	- -	6 27.3	- -	3 13.6	- -	2 12.5	- -	2 8.3	1 33.3	- -	1 50.0	2 28.6
3	14 26.4	3 30.0	2 20.0	7 31.8	2 18.2	5 22.7	4 50.0	4 25.0	1 20.0	7 29.2	1 33.3	1 50.0	- -	2 28.6
4	13 24.5	2 20.0	5 50.0	2 9.1	4 36.4	6 27.3	1 12.5	4 25.0	2 40.0	5 20.8	1 33.3	- -	1 50.0	2 28.6
5 STRONGLY AGREE	10 18.9	2 20.0	2 20.0	2 9.1	4 36.4	4 18.2	- -	6 37.5	1 20.0	6 25.0	- -	- -	- -	- -
HIGH NET	23 43.4	4 40.0	7 70.0	4 18.2	8 72.7	10 45.5	1 12.5	10 62.5	3 60.0	11 45.8	1 33.3	- -	1 50.0	2 28.6
MEAN	.19	.10	1.00	-.45	.91	.24	-.63	.88	.40	.29	-	-1.00	-	-.29
STD ERR	.18	.46	.24	.28	.37	.29	.42	.27	.68	.29	.58	1.00	1.00	.42

TABLE 4 I

RATING OF EFFECT OF TRIRAD SYSTEM: I EXPECT THAT BENEFITS FROM THIS SYSTEM WILL INCREASE IN THE FUTURE

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	4 7.5	1 10.0	- -	2 9.1	1 9.1	1 4.5	3 37.5	1 6.3	1 20.0	3 12.5	- -	- -	- -	- -
1 STRONGLY DISAGREE	3 5.7	1 10.0	- -	2 9.1	- -	1 4.5	2 25.0	- -	- -	2 8.3	- -	- -	- -	- -
2	1 1.9	- -	- -	- -	1 9.1	- -	1 12.5	1 6.3	1 20.0	1 4.2	- -	- -	- -	- -
3	9 17.0	2 20.0	2 20.0	4 18.2	1 9.1	4 18.2	1 12.5	1 6.3	- -	2 8.3	2 66.7	1 50.0	- -	3 42.9
4	19 35.8	4 40.0	5 50.0	9 40.9	1 9.1	6 27.3	3 37.5	6 37.5	1 20.0	10 41.7	1 33.3	1 50.0	1 50.0	3 42.9
5 STRONGLY AGREE	21 39.6	3 30.0	3 30.0	7 31.8	8 72.7	11 50.0	1 12.5	8 50.0	3 60.0	9 37.5	- -	- -	1 50.0	1 14.3
HIGH NET	40 75.5	7 70.0	8 80.0	16 72.7	9 81.8	17 77.3	4 50.0	14 87.5	4 80.0	19 79.2	1 33.3	1 50.0	2 100.0	4 57.1
MEAN	1.02	80	1.10	.86	1.45	1.18	-	1.31	1.20	.96	.33	.50	1.50	.71
STD ERR	.15	.39	.23	.25	.31	.22	.53	.22	.58	.24	.33	.50	.50	.29

TABLE 4 AA

RATING OF EFFECT OF TRIRAD SYSTEM: I DO NOT TRUST THE INFORMATION I OBTAIN

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	18 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	1 1.9	-	-	-	1 9.1	-	1 12.5	1 6.2	1 20.0	1 4.2	-	-	-	-
LOW NET	38 71.7	7 70.0	10 100.0	12 54.5	9 81.8	17 77.3	5 62.5	12 75.0	3 60.0	19 79.2	-	2 100.0	-	2 28.6
1 STRONGLY DISAGREE	23 43.4	3 30.0	5 50.0	8 36.4	7 63.6	10 45.5	2 25.0	10 62.5	1 20.0	12 50.0	-	1 50.0	-	1 14.3
2	15 28.3	4 40.0	5 50.0	4 18.2	2 18.2	7 31.8	3 37.5	2 12.5	2 40.0	7 29.2	-	1 50.0	-	1 14.3
3	7 13.2	2 20.0	-	4 18.2	1 9.1	3 13.6	1 12.5	2 12.5	1 20.0	2 8.3	1 33.3	-	1 50.0	2 28.6
4	5 9.4	-	-	5 22.7	-	2 9.1	1 12.5	-	-	1 4.2	1 33.3	-	1 50.0	2 28.6
5 STRONGLY AGREE	2 3.8	1 10.0	-	1 4.5	-	-	-	1 6.3	-	1 4.2	1 33.3	-	-	1 14.3
HIGH NET	7 13.2	1 10.0	-	6 27.3	-	2 9.1	1 12.5	1 6.3	-	2 8.3	2 66.7	-	1 50.0	3 42.9
MEAN	1.00	.80	1.50	.59	1.60	1.14	.86	1.33	1.00	1.22	-1.00	1.50	-.50	-.14
STD ERR	.18	.39	.17	.28	.22	.21	.40	.30	.41	.23	.58	.50	.50	.51

TABLE 4 AB

RATING OF EFFECT OF TRIRAD SYSTEM: I PERSONALLY TRY TO USE IT AS LITTLE AS POSSIBLE

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	MUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -	- -
LOW NET	44 83.0	8 80.0	10 100.0	17 77.3	11 100.0	20 90.9	5 62.5	16 100.0	5 100.0	21 87.5	1 33.3	2 100.0	- -	3 42.9
1 STRONGLY DISAGREE	31 58.5	4 40.0	5 50.0	13 59.1	9 81.8	15 68.2	3 37.5	10 62.5	4 80.0	14 58.3	1 33.3	1 50.0	- -	2 28.6
2	13 24.5	2 20.0	5 50.0	4 18.2	2 18.2	5 22.7	2 25.0	6 37.5	1 20.0	7 29.2	- -	1 50.0	- -	1 14.3
3	6 11.3	2 20.0	- -	4 18.2	- -	1 4.5	1 12.5	- -	- -	1 4.2	2 66.7	- -	2 100.0	4 57.1
4	1 1.9	- -	- -	1 4.5	- -	- -	1 12.5	- -	- -	1 4.2	- -	- -	- -	- -
5 STRONGLY AGREE	2 3.8	2 20.0	- -	- -	- -	1 4.5	1 12.5	- -	- -	1 4.2	- -	- -	- -	- -
HIGH NET	3 5.7	2 20.0	- -	1 4.5	- -	1 4.5	2 25.0	- -	- -	2 8.3	- -	- -	- -	- -
MEAN	1.32	.60	1.50	1.32	1.82	1.50	.63	1.63	1.80	1.33	.67	1.50	-	.71
STD ERR	.14	.50	.17	.20	.12	.21	.53	.13	.20	.21	.67	.50	-	.36

TABLE 4 AC

RATING OF EFFECT OF TRIRAD SYSTEM: I HAVE HAD LESS FLEXIBILITY BECAUSE OPERATIONS ARE MORE ROUTINIZED

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	2 3.8	- -	1 10.0	- -	1 9.1	1 4.5	- -	1 6.2	- -	1 4.2	- -	- -	- -	- -
LOW NET	23 43.4	4 40.0	6 60.0	7 31.8	6 54.5	11 50.0	1 12.5	8 50.0	3 60.0	10 41.7	1 33.3	- -	1 50.0	2 28.6
1 STRONGLY DISAGREE	8 15.1	1 10.0	1 10.0	2 9.1	4 36.4	3 13.6	1 12.5	4 25.0	2 40.0	5 20.8	- -	- -	- -	- -
2	15 28.3	3 30.0	5 50.0	5 22.7	2 18.2	8 38.4	- -	4 25.0	1 20.0	5 20.8	1 33.3	- -	1 50.0	2 28.6
3	19 35.8	4 40.0	2 20.0	11 50.0	2 18.2	7 31.8	6 75.0	3 18.8	1 20.0	8 33.3	2 66.7	2 100.0	- -	4 57.1
4	5 9.4	1 10.0	1 10.0	2 9.1	1 9.1	3 13.6	1 12.5	1 6.3	- -	2 8.3	- -	- -	- -	- -
5 STRONGLY AGREE	4 7.5	1 10.0	- -	2 9.1	1 9.1	- -	- -	3 18.8	1 20.0	3 12.5	- -	- -	1 50.0	1 14.3
HIGH NET	9 17.0	2 20.0	1 10.0	4 18.2	2 18.2	3 13.6	1 12.5	4 25.0	1 20.0	5 20.8	- -	- -	1 50.0	1 14.3
MEAN	.35	.20	.67	.14	.70	.52	.13	.33	.60	.30	.33	-	-.50	-
STD ERR	.16	.36	.29	.22	.45	.20	.30	.39	.75	.27	.33	-	1.50	.38

TABLE 4 AD

RATING OF EFFECT OF TRIRAD SYSTEM: SOME DECISION-MAKING HAS BEEN TAKEN AWAY FROM ME

		STAFF TYPE				SECTION								
	TOTAL	RAD	RESI-DENT	TECH	OTHER	DIAG	CT	NUC MED	US	IMAG	SPE-CIAL	ORTHO	UROL	OTHER
TOTAL	53 100.0	10 100.0	10 100.0	22 100.0	11 100.0	22 100.0	8 100.0	16 100.0	5 100.0	24 100.0	3 100.0	2 100.0	2 100.0	7 100.0
NO ANSWER	2 3.8	- -	1 10.0	- -	1 9.1	1 4.5	- -	1 6.2	- -	1 4.2	- -	- -	- -	- -
LOW NET	28 52.8	8 80.0	6 60.0	10 45.5	6 54.5	10 45.5	6 75.0	10 62.5	4 80.0	17 70.8	- -	1 50.0	- -	1 14.3
1 STRONGLY DISAGREE	12 22.6	4 40.0	- -	6 27.3	2 18.2	3 13.6	4 50.0	4 25.0	1 20.0	9 37.5	- -	- -	- -	- -
2	16 30.2	2 20.0	6 60.0	4 18.2	4 36.4	7 31.8	2 25.0	6 37.5	3 60.0	8 33.3	- -	1 50.0	- -	1 14.3
3	17 32.1	4 40.0	2 20.0	10 45.5	1 9.1	8 36.4	1 12.5	3 18.8	- -	4 16.7	3 100.0	1 50.0	1 50.0	5 71.4
4	3 5.7	- -	- -	2 9.1	1 9.1	1 4.5	- -	1 6.3	- -	1 4.2	- -	- -	1 50.0	1 14.3
5 STRONGLY AGREE	3 5.7	- -	1 10.0	- -	2 18.2	2 9.1	1 12.5	1 6.3	1 20.0	1 4.2	- -	- -	- -	- -
HIGH NET	6 11.3	- -	1 10.0	2 9.1	3 27.3	3 13.6	1 12.5	2 12.5	1 20.0	2 8.3	- -	- -	1 50.0	1 14.3
MEAN	.61	1.00	.44	.64	.30	.38	1.00	.73	.60	1.00	-	.50	-.50	-
STD ERR	.15	.30	.34	.21	.47	.24	.50	.30	.68	.23	-	.50	.50	.22

APPENDIX E. COST INFORMATION

Table E-1 presents annual costs for hardware, software, and maintenance of TRIRAD at NHB, from FY82 through FY89. One-time costs applied in FY82 are summarized in Table E-2.

TABLE E-1

COSTS OF TRIRAD SYSTEM FOR FY 82-89 HARDWARE, SOFTWARE AND MAINTENANCE --
EVALUATION OF TRIRAD AT NAVAL HOSPITAL, BETHESDA

	No.	Cost/Item or Monthly Cost/Item	FY 82	FY 83	FY 84	FY 85	FY 86	FY 87	FY 88	FY 89
Hardware Lease										
8-Channel Expander	6	$ 70.00	$ 3,682	$ 5,040	$ 5,040	$ 5,040	$ 5,040	$ 5,040	$ 5,040	$ 2,506
Bar Code Printer	7	295.00	18,103	24,780	24,780	24,780	24,780	24,780	24,780	12,321
Bar Code Reader	24	45.00	9,468	12,960	12,960	12,960	12,960	12,960	12,960	6,444
KVDT Basic	17	55.00	8,197	11,220	11,220	11,220	11,220	11,220	11,220	5,579
KVDT Intelligent	4	125.00	4,383	6,000	6,000	6,000	6,000	6,000	6,000	2,983
MAXIFILE System	1	2,390.00	20,952	28,680	28,680	28,680	28,680	28,680	28,680	14,260
Modem Short Haul	53	10.00	4,646	6,360	6,360	6,360	6,360	6,360	6,360	3,162
Modem Short Haul[1]	1	10.00	37	120	120	120	120	120	120	60
Optical Scanner	1	525.00	1,960	6,300	6,300	6,300	6,300	6,300	6,300	3,133
Printer 150CPS	6	120.00	6,312	8,640	8,640	8,640	8,640	8,640	8,640	4,296
Hardware Lease Total Costs			$77,740	$110,100	$110,100	$110,100	$110,100	$110,100	$110,100	$54,744
Hardware Maintenance										
8-Channel Expander	6	$ 20.00	$ 1,105	$ 1,584	$ 1,656	$ 1,728	$ 1,800	$ 1,872	$ 1,944	$ 1,002
Bar Code Printer	7	130.00	8,377	12,012	12,558	13,104	13,650	14,196	14,742	7,602
Bar Code Reader	24	25.00	5,523	7,920	8,280	8,640	9,000	9,360	9,720	5,012
KVDT Basic	17	25.00	3,912	5,610	5,865	6,120	6,375	6,630	6,885	3,550
KVDT Intelligent	4	35.00	1,289	1,848	1,932	2,016	2,100	2,184	2,268	1,169
MAXIFILE System	1	1,400.00	12,887	18,480	19,320	20,160	21,000	21,840	22,680	11,695
Modem Short Haul	3	10.00	4,879	6,996	7,314	7,632	7,950	8,268	8,586	4,427
Modem Short Haul[1]	1	10.00	39	132	138	144	150	156	162	84
Optical Scanner	1	150.00	588	1,980	2,070	2,160	2,250	2,340	2,430	1,253
Printer 150CPS	6	50.00	2,762	3,960	4,140	4,320	4,500	4,680	4,860	2,506
Hardware Maintenance Total Costs			$41,361	$60,522	$63,273	$66,024	$68,775	$71,526	$74,277	$38,300
Software Equipment and Maintenance										
Film File Management	1	$ 50.00	$ 438	$ 600	$ 600	$ 600	$ 600	$ 600	$ 600	$ 298
Patient Record File	1	50.00	438	600	600	600	600	600	600	298
Scheduling Feature	1	50.00	438	600	600	600	600	600	600	298
Raport II-A Module	1	75.00	658	900	900	900	900	900	900	448
Raport II-B Module	1	75.00	225[1,2]	900	900	900	900	900	900	448
Statistical Package	1	50.00	--	522	600	600	600	600	600	298
Teaching File	1	75.00	213	900	900	900	900	900	900	448
Software Equipment and Maintenance Costs			$2,410	$5,022	$5,100	$5,100	$5,100	$5,100	$5,100	$2,536
Equipment Lease and Maintenance Costs			$ 41,361	$ 65,544	$ 68,373	$ 71,124	$ 73,875	$ 76,626	$ 79,377	$40,836
One-Time Costs			$110,650	--	--	--	--	--	--	--
Total Costs			$232,161	$175,644	$178,473	$181,224	$183,975	$186,726	$189,477	$95,580

[1]Delivery delayed.
[2]Installed FY 84.

TABLE E-2

TRIRAD SYSTEM
ONE-TIME CHARGES FOR FY82
NAVAL HOSPITAL, BETHESDA

One-Time Charges	Number	Cost/Item or Monthly Cost Per Item	Total Cost
Documentation:			
Computer Operator Manual	3	$ 15.00	$ 45.00
Functional User 1 Manual	13	15.00	195.00
Functional User 2 Manual	13	15.00	195.00
System Description Manual	3	10.00	30.00
Terminal Operator Manual	13	10.00	130.00
Training Materials	135	5.00	675.00
Total Documentation Costs			$ 1,270.00
Software Items License Fees:			
Software Film File Management	-	-	$ 11,250.00
Software Patient Record File	-	-	15,000.00
Raport IIA	-	-	15,000.00
Raport IIB	-	-	11,250.00
Scheduling Feature	-	-	11,250.00
Statistical Package	-	-	7,500.00
System Initialization	-	-	7,000.00
Teaching File	-	-	7,500.00
Total Software Items License Fees			$ 85,750.00
Training Costs:			
Computer Operator Class	1	$ 1,390.00	$ 1,390.00
Executive Orientation Class	1	1,390.00	1,390.00
File and Table Building Class	2	1,390.00	2,780.00
Functional User Class[1]	10	1,390.00	13,900.00
Functional User Class[2]	3	1,390.00	4,170.00
Total Training Costs			$ 23,630.00
Total One-Time Charges			$ 110,650.00

[1]Conducted after system installation

[2]Conducted after optical scanner installation

APPENDIX F. DAILY DEPARTMENT WORKLOAD DURING POST-IMPLEMENTATION PERIOD

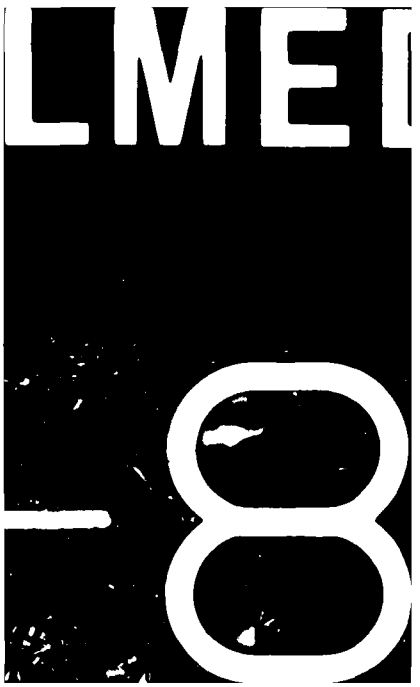
Table F-1 provides the daily volume of completed procedures in each of the eight sections of the Department in which TRIRAD was implemented for the period of post-implementation data collection.

TABLE F-1

NUMBER OF COMPLETED PROCEDURES DURING POST-IMPLEMENTATION DATA COLLECTION --
OCTOBER 5, 1982 - NOVEMBER 5, 1982
EVALUATION OF TRIRAD
NAVAL HOSPITAL, BETHESDA

	Main Radiology[a]	Orthopedic Radiology	Urologic Radiology	Special Procedures	Nuclear Medicine	Computerized Tomography	Ultra-Sonography	Total
Oct. 5	204	41	23	8	31	14	13	334
6	184	31	17	4	16	17	10	277
7	237	60	19	2	14	14	10	356
8	165	41	15	2	11	17	9	260
9	40	-	-	-	2	-	-	42
10	42	-	-	-	-	-	1	43
11	64	-	1	-	-	1	-	66
12	217	52	26	4	25	18	10	352
13	179	42	19	1	11	16	16	284
14	167	42	14	3	12	21	17	276
15	107	28	19	5	24	18	12	213
16	60	-	1	-	-	3	-	64
17	63	1	-	-	-	1	1	66
18	138	70	22	4	19	16	20	289
19	365	48	18	4	26	12	16	489
20	194	40	19	4	11	19	16	303
21	219	41	20	1	18	21	13	333
22	163	37	9	1	13	13	11	247
23	53	-	-	-	-	2	-	55
24	55	1	-	-	-	-	-	56
25	216	52	15	1	14	12	15	325
26	198	50	13	-	28	14	12	315
27	189	36	17	-	10	17	13	282
28	206	54	11	4	16	20	12	323
29	182	30	18	1	10	22	14	277
30	69	-	1	-	-	1	-	71
31	89	-	-	-	-	2	-	91
Nov. 1	218	49	17	6	17	18	14	339
2	225	46	16	1	23	10	9	330
3	194	45	17	2	12	15	5	290
4	224	52	31	2	13	3	11	316
5	168	39	22	3	15	0	1	248
	5094	1008	420	63	389	378	261	7633

[a] Includes procedures for GI Radiology which average 12 procedures per day (Monday to Friday).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