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STAFFING SOURCES OF USAF MEDICAL CENTER SYSTEMS OFFICES: A STUDY OF THEIR RELATION TO INFORMATION SYSTEMS QUALITY

THESIS

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THESIS

Presented to the Faculty of the School of Systems and Logistics of the Air Force Institute of Technology
Air University
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Master of Science in Information Resource Management

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Preface

The purpose of this study was to determine the extent to which Air Force Medical Systems Office staffing source was related to the level of quality of services provided in six medical centers. In these days of increased emphasis on quality management, we found a deep concern for providing the best medical information system customer service at every leadership level in the Air Force Medical Service.

Several people provided us with considerable assistance and guidance in this research project and deserve to be mentioned. Captain Herb Smaltz at USAF Medical Center Wright-Patterson spent several sessions brainstorming with us to find a manageable and interesting thesis topic. Major Pat Lewis smoothed the way to our receiving research sponsorship from AFMSA and provided invaluable guidance, background, and suggestions for further sources of information. We are also grateful to the CIOs at all six USAF medical centers for their interest, cooperation, and time in providing us with factual information and in the complicated process of distributing surveys to their users. We would also like to thank Colonel Obuchowski and his staff for their sponsorship and assistance and especially Nicki for her patience with our dozens of phone calls and diligence in obtaining her boss's blessing on this project. Last but certainly not least, we are greatly indebted to Lt Col Clyde Caufield and Dr. Guy Shane, our thesis advisors, for their

persistent guidance and encouragement. As a result of their talents as educators, we believe we are able to conduct good research.

Shelley D. Christian and William K. Dorr

Throughout my time here at AFIT, and especially while putting in the grueling hours for this thesis, I have been constantly reminded of the foremost importance of my family. My husband, Jim, was unwavering in his support for my career aspirations and understanding of the hardships involved in our 2000 mile separation because of my tour at AFIT. Our oldest daughter, Shannon, faithfully helped her dad in maintaining our California household. I hope someday Carrie, our almost 4 year old, will understand why she couldn't see her daddy and sister very often and why her mommy had to study so much. Their loyalty and love helped me to remember that in the grand scheme of things family is what matters most. I lovingly dedicate this project to them.

Shelley D. Christian

I wish to thank my wife, Deirdre, for her never ending support as I struggled to complete my thesis here at AFIT. As always she kept the family unit intact while I was thoroughly immersed in the AFIT experience. A special thank you is extended to my children Marian and Bill who spent countless hours assembling research questionnaires and stuffing

envelopes with minimal supervision. Their commitment and understanding helped me to stay focused and see this project through to completion.

William K. Dorr

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Abstract

This study measured the relationship between Medical Systems Office staffing source (i.e., military medical, military communications/computer, civilian government, and contractor personnel) and quality of automated information services provided at CONUS USAF medical centers. A literature search determined that information system quality is best measured on eight dimensions: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality. The CIO at each medical center was surveyed to determine the level of system conformance to Air Force standards with a 100 percent response rate and to gather data on each MSO staff. Users at the medical centers were also surveyed in order to measure performance, features, reliability, serviceability, aesthetics, and perceived quality. Durability was not measured in this study. The users were given the opportunity to evaluate up to three different information systems in operation at their medical center in several areas. Approximately 42.5 percent of the user survey population responded. No relationship was evident between MSO staffing source or source of staff supervision and the level of quality of information services. Further, the level of quality was unrelated to the types of information systems in operation.

STAFFING SOURCES OF USAF MEDICAL CENTER SYSTEMS OFFICES: A STUDY OF THEIR RELATION TO INFORMATION SYSTEMS QUALITY

I. Introduction

General Issue

In 1990, Captain Alan R. Constantian conducted a feasibility assessment of executive information systems for USAF hospital administrators. After analyzing data collected from Air Force hospitals within the continental United States (CONUS), he recommended "the training and educational opportunities for medical systems officers and their staffs must be seriously evaluated" (Constantian,1990:155). His data revealed that information system staffs had a low level of confidence in their own abilities. Further, he found that systems end users (see Definitions, below) generally did not feel the information system staff could adequately provide support for technological advances, such as the addition of an executive information system (Constantian,1990:155).

Armed with Constantian's findings and recommendations, the researchers approached Captain Detlev H. Smaltz, chief information officer at Wright-Patterson Air Force Base Medical Center. The goal in this initial meeting was to get Capt Smaltz's opinions on the topic of information system

(IS) staff training opportunities and skill levels. The interview revealed that this topic was the subject of much debate in the Air Force Medical Service (Smaltz,1991).

Smaltz stated that U.S. Air Force Program Action Directive (PAD) 90-4, which has been approved for implementation, would have profound effects on the staffing of USAF hospital information systems (HIS) (Smaltz,1991). The PAD has been approved by the Air Force Office of Medical Systems and implements a new plan for management of computers throughout the Air Force. When fully operational, all USAF computer systems (medical and nonmedical) will be staffed by personnel with communications-computer specialty codes. The computer people will remain under the supervision of the communications community, but will physically work wherever the actual computer hardware is located (Department of the Air Force,1990a).

According to Smaltz, the greatest impact of the PAD at Wright-Patterson AFB Medical Center will be to change organizational responsibility. The Medical Systems Office (MSO) is presently staffed with communications-computer people who report directly to the medical administrative portion of the hospital. Other USAF Medical Centers are staffed using alternative methods and will be affected differently by the PAD (Smaltz,1991).

Specifically, Capt Smaltz informed the researchers that at least one medical center had contracted out the

management of its information system with a civilian corporation. Further, other medical centers were staffed with medical administrative specialists who had received additional computer training (Smaltz,1991).

With evidence of a wide range of information systems staffing sources, the researchers see a potential for a wide range of quality levels within the information systems themselves. Therefore, the issue in this research is the extent to which the quality of information system support is related to the staffing source in Air Force medical center systems offices.

Research Objective

Under the sponsorship of the Air Force Medical Systems Agency (AFMSA), formerly the Air Force Office of Medical Support (AFOMS), the researchers examined the various information systems staffing methods and quantified the level of quality in the information systems at each of the six USAF medical centers in the continental United States (CONUS). The results of this study will reveal the extent of the relationship between staffing source and quality of the information system.

Specific Research Question

To what extent is there a relationship between the source of MSO staffing and the level of quality of the

services provided by medical systems offices in United States Air Force medical centers?

Investigative Questions

In order to answer the above specific research question, the following investigative questions need to be answered.

Question 1. What is the source of each Medical Systems Office staff member at each medical center (i.e., medical personnel with additional computer training, communications squadron personnel, or contractor)?

Question 2. What are the quality indicators necessary to measure the quality of information systems at USAF Medical Centers?

Question 3. What are the performance standards and goals of the USAF Medical Service as set by the Air Force Medical Systems Agency concerning information systems at USAF Medical Centers?

Question 4. To what extent are the Medical Systems Offices meeting the standards and goals set by the Air Force for the operation of medical information systems?

Question 5. To what extent do the customers feel that the Medical Systems Office is providing them with quality technical support in information systems?

Definitions

In order to avoid any misunderstandings of terminology, some key terms will be defined here as a means to eliminate possible obstacles to the reader's clear assessment of the research.

Information System (IS). An information system is an entity composed of hardware, software, data, procedures, and people. The information system's functions are to collect, transmit, process, and store data, and retrieve and distribute information to the system's users (Ahituv and Neumann,1990:2).

Chief Information Officer (CIO). The Chief Information Officer is the director and top manager of an organization's information system (Ahituv and Neumann,1990:200).

End User. End users are those individuals who directly use terminals or microcomputers to access data and programs. They are the information system's customers (Ahituv and Neumann,1990:547).

Outsourcing. Outsourcing is the practice of hiring a group from outside the organization to manage and oversee the operations of the organization's information system. The contractors do not fall under the administrative auspices of the organization (Hard, 1991; Kelly,1990; Williamson,1991).

Hospital Information System (HIS). A hospital information system is a group of computers and/or software designed

to support the flow of interdepartmental information (both administrative and clinical) within hospitals (Abrami and Sneider,1985:44).

Medical System Office (MSO). A medical system office refers to a hospital's information system staff and the physical location where they perform their duties.

USAF Medical Center. Air Force Medical Centers have the most inpatient beds (the gauge by which the size of a hospital is measured) of the three classes of Air Force hospitals. They provide a wider range of medical services than the smaller hospitals, receive referrals from the lower level hospitals, and provide specialty training to medical professionals. The Air Force has six medical centers in the CONUS: Wilford Hall Medical Center (Lackland AFB, Texas), Wright-Patterson Medical Center (Wright-Patterson AFB, Ohio), David Grant Medical Center (Travis AFB, California), Malcolm Grow Medical Center (Andrews AFB, Maryland), Keesler Medical Center (Keesler AFB, Mississippi), and Scott Medical Center (Scott AFB, Illinois) (AFR 168-4,1990:2-9a).

Air Force Medical Systems Agency (AFMSA). The USAF Medical Systems Agency, formerly the Air Force Office of Medical Support or AFOMS, located at Brooks AFB, Texas, and specifically the Medical Service Information Systems Division, functions to ensure standardization and equality among Air Force medical treatment facility information systems (AFR 168-4,1990:15).

Scope and Limitations

The scope of this research is limited by the population under study, i.e., the six medical centers. Although there are 40 Air Force hospitals of varying size in the CONUS, the researchers deemed it appropriate to limit this study to medical centers for two reasons. First, the medical centers have more highly developed information systems with large full-time staffs due to the nature of their medical mission. Second, as will be discussed in the third chapter, personal interviews will be administered to CIOs in order to obtain pertinent data concerning IS services and IS staff members at the medical facilities. A limited population of the six medical centers helped to ensure that this project dealt with sites with similar missions, range of services, and available resources. A similar research project using a larger number of medical facilities in the population could be a topic for further research.

Summary

This chapter identified an issue of concern to the USAF Medical Service: the relationship between information systems staffing source and quality of the information system. Furthermore, specific investigative questions were identified pertaining to the research question and key definitions were provided. The remainder of this thesis will be dedicated to responding to those investigative questions that could be answered from secondary data sources, to describing

the research methodology that will be used to answer those questions for which primary data is necessary, and to analyzing and drawing conclusions from gathered data. The next chapter will summarize pertinent information from the literature concerning trends in HIS, quality information systems, staff prerequisites, and available staffing sources. It will also report the standards and goals for Air Force medical system offices as outlined in Air Force Regulation 168-4, Chapter 14. Chapter III will describe the survey instruments and methods of validation, populations for each phase of the research, data collection process, and methods of data analysis.

After all data has been collected, statistical analysis of the data will begin. Chapter IV will describe the analysis procedures as well as draw conclusions from the analysis that serve to answer the remaining investigative questions. Finally, Chapter V will discuss the findings from the previous chapter and answer the specific research question. Moreover, the researchers will make recommendations for further research on this and related topics.

II: Literature Review

Introduction

The Air Force Medical Service is presently exploring a variety of sources for information systems specialists at its six medical centers. At least three different sources are currently being used, and at least one medical center chief information system officer has raised the question, "Which staffing method is best" (Obuchowski,1992; Smaltz,1991)?

In order to answer this question, several issues were explored in the literature. This literature review will answer the researchers' second investigative question by summarizing published works on current trends in hospital information systems. This part of the review will serve to emphasize the importance of the information system to the mission of the entire medical center and the need for attaining and maintaining currency and competitiveness in computer technology.

Second, a general definition of quality and how it pertains to hospital information systems will be discussed. In the process, definitive measures of quality in information systems (ISs) will be explored in order to establish guidelines for gauging how well Air Force Medical Centers are producing information.

Third, the researchers will summarize characteristics of information systems specialists required to maintain a quality information system. These characteristics will also be used as subjects of discussion later in this research paper. After all data concerning each IS staff has been gathered and analyzed, the researchers will discuss the characteristics' goodness of fit to the study population.

Finally, published viewpoints on the advantages and disadvantages of various staffing sources will be discussed. The literature abounds in differing views and little consensus is apparent. This discussion will be of interest after the final data analysis has been completed concerning the relationship between the staffing sources of sample medical systems offices and the IS quality ratings.

Current Trends in Hospital Information Systems

The 1970s, 80s, and 90s have signaled the coming of age of the computer. In the late 1950s, a computer capable of storing one megabyte of memory would have occupied about 400 square feet, and one with the same memory capacity in the mid 1970s was less than 3 square feet (Lemon and Toole, 1987:62). Although size hasn't changed much, today's so called "minicomputers" can store millions of megabytes of memory. In order to survive in this modern, rapidly advancing electronic era, highly competitive industries have had to aggressively develop state-of-the-art information systems (Lemon and Toole,1987).

In contrast, the medical care industry has, historically, made a very poor showing in the world of information systems development (Lemon and Toole,1987) because, prior to about 1984, hospitals did not have to compete with one another as other industries did. Hospitals charged patients and insurance companies whatever it cost them to treat the patient, plus a little to ensure a profit. Although medical professionals did make a feeble effort to automate some functions, they did so because computers were "nice to have," and hospital staff members strove to establish reputations as pioneers among their peers (Morris,1986).

In the last seven or eight years, the situation has changed dramatically. Federal and state governments, along with the insurance industry, have placed strict ceilings on reimbursements to hospitals, and patients have changed their attitudes concerning their expectations of the medical care system. These new developments have forced hospitals to compete fiercely with each other for shrinking economic gains. Necessarily, hospital information systems (HIS), defined as groups of computers and/or software designed to support the flow of interdepartmental information within hospitals (Abrami and Sneider,1985:44), have become the primary weapon in the medical center "fight for corporate survival" (Morris,1986:32).

Changes in the Environment.

The Economic Environment. This section discusses the dramatic changes in the economic, socio-political, and technological environments in which hospitals operate and how our medical care industry has sought to adapt to those changes through innovative information systems development.

In the early 1980s, our state and federal governments and health insurance companies began to realize that, without external influence, the cost of health care would continue to skyrocket as it did in previous decades. They began to implement controls to curb costs through prospective payment systems and diagnosis related groups (DRGs). Simply put, these plans dictated the amount of monetary reimbursement according to the patient's diagnosis, no matter how much it cost the hospital to provide treatment (Kim and Michelman,1990).

Hospital administrators found themselves having to make a very rapid transition from working in a noncompetitive industry whose only function was to fulfill a social need to one based on business and competition. Patients began shopping around for the hospital that would completely provide for their medical needs at a price their insurance company was willing to pay (Morris,1986).

Concurrent with the imposition of fixed fee payment structures on civilian hospitals, the public and the federal government were placing severe cost constraints on military

hospitals as well. The public began to balk at overcharging on the part of government contractors and the apparent waste of taxpayer money. Simultaneously, Congress began making drastic cuts in Department of Defense spending. Hence, military hospitals were forced to live within their yearly budgets with little hope of more money when they overspent (Shaw,1984).

Thus, in both the civilian and military sectors, medical cost managers and administrators were forced to look outside their industry for new approaches to get the "most bang for the buck." Most are finding the answers to their survival in the use of information technology (Hofman,1984; Lemon and Toole,1987).

The Socio-Political Environment. At the same time medical care costs have come under intense scrutiny, both hospital employees and the general public have changed their attitudes toward the way they provide and receive medical treatment. On the one hand, patients have begun to view themselves as customers seeking products and services from the health care system. They are no longer willing to endure poor customer service and are quick to switch hospitals and care providers if they are not satisfied. Customers now expect short waiting lines, immediate appointments, and rapid, efficient medical records processing. Thus, medical care facilities are forced to compete with each other in cost of treatment and quality of the customer

service they provide. Besides financial management, information systems have become invaluable in performing other functions--scheduling patients, reporting test results, and distributing other patient information (Hofman,1984; Kowalski,1991).

On the other hand, while demanding that less time be taken away from direct patient care, hospital employees have generally become more computer literate. Since computers are prevalent in homes and schools, staff members now, more than ever, accept the use of technology as a means of improving their on-the-job productivity. Thus, the hospital's employees have become the information systems department's internal customers. The result is even greater pressure to improve hospital information systems (Lemon and Toole,1987).

In contrast to the above factors encouraging hospitals to develop more modern information systems, there are other socio-political challenges within those hospitals. The first challenge is to lessen the fears of the small group existing within every organization which suffers from "computerphobia" (Sehr,1985:78). These individuals are highly resistant to change and even view computers as a threat to their position within the organization. Many feel their jobs may be eliminated through automation (Mann,1988).

Further, many physicians feel threatened by computerization. They feel they have exclusive rights to much of the

patient information they collect and that it should not be made available through hospital-wide information systems. In addition, many physicians view computers as "'control systems' whose sole purpose is to monitor and report on their behavior" (Kim and Michelman,1990; 204). The result has been a long-fought battle between physicians and hospital administrators on the subject of technological advancement of hospital information systems (Kim and Michelman,1990).

Hence, hospital information systems experts and administrators are being pulled in two directions in their efforts to more effectively use their computer systems to survive in the world of business. While trying to keep up with rapidly advancing technology, they must also make every effort to appease those social groups adamantly opposed to computer innovation.

The Technological Environment. As tight budget constraints, demands for quality customer service, and demands for high productivity are on the rise in the medical care industry, the world of automation is evolving at a rapid pace. Many of these breakthroughs significantly broaden the possibilities in expanding today's hospital information systems. A few of the most consequential developments which are directly relevant to the current study are discussed here.

One of the most important developments in the world of computing over the last decade has been the decreasing cost of hardware (by about 20 percent per year). This price reduction has enabled hospital administrators to consider new systems as a viable alternative (Lemon and Toole,1987:62).

Further, as noted earlier, microchip technology has decreased the size of computers and increased memory capacity, thereby adding capabilities beyond the imagination of the 1950s pioneers. Memory storage capacities are a million times greater and mainframes are a thousand times smaller than those of only three decades ago. Moreover, machines are now able to process information more than a hundred times faster than they could in 1970 (Lemon and Toole,1987:62).

Finally, improved telecommunications have greatly affected computerization. The extent to which this new technology has improved information distribution is well-stated by Lemon and Toole:

> Major changes in the communications industry have occurred in recent years, largely due to deregulation of the telephone industry. Historically, communications has [sic] been a limiting and expensive link in transferring large amounts of digital data. Information for computers had to be converted to analog form before it could be transmitted, then reconverted to digital pulses at the destination. This situation is changing rapidly as dedicated transmission links and related software are being developed. (Lemon and Toole,1987:62-63)

Lemon and Toole go on to that suggest fiber-optic lines will enable information to be transmitted at "ultra-high speeds" (Lemon and Toole,1987:63).

Maintaining a competitive edge in the world of business through information systems has proven to be a nearly overwhelming challenge for industries that began automating decades ago. Hospital staffs are being challenged even more in their attempts to narrow the 10 to 20 year information technology gap between the medical care industry and other industries.

Meeting the Challenge. New applications for hospital information systems that help medical centers adapt to the changing economic and socio-political environments are rapidly becoming available. They can be grouped into three broad categories: financial management, patient care, and decision support and strategic planning.

Financial Management. One of the largest items in any hospital's budget is its supplies and the movement of those supplies. Wagner states that medical care facilities will spend approximately 16 to 28 percent of their annual budgets on supply purchases. And surveys have shown that for every $1 spent to purchase an item, an additional $0.70 to $1 is spent on getting the item to its final destination, the user (Wagner,1990:23). The combination of supply purchases and supply movement can amount to as much as 45% of the total budget (Mendenhall,1988:54). Obviously, hospital

administrators have found the area of materiel management ripe with potential for trimming costs through information systems innovation.

Two new concepts in controlling inventory are slowly being accepted by the medical field. Both methods integrate new information technology into supply management. The first, "just-in-time inventory," requires "smaller but more frequent bulk deliveries to the hospital, thereby reducing stockpiles of supplies stored at the hospital" (Wagner, 1990:23).

The second, called "stockless inventory," entails no bulk deliveries, but instead requires suppliers to "send supplies already packaged for end-user sites. They may even deliver the supplies directly to those sites throughout the hospital" (Wagner,1990:23). Both systems require current, immediate communications between the hospital and the distributor. Often, end-user sites (wards and clinics) have direct on-line access to the distributor's computers through barcode scanners, enabling them to order their own supplies and eliminating the use of middlemen in the hospital's materials management department (Wagner,1990).

Patient Care. One of the most intriguing new concepts in hospital automation is called point-of-care or bedside computing. Terminals placed at the patient's bedside speed up the charting process by nursing personnel and the querying and ordering process by physicians. Nurses

eliminate about one hour per shift previously spent on paperwork, allowing them more time for direct patient care (Lemon and Toole,1987:66). Thus, productivity and job satisfaction are enhanced and the hospital saves money. "Although still largely in the research and development stage, point-of-care computing is projected by many to hold the strongest potential for achieving real productivity gains through information technology" (Lemon and Toole, 1987:66).

Further, complete automation of the patient's chart by the caregivers provides the hospital with the "ultimate database" (Mendenhall,1988:54). The computerized record of the patient's hospital stay can now become the source document for quality assurance review, the ordering of tests and recording of results, and even information pertinent to the patient's bill (Mendenhall,1988).

Decision Support and Strategic Planning. Perhaps the new information system technology that provides the greatest long-term benefit is in the area of decision support to hospital administrators. Decision support systems (DSSs) can aid in long range planning and forecasting future cost savings and improvements in customer service and productivity. These systems enable decision makers to extract and summarize pertinent information from computerized patient records, materiel management accounts, admission/ discharge scheduling records, and billing accounts.

Further, they will allow access to information concerning market share in relation to other hospitals in the same geographic area through public data bases (Lemon and Toole,1987; Kim and Michelman,1990; Hard,1990b).

The hospital administrator's goal in implementing decision support systems is to develop a tool to help him or her make quality strategic decisions concerning the hospital's future direction. A good DSS requires total integration of all computer systems within the organization, to include both historical and current data and future requirements, so that the decision maker has all the information he or she needs to make quality decisions (Lemon and Toole,1987; Kim and Michelman,1990; Hard,1990b).

DSSs can also be valuable to medical providers. They can "assist in diagnosing and treating illnesses, selecting antibiotics for infectious diseases, and managing complex chemotherapy for cancer patients" (Lemon and Toole,1987:64).

If users are unhappy with the information system, they will not use it unless forced to do so, and the system will not, in all likelihood, live up to management's expectations. Thus, in implementing new applications, managers must always keep in mind the social and political ramifications discussed earlier.

First, system designers must always remember that one of the critical success factors of today's hospitals is quality customer service. If the introduction of a new computer

technology does not have the potential to live up to this demand, management may want to give higher priority to another technology (Kowalski,1991).

Further, the needs of the hospital staff are also important. In addition to bedside computing, which increases productivity of nurses, other new ideas are currently being tried to increase job satisfaction. One of these ideas is the concept of an information center. Besides providing on-going training, this department's job entails convincing hospital employees of the need for change, hotline IS support, and maintaining a resource library. The goal in providing these services is to change the attitudes of those fearing computers so that they become comfortable with information processing and realize help is always available (Sockolow,1989).

To placate the anxieties of physicians, the information center staff must be very helpful in developing specialized applications tailored to the needs of individuals. End-user computing allows physicians to determine their needs in an information system, and thus reduce the feelings of being controlled by the system (Kim and Michelman,1990).

An overview of the hospital information system development process is shown in Figure 1. Hospitals are pushed toward the implementation of more comprehensive systems by growing budget constraints, the advent of new computer technology, and increasing computer literacy on the part of

hospital employees. Meanwhile, pockets of resistance, in the form of staff computerphobia and fear of territorial encroachment among physicians, tend to slow the change to comprehensive automation.

After hospital managers have determined that the potential benefits of system development outweigh the risks of furthering job dissatisfaction among the dissenters, they generally install new applications fitting into one of three

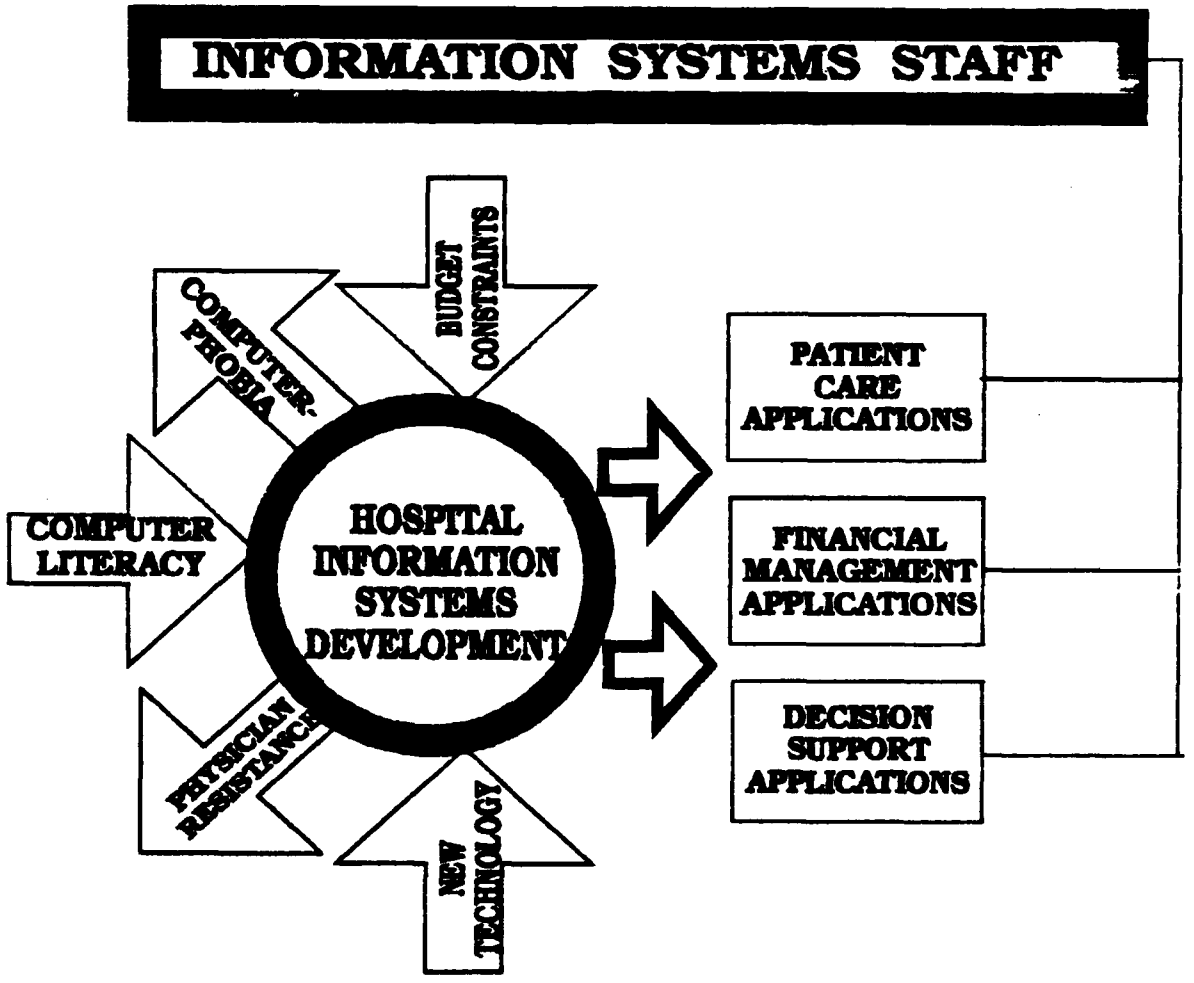

Figure 1. HIS Development Influences and New Applications

categories. These application categories are patient care, decision support and strategic planning, and financial management. The information system staff seeks to fulfill two functions: overseeing the transition and convincing those resistant to change of the potential rewards.

The 1980s brought a new business-oriented climate to hospitals. Along with the new climate, the last decade brought the coming of age of the computer. Information systems have matured into vital competitive weapons in effecting necessary changes in hospital business strategy.

How can one measure the HIS's level of success in helping the hospital meet its strategic goals? How can one measure the HIS's level of success in meeting the needs and desires of its customers? The answer to these questions lies in the measurement of the information system's most critical success factor--its quality.

What is Quality in Information Systems?

> *Kane ga naru ka ya*
> *Shumoku ga naru ka*
> *Kane to shumoku no ai ga naru*
>
> Is it the bell that rings,
> Is it the hammer that rings,
> Or is it the meeting of the two that rings?
> (Barankin:216,1964)

Measuring quality in the production of goods and services has become a science in and of itself in recent years. Many different factors must contribute to this measurement. In the absence of even one of the factors, the quality

"bell" will not ring. In this section, the most prominent views of the measurement of quality will be discussed.

To adequately assess the level of quality of an information system one must first precisely define the word "quality." This is something many researchers, philosophers, and managers have been attempting to do for decades. Quality is a slippery term whose meaning has been evolving since the dawn of the manufacturing age (Juran,1989).

Immediately following World War II, the United States found itself in a seller's market with the rest of the world. All of its factories, left unscathed by the ravages of battle, produced goods at breakneck speed in order to keep up with demand. Quality control was of little value since customers were satisfied with whatever they could get (Juran,1989:6-7).

At the same time that our country was lengthening its lead among manufacturing giants, the Japanese set their sights on entering the race. W. Edwards Deming was among the first experts on quality to assist Japan in this endeavor. He began by introducing that country's manufacturers to his 12 points for the transformation of industry. His aim was to steer management away from profit goals, management by objective, and quotas. He advocated a "constancy of purpose toward improvement of product and service" (Deming,1982:3). His original 12 points expanded to 14 after his first work with the Japanese (Deming,1982).

Through the assistance of Deming and others and the grass-roots determination of the Japanese people, many products manufactured today in Japan are preferred by customers the world over while many American industries are floundering (Garvin,1988; Deming,1982).

Deming states:

> With the storehouse of skills and knowledge contained in its millions of unemployed, and with the even more appalling underuse, misuse, and abuse of skills and knowledge in the army of employed people in all ranks in all industries, the United States may be today the most underdeveloped nation in the world. (Deming,1982:6)

For the last two decades, American producers have gradually begun to realize old ways will no longer keep our products and services competitive at home or in the world's marketplace (Garvin,1988). The emphasis has begun to shift from maintaining the bottom line to producing what the customer wants. David Garvin states:

> Quality is fast becoming one of the competitive issues of the 1980s and 1990s. A wave of imports, federal and state programs, and increased customer sensitivity have combined to give it new visibility. Pressures for improvement have become intense. The result is a heightened interest in quality management at many U.S. companies and a growing recognition of quality's strategic importance. (Garvin,1988:xi)

<u>What is Quality?</u> Having fully realized the impact of quality output on business success, managers next sought to define quality in terms that could be quantified at any point in time in the business cycle and improvement that could be measured. Useful definitions are abundant in

recent literature and all are derived from the same two themes: industry standards and customer desires.

Ernst and Young summarize the incorporation of standards and desires very clearly. They say the first step toward achieving product quality is "conformance to standards," or production free of flaws. Next is "meeting customer requirements," or the degree to which the user is satisfied with the product's design and usefulness (Ernst and Young,1990:4).

High quality will not be achieved by only satisfying one of the requirements. In fact, conformance to industry specifications only indicates the product is not of poor quality. Neither is a high level of quality ensured--only neutrality. Only when the second requirement, that of satisfying the customer, is met does the product have a positive quality value (Ernst and Young,1990:4-5). This two-portion concept of quality production is illustrated in Figure 2, on the following page.

J.M. Juran's term "fitness for use" aptly describes Figure 2. Conformance to specifications involves measurements such as error rates, waste and rework, time to market, and field failures. The standards for each of these measurements are set by people within the corporation and usually do not take into account the desires of the customer. These measurements are not a new idea. They have

been among the most heavily relied upon production quality control parameters for decades (Juran,1989:15-16).

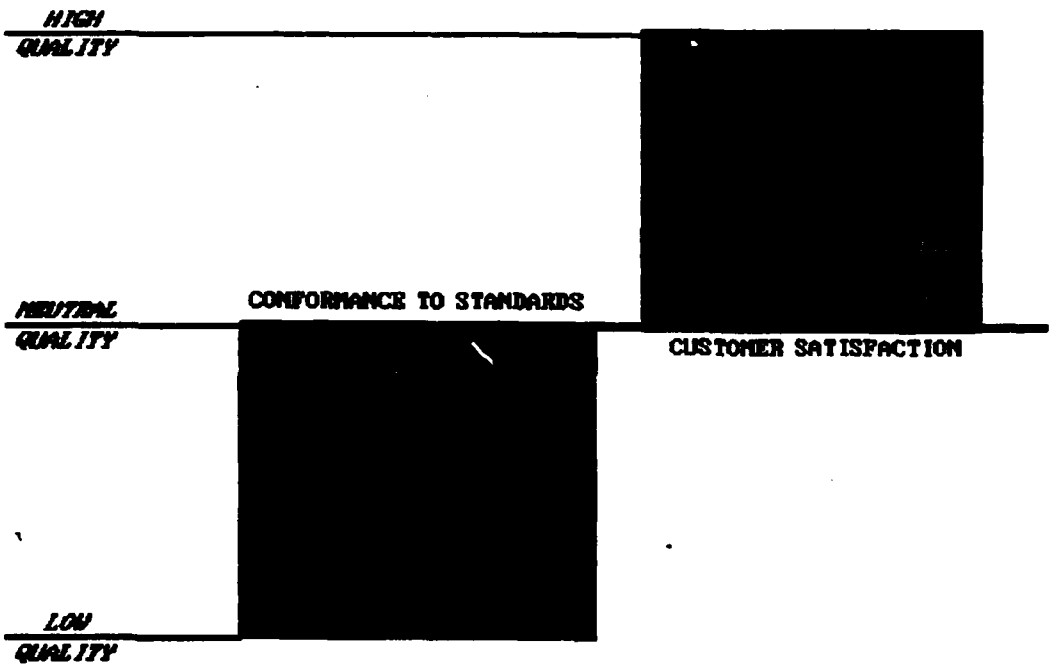

Figure 2. Measuring Quality (adapted from Ernst and Young,1990)

The measurements involved in determining the value of the right side of the above illustration (customer satisfaction) are the new ingredients in the total quality gauge. As American business people realize that competition is the key to survival, they are also realizing that the customer is the ultimate decision maker in determining a product's value. Ernst and Young state that "while quality of conformance is of obvious importance, conformance alone does not ensure competitiveness. One can easily imagine a perfect (defect-free) product that no one wants" (Ernst and

Young,1990:4-5). Indeed, an unsold, though flawless, product does little to improve a corporation's financial standing. Further, the former Soviet manufacturing system was a good example of how products can meet preset specifications without being of high quality. State standards abounded but customer preferences were never considered. The resulting goods were of questionable quality and, if put on the market in a competitive business environment, would have probably only gathered dust (Forker,1991).

The new movement toward attempting to fulfill customer desires has led to methods of precisely measuring a product's effectiveness in fulfilling those desires. Garvin is responsible for authoring a framework for product quality analysis which includes eight dimensions or categories of quality:

1. Performance - key operational attributes
2. Features - "nice to have" options that enhance the product's functionality
3. Reliability - measure of a product's probability of failure
4. Conformance - degree to which a product meets the manufacturer's specifications
5. Durability - length of a product's life
6. Serviceability - speed and ease of repair and the degree the manufacturer is willing to provide prompt, knowledgeable, and courteous service
7. Aesthetics - a very subjective measure of the degree a product appeals to the customer's senses

8. Perceived Quality - reputation and affiliation of the producer; often a product will be purchased by virtue of this dimension alone (Garvin,1988:49-60)

With the exception of conformance, the best means of measuring each of the dimensions include assessing the products of competitors and surveying potential buyers "to establish what customers mean when they say one product is of higher quality than another" (Garvin,1988:24).

Other authors have identified their own sets of quality indicators, but all direct managers to rely heavily on the customer's perception as the ultimate determinant of quality (Emmelhainz,1991; Juran,1989; Murray,1991; Spitzer,1991).

After years of poor performance on the part of American industry, quality management goals have finally become top priorities among our most competitive companies. In fact, striving to be "world class" has become the guiding principle in many strategic planning circles (Murray:7,1991). The 1992 Malcolm Baldrige National Quality Award will be given to the company which best meets the criteria in seven categories: "leadership, information and analysis, strategic quality planning, human resources, quality assurance, results, and customer satisfaction" (Sonnenberg,1990:63).

These criteria have been so successful in truly measuring quality that "30,000 [companies] are using the criteria to assess their own performance, to guide quality planning, and to understand the components of a total quality program" (Sonnenberg,1990:63). This widespread interest in quality

improvement throughout the country is, indeed, a long-needed trend in the way our producers do business.

Hence, to answer the question, "What is quality?", a product's quality is the degree to which the product meets industry standards and specifications and the degree to which the product satisfies the needs and desires of the customer (Deming,1982; Ernst and Young,1990; Juran,1989).

Applying Quality to Hospital Information Systems. The need to provide better quality service in our nation's medical industry resulted from governmental and insurance industry pressure to lower the cost of care and from demands for increased customer satsifaction. As was discussed earlier, a hospital's information system is a key element in meeting this need. Further, the information system itself must have a high level of quality in order to contribute to the entire organization's level of quality. Thus, quantitative measures of the system's quality must be made to assess its worth to the hospital (Spitzer,1991).

Spitzer has recommended measuring the extent to which:

- the customer-desired outcomes are achieved (and this is realized by the customer),
- undesired outcomes and repercussions are minimized, and
- the service is a positive experience for the customer. (Spitzer,1991:24-25)

Thus, even in a service-only discipline such as information systems, the same key indicators of quality as those used in manufacturing should be applied. Murray reinforces this thinking by saying, "Defining world class [information system performance] starts with seeing the world from the customer's point of view" (Murray,1991:7). He goes on to describe his "eight steps to target and develop the business case for quality improvement [in information systems]" (Murray,1991:8). Not surprisingly, these "eight steps" almost exactly mirror Garvin's (1988) "eight dimensions" mentioned earlier. Therefore, gauges determining the extent to which (1) an information system conforms to industry standards and specifications, and (2) an information system meets the needs and desires of its users are appropriate in measuring the HIS's level of quality.

People Who Manage Quality Hospital Information Systems

With the drastic changes currently being made in the tactics of business survival, every person in the organization must also adapt to the new work environment. In the case of information systems, people are the key element at the ends of the process, that of supplying the right kind of information, in an adequate amount, at the right time in order to meet the goals of the organization. People (information system specialists) must be able to interpret the information needs of other people (system users) and implement processes that meet those needs. Hence, great

emphasis must be placed on developing a quality information system staff conscious of every aspect involved in producing quality information (Moad,1990).

How would one go about describing the ideal information system staff member? The next section will summarize the views of several experts in information system management.

Technological Skills. A high level of technological competence is a mandatory requirement for every member of the IS department. As was discussed in a previous section, the pace at which computer technology is advancing is staggering. The ability of an organization to use these advances to keep one step ahead of the fierce competition is fundamental to the organization's survival (Moad,1990).

Information technicians who are lagging behind the times may find themselves dwelling on main-frame orientation, analysis, and project management, when they should be focusing on state-of-the-art technologies such as personal computers, local area networks, and fourth generation languages. Constant training and updating are mandatory for every IS person. If on-the-job training is not offered to them, they must actively seek out programs during off-duty time to keep abreast of new technology (Moad,1990).

Additionally, the day of the specialist is over in information systems. Because of the high degree of integration across the various systems in the organization, networks and data base sharing require the IS workers to be

experts in an increasingly wide array of information-related subjects (Moad,1990).

The task of keeping a staff versed on technology issues is a challenge by itself to the IS department manager. The manager's job becomes even greater when two other skill areas--interdepartmental relations and business acumen--are added to the list of employee requirements.

Organizational Public Relations. Coupled with the requirement for keeping up with a constantly changing technological environment, IS staff members must also learn to work face-to-face with users. The development of end-user computing is driving the information people out of their offices and computer rooms and into the customers' domains. They must constantly keep in touch with users, the jobs they do, and the special jargon they use in order to anticipate needs (Stokes). Ouellette writes that this intimate interaction with customers should extend to the point where IS professionals even "read their clients' trade publications and attend their clients' seminars and conferences" (Ouellette,1990:353).

The IS manager must ensure his or her people are continually abreast of changes in computing technology and are very familiar with the various career specialties of the clients. Still, this knowledge is not enough to guarantee quality among the staff. They must also become

knowledgeable about the business of the overall organization (Stokes,1991).

Business Concepts. The third area of expertise the manager must nurture among his staff and within himself concerns "the enterprise's vision, mission, objectives, and strategies" (Stokes,1991:46). Only then, will the entire department totally grasp their reason for being (Stokes, 1991).

The cultivation of business acumen within the information department will lead to an understanding of marketing and sales strategies, consulting, budgeting, the organizational power structure, planning, and competitive positioning (Stokes,1991). When the staff has a full understanding of these business concepts they will find themselves in the role of "strategic partners" with upper management (Ouellette,1990:354). They will be able to "have a strategic impact on corporate goals, and to position themselves for future success" (Ouellette,1990:355).

Certainly, the degree to which each of the above three skill areas needs to be developed in each IS individual is dependent upon that individual's level in the management hierarchy. A person on the lower rungs of the IS ladder needs to place a great deal of emphasis on technological competence, moderate emphasis on interdepartmental relations skills, and little or no concern with corporate business strategies. On the other hand, the department manager needs

to focus him/herself primarily on organizational business goals and public relations skills while technology is of tertiary importance (Hard,1990a; Stokes,1991). Stokes' illustration correlating the three area of competence to management level is shown in Figure 3, below.

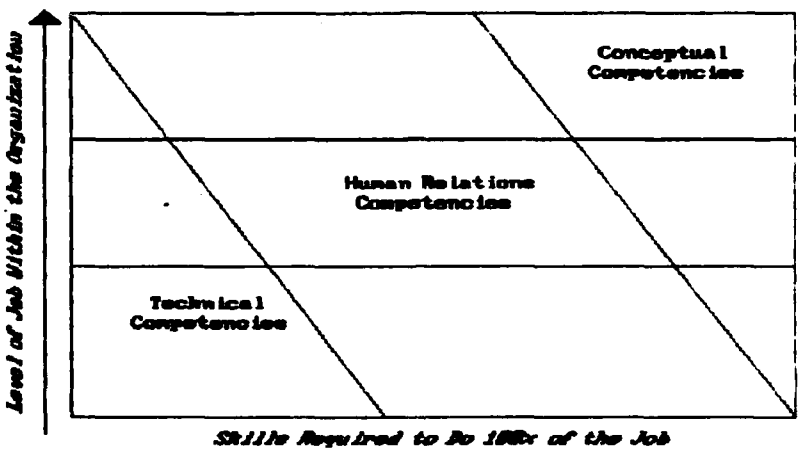

Figure 3. Competency Development by Managerial Level (adapted from Stokes,1991)

Organizational Loyalty. The final ingredient in the formula for a total quality information system staff is not a skill, but a belief. Numerous authors have written that shifting loyalty from profession to organization is critical to the success of the IS department (Bowen,1991; Carlyle,1990; DeJarnett,1990; Ouellette,1990).

Devotion to the mission of the corporation on the part of employees naturally leads to improving the human relations and business skills mentioned above. Information systems people begin to relate to their customers and are

more willing to get out and see what is going on in the rest of the organization. They no longer think of themselves as a stand-alone group doing a job unrelated to those outside the department. Instead, they believe "we're all in this together." Most importantly, they have a personal stake in the success of the whole company, not just their own information systems (Bowen,1991; Carlyle,1990; DeJarnett,1990; Ouellette,1990).

In review, the consensus reached by most information system management authors is that the most critical characteristics required of quality IS people are loyalty toward the organization and competence in technology, human relations, and business. These traits instilled into each individual member will result in what Bowen terms "person-organization fit" and a quality information system department (Bowen,1991:37-38).

Sources of Information Systems Specialists

Finding people who will meet the formidable criteria of quality information system specialists is proving to be quite a challenge for managers. Until recent years, skilled computer technicians met the organization's needs, but now, the information system must be piloted by people with a repertoire of talents ranging from business to public relations to finely-tuned technical expertise. Where should the chief information officer turn to uncover the best sources of people?

Experts in the field have fairly closely agreed on all concepts discussed in this review of the literature until this point, but when broaching the subject of staffing sources, the authors have divergent opinions. Some have attempted to adapt in-house employees to the new quality environment while others have contracted management of the information systems with an outside source. The latter method is called "outsourcing" (Kelly,1990:103). This section will cover the advantages and disadvantages of each. In most instances, the advantages of one will be the disadvantages of the other and *vice versa*.

In-House Staffing. Organizational loyalty is the most commonly cited advantage of using people from within an organization to run the information system. Employees have developed a sense of belonging to the company, and they are interested in seeing the business succeed. Coupled with loyalty is a clear chain of command with in-house personnel. Because people on the premises are responsible for direct supervision of the employees, many problems are minimized. Overtime during heavy workload periods is less likely to be debated and response time is better when quick service is required (Carlyle,1990; Kelly,1990).

Further, in-house employees tend to have a better knowledge of the organization's business and to know the users better. They do not feel like visitors in the workplace and

are more likely to get out of their offices and explore other work areas (Kelly,1990; Moad,1990).

Finally, several authors claim the organization has better control over the quality of the product and over disaster recovery. Information system personnel are part of the immediate organizational structure and, thus, top management has oversight responsibility for disaster plans, quality control monitoring, and the hiring process of individuals (Kelly,1990; Williamson,1991).

On the negative side, IS employees from within the organization tend to fall behind their outsourced counterparts in technical expertise. Costs for continuing training can amount to as much as $10,000 to $20,000 per year per person, a staggering amount in the minds of top managers who may not view IS training as a fiscal priority (Kelly,1990: 106).

Running the information system from within the organization often costs much more than having a contracted vendor do it. The vendor has the advantage of economies of scale, because information technology is its entire business and it may hold the IS contract with several corporations. Kelly cites a figure of 50 million instructions per second (MIPS) as the lower bound for economical in-house management. Below that level of information load, "the existing IS staff will be hard pressed to match the expense ratios available

to an outsourcing vendor that can spread the fixed costs over a higher volume" (Kelly,1990:103-104).

Outsourcing. In addition to the lower costs and increased ability to adequately train personnel, outsourced vendors will often employ more technically motivated and competent people. One of the reasons behind this practice is that vendor employees can more realistically "aspire to a job in senior management" than they can in an organization that is not in business solely to produce information (Williamson,1991:24). Many IS specialists will begin in another type of corporation and later move to an information company because of the greater advancement potential (Williamson,1991).

As was discussed earlier, lack of loyalty, ignorance of the corporate business, and inability to interact with end-users are the greatest disadvantages for outsourcing (Williamson,1991).

In addition, many corporations who have outsourced their IS operations have found that it is still necessary to keep knowledgeable systems people in their employ "both to manage the outsourcing vendor and also to manage the needs of users within the firm" (Kelly,1990:104). Thus, neither the IS personnel budget nor the IS training budget will fall entirely on the shoulders of the vendor (Kelly,1990).

Finally, at least two authors have stated that once the decision is made to outsource, that decision is probably

non-rescindable. Reversing the plan once it has been implemented would mean building and training a competent staff from the ground up (Kelly,1990; Williamson,1991).

Outsourcing information services is becoming increasingly more prevalent in corporate America. In 1990, Hard says it was a $5 billion industry and he predicts it will grow to $50 billion by 1994 (Hard,1991:54).

Certainly, any organization that processes information as part of its day-to-day operation should consider the applicability of outsourcing its IS staff, and every CIO should keep the idea at the forefront at all times even if he elects not to pursue it (Carlyle,1990:31). "Hospitals are perfect candidates for outsourcing IS because they are information-intensive, yet information systems are not their prime business function" (Hard,1991:54). According to Kelly, "It's difficult to turn back from outsourcing. But if the decision to outsource is irrevocable, the decision not to is infinitely reviewable" (Kelly,1990:106).

The Air Force Medical Service is keeping the idea of outsourcing hospital information systems at the forefront with its various methods of staffing, (i.e., contracting with civilians as at Wilford Hall Medical Center) (Obuchowski,1992) and using communications personnel to perform all information system functions as in Program Action Directive 90-4 guidelines (PAD 90-4,1990; Smaltz,1991). The advantages and disadvantages of each

source and the best staffing method in serving the customers' needs have been widely argued in the literature. The researchers set out to determine if there is a relationship between staffing method and information system quality in Air Force medical centers.

Standards and Goals of USAF Medical Information Systems

In order to establish the first level (the neutral level) of quality in medical information systems, a set of standards has been written by experts at the policy making level in the Air Force. These standards are found in Air Force Regulation 168-4, Chapter 14, Medical Information Systems Management. Air Force IS management objectives are listed below.

USAF MEDICAL INFORMATION SYSTEMS
MANAGEMENT OBJECTIVES

1. To help health care managers at all levels obtain timely and accurate information needed to plan, organize, direct, coordinate, and control operations of the Medical Service according to the priorities of the Air Force Surgeon General.

2. To establish and maintain an effective IS architecture to support the Medical Service mission consistent with the Defense Medical Systems Support Center and Air Force Plans.

3. To simplify, integrate, and modernize health care IS policies and procedures to the extent possible consistent with a coherent approach to effective management of medical information resources.

4. To ensure physical, administrative, and technical security measures and management standards are adequate for protection of sensitive unclassified health care and patient information, Privacy Act, and classified data.

5. To establish procedures to assess the effectiveness and operational impacts of Medical IS installations.

6. To ensure that Medical IS applications procured or developed are compatible with existing and planned capabilities.

7. To minimize duplication in reporting, data collection, and promoting information sharing among medical treatment facilities (MTF), Major Command Surgeon's offices, Headquarters USAF Surgeon General, and the Defense Medical Systems Support Center (AFR 168-4, Chap 14, Para 14-3).

In addition, the regulation spells out the individual medical center CIO's responsibilities in ensuring his or her facility meets those standards. These responsibilities are found in Appendix A. Briefly, Air Force medical treatment facility CIOs are responsible for determining the management and clinical information needs of the hospital staff, the level of detail and scope of the needed information, the best possible method of providing the information, and the presentation and analysis of the information. Further, they are responsible for planning for future information needs and system requirements; maintenance, monitoring, and security of all information systems and software; and the establishment and management of an in-house users' group. The specific approach taken to fulfill CIO responsibilities must be tailored to meet the needs and resources of the individual facilities (AFR 168-4,1990).

Medical information systems policy is initially developed at the Department of Defense level by an agency entitled Defense Medical Systems Support Center (DMSSC).

Those policies are amended and tailored to meet the needs of the Air Force by Medical Service Information Systems Division of AFMSA after coordination with the Air Force Standard Systems Center and the Air Force Surgeon General's Office. Finally, the Major Command Medical Information Systems Offices further adapt the guidance to fit the command mission before passing it down to the MTF CIOs for implementation. Figure 4 is an illustration of the Air Force Medical Service's medical information system policy and guidance hierarchy.

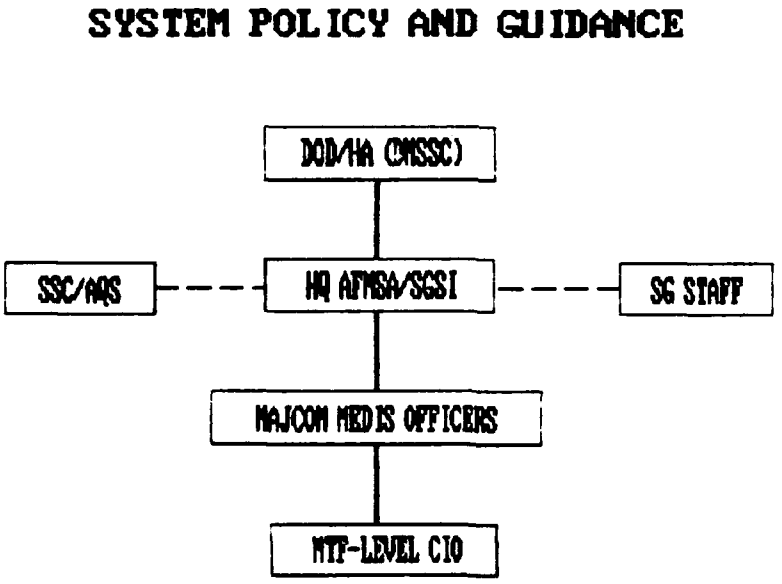

Figure 4. Medical System Policy and Guidance Hierarchy (AFR 168-4,1990:Chap 14, Para 14-2)

Responsibility for reporting to the Air Force Surgeon General's Office as to compliance with policy at each MTF lies with the Healthcare Services Management Inspection (HSMI) team. This team inspects every Air Force MTF every

12 to 24 months using checklists similar to the one found at Appendix B (AFR 168-4,1990). During their last inspections, all six Air Force medical centers were found to be satisfactorily complying with the objectives and standards (Obuchowski,1992).

This section served to answer Investigative Question 3: What are the performance standards and goals of the USAF Medical Service as set by the Air Force Medical Systems Agency concerning information systems at USAF medical centers? The explicit methods undertaken by the six sites to meet these goals will be discussed in the next chapter.

In addition, this section served to partially answer Investigative Question 4: To what extent are the Medical Systems Offices meeting the standards and goals set by the Air Force for the operation of medical information systems? All six research sites are adequately meeting the standards and goals of the USAF concerning information systems. In so doing, they have attained at least a neutral level of quality by conforming with standards. Again, further discussion of the individual programs within each MSO is warranted and is found in the next chapter. Establishing the level of quality above the neutral point must be done by measuring the level of customer satisfaction as illustrated earlier in this chapter in Figure 2 (Ernst and Young,1990). A survey of information system customers was used for this measurement and will be described in the next chapter.

Summary and Conclusions

This chapter established the need for quality in Air Force Medical Center information systems by examining the changes in the economic, socio-political, and technologic environments of the medical care industry. The importance of quality information production in keeping up with those changes was discussed.

Furthermore, measurement criteria, as established by experts, for gauging the quality of hospital information systems were defined. Specifically, the criteria are: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality. These criteria will be more thoroughly discussed as they apply to this research project. This section served to answer Investigative Question 2: What are the quality indicators necessary to measure the quality of information systems at USAF medical centers?

The researchers discussed technical competence, interpersonal skills, medical industry knowledge, and loyalty to the organization as requirements of information system staff members. These attributes will serve as a topic of discussion in the final chapters following the analysis of the findings pertaining to staffing methods at U.S. Air Force Medical Center information system offices.

Lastly, the standards and goals of information systems in USAF medical facilities were discussed as outlined in Air

Force Regulation 168-4. These standards are the yardstick by which information system conformance is measured. Because all six USAF medical centers met these standards during their last inspection by medical information system experts, a neutral level of quality was established. Thus, those criteria pertaining to customer satisfaction remained the deciding factors for the establishment of quality at the six research sites. This section provided the answer to Investigative Question 3: What are the performance standards and goals of the USAF Medical Service as set by the Air Force Medical Systems Agency concerning information systems at USAF medical centers? Further, it partially answered Investigative Question 4: To what extent are the Medical Systems Offices meeting the standards and goals set by the Air Force for the operation of medical information systems? Further discussion of Investigative Question 4 will be provided in the next chapter in a summarization of how each medical center information system office monitors the status of the Air Force's standards and goals within their individual facilities.

The following chapter will address the methodology used by the researchers to acquire the necessary data for evaluating the level of quality of information systems at USAF Medical Centers and the relationship to staffing sources.

III. Methodology

Introduction

This chapter discusses the methodology to be used to answer the investigative questions that were posed in chapter one. Included in this chapter is a description of the four research phases; a description of the measurement instruments to include justification of their use, developmental considerations, and the verification process; a description of the populations under study; and a description of the analytical tests to facilitate interpretation of the data.

Phases

TABLE 1

INVESTIGATIVE QUESTION RELATIONSHIPS TO RESEARCH PHASES

Phase #	Phase Description	Investigative Question #
One	Literature Review	2,3,4
Two	CIO Information Surveys	1,4
Three	Systems Expert Interviews	4
Four	User Surveys	5

The research was completed in four phases, as shown in Table 1. Phase One was a literature review to gather current information on hospital information systems and criteria for measuring quality. Phase Two was the

development and administration of a survey of USAF Medical Center CIOs, the purpose of which was to gather factual information concerning the MSO staff and functions and available information systems. In the third phase, information was gathered about the major information systems identified in Phase Two in order to more objectively evaluate the computing services and resources available at each medical center. Finally, Phase Four involved the development and administration of a questionnaire to system users at each medical center. Its purpose was to survey opinions about the quality of information services provided by the MSOs.

Phase One: The Literature Review. Phase one involved a review of the existing literature on trends in hospital information systems and measuring quality in these systems, and personal interviews with officials at the policy making level at the Air Force Medical Systems Agency (AFMSA). This initial phase was necessary to answer the first and second investigative questions and to partially answer the fourth investigative question:

Question 2. What are the quality indicators necessary to measure the quality of information systems at USAF medical centers?

Question 3. What are the performance standards and goals of the USAF Medical Service concerning information systems at USAF medical centers?

Question 4. To what extent are the Medical Systems Offices meeting the standards and goals set by the Air Force Medical Systems Agency concerning information systems at USAF medical centers?

The review of the literature was conducted using an on-line search of the Defense Technical Information Center (DTIC) and review of the holdings at the Air Force Institute of Technology (AFIT), Wright-Patterson Medical Center, and Wright State University medical and general libraries. The findings of the literature review were presented in Chapter II.

Three goals were achieved in the literature review phase. First, criteria were documented for highly qualified information system specialists in order for hospitals to keep pace with the rapidly advancing world of hospital information systems. The various types of qualified information system specialists (i.e., people directly employed by the organization and contractors) were discussed. Information concerning the types used by USAF MSOs was obtained in Phase Two of the research.

The second goal, to define and establish criteria for quality in Air Force medical center information systems, was partially accomplished by searching the literature on quality. Garvin's "eight dimensions of quality" provided a framework for measuring a product's effectiveness in fulfilling the desires of customers. These eight dimensions

are: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality (Garvin,1988). The researchers feel that durability, usually measured by the length of the product's life, is outside the scope of measuring the quality of information systems. This conclusion was reached because the ultimate product of an information system is the information it provides. The hardware and software that produce the information will periodically be replaced and updated, but the lifespan of the information itself is dictated solely by external factors (Ahituv and Neumann,1990). However, the remaining seven dimensions were used as specific criteria for measuring the quality of information systems at the medical centers. Table 2 shows the phase in which each quality dimension was measured. Those phases and instruments not yet discussed will be covered in following sections.

TABLE 2

QUALITY DIMENSIONS AND PHASES OF MEASUREMENT

Dimension	Phase	Instrument
Performance	One	Literature Review
	Two	CIO Survey
	Three	System Summary
	Four	User Survey
Features	Three	System Summary
	Four	User Survey
Reliability	Three	System Summary

TABLE 2 (continued)

Conformance	One	Literature Review
	Two	CIO Survey
	Three	System Summary
Serviceability	Two	CIO Survey
	Three	System Summary
	Four	User Survey
Aesthetics	Four	User Survey
Perceived Quality	Four	User Survey

The third goal of the literature research phase was to establish guidelines for evaluating performance and conformance of the services provided by USAF Medical Center MSOs. The intent of the researchers was to determine what performance standards and goals exist for Air Force medical information systems and the organizational level at which those standards and goals are formulated. Air Force Regulation 168-4, *Administration of Air Force Medical Facilities,* provided the researchers with insight into computer system development and monitoring procedures utilized by the USAF medical service (1990). The specific objectives of USAF medical information systems management are listed in Chapter II. Further, the specific responsibilities of the medical facility CIO for meeting those objectives are found in Appendix A.

The information gathered from published literature provided the researchers with a framework for developing the criteria for measuring quality in medical information systems and the standards and goals of USAF medical information

systems, thereby answering Investigative Questions 2, 3, and 4.

The next logical step in the research was to use the quality criteria and standards established in this phase to evaluate the services provided by each MSO. This process is discussed in the next section.

Phase Two: The CIO Survey. Phase Two involved the development and administration of the first of two survey instruments. The purpose of this survey was to answer Investigative Questions 1 and 4:

Question 1. What is the source of each Medical Systems Office staff member at each medical center (i.e., medical personnel with additional training, communications squadron personnel, or contractor)?

Question 4. To what extent are the Medical Systems Offices meeting the standards and goals set by the Air Force for the operation of medical information systems?

In order to fully answer these investigative questions, specific, factual information was needed from the CIOs at each medical center. The researchers designed a questionnaire for this purpose.

Population. The population of interest for this phase of the research are the chief information officers at each of the six continental United States (CONUS) medical centers in the Air Force.

Air Force hospitals are divided into three categories: hospitals, regional hospitals, and medical centers. Medical centers are distinguished from the other categories because they have a higher number of inpatient beds, provide a wider range of medical services, receive referrals from the lower level hospitals, and provide specialty training to medical professionals (AFR 168-4,1990). The six USAF medical centers in CONUS are located at Andrews AFB, Maryland, Keesler AFB, Mississippi, Lackland AFB, Texas, Scott AFB, Illinois, Travis AFB, California, and Wright-Patterson AFB, Ohio.

As stated in Chapter I, this study was limited to the medical centers because the researchers were interested in keeping the population fairly homogeneous so reasonable comparisons were possible. The medical centers have more highly developed information systems with large full-time staffs due to the nature of the medical mission. Many of the smaller hospitals are limited in their automated information services because they have part-time CIOs and because they have fewer monetary and labor resources from which to draw (Constantian,1991).

During Phase Two, the survey respondents were the CIOs at each medical center. The objective of this phase was to obtain factual data pertaining to the demographics of the MSO staff, the available information systems, and monitoring and control procedures. The researchers felt that the CIO at each medical center was the best source for factual,

statistical data about operations and staffing in his MSO. In addition, with the strong emphasis on quality and planning throughout the Air Force Medical service, the researchers felt that the information provided by the CIOs could possibly be supplemented by a detailed, accurate mission statement. The researchers surveyed every USAF Medical Center CIO to obtain a total census of the population.

Measurement Instrument. Written surveys were determined to be the appropriate method for collecting the information required in Phase Two for several reasons. First, there was a large geographical distance between the researchers and most of the survey population making personal interviews infeasible at all but one location, Wright-Patterson AFB. Telephone interviews were ruled out because the researchers felt that the survey participants would require some time to gather the data once they were informed what was needed. Moreover, a written survey ensured that all CIOs were asked the same questions in exactly the same way and that transcription errors by the researchers would not occur, common problems with telephone interviews. The CIO survey is found at Appendix C.

Each of the questions was followed by a large blank area in which the respondents could write as much additional information as they felt necessary for the researchers to obtain an accurate picture of the nature of each MSO's staffing source, work load, and functions. The researchers

remained available via telephone to answer questions from the CIOs pertaining to the intent of the survey. During initial telephone conversations, the researchers found a great deal of interest in the results of this research among the CIOs. Therefore, adequate and detailed information was expected from all six of the CIOs. Additionally, the researchers followed up by telephone if more information was required from the respondents. This method of combining written questionnaires, in order for the CIOs to have adequate time to retrieve required statistical data, with follow-up telephone conversations proved to be effective in obtaining consistent information among the medical centers.

Development of the Instrument. The questions included in this survey were developed by the researchers based on knowledge gained from published literature, preliminary discussions with the CIO at Wright-Patterson Medical Center, and discussions with the Medical Service Information Systems Division Chief at AFMSA. Individual questions were designed with the objective of finding answers to Investigative Questions 1 and 4 at the forefront. In writing the questions, the researchers followed the guidance of Emory and Cooper (1991) concerning question wording to guard against bias in the measurement questions.

The questions in the CIO survey were open-ended for several reasons. First, this is the most appropriate style of question when the objective is to obtain sources of

information and factual data (Emory and Cooper,1991). Second, the range of possible responses were too numerous to list in the closed question structure. Further, the range of possible responses could not be predicted by the researchers. Therefore, multiple-choice questions with exhaustive sets of possible answers were infeasible. Multiple-choice questions without every possible answer provided as a choice are inappropriate in scientific research (Emory and Cooper,1991). Finally, all six CIOs seemed motivated to provide detailed answers to the survey questions during initial telephone conversations with the researchers. Open-ended questions are well suited to a willing and small survey population (Emory and Cooper,1991).

The purpose of the first section of the survey was to establish reliable points of contact at each medical center. In so doing, the researchers were able to follow up on the survey's progress fairly easily. Included were questions pertaining to Defense Data Network electronic mail addresses and Defense Systems Network telephone number, along with the individual's name who would be distributing the Phase Four user surveys. This information provided the researchers with several avenues for communications with the respondents.

The next section of the CIO survey was designed to provide the answer to Investigative Question 1. It solicited demographic information about each medical center's

information system office staff. Respondents were asked how many people were on their staffs and to categorize the staff members according to Air Force Specialty Code (AFSC), civilian occupational code title, or externally contracted information service provider. Civilian occupational code titles and AFSCs are an indication of the nature and level of occupational training the individual has received (AFR 39-1,1991). The CIOs were further asked whether the staff members were supervised directly by the medical center, by the Air Force communications/computer community, or by a contractor. The answers to these questions enabled the researchers to group staff members into the following categories: medical personnel with additional computer training, communications squadron personnel, or contractor personnel. The communications squadron personnel were further grouped according to whether they are directly supervised by individuals within the medical center or by individuals within the communications/computer community outside the medical center.

In the third section, the CIOs were asked to list the information systems in service at their medical centers and the types of system control statistics that are regularly monitored.

The system control statistic information was used to further answer Investigative Question 4. Chapter II reports the findings that all six medical centers satisfactorily

meet the standards and goals of the Air Force in providing information services to the hospital staff. The researchers were interested in finding out how each MSO judges its own level of success; by measuring the amount of system down time, time between failures, time to repair, or any of a number of other measures of system quality (Garvin,1988).

The information concerning available systems, budgets, and MSO staff to medical center staff ratio were included to provide additional insight into the individual MSO's ability to provide additional services to its customers and the constraints under which the information specialists are working. These constraints will be one of the topics of discussion in Chapter V.

Pretesting. The draft CIO questionnaire underwent critical evaluation prior to its distribution to the survey population. First, it was reviewed by the thesis advisors for completeness and appropriate wording. Following their review, the survey was given to a medical systems expert in the Command Surgeon's office at Air Force Materiel Command Headquarters (HQ AFMC) and two AFIT graduate students who are U.S. Army Medical Service Corps officers. The recommendations of these experts resulted in several minor revisions to the questionnaire. Given the factual nature of the questions on the CIO survey and the fact that the survey participants were identified and easily accessible for

follow-up for answer clarification, further pretesting of this instrument was deemed unnecessary by the researchers.

Finally, the CIO survey was passed, along with the Phase Four survey instrument, through official channels to the Medical Systems Directorate of the Air Force Office of the Surgeon General at AFMSA for final approval. This approval was granted on 1 May 1992, with required changes only to the Phase Four survey. This second survey will be discussed in detail in a later section of this chapter.

Data Collection Plan. The CIO surveys were distributed to the medical center CIOs via data facsimile on 22 May 1992. Each of the officers was given a thorough explanation of the survey over the telephone prior to its being sent and further questions were answered by the researchers as the respondents were going though the process of completing the surveys. All six surveys were sent back to the researchers by 14 July 1992.

Survey Follow-Up Procedures. The researchers telephoned the six recipients of the CIO survey just prior to and immediately after the questionnaire was sent to them. In addition, three to four follow-up telephone calls from the researchers to the CIOs to check on survey completion progress were the norm. Five of the six surveys were returned to the researchers within two weeks after they were sent. One survey was somewhat delayed in its return. At that location, there was a misunderstanding concerning

survey procedure. The sixth completed survey was returned to the researchers within a short time after the issue was resolved for a survey response rate of 100 percent.

Statistical Tests. Results from the information systems officer surveys were summarized by the researchers. These summaries are in Chapter IV and will be discussed in detail in that chapter. The MSO data were not amenable to statistical analysis other than by categorical summary of the individual MSOs according to staffing source. Instead, it was used as a basis for comparison of the user survey results among the six medical centers.

Phase Three: Air Force Medical Systems Data. Part of the data acquired from the individual medical center CIOs involved a listing of information systems in service at each of the six locations. There was little uniformity among the medical centers in the types of systems used to provide information support. Further, many of these systems have been in service for a number of years while others are very recent additions.

The researchers and the research sponsor determined that additional information was needed describing the major medical information systems to include maintenance requirements, manpower requirements, and quantity and quality of information provided by each system (Obuchowski,1992). This information gave the researchers further insight into the interpretation and analysis of the Phase Four user survey

instrument. Detailed descriptions of the major information systems at USAF medical centers were obtained from a periodic report compiled by AFMSA as required by Air Force Regulation 168-4, Chapter 14.

Phase Four: The User Survey. As discussed in the first research phase section reported in this chapter, four of Garvin's measures of quality were to be gauged using the subjective opinions of information system customers (Garvin,1988). Therefore, the aggregate opinions of system users at each medical center were used to answer Investigative Question 5: To what extent do the customers feel that the MSO is providing them with quality technical support in information systems? With this objective in mind, the researchers designed and administered a survey to a sample of the users at each research site.

Measurement Instrument. As in Phase Two, the mail survey was determined by the researchers to be the most appropriate instrument for collecting the information required to meet the objective of Phase Four. This survey method was chosed for several reasons. First, the anonymity of the respondents was extremely important in order to receive honest answers to opinion questions. Specific answers can easily be attributed to specific individuals in personal and telephone interviews (Emory and Cooper,1991). Second, the researchers felt that the respondents would need extra time to think about the survey questions and to verify

answers. The self-administered mail questionnaire allows the respondent to take as much time as they need to answer the questions (Emory and Cooper,1991). Therefore, both personal and telephone interviews were infeasible and undesirable.

Moreover, the researchers had a limited amount of time in which to conduct their study. One of the advantages of mail surveys over personal or telephone interviews is that the surveys will reach respondents who might otherwise be inaccessible (Emory and Cooper,1991).

Emory and Cooper list several drawbacks to mail surveys. The researchers overcame these drawbacks in the design and distribution method of the instrument. First, mail surveys have consistently produced lower response rates than personal or telephone interviews (Emory and Cooper, 1991). Based on the experiences of other researchers who have surveyed Air Force medical personnel, specifically those of Parker (1987) and Constantian (1990), a response rate of approximately 40% was anticipated.

A second limitation of mail surveys lies in the quantity and kind of data that can be gathered. Probing and/or complex questions are not positively received by mail survey respondents (Emory and Cooper,1991). Therefore, relatively simple questions were written with short multiple-choice answers. Definitions were provided for terms that might be confusing to the respondents (detailed in the next section).

In addition, the survey was designed to take a short time to complete. During pretesting, the user survey was timed to take an average of 14 minutes to complete.

Development of the Instrument. During Phase Four of the research, a self-administered survey was used to collect data from a sample of the information system user population at the six medical centers. This survey is found at Appendix D. The researchers surveyed the administrative and clinical customers of the MSOs to determine their attitudes and preferences about the quality of technical support in information systems. The purpose of this survey was to answer Investigative Questions 4 and 5. The researchers used multiple-choice questions and statements with a Likert-type scale. According to Emory and Cooper (1991), multiple-choice questions are appropriate for determining gradations of preference, interest, or agreement while summated scales are appropriate for measuring a respondent's attitude toward the object of interest.

The first few questions asked for factual background information about the administrators and clinicians followed by questions to determine their attitudes and preferences related to the types and quality of information services offered by the MSOs. The survey began with questions that were straightforward and that required little thought on the part of the respondent. As the respondent progressed through the survey, the questions became increasingly

probing. This method, recommended by Churchill, gradually draws in the interest of the participant, and previous research has suggested that it increases the likelihood that the survey will be completed by the respondent. As the questions increase in depth, they encourage the participant to reflect upon his or her responses, thus providing greater theoretical validity to the more difficult questions (Churchill,1991:231-232).

Part one of the questionnaire specifically sought to define personal characteristics of the user such as job duties, previous computer experience and training, and level of computer use while on duty. Great care was taken in formulating the demographic questions such that respondent anonymity was preserved. This data was requested so that the researchers could check for and evaluate any correlation between the user's computer knowledge level and level of satisfaction with the medical center's information systems.

In part two, the user was asked to specify the three information systems they use most often while performing their duties and then to rate those three systems on performance, additional features, serviceability, and aesthetics. These evaluation criteria are four of the five most appropriately measured by the customers from Garvin's list of quality dimensions as discussed earlier in this chapter (Garvin,1988). Giving the respondent the option to rate up to three separate information systems was a recommendation

from the sponsor (Obuchowski,1992). It was felt that the different systems in service at each medical center offer different levels of services and are at different stages in their development life cycles. If the user were required to rate all the systems he or she uses with a composite score for each factor, the user might tend to skew the score toward the one with which he or she is least satisfied. Therefore, the four satisfaction scores (performance, additional features, serviceability, and aesthetics) would not be a true indication of the user's level of satisfaction with overall medical information services (Obuchowski:1992). Moreover, the researchers were of the opinion that some of the factors of satisfaction might be of greater importance to the users than others. Thus, the users were given the opportunity to rate the level of importance they place on each factor in each system they rated. These importance ratings were used by the researchers to weight the satisfaction scores. The method of weighting will be detailed further in the Statistical Tests section of this chapter.

Finally, part three asked the user to rate his or her overall satisfaction with the MSO staff and the medical center information systems. The objective of this section was to measure the customers' level of perceived quality of medical information services. Perceived quality is the fifth of Garvin's dimensions most appropriately judged by the system users (Garvin,1988).

All questions that surveyed the opinions of the respondents were based on a 5-point Likert scale. The scale of responses for all questions requiring a subjective answer were considered to be interval. Although the respondents had six answers from which to choose, answer number one was "No opinion." and was, therefore, considered to a be nonresponse and not on the Likert scale. Respondent demographic data was gathered using multiple-choice answers with each choice considered a discrete value.

The questions in this survey were designed to circumvent misunderstandings by avoiding generalizations or assuming previous knowledge of technical terminology. For example, the respondent was asked to rate his or her level of satisfaction with and how important he or she considered several factors (i.e., performance, additional features, serviceability, and aesthetics) in medical information systems. Before each specific question, the researchers provided a detailed definition of the factor.

Pretesting. The draft user survey was critically evaluated prior to its distribution to the users to ensure that the researchers' objectives in survey design were achieved. The researchers used a multiphased approach for pretesting the instruments.

As with the CIO survey, the Phase Four measurement instrument was first submitted to thesis advisors to review for completeness and appropriateness. Next, the CIO and a

nursing-information systems liaison officer who is a part-time AFIT student, both stationed at Wright-Patterson Medical Center, were called upon for their recommendations. Finally, the medical systems expert at HQ AFMC reviewed the survey.

The second phase of pretesting the user survey consisted of administering the questionnaire to fifteen graduate students at AFIT. Twelve of those taking the pretest were students in Information Resource Management program and the remaining three were U.S. Army and Air Force Medical Service Corps officers in other programs. All were asked to use the computer systems and the information system office at AFIT as the basis for their answers to the survey questions. The fact that those taking the pretest were evaluating educational information systems rather than medical information systems was not relevant to the objectives of pretesting the instrument.

The user's survey took an average of slightly more than 14 minutes for the pretest group (range - 9.25 to 17.5 minutes). Both the pretest group and the systems experts made several recommendations, which led to minor modifications to the survey.

Finally, the user survey, along with the CIO survey, was passed through official channels to the Medical Systems Directorate of the Air Force Office of the Surgeon General (AFMSA) for final approval. This approval was granted on

1 May 1992, with the only required change being the addition of the respondent's option to choose which information systems he or she would evaluate on the user survey.

Sampling Plan. In Phase Four, the population of interest consisted of both administrative and clinical personnel who are the users of the information systems at each of the six medical centers. The reasons for limiting this study to only the medical centers are discussed under Phase Two. This population represents the customers of the MSO at each medical center.

The researchers' goal was to send out approximately 300 surveys to each site. In so doing, the researchers were confident that they would have an adequate return rate to use the survey data to make assumptions about the entire population in accordance with the Law of Large Numbers (McClave and Benson,1991). The survey response means are an unbiased estimator of the response means if the entire population were surveyed independent of sample size according to the Central Limit Theorem (McClave and Benson,1991). From the CIO survey, the researchers learned that there were approximately 12,500 information system users at the medical centers. Therefore, about 14 percent of users were sent surveys in order to average 300 surveys at each medical center.

The user surveys were packaged in bulk and mailed to the individual points of contact within each MSO on 22 May

1992. Each point of contact was given distribution instructions as shown in Appendix E. The researchers' plan was to have the points of contact use their Terminal Area Security Officers (TASO) as sub-distribution points.

As explained earlier, the researchers' goal was to give surveys to approximately 14% of the systems users at each medical center and to send an average of about 300 surveys to each site. This number would ensure that at least 30 surveys would be returned from each site given a pessimistic response rate of 10 to 15 percent. The total number of users at each site was taken from the CIO survey. At all six medical centers, the total number of users equaled the total number on the medical center staff. As relayed to the researchers during telephone conversations, all six CIOs considered everyone employed by their medical centers to use medical information systems either directly or indirectly. Therefore, all medical center staff members are MSO customers.

Initial survey distribution numbers were calculated by taking 14 percent of the total number on staff at each medical center. Four of the six distribution numbers (Andrews AFB, Keesler AFB, Travis AFB, and Wright-Patterson AFB) were considered to be adequate to produce at least 30 responses from each site. However, Scott AFB and Lackland AFB's numbers were adjusted.

Fourteen percent of Scott's 1000 users is 140. The researchers felt that if only 140 of Scott's users were sent surveys, fewer than 30 might be returned. Therefore, the distribution number was adjusted to 230, the lowest number among the other sites.

The medical center at Lackland AFB has 4500 staff members, and its initial distribution number was calculated to be 630. The researchers adjusted this number downward to 450 out of consideration for the point of contact in the MSO. They felt that the distribution of 630 surveys would place an inordinately large additional workload on one person and might decrease her level of cooperation with and enthusiasm for the research project.

The distribution rate at each medical center was calculated by dividing the distribution number into the total number on staff. With the exceptions of Scott and Lackland, one survey needed to be distributed per seven users. Because of the distribution number adjustments described earlier, Scott's distribution rate was one survey per five users, and Lackland's distribution rate was one survey per ten users.

Table 3 shows distribution numbers and distribution rates for the medical centers.

Every TASO in each medical center has access to an alphabetical listing of the staff members in their area of responsibility. In order to distribute surveys at the

assigned rate, the MSO points of contact were asked to give that number of surveys to each of their TASOs equal to the medical center's distribution rate based on the number of staff members assigned to them. The TASOs were then instructed to distribute one survey to every seventh staff

TABLE 3

SURVEY DISTRIBUTION AND RETURN RATES

Medical Center	# Surveys	# Users	Dist. Rate	Response Rate	%
Andrews	230	1600	1 per 7	149/230	64.8
Keesler	290	2000	1 per 7	111/290	38.3
Lackland	450	4500	1 per 10	135/450	30.0
Scott	230	1000	1 per 5	124/230	53.9
Travis	230	1600	1 per 7	94/230	40.9
Wright-Patterson	260	1800	1 per 7	103/260	39.6

member on their list (every fifth staff member at Scott and every tenth staff member at Lackland.) An example of the distribution instructions is provided at Appendix E.

This method of distribution is called systematic sampling and virtually ensured that every medical department, occupational type, rank, and computer experience level would be represented. Further, by choosing every fifth, seventh, or tenth person on each TASO's list, a high degree of randomness was provided (Emory and Cooper,1991:265).

Survey Follow-Up Procedures. The CIOs at the medical centers were very helpful in assisting with follow-up procedures after the system user surveys were distributed. Specifically, the CIOs at Keesler, Andrews, and Scott enclosed their own cover letters with each survey

encouraging participation. Additionally, electronic mail messages, originating at the MSO, were transmitted at Keesler, Scott, Andrews, and Lackland as reminders to all recipients to fill out and return the surveys as soon as possible. The points of contact at Andrews, Travis, and Scott personally spoke to all of the medical center's TASOs to encourage them to follow-up within their own areas. Prior to survey distribution at Wright-Patterson, the CIO made announcements at staff meetings about the survey and explained the importance of high response rates and accurate completion of the answer sheets. After the surveys were distributed at Travis and Wright-Patterson, written reminders were sent to recipients to encourage participation.

A delay in the distribution of surveys at Travis resulted from a misunderstanding concerning survey procedures. Immediately after the issue was resolved, the surveys were distributed and the point of contact diligently follo. ed up with recipients.

Further, the researchers remained in telephone contact with the medical center points of contact to promote rapid and high response rates. Notwithstanding the transmission errors inherent in electronic mail systems and possibility of paper memos not reaching the intended recipient in mail distribution systems, each person to receive a user survey at each medical center was ideally contacted at least two times.

By 24 July 1992, a total of 718 usable surveys had been returned to the researchers for an overall response rate of 42.5 percent. Not counted in the response rate were 21 unusable surveys, either because most of the data was missing or the demographic data was inconsistent (e.g., three answers to the same question.)

Instrument Validity. Validity of measurement is "the ability of a research instrument to measure what it is purported to measure" (Emory and Cooper,1991:180). Emory and Cooper (1991) further state that instrument validity can be classified into three major types: content validity, criterion-related validity, and construct validity.

Criterion-related validity is the level of correlation between the results of the measurement instrument and some set of external criteria (Emory and Cooper,1991:181-182). Clearly, at this stage of research, there have been no criterion measures developed.

Construct validity is the degree to which the measurement instrument is related to the overall theoretical framework. A construct is an abstract idea which is not directly measurable. Evidence of construct validity normally involves multiple measures of the constructs under consideration (Emory and Cooper,1991:182-184). The current study's design makes no provision for such extra measures. Thus, it was not possible to validate Garvin's dimensions of quality constructs in this study.

Content validity is the type most applicable to surveys. An instrument is said to have content validity if it provides sufficient coverage of the research topic. It is usually a judgmental determination by experts. Specifically, the instrument is evaluated in terms of how well it covers all aspects of the topic, and the individual survey items are evaluated for adequacy and correctness. Content validity cannot be established quantitatively (Emory and Cooper,1991:180). The content validity of the user survey was determined through pretest and assessment by locally available Medical Service Corps officers and other medical systems experts. The pretest process was described earlier in this chapter.

An instrument's reliability is the degree to which it provides consistent results, that is its dependability, stability, and predictability. Reliability is a necessary contributor to, but not sufficient for the establishment of validity. Reliability can be measured using several different approaches. Some of these approaches are test-retest (stability), parallel forms (equivalence), split-half, and internal consistency (Emory and Cooper,1991). In the system user survey, the internal consistency approach was used to evaluate critical quality factors.

Cronbach's alpha coefficient was used to assess the level of reliability among the questions that sought to evaluate the overall quality of the MSO staff and the

available information systems. Cronbach's alpha coefficient was useful in determining the consistency of responses to these questions. According to Cronbach, alpha is "an estimate of the correlation between two random samples of items from a universe of items like those in the test" (Cronbach, 1951:297). The correlation between any two questions seeking to measure the same characteristic is also called a coefficient of equivalence, "showing how nearly two measures of the same general trait agree" (Cronbach,1951:298). The formula for calculating Cronbach's alpha coefficient is *n/(n-1)* times the *ratio of interitem covariance to total variance* where *n* is the number of items (Cronbach,1951). The researchers used SAS, a statistical analysis computer application, to calculate the alpha coefficients (SAS Institute,1990a and 1990b).

In formulating his equation for alpha as a measure of a test's reliability, Cronbach gave a conservative estimate of at least 0.6 as indicating adequate reliability especially since alpha is usually an underestimate of actual interitem correlation (Cronbach,1951). The researchers chose to use 0.6 as the minimum level for interitem reliability in this study.

Some concepts, specifically the users' opinions of information system quality and their levels of satisfaction with information system services, were incorporated into the survey using multiple questions to formulate an answer to

Investigative Question 5: To what extent do the customers feel that the Medical Systems Office is providing them with quality technical support in information systems? Cronbach's alpha coefficient was used to determine if respondents interpreted questions as intended by the researchers. This reliability measure was applied to the multiple questions to used build each composite response. Table 4 lists the variables determined by the answers to multiple questions and the survey question numbers pertaining to them. The reliability of each variable when using all components is also listed. Each variable was shown to be reliable with an acceptable Cronbach alpha score.

TABLE 4

VARIABLES DETERMINED BY MULTIPLE USER SURVEY QUESTIONS

Variable	Description	Survey Question #	Cronbach Alpha
1	User confidence level with information system and MSO office staff	30,32,58,59	0.620535
2	User satisfaction level with information system	34,35,36,40,41, 42,46,47,48,52, 53,54,60	0.869922

Variable one is a consolidation of the responses to questions asking the respondent to rate the level in improvement in the user's quality of work as a result of computers, the level of confidence the user has in the medical center's computers, the level of confidence the user

has in the medical center's MSO staff, and the level of satisfaction the user has with assistance provided by the MSO staff. This variable's alpha coefficient was acceptable by the criterion presented above.

Variable two was calculated from several sets of related questions. One set of questions concerning the user's level of satisfaction with performance, additional features, serviceability, and aesthetics were asked three times so that the respondent could evaluate up tc three different individual information systems in these areas. Further, another set of questions asked the user to rate the level of importance he or she considers applicable to each of the above areas. These importance ratings were used to weight the above satisfaction ratings. Each evaluated system's satisfaction factor importance score was converted to a decimal with a score of 2 (very low importance) equal to 0.2 and a score of 6 (very high importance) equal to 1. As discussed earlier, a score of 1 (no opinion) was considered to be a nonresponse. Each system's satisfaction factor score was then multiplied by its importance weight to get a weighted satisfaction score. These weighted scores were used to calculate the reliability for user satisfaction with information system. In addition, the user's satisfaction with the overall facility-wide information system was considered. The alpha coefficient for variable two was

sufficiently high to ensure high confidence in results from this measure.

Statistical Tests. Upon receipt of the completed user surveys, the results were sorted by medical center and loaded into six separate data files along with a file containing the total data set. Each answer sheet was verified for accuracy and rechecked by the researchers to ensure the answers were usable. Several statistical analysis programs were written in SAS for the purpose of examining the data. The programs were thoroughly pretested using a sample set of data (consisting of 15 answer sheets) to ensure that the programs were error-free and that they accurately measured the frequencies and interitem correlations as intended.

A Chi-Square (X^2) test was administered to determine if the distribution of the responses among the six research sites differed from the expected distribution based on the overall response percentage rate. Any significant differences between the actual site response rate and that expected would indicate unequal or skewed representation across the six medical centers (McClave and Benson,1991).

The researchers received 718 usable responses out of 1690 surveys distributed, resulting in a response rate of 42.5 percent. A Chi-Square test was done to determine if the distribution of responses significantly differed from the number of expected responses by medical center. The

researchers felt this test was necessary to ensure an unskewed representation across medical centers. The null hypothesis for the procedure was that the responses were not biased across medical centers. The calculation revealed that the response rates were, in fact, skewed at an alpha of 0.05, with a Chi-Square of 51.6, leading the researchers to reject the null hypothesis.

TABLE 5

OBSERVED VERSUS EXPECTED MEDICAL CENTER RESPONSE

Medical Center	Observed	Expected
Andrews	149	98
Keesler	111	123
Lackland	135	191
Scott	124	98
Travis	94	98
Wright-Patterson	103	110

Table 5 shows the actual number of surveys received (observed) and the number expected, based on an overall response rate of 42.5 percent, for each survey site. The medical centers at Andrews AFB and Lackland AFB were the most significant contributors to the high Chi-Square value. The expected response frequency for Andrews was 98 while its observed frequency was 149. The expected response frequency for Lackland was 191 while its observed frequency was 135.

Since the responses (particularly from Andrews AFB and Lackland AFB) were not consistent with uniform representation across medical centers, some caution must be taken in

interpreting results. This subject will be discussed further in Chapter V.

SAS programs calculated the frequencies, means, and standard deviations of each of the user survey questions. In addition, a Spearman's rho rank-correlation coefficient was calculated to measure the strength of the correlation among the user's educational level, prior computer training, and level of satisfaction with the medical center's computer systems. All of the above values were used to make further conclusions summarized in Chapters IV and V.

Finally, the specific research question (i.e., To what extent is there a relationship between the source of MSO staffing and level of quality of the information system in United States Air Force Medical Centers?) was answered with a measure of the strength of the correlation between staffing source (from the CIO survey) and the quality of the information services (from the user survey) provided at each medical center.

Summary

This chapter has provided a description of the research process for this study. Four separate phases of research have been identified and discussed. Phase One involved a review of the existing literature on trends in hospital information systems and the standards and goals of medical information services in the Air Force. The results of this research phase were reported in Chapter I.

This chapter focused its discussion on the final three phases of the study. Phase Two involved the development and administration of a survey instrument for the CIO at each of the six Air Force medical centers. The purpose of this phase was to gather information pertaining to MSO staffing and available information systems at each medical center. The population of interest, measurement instrument, development of the instrument, and instrument pretesting method were discussed. In addition, the data collection plan, survey follow-up procedures, and data analysis design were outlined.

Phase Three's objective was to gather data about the information systems most prevalent at Air Force medical centers in order to provide the researchers with a more objective basis for comparison among the six research sites. Brief descriptions of major information systems are in Chapter IV.

Finally, Phase Four involved the development and administration of a survey instrument to be given to a sample of information system customers at the six medical centers. The purpose of this survey was to quantitatively determine the level of customer satisfaction with the available information systems and services provided by the MSO staff. The population of interest for this survey, the measurement instrument, and the instrument development procedures were described. Instrument pretesting, plan for data collection,

follow-up procedures, and instrument validity were also discussed. Finally, the plan for analyzing the data gathered from the administration of the user survey was reported. Chapter IV discusses the findings of these analyses. The researchers' recommendations and conclusions based on the findings are found in Chapter V.

IV. ANALYSIS OF DATA

Introduction

This chapter discusses and analyzes the data gathered in Phases Two, Three, and Four of the research. Phase Two involved the development and administration of a CIO survey which was used to gather factual, statistical data about operations, staffing, and personnel in each MSO. In Phase Three, the researchers conducted telephone interviews with medical systems experts at AFMSA to obtain detailed descriptions of the major information systems at the six medical centers. Phase Four involved the development and administration of a User survey designed to determine the users' level of satisfaction with the MSO and information systems at their medical centers.

First, there is a discussion of the responses to the CIO survey from Phase Two. This section describes the individual MSO demographics to include a depiction of staffing characteristics at each medical center followed by a listing of available information systems at the six research sites.

Next, the results of the system user survey are detailed. In this discussion, an assessment of respondent representativeness and a summary of respondent demographics are included. The user responses are analyzed by medical

center and then by individual information system. Then, an overall picture of all responses is drawn.

Finally, the functions, capabilities, and other factors of the major information systems found at Air Force medical centers are summarized.

This chapter answers Investigative Questions 1, 4, and 5 which follow.

Question 1. What is the source of each Medical Systems Office staff member at each medical center (i.e., in-house, other military organization, or civilian organization)?

Question 4. To what extent are the Medical Systems Offices meeting the standards and goals set by the Air Force for the operation of medical information systems?

Question 5. To what extent do the customers feel that the Medical Systems Office is providing them with quality technical support in information systems?

The CIO Survey

This section presents the results of the CIO survey found at Appendix C and serves to answer Investigative Questions 1 and 4.

Question 1. What is the source of each MSO staff member at each medical center, (i.e., in-house, other military organization, or civilian organization)?

Question 4. To what extent are the Medical Systems Offices meeting the standards and goals set by the Air Force for the operation of medical information systems?

The CIO survey was sent to the chief information officers at each of the six USAF medical centers in the continental United States. The survey was a fill-in-the blank format, designed to collect factual, statistical data about operations, staffing, and personnel from each medical systems office.

All six of the CIOs responded to the survey resulting in a response rate of 100 percent. All of the surveys were usable and are included in the analysis.

Medical System Office Personnel Functions. Table 6 presents a summary of the number of personnel and the personnel functions in the information systems offices as reported in the CIO surveys. In Table 6 and all succeeding tables and figures, the names of the medical centers are abbreviated as follows:

David Grant Medical Center = DGMC
Keesler Medical Center = KMC
Malcolm Grow Medical Center = MGMC
Scott Medical Center = SMC
Wilford Hall Medical Center = WHMC
Wright-Patterson Medical Center = WPMC.

TABLE 6

MEDICAL SYSTEM OFFICE PERSONNEL FUNCTIONS

	NAME OF MEDICAL CENTER					
STAFF FUNCTIONS	DGMC	KMC	MGMC	SMC	WHMC	WPMC
Programmers	2	4			10	5
Computer Operators		13	7	3		
Training/Work Center Support		5	3			
Administrative Support		2			5	
Composite Health Care System (CHCS) Support		4	2			
Individual System Specialists	7		2	1	8	19
LAN Specialists					7	1
Customer Service	2			2	12	4
Management	1	2	2	1	9	3
Number on IS Staff	12	30	16	7	51	32

There is a wide range in the number of personnel working in each MSO. As shown in Table 5, the number of personnel ranged from a low of seven at Scott AFB to a high of fifty-one at Wilford Hall.

The surveys revealed that personnel in the MSOs work in one of nine functional areas. These nine areas are: programmers, computer operators, training/work center support, administrative support, Composite Health Care System (CHCS) specialists, individual system specialists, local area network (LAN) specialists, customer service, and management.

CHCS is a new medical system currently being fielded for outpatient use throughout DOD. Presently, Keesler AFB and Malcolm Grow Medical are using CHCS for outpatient clinics and serving as inpatient test sites for the system.

Medical System Office Personnel Staffing by Source. Table 7 presents a summary of the source of staffing for information systems office personnel. The sources of staffing are divided into four categories. USAF medical systems refers to any active duty Air Force member with a medical systems specialty. Their experience and training requirements are specifically stated in Air Force Regulation 39-1 and are authorized to carry a "W" prefix on their Air Force Specialty Code (AFSC) which denotes their duty qualifications and experience. They are medical specialists who have undergone extra training in computer application design, analysis, supervision, and monitoring and who have held a medical systems job position for at least 24 months (AFR 39-1).

Personnel with an "SC" specialty would normally work in a communications squadron. USAF SC personnel do not receive any formal training in hospital administration, operations or medical systems. Rather, they are trained in the operation of generic information systems.

A civilian government employee is a USAF General Schedule (GS) or a General Management (GM) employee working in a medical systems related occupational code title.

TABLE 7

MEDICAL SYSTEM OFFICE PERSONNEL STAFFING BY SOURCE

	NAME OF MEDICAL CENTER					
SOURCE OF STAFF	DGMC	KMC	MGMC	SMC	WHMC	WPMC
Military Medical Systems	6	4			5	6
Military SC		3	4		4	15
Civilian Government Employee	6	6	7	6	29	6
Contractor		17	3		13	2
Other				1		3
TOTAL	12	30	16	7	51	32
Number Supervised by Medical Center	12	13	0	0	0	18
Percent Supervised by Medical Center	100%	43%	81%	100%	75%	56%
Number Supervised by SC	0	0	0	0	0	12
Percent Supervised by SC	0%	0%	0%	0%	0%	38%
Number Supervised by Contractor	0	17	3	0	13	2
Percent Supervised by Contractor	0%	57%	19%	0%	25%	6%

A contractor is a civilian employee who is working in an information systems office but is employed by a commercial firm contracted by the Air Force.

The category "Other" refers to those personnel working in the MSO who are medical specialists but have not undergone extra training in computer application design,

analysis, supervision, or monitoring. As an example, at Scott Medical Center, there is a military cardiopulmonary technician working in the MSO.

The categories below the row labelled "TOTAL" are not categories of source of staffing. "Number supervised by medical center" is the number of people on the MSO staff supervised by the medical center. This category includes staff members who are military medical systems, civilian GS or GM employees, others, and SC personnel who are supervised in their activities by the MSO staff. "Number supervised by SC" is the number of people on the MSO staff who are supervised by the communications squadron. "Number supervised by contractor" is the number of people supervised by the contractor by which they are employed. All of the contractor personnel at the medical centers are supervised by a representative of the contractor rather than the MSO. When dealing with issues concerning contract personnel, the MSO staff must deal with a government contracting representative. The government contracting representative presents the issues to the contractor's representative who then deals with the contractor personnel. The only personnel who can fall into this category are contractor personnel and SC personnel who are not supervised by the MSO and contractor personnel.

The researchers were surprised by the mix of personnel staffing sources at all of the medical centers. Table 7

reveals that, with the exception of David Grant and Scott, each medical center has staff members in at least three categories of staffing source. Prior to receiving the results of the CIO surveys, the researchers thought it would be appropriate to categorize each medical center by primary source of staffing, (i.e., source of staffing at one medical center might be predominantly civilian contractor). However, with the mix of personnel staffing sources at individual medical centers, the researchers found that it would be misleading to attempt to categorize each medical center by source of staffing.

Nonetheless, Figures 5 and 6 show that some generalizations can be made from the CIO survey data concerning MSO staffing sources. In both figures, the names of the medical centers are abbreviated as follows:

David Grant Medical Center = DGMC
Keesler Medical Center = KMC
Malcolm Grow Medical Center = MGMC
Scott Medical Center = SMC
Wilford Hall Medical Center = WHMC
Wright-Patterson Medical Center = WPMC.

First, the Scott and David Grant Medical Center MSOs have no contracted or SC staff members. They are made up entirely of military medical and civilian government employees. On the other hand, Keesler's MSO is staffed about 50 percent by contracted personnel, far more than any other medical center.

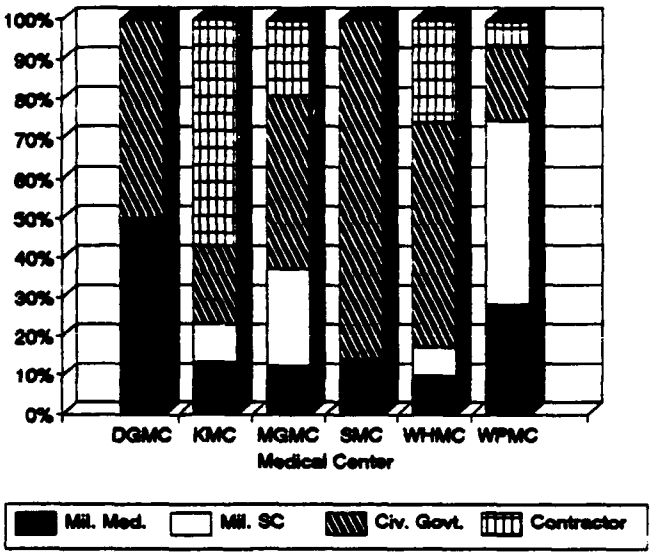

Figure 5. MSO Staffing by Source

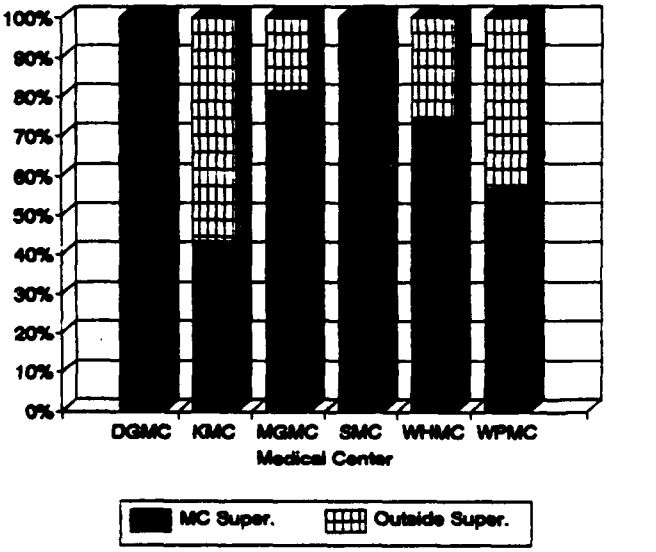

Figure 6. Supervision of MSO Staff Members

The David Grant, Wilford Hall, and Scott MSOs have 50 percent or more civilian government employees. Scott's civilian government work force makes up about 85 percent of the total.

Finally, Wright-Patterson MSO has the largest proportion of SC staff members of all the medical centers with about 50 percent of its staff made up of SC personnel. There is a smaller proportion of SC employees on the MSO staffs at Keesler, Malcolm Grow, and Wilford Hall.

Malcolm Grow has the most heterogeneous staffing make up, with each of the four main categories fairly well represented.

Further observations can be made about medical center staffing if civilian contractors and individuals who are supervised by SC are grouped together because they are not supervised by medical center personnel. Figure 6 shows percent under medical center supervision versus percent under outside supervision. In Figure 6, the category "MC supervision" refers to the percentage of personnel from Table 7 who are supervised by medical center. The category "outside supervision" is the percentage of personnel who are either supervised by SC or supervised by a contractor. Most noteworthy are the facts that almost 57 percent of Keesler's MSO staff and almost 44 percent of Wright-Patterson's MSO staff are under outside supervision.

Medical Center Information Systems. From the CIO surveys, the researchers obtained a list of information systems currently operating at each medical center. Table 8 is a consolidation of these lists and was developed to provide a roster of information systems in all of the medical centers and to show which medical centers operate each system. A more detailed description of the functions and capabilities of the major systems is found in the next section of this chapter and at Appendix F.

TABLE 8

MEDICAL CENTER INFORMATION SYSTEMS

	NAME OF MEDICAL CENTER					
INFORMATION SYSTEM	DGMC	KMC	MGMC	SMC	WHMC	WPMC
Automated Quality of Care Evaluation Support System (AQCESS)	X	X	X	X	X	X
Commanding Medical Information System (CMIS)		X				
Composite Health Care System (CHCS) *		X	X			
Computer Assisted Processing of Cardiogram (CAPOC)		X			X	X
CPT System					X	
Dental Data System			X		X	
EAS-III/MEPRS	X	X		X	X	X
Hospital Information System			X			
Managed Health Care						X
MEDLOG	X			X	X	
MEDNET		X		X	X	X
PC III		X			X	
SAS III			X			
TMPS PC Network						X
TRIFOOD		X	X		X	
TRILAB			X	X		X
TRIPHARM	X	X	X	X	X	X
TRIRAD	X		X	X	X	
Wang Inventory					X	

*Note: System is approved and is being fielded for outpatient use throughout the DOD. It is being tested for inpatient use at Keesler and Malcolm Grow Medical Centers.

Medical Center Control Statistics. There was one common link in the control statistics which the medical centers track and report. All of the medical centers reported that they track the amount of downtime for their major information systems on a monthly basis. As the downtime is compiled and recorded, it is reported as System Availability or percentage of time the systems were operational. At David Grant, Keesler, Malcolm Grow, and Scott Medical Centers, System Availability was the only control statistic reported by the MSO.

The MSOs at the larger medical centers reported that they track additional control statistics. Wilford Hall reports three additional control statistics. The MSO performs a random system monitor of software at three-day intervals. This measurement tracks Central Processing Unit (CPU) response time and indicates if response time for a system is slow. A daily error log is kept to record system errors, and a VAX Performance Advisor measurement, a software product of VAX, is recorded to monitor hardware and software system performance at the time of a system problem and quarterly.

The Wright-Patterson MSO tracks trouble response time and trouble repair time. Trouble response time is the amount of time it takes for a service technician to respond to a reported system problem, and trouble repair time is the amount of time that it takes to repair a system problem from the time a service technician responds to a reported

system problem. In addition, the MSO conducts an annual survey among the information system users in the medical center. The survey allows users to let the MSO know in which areas the users desire additional applications, services, and training. These results are analyzed and reported by the MSO to the medical center commander and to the users. The MSO also conducts monthly training classes for users in applications such as Enable and Wang E-mail. The attendance at these classes is reported as a control statistic.

The User Survey

A total of 1,690 user surveys as shown at Appendix D were distributed to information system users at the six medical centers. 718 usable questionnaires were returned to the researchers, for a 42.5 percent response rate. The purpose of this survey was to determine the users' level of satisfaction with the MSO and information systems at their medical centers. Additionally, they were asked to rate the performance, additional features, serviceability, and aesthetics of the information systems they use most often. The information gathered from this survey was used to answer Investigative Question 5: To what extent do the customers feel that the medical systems office is providing them with quality technical support in information systems?

Information Systems User Respondent Demographics.

There were 739 respondents in the survey population of 1690, resulting in a response rate of 43.7 percent. Of these 739 responses, 21 were deemed unusable because they were either filled out incompletely or contained inconsistent demographic data (e.g., one respondent indicated that he was an enlisted member, an officer, and a civilian employee).

After eliminating the unusable responses, there were 718 usable responses which resulted in an adjusted response rate of 42.5 percent. The response rates by medical center are shown in Table 3 in Chapter III. Based on previous studies done by Constantian (1990) and Parker (1987), the researchers expected a 40% response rate.

The frequencies and percentages of the key demographic variables from the survey responses follow. In the Tables which follow in this section, the number of responses, n, does not always equal 718 because some survey respondents did not answer all questions.

Gender. The gender of the respondents was almost equally divided with 355 female respondents and 357 male respondents. Six respondents did not indicate their sex on the response sheet.

Age. The typical survey respondent was in one of two age brackets: either 26 to 32 years old (27.2 percent) or 33 to 39 years old (27.7 percent).

Education. All but 46 of the respondents had at least a high school diploma as their highest level of education. The typical survey respondent had at least a high school diploma (35.2 percent) while 34.8 percent of the respondents had a bachelor's degree or higher.

Status. The great majority of respondents were active duty military (72.4 percent). Civilian civil service employees accounted for 24.2 percent of the responses and the remaining responses (3.4 percent) were classified as "other civilian," such as volunteers.

Grade. There were 530 military respondents. The complete distribution of their grades is shown in Table 9.

Of the 169 civilian civil service respondents, the typical grade range was GS-5 to GS-8. A complete distribution of the grades of civilian civil service respondents is shown in Table 10.

There were twenty civilian respondents who were not civilian civil service employees. The majority of these were contracted employees.

TABLE 9

GRADES HELD BY MILITARY RESPONDENTS [n=530]

Grade	No. of Responses	Percentage
E-1 to E-4	137	25.8
E-5 to E-6	143	27.0
E-7 to E-9	66	12.5
O-1 to O-3	84	15.8
O-4 to O-5	83	15.7
O-6 or higher	17	3.2

TABLE 10

GRADES HELD BY CIVIL SERVICE RESPONDENTS [n=169]

Grade	No. of Responses	Percentage
Wage Grade	2	1.2
GS-1 to GS-4	41	24.3
GS-5 to GS-8	93	55.0
GS-9 to GS-12	33	19.5

Corps. This category shows the corps to which the respondents who are active duty officers are assigned. The Nurse Corps accounted for 43.2 percent of the active duty officer respondents. A complete distribution of active duty officer respondents is shown below in Table 11.

TABLE 11

OFFICER RESPONDENTS BY CORPS [n=183]

Corps	No. of Responses	Percentage
Medical	40	21.9
Dental	9	4.9
Nurse	79	43.2
Medical Service	18	9.8
Biomedical Service	36	19.7
Other	1	.5

Duties. There was a complete representation of hospital functions among the survey respondents. About one third of the respondents performed some type of medical administration duties. Table 12 shows the distribution of duties performed by the respondents.

TABLE 12

DUTIES OF RESPONDENTS [n=682]

Duty Location	No. of Responses	Percentage
Direct Inpatient Care	139	19.8
Direct Outpatient Care	121	17.2
Ancillary Service	105	15.0
Medical Administration	228	32.5
Medical Logistics	40	5.7
Other	69	9.8

Experience Using Computers. Slightly more than one third of the respondents had between five and ten years of experience using computers either on or off the job. Only seven percent had less than one year of computer experience. Table 13 summarizes the respondents' experience using computers.

TABLE 13

EXPERIENCE USING COMPUTERS [n=708]

Experience	No. of Responses	Percentage
Less than 1 year	50	7.1
1 to 3 years	145	20.5
3 to 5 years	175	24.7
5 to 10 years	256	36.2
10 years or more	82	11.6

Highest Level of Computer Training. About one third of the respondents taught themselves how to use a computer while almost eight percent had not received any computer training. Another one third reported having completed a computer course at either the high school or the college level. 2.8 percent of the respondents had a degree in computer science ranging from an associate to a master's degree. In Table 14, a complete distribution of computer training is shown for all respondents.

TABLE 14

HIGHEST LEVEL OF COMPUTER TRAINING [n=705]

Level of Training	No. of Responses	Percentage
None	54	7.7
Self Taught	234	33.2
High School Course	46	6.5
Adult Education	129	18.3
College Course	188	26.7
Associate Degree in Computer Science	15	2.1
Bachelor Degree in Computer Science	4	.6
Master's Degree or higher in Computer Science	1	.1
Other	34	4.8

Time at Current Assignment. The range of time at the present assignment did not yield any unusual results. Almost twenty-five percent selected the most frequent category of "more than four years." This may seem like a long time for active duty Air Force personnel, but almost one fourth of the respondents were civilian employees who tend not to move as often as military personnel. A summary of job experience is shown in Table 15.

TABLE 15

TIME AT CURRENT ASSIGNMENT [n=712]

Time at Assignment	No. of Responses	Percentage
0 to 1 year	159	22.3
1 to 2 years	150	21.1
2 to 3 years	135	19.0
3 to 4 years	96	13.5
more than 4 years	172	24.2

Time in Current Occupation. There were no unusual results noted in the range of tenure in current occupation for respondents. The distribution of time in current occupation is shown in Table 16.

TABLE 16

TIME IN CURRENT OCCUPATION [n=705]

Time in Occupation	No. of Responses	Percentage
0 to 5 years	225	31.8
5 to 10 years	157	22.2
10 to 15 years	135	19.1
15 to 20 years	108	15.3
more than 20 years	80	11.3

Confidence in Using Computer Applications. The respondents were asked to rate their confidence in using nine computer applications. They rated their confidence for each application using the following Likert scale intervals:

1. I do not recognize this application.

2. I do not use it at all.

3. I can perform only basic functions following prompts or menus; I usually need help recovering from mistakes.

4. I can perform all of the basic functions and follow instructions in a manual for more advanced functions; I sometimes require help in performing more advanced functions.

5. I can perform all of the basic and advanced functions; I rarely, if ever, require assistance.

6. I can perform all of the functions of the application; others seek my help in using the application.

The mean ratings for the applications are shown in Table 17. As expected, the more common applications such as departmental applications, word processing, and electronic mail received the highest scores. Decision support systems which have only recently been introduced to hospitals received the lowest ratings.

TABLE 17

CONFIDENCE RATINGS IN USING COMPUTER APPLICATIONS

Application	No. of Responses	Mean Rating
Word Processing	713	3.8
Graphics	706	2.8
Electronic Mail	704	3.2
Appointment System	703	2.8
Departmental Applications	698	4.0
Medical Records Access	707	2.5
Report Production	710	2.9
Decision Support Systems	709	1.8
Spreadsheets	689	2.5

Satisfaction Ratings. Mean satisfaction ratings for the information systems were calculated from all usable responses to questions 34-57 as shown at Appendix D. To calculate satisfaction ratings, one set of questions concerning the user's level of satisfaction with performance, additional features, serviceability, and aesthetics was asked three times so that the respondent could evaluate up to three different information systems in these areas. Further, another set of questions for each evaluated system asked the user to rate the level of importance for each of the above areas. All questions that surveyed the respondents' opinions were based on a 5-point Likert scale. The scale of responses for all questions requiring a subjective answer was considered to be interval. Although the respondents had six answers from which to choose, answer number one was "No opinion" and considered to be a nonresponse and not on the Likert scale.

The importance ratings were used to weight the above satisfaction ratings. The importance score of each evaluated system's satisfaction factor was converted to a decimal with a score of 2 (very low importance) equal to 0.2 and a score of 6 (very high importance) equal to 1. Each system's satisfaction factor score was then multiplied by its importance weight to get a weighted satisfaction score. These satisfaction ratings are presented in the following three ways in this section. They are shown in total without regard to information system or medical center, by medical center for information systems in operation, and individually by information system regardless of medical centers in which it is operational.

Total Satisfaction Ratings. A mean satisfaction rating was calculated across all medical centers for all information systems. Table 18 lists the mean satisfaction ratings and the number of respondents who evaluated them. The rated satisfaction factors are shown as follows in the table:

System performance = PFTOT
Additional features = FETOT
Serviceability = SVTOT
Aesthetics = AETOT
Computer Satisfaction = COMPSAT.

As discussed above, the satisfaction rating of each of the above first four factors was weighted using its corresponding importance rating. The computer satisfaction rating was calculated from a mean of the responses to

question 60 from the user survey shown in Appendix D. The total satisfaction rating was calculated by taking the mean of the five satisfaction ratings. The satisfaction ratings can be compared against the following scale which was used in the user survey:

1	2	3	4	5	6
no opinion	very low	low	moderate	high	very high

TABLE 18

SATISFACTION RATINGS FOR ALL MEDICAL CENTERS

Computer Support	Mean Rating
PFTOT	3.365
FETOT	2.877
SVTOT	3.526
AETOT	2.811
COMPSAT	3.995
TOTAL	3.315

Medical Center Satisfaction Ratings.

As described above, satisfaction ratings were calculated by medical center for information systems which were in operation. Table 19 shows the satisfaction rating of the information systems for each medical center. The medical centers are ranked in descending order of total satisfaction rating. The names of the medical centers are abbreviated as follows:

David Grant Medical Center = DGMC
Keesler Medical Center = KMC
Malcolm Grow Medical Center = MGMC
Scott Medical Center = SMC
Wilford Hall Medical Center = WHMC
Wright-Patterson Medical Center = WPMC.

TABLE 19

SATISFACTION RATINGS FOR INDIVIDUAL MEDICAL CENTERS

RANK	MEDCENTER	TOTAL	PPSCR	PESCR	SVSCR	AESCR	COMPSAT
1	MGMC	3.418	3.390	2.914	3.522	3.009	4.256
2	WHMC	3.376	3.401	2.992	3.519	3.003	3.966
3	DGMC	3.344	3.541	2.825	3.880	2.815	3.658
4	KMC	3.277	3.141	2.919	3.441	2.742	4.141
5	WPMC	3.209	3.157	2.681	3.503	2.644	4.061
6	SMC	3.159	3.158	2.821	3.522	3.009	3.712

The researchers used a Pearson's correlation coefficient to see if the overall computer system satisfaction rating was related to any of the demographic characteristics of the respondents. This test showed that the demographics of respondents (i.e., gender, age, educational level, duty status, rank, grade, corps, computer experience, computer training, and occupational longevity) were independent of the satisfaction rating (i.e., none of the measured characteristics of respondents led to differentiated responses to system satisfaction).

Information System Satisfaction Ratings. Mean satisfaction ratings across medical centers were calculated for individual information systems that were evaluated by at least 20 respondents. The researchers chose this cutoff to show those systems which respondents rated the most frequently. There were 14 such systems. Table 20 lists the systems along with their satisfaction ratings and the number of respondents who evaluated them. Descriptions of the systems shown in Table 20 are found in Appendix F.

The rated satisfaction factors are abbreviated as follows:

System performance = PFTOT
Additional features = FETOT
Serviceability = SVTOT
Aesthetics = AETOT.

TABLE 20

SATISFACTION RATINGS BY SYSTEM

RANK	SYSTEM	TOTAL	PFTOT	FETOT	SVTOT	AETOT	n
1	*Managed H.C.	3.327	3.285	3.017	3.760	3.248	63
2	**CMIS	3.264	3.422	3.233	3.554	2.846	33
3	***LAB	3.206	3.483	3.000	3.738	2.647	44
4	CHCS	3.165	3.282	2.933	3.563	2.882	159
5	Tripharm	3.156	3.310	2.871	3.632	2.811	22
6	LAN	3.102	3.189	2.814	3.583	2.825	77
7	EASIII/MEPRS	3.082	3.145	2.405	3.431	3.077	30
8	Wang PAS	3.030	3.352	2.600	3.400	2.767	28
9	AQCESS	2.995	3.190	2.587	3.425	2.776	151
10	Wang Office	2.960	3.121	2.636	3.471	2.610	53
11	MEDLOG/MMMS	2.893	3.217	2.581	3.153	2.621	51
12	PCIII	2.871	2.808	2.832	3.409	2.435	24
13	Trilab	2.742	3.215	2.248	3.219	2.285	120
14	Trirad	2.620	2.848	2.333	3.055	2.245	26

* Wright-Patterson Medical Center only
** Keesler Medical Center only
*** Wilford Hall Medical Center only
Note: Descriptions of the above systems are found in Appendix F.

As discussed in Chapter III, the satisfaction rating in each of the above four factors was weighted using its corresponding importance rating. The total satisfaction rating was derived by calculating the mean of the above satisfaction factor ratings. The systems were then ranked by total satisfaction rating. The three highest ranked systems were developed and implemented by individual medical centers and therefore are unique to that location.

In Table 20, the satisfaction ratings can be directly compared to the scale in the User survey shown at Appendix D. If the average worker feels at all comfortable using a system, the satisfaction rating for the system should range from at least a 3.000 to a 4.000 which corresponds to a low to moderate satisfaction rating.

Comments. The users were encouraged to provide comments on the User survey in question 62 as shown at Appendix D. Of the 718 useable responses, 92 respondents took the time to provide comments about the quality of information system support in their medical center. There were sufficient comments made about information system training and CHCS to provide a summary of those responses.

One strong theme emerged from the comments of respondents pertaining to training. Many respondents were concerned that they had not received adequate training to use the information systems present at their work site. They felt that proper training on how to use the systems would improve their productivity at work. This theme seems to reinforce the information provided in Table 14 about the level of computer training received by the system users. Table 14 revealed that 33.2 percent of the respondents had taught themselves to operate the information systems while 7.7 percent had not received any computer training.

At Keesler and Malcolm Grow Medical Centers, there were seven comments made at each site about the new medical system, CHCS. Opinions were mixed about the reliability and the usefulness of CHCS. Users who liked the system said that it was wonderful and very user friendly compared to other medical information systems. As one would expect for a newly implemented system, many users expressed frustration with what they perceived as flaws in the system. One common complaint was that the system was cumbersome to use and not user friendly. Another frequent complaint was that patient appointments "mysteriously" disappeared from the appointment system after they had been input.

System Summaries

In Phase Three of the research, pertinent data was gathered about the most widely used Air Force medical information systems. As discussed in Chapter III, this information was needed to give the researchers further insight into the interpretation of the results from the CIO and user surveys. The researchers and sponsor determined that such individual system factors as age, maintenance and manpower requirements, and quantity, quality, and type of information required could potentially effect the level of service quality provided by the medical center's MSO.

Descriptions of those systems that were evaluated by at least 20 user survey respondents, as shown in Table 20, are found at Appendix F.

Summary of Analysis

This chapter presented and discussed the findings from the analysis of the data gathered in the last three phases of the research. The findings in this chapter answered Investigative Questions 1, 4, and 5.

First, the responses to the CIO survey were summarized. The response rate for this survey was 100 percent. The MSO demographics including personnel functions and personnel staffing were presented in Tables 6 and 7. Table 8 presented a roster of information systems found at each medical center. Finally, the control statistics reported by each medical center were discussed.

Next, the responses to the system user survey were analyzed and summarized. The response rate for this survey was 42.5 percent. The results of a respondent representativeness assessment from the survey responses were presented. From this assessment, the researchers cannot claim that the system users are uniformly represented among medical centers but they believe the response rate was adequate from each medical center to draw some conclusions from the collected data. A summary of respondent demographics was presented which included personal data along with level of experience, training, and confidence in using computers. Information from the analysis of the user survey was used to develop total satisfaction ratings. First, total information system satisfaction ratings were

presented by information system without regard to medical center. Next, satisfaction ratings were presented collectively for each information system by medical center for which sufficient data were available. Finally, individual information system ratings were presented for each information system regardless of medical center in which it is operational. User comments included in the survey responses were summarized. The users were concerned about the lack of training provided on the information systems. A summary of comments was also provided about CHCS.

Descriptions of the information systems listed in Table 20 which were evaluated by at least 20 survey respondents, were provided in Appendix F. The descriptions included such individual system factors as age, maintenance, and manpower requirements which could potentially effect the level of service quality provided by the medical center's MSO.

This chapter described the analysis performed on responses to the survey instruments sent to the CIOs and information system users in the CONUS-based USAF medical centers. Chapter V will continue with a discussion of the findings in this chapter followed by recommendations for future research and an overall conclusion.

V. Findings, Recommendations, and Conclusion

Introduction

This thesis has considered the question of whether there is a relationship between the source of MSO staffing and the level of quality of the services provided by medical systems offices in Air Force medical centers. In so doing the researchers have sought to determine that MSO staffing method whose information services are of the highest relative quality.

Chapter I introduced general issues surrounding the current information service staffing environment in Air Force medical centers. Air Force Program Action Directive 90-4 was initially proposed because Air Force information experts believe that computer system management is best provided by communications/computer specialists. However, some Air Force medical center CIOs have questioned the ability of nonmedical computer specialists to cater to the information needs of the military medical community.

A literature review was performed in Chapter II to better understand current trends in medical information services and the measurement of system quality. Juran (1989) and Ernst and Young (1990) have developed models for measuring product or service quality, both of which emphasize the importance of conforming to the standards of the industry and meeting the requirements of the customers.

When a producer's goods and/or services conform with industry standards, a neutral level of quality is attained. However, not until the customer is satisfied with the good or service can it be considered to be of high quality (Ernst and Young,1990).

Garvin (1988) enhanced the model by identifying eight dimensions of quality as precise measurement criteria. These dimensions are: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality (Garvin,1988). The researchers determined that all of the quality dimensions except durability could be measured in this study. This determination was made because the ultimate product of an information system is the information it provides. The hardware and software that produce the information will periodically be replaced and updated, but the lifespan of the information itself is dictated solely by external factors (Ahituv and Neumann, 1990).

Further, several personal characteristics were identified as being necessary among managers of information systems. Those characteristics are technological competence, highly developed client relations skills, knowledge of the organization's business and mission, and loyalty to the organization. This broad range of necessary skills has sparked much debate in the literature as to whom should manage the organization's information skills: either

in-house personnel who are knowledgeable about the organization's industry and are loyal to the organization, or people from enterprises whose trade is providing information services and who might be considered to be more technically competent. In the literature, neither group demonstrated a higher level of client relations skills.

Finally, Chapter I discussed the standards and goals of the Air Force Medical Service for providing information services and the responsibilities of the CIOs at the individual Air Force medical treatment facilities. All six USAF medical centers are successfully meeting those standards and goals according to the Chief of the Air Force Medical Service Information Systems Division (Obuchowski,1992). This is a first step toward meeting the conformance criterion of quality.

Two survey instruments, one for USAF medical center CIOs and another for information system users, were developed in order to assess medical center MSO staffing and the quality of services provided by the MSOs. These surveys are found at Appendices C and D.

The purpose of the CIO survey was determine the source of each individual MSO staff member, the specific information systems available at each medical center, and the system control functions performed at each site. Surveys were sent to the CIOs at all six USAF medical centers in the

continental United States. The response rate was 100 percent.

The objective of the user survey was to assess the quality of information services at the medical centers on the basis of performance, features, serviceability, aesthetics, and overall perceived quality. The respondents were given the opportunity to evaluate up to three different information systems. The surveys were sent to 1690 system users at the six sites, 718 of which were returned to researchers with usable data for a response rate of 42.5 percent. An extensive analysis of the responses to both surveys was performed, the results of which were reported in Chapter IV.

This chapter discusses the pertinent information from the surveys organized by medical center, specifically addressing the quality issues as they relate to the method of staffing at each site. Further, the researchers will make recommendations for action and for further research and draw an overall conclusion regarding MSO staffing and quality in this chapter.

Findings

The user surveys sought to determine the level of service quality provided by information systems in USAF medical centers. Quality was measured in the survey on five dimensions: performance, additional features, serviceability, aesthetics, and overall computer system

satisfaction. Users' satisfaction with each of these dimensions was measured using a Likert continuous scale as follows:

1	2	3	4	5	6
no opinion	very low	low	moderate	high	very high

Answers of "1" or "no opinion" were considered to be nonresponses and were not calculated into the mean ratings, therefore each response had a 5-point range with a median of "4" or "moderate." The five dimension scores were averaged together resulting in a total quality rating.

The total quality rating across all six medical centers was 3.315, which on the Likert scale is in the low to moderate range.

Overall satisfaction with medical center computer systems received the highest individual dimension score with a mean of 3.995. Specifically, the respondents were asked rate their level of satisfaction with the medical center computer system's ability to help them perform their jobs.

Serviceability was given a mean rating of 3.526 by the users. Survey respondents were provided with the following definition of serviceability: "the amount of time the computer system is in full service to the users and the degree to which the medical information system specialists provide prompt, knowledgeable, and courteous maintenance."

Satisfaction with performance received the next highest mean score of 3.365. In the survey, performance was defined

as a measure of: "how well the user thinks the computer system does what he or she thinks it should do, such as readability and usefulness of reports and printouts, availability of necessary information, and correctness of output."

The mean score for users' satisfaction with the computer systems' additional features was 2.877. Additional features were defined as: "those options that add to the computer system's functionality, but are not required in performing duties at the medical center." Examples of additional features include menus, on-line help, and virus scanning.

Finally, aesthetics received the lowest mean score of 2.811. For the purposes of this study, aesthetics are a measure of: "the degree the computer system appeals to the user's senses in such things as monitor screen colors, appearance of reports and printouts, location of computer terminals, and operator comfort at computer work stations."

Because survey respondents were given the opportunity to assess their satisfaction with up to three individual computer systems at their medical facility, the researchers were able to calculate mean satisfaction ratings for many of the systems available at the medical centers. Mean ratings were only calculated for those systems evaluated by at least 20 survey respondents. This number was chosen because the researchers felt evaluations by fewer than 20 respondents

would not be sufficient to make assumptions about the entire population.

The individual systems were evaluated on four quality dimensions: performance, additional features, serviceability, and aesthetics. The mean scores for each of these dimensions were averaged together to arrive at a total score. Table 20 in Chapter IV shows the 14 systems for which these scores were calculated and the relative system rankings by total score.

The three highest total ratings were scored by systems that were developed and implemented by a single medical center, specifically Managed Health Care at Wright-Patterson (3.327), CMIS at Keesler (3.264), and LAB at Wilford Hall (3.206).

The Composite Health Care System (CHCS), a system developed by the Department of Defense and currently in its final beta testing stages at DOD medical facilities, was ranked number four with a total rating of 3.165. At present, it is only available at two Air Force medical centers, Malcolm Grow and Keesler.

The individual system ratings will be discussed in more detail in the following sections as they relate to each of the medical centers' total scores.

Individual Medical Center Ratings. Table 21 is a consolidation of the data from Tables 7, 8, 19, and 20 from Chapter IV. The second column lists the rankings of each

medical center relative to the others in system user satisfaction. The fourth column shows the rank of each information system's user satisfaction rating across medical centers.

TABLE 21

MEDICAL CENTERS, SYSTEMS, AND STAFFING

Medical Center	Rank	Rated Systems	System Ranks	Staffing Sources	Supervision
Malcolm Grow	1	CHCS	4	Mil Med (12.5%)	Med Ctr (81.3%)
		AQCESS	9	Mil SC (25 %)	Outside (18.7%)
		Trilab	13	Civ Govt(43.8%)	
		Tripharm	5	Contract(18.7%)	
		Trirad	14		
Wilford Hall	2	LAB	3	Mil Med (9.8%)	Med Ctr (74.5%)
		AQCESS	9	Mil SC (7.8%)	Outside (25.5%)
		EASIII/MEPRS	7	Civ Govt(56.9%)	
		MEDLOG	11	Contract(25.5%)	
		PCIII	12		
		Tripharm	5		
		Trirad	14		
David Grant	3	AQCESS	9	Mil Med (50 %)	Med Ctr(100 %)
		EASIII/MEPRS	7		
		MEDLOG	11	Civ Govt(50 %)	
		Tripharm	5		
		Trirad	14		
Keesler	4	CMIS	2	Mil Med (13.3%)	Med Ctr (43.3%)
		AQCESS	9	Mil SC (10 %)	Outside (56.7%)
		CHCS	4	Civ Govt(20 %)	
		PCIII	12	Contract(56.7%)	
		Tripharm	5		
Wright-Patterson	5	Managed HC	1	Mil Med (28.1%)	Med Ctr (56.2%)
		AQCESS	9	Mil SC (46.9%)	Outside (43.8%)
		EASIII/MEPRS	7	Civ Govt(18.8%)	
		Trilab	13	Contract (6.2%)	
		Tripharm	5		
Scott	6	AQCESS	9	Mil Med (14.3%)	Med Ctr(100 %)
		EASIII/MEPRS	7		
		MEDLOG	11	Civ Govt(85.7%)	
		Trilab	13		
		Tripharm	5		
		Trirad	14		

Andrews Air Force Base. Surveys were distributed to 230 users at Andrews' Malcolm Grow USAF Medical Center of which 149 were returned to the researchers in usable form for a 64.8 percent response rate. Malcolm Grow achieved the highest total satisfaction rating of any other medical center with a score of 3.418. They also received the highest ratings in the computer system satisfaction and aesthetics dimensions.

Of the 14 computer systems given satisfaction ratings, Malcolm Grow has five in operation: AQCESS (ranked number 9 across medical centers), CHCS (ranked number 4), Trilab (ranked number 13), Tripharm (ranked number 5), and Trirad (ranked number 14).

The MSO at Malcolm Grow is staffed with 16 people and is made up of staff members from each of the four major source categories, namely military medical, military SC, civilian government, and contractor. The largest portion is civilian government at almost 44 percent. The MSO staff member to total center staff ratio is 1 to 100.

Lackland Air Force Base. A total of 450 surveys were distributed to system users at Wilford Hall USAF Medical Center at Lackland Air Force Base. Of those, 135 were returned to the researchers in usable form for a 30 percent response rate. Wilford Hall was second only to Malcolm Grow in its total satisfaction rating of 3.376. Additional features were rated highest of any of the medical centers.

Wilford Hall has 7 of the 14 evaluated systems in operation: LAB (ranked number 3 across medical centers), AQCESS (ranked number 9), EASIII/MEPRS (ranked number 7), MEDLOG (ranked number 11), PCIII (ranked number 12), Tripharm (ranked number 5), and Trirad (ranked number 14).

Wilford Hall's MSO is staffed by 51 people, 42 of whom are civilians. Almost 60 percent of the staff are civilian government employees while about 25 percent are contracted personnel. The other two source categories are respresented on the staff as well. About 75 percent of the staff are supervised by people within the medical center. There is one MSO staff member for every 88 people on the medical center staff.

Travis Air Force Base. Two-hundred thirty users at David Grant USAF Medical Center were given surveys, 94 of whom returned them in usable form. This number represented a response rate of 40.9 percent. David Grant's user satisfaction rating ranked third among USAF medical centers. The medical center was ranked at the top in two of the quality dimensions: performance and serviceability.

David Grant has 5 of the evaluated systems in service locally: AQCESS (ranked number 9 across medical centers), EASIII/MEPRS (ranked number 7), MEDLOG (ranked number 11), Tripharm (ranked number 5), and Trirad (ranked number 14).

There are 12 people on Travis' MSO staff equally divided between military medical and civilian government.

All of the staff members are supervised by people within the medical center. David Grant's MSO staff to medical center staff ratio is about one to 133.

Keesler Air Force Base. Keesler USAF Medical Center had a 38.3 percent user survey response rate with 111 returned usable responses of the 290 distributed. Keesler's total user satisfaction score was 3.277, ranking fourth among the medical centers. The medical center ranked second in overall computer system satisfaction and additional features.

Five of the 14 evaluated systems are operational at Keesler: CMIS (ranked number 2 across medical centers), AQCESS (ranked number 9), CHCS (ranked number 4), PCIII (ranked number 12), and Tripharm (ranked number 5).

The MSO staff at Keesler is equally divided between military medical and civilian government. All of the staff members are supervised by people within the medical center. There is one MSO staff member for about every 66 people on the medical center staff.

Wright-Patterson Air Force Base. One hundred three user surveys from Wright-Patterson were returned to the researchers of the 260 distributed for an overall response rate of 39.6 percent. The respondents gave the medical center a total user satisfaction score of 3.209, fifth ranked among the medical centers.

Wright-Patterson's in-house developed and implemented information system, Managed Health Care, was ranked number one among the 14 systems evaluated in total user satisfaction with a score of 3.327. The system also scored the highest ratings in serviceability and aesthetics. Also in operation at Wright-Patterson are AQCESS (ranked number 9 across medical centers), EASIII/MEPRS (ranked number 7), Trilab (ranked number 13), and Tripharm (ranked number 5).

There are 32 people on the Wright-Patterson MSO staff. This is the only Air Force medical center that has SC supervised military computer specialists on its staff. There are also 3 military SC staff members who are supervised by medical center personnel. The military medical, civilian government, and contractor staff source categories are also represented. The MSO staff to medical center staff ratio at Wright-Patterson is 1 to 56, the lowest among the medical centers.

Scott Air Force Base. User surveys were distributed to 230 computer system customers at Scott USAF Medical Center of which 124 were returned (53.9 percent). The total user satisfaction score at Scott was 3.158. The aesthetics satisfaction portion of the rating was highest among the medical centers. Serviceability was second highest.

Six of the evaluated information systems are in operation at Scott: AQCESS (ranked number 9), EASIII/MEPRS (ranked number 7), MEDLOG (ranked number 11), Trilab (ranked

number 13), Tripharm (ranked number 5), and Trirad (ranked number 14).

Scott has seven people on the MSO staff, six of whom are civilian government employees. The seventh person is military medical. All seven staff members are supervised from within the medical center. There is one MSO staff member for every 143 medical center employees, the highest ratio among the medical centers.

Summary of Findings. The difference between the highest total satisfaction rating at Malcolm Grow (3.418) and the lowest rating at Scott (3.158) is less than 0.3. Further, the lowest rating is only about 0.16 lower than the total satisfaction rating across medical centers (3.315). This narrow range of scores between the highest and lowest led the researchers to conclude that the difference in the level of information service quality across medical centers is too small to be considered significant at $\alpha = 0.05$. However, the difference is significant at $\alpha = 0.1$ ($z = 1.6$; $0.05<p<0.10$).

Even if the differences among medical centers were to be considered significant (at $p=0.10$), differences in the level of service quality provided to customers at the medical centers is not due to the sources of MSO staffing or upervision. No noticeable trends in methods of staffing appeared from the data and every MSO, to some extent, was staffed by people belonging to more than one source

category. Further, MSO staff to medical center staff ratio does not appear to be a factor in determinine quality of information services. The MSO with the lowest ratio was ranked fifth in overall user satisfaction while the MSO with the highest ratio was ranked sixth. The medical center with the most satisfied information system users has an MSO staffing ratio that is halfway between the lowest and highest ratios.

Moreover, the operational information systems at each medical center seemed to play little part in the medical center's total satisfaction rating. All six sites have at least one system ranked in the top five on the basis of user satisfaction and at least one in the bottom five.

Recommendations

The researchers have divided their recommendations from this study into two types. The first involves recommendations for action by the Air Force Medical Service and the individual medical center MSOs. The second group of recommendations is suggested areas for future research.

Recommendations for Action. Because staffing method and source of supervision appeared to have no influence on the quality of service provided by MSOs, the researchers recommend that the individual medical centers continue with the practice of staffing their MSOs to meet their own requirements and constraints. Management of information

systems in Air Force medical centers should not be centrally standardized.

Although no conclusions could be drawn relating information system user satisfaction to MSO staffing sources, other trends did become evident during the course of this study. One of those trends is that USAF medical center information system users seem to be more satisfied with those systems that were developed and implemented at a single medical center than with those developed by DOD or Air Force agencies for implementation at multiple locations.

There are several possible explanations for this trend. One explanation might be that local developers are in closer contact with customers and are, therefore, more able to tailor the system to meet the unique requirements at that site. Customers are able to voice their opinions and concerns about the features of the system. Further, the customers feel more of a sense of ownership for the system once it is operational. Another explanation might be that developers at a single site do not need to deal with constraints of standardization. They only need to consider interface with hardware, software, and operating systems already in place at their own location rather than those of many locations.

Regardless of the explanation for this phenomenon, the researchers recommend that the Air Force Medical Service continue to encourage these innovative projects at

individual medical treatment facilities. In addition, AFMSA should widely disseminate information about these single location projects among all Air Force hospitals and clinics. Many of the projects could potentially be implemented at other sites with minimal adaptation.

A second trend found by the researchers was that system users are least satisfied with the aesthetics and additional features dimensions. It is recommended that not only the staff at AFMSA, but also the CIOs at the medical centers, explore ways to improve Air Force medical information systems in these dimensions. Using the definitions from the user survey, these dimensions are those that make the user's job at the computer a little easier and more pleasant. The researchers suggest that improvements in these areas may improve productivity among hospital staff members with such things as enhanced screen color capabilities, more comfortable work stations, help menus, and on-line tutorials.

If the widespread implementation of CHCS continues as scheduled once beta testing has been completed, many of the systems with lower total satisfaction ratings will be replaced. Some of the systems whose functions will be taken over by CHCS include Automated Quality of Care Evaluation Support System (AQCESS), Tri-Service Laboratory System (Trilab), Tri-Service Pharmacy System (Tripharm), and Tri-Service Radiology System (Trirad). Additionally, as CHCS is developed further, on-line interfaces are planned with

Medical Logistics System (MEDLOG) and Medical Expense and Performance Reporting System (MEPRS) (Air Force Medical Information Systems Plan,1989).

It should be noted, however, that CHCS is an experimental system under DOD-wide development, and should be expected to have some early implementation difficulties, despite which it ranked fourth among evaluated systems. It may be that, with modifications that are usual with software system development, this system may prove to be flexible and equally or more satisfactory as those anomalies and deficiencies are corrected. Further, because CHCS received relatively high satisfaction ratings from users, the researchers believe that overall user satisfaction will be improved by the elimination of lower-rated systems. Therefore, it is recommended that the Air Force Medical Service continue with its plans to build more comprehensive medical information systems with more initiatives for additional functionality and interface with other stand-alone systems.

Many of those users who took the time to provide additional comments in the section provided at the end of the user survey noted the lack of training given them in the use of medical center information systems. These comments are borne out in Table 13, Highest Level of Computer Training, in Chapter III. The researchers recommend that more time be devoted to training users both when a system is newly implemented and on a continuing basis.

Finally, the researchers could find little evidence of a set of standards for measuring the technical performance and reliability of medical information systems in the Air Force. The researchers recommend that specific guidelines be developed for use by Air Force MSOs to monitor such things as down time, mean time between failures, mean time to repair, and stress work loads. Perhaps these guidelines could be developed as a joint effort between DOD and Headquarters Air Force level system experts and CIOs at the medical treatment facility level. These guidelines would enable system managers to more precisely measure information system quality in the conformance dimension (Garvin,1988).

TABLE 22

RECOMMENDATIONS FOR ACTION

#	Recommended Action
1	Tailor MSO staffs to medical center needs
2	Encourage IS development at medical centers
3	Improve IS aesthetics and additional features
4	Develop comprehensive ISs with more functionality and interface with stand-alone systems
5	Provide more user training throughout the system life cycle
6	Develop guidelines for monitoring system technical performance and reliability

Recommendations for Further Research. This study revealed several opportunities for additional research in the area of Air Force medical information system quality.

This research was conducted using only Air Force medical centers. Some valuable insight might be gained from expanding the study to include smaller medical treatment facilities. The researchers speculate that fewer resources are, in general, expended in the smaller hospitals and clinics toward the development and implementation of information systems. It would be of use to system planners to see if users at these smaller facilities are more or less satisfied with available information systems and services than those at the medical centers.

The second topic for further research is the level of user satisfaction after full implementation of CHCS. Has the level of user satisfaction improved with the implementation of CHCS Air Force wide? Future researchers might consider comparing the data from this project gathered from those facilities where CHCS is not yet operational to data gathered after implementation at those same facilities.

Another opportunity for further research is in the area of users' perceived competence in using specific systems. In this study, the users were asked to evaluate their level of competence in various applications such as word processing, spreadsheets, and electronic mail. Future researchers could determine if there is a relationship between the users' perceived competence and perceived quality ratings for individual systems.

Finally, the researchers recommend that a study be undertaken to find out specifically what improvements could be made to present information systems to better meet the needs of users. A study of this type would involve a survey of users of specific systems across medical facilities and at every level: administrative and clinical, technical and managerial.

TABLE 23

RECOMMENDATIONS FOR FURTHER RESEARCH

#	Further Research Recommendation
1	Conduct same study across MTFs of all sizes
2	Conduct same study after full implementation of CHCS
3	Conduct study comparing user perceived competence with system satisfaction
4	Conduct study of users to determine system improvements to better meet users' needs

Conclusion

The objective of this research was to determine the extent of the relationship between the source of MSO staffing and the level of quality of the services provided by medical systems offices in United States Air Force medical centers. The data collected during the course of this study does not clearly indicate any relationship between the source of MSO staffing and the level of information service quality.

On a Likert scale ranging from 2 to 6, where 4 was the median, users across medical centers rated their level of information system satisfaction at 3.315. The range of individual medical center scores was from 3.158 to 3.418.

There were no discernible trends in MSO staffing sources to relate to the level of user satisfaction at individual medical centers. Most MSOs in the population are composed of a mixture of source categories, and those that are made up of predominantly one category or another did not produce any noticeable pattern in satisfaction rating. In addition, the source of supervision of MSO staff members seemed to have little influence on the satisfaction ratings. The MSO staff to medical center staff ratio also did not appear to effect the level of information service quality.

In conclusion, methods of staffing, level of staffing, and supervision of USAF medical center systems offices seem to be independent of the quality of the services provided to their customers by those offices. Therefore, medical systems office staffing should be tailored to meet the individual needs of the medical center given budget and other resource constraints.

Appendix A: CIO Responsibilities

1. Establish local implementation of higher headquarters information management activities involving both management and clinical information, to include implementation plans, site preparation, and training.

2. Establish local information management activities in conjunction with other implemented systems to ensure adequate managerial and clinical information is available for all levels of medical treatment facility (MTF) management.

3. Employ available systems, technology, and manpower to provide and assist with the analysis and presentation of all required information.

4. Assist the MTF Executive Committee to identify and determine the availability of needed information resources.

5. Assist other formally established hospital committees or departments in the acquisition, analysis and presentation of required information.

6. Appoint a Systems Administrator if appropriate.

7. Prepare the annual MTF Communications-Computer Systems Plan for the facility.

8. Provide input for the Base Communications-Computer Systems Plan, as required.

9. Document functional information system requirements in accordance with established Major Command standards. Manuals for program maintenance, system operations, and users must be prepared for all applications software developed at the facility.

10. Coordinate with appropriate base agencies such as the Communications Squadron, and Civil Engineering on all requirements for telecommunications associated with local and or satellite health care information processing systems.

11. Monitor all internally developed software that is undergoing testing, evaluation, and validation, which must be documented for both initial operation and after subsequent modifications and track all programmer actions which affect any production programs or operating systems.

12. Establish procedures to assure that production programs and operating systems cannot be changed without knowledge and approval of the CIO or Database Administrator.

13. Provide proper management controls and directives for system analysts and programmers assigned to the office, if applicable and appoint a qualified individual to technically review all software programs and procedures developed on the local systems. Ensure separation of duties where the operation is large enough to warrant computer operators, programmers, analysts and librarians. Ensure system test evaluations are performed by persons other than the system developer.

14. Prepare system plans for security, continuity of operations, routine back-up and user training. Facilities must . . . appoint a Computer Systems Security Officer and Terminal Area Security Officers (TASO).

15. Certify IS equipment/services received for payment. The CIO must monitor maintenance performance.

16. Prepare and monitor status of Systems Change Requests (SCR) and System Incident Reports (SIR).

17. Coordinate with appropriate Major Command Medical Informations Systems Offices, [AFMSA, and other agencies] on all matters which pertain to contractual arrangements with system contractors.

18. Establish and chair a Medical IS Users' Group. Membership should include representatives from each functional area either directly using or deriving benefits from a system. The purpose of this group is to define user requirements and determine responsibilities, problems and recommendations relating to system site preparation, implementation, operation and modification. This group will meet at the discretion of the CIO, but at least quarterly. Minutes will be briefed to the MTF Executive Committee.

19. Establish practices and procedures to protect in-house IS equipment from adverse weather conditions such as lightning strikes and flood damage (AFR 168-4, Chap 14, Para 14-5.f.(1)).

Appendix B: Checklist of Control Measures

YES NO

13. Had executive management committed reasonable fiscal and manpower resources and sufficient visibility within the organization to provide adequate internal understanding and support of the systems installed in the MTF? (AFR 168-4, Para 15-5g(1))

SECURITY:

14. Were Computer Systems Security Officers (CSSO) and Terminal Area Security Officers (TASO) designated in writing? (AFR 205-16, Para 2-10, 2-11)

15. Were automated data processing (ADP) users receiving annual ADP security training? (AFR 168-4, Para 14-5f(1)(n); AFR 205-16, Para 16-8; AFR 700-10, Para 1-5m)

16. Were procedures for reporting ADP security incidents of fraud, waste, and abuse known to all users? (AFR 168-4, Para 14-5f(1)(n); AFR 205-16, Para 5-3f; AFR 700-26, Para 3-6b)

17. Did each individual user on every computer system have a user identification? (AFR 168-4, Para 14-5f(2)(a); AFR 205-16, Para 8-2, 11-5)

18. Was Privacy Act Information protected to avoid unauthorized access to information maintained on individuals? (AFR 700-10, Para 2-5b)

19. Was a "Risk-Analysis" of all computer systems (e.g., AQCESS, CHCS, MEDLOG, MEPRS, TMPS, TRILAB, etc.) completed and on file? (AFR 205-16, Para 2-9e, Atch 8, Para A8-7)

20. Was there a current security plan? (AFR 168-4, Para14-5f(1)(n); AFR 205-16, Atch 7)

21. If processing classified information:

a. Was a TEMPEST check of all equipment used to process, store or display classified information performed annually with the last two tests kept on file? (AFR 125-37, Para 15-1e; AFR 700-10, Para 2-8)

b. Was access to the computer restricted only to personnel who have a need to use it? (AFR 205-16, Para 8-2; AFR 700-10, Para 2-8a)

22. Had the security police and/or Resource Protection Executive Committee made a determination as to whether or not the computer room needed to be a controlled area? (AFR 125-37, Para 12-2c(3), 15-1c; AFR 700-7, Para 2-8a)

23. Was entry to the computer room controlled? (AFR 125-37, Para 15-1b)

YES NO

13. Had executive management committed reasonable fiscal and manpower resources and sufficient visibility within the organization to provide adequate internal understanding and support of the systems installed in the MTF? (AFR 168-4, Para 15-5g(1))

SECURITY:

14. Were Computer Systems Security Officers (CSSO) and Terminal Area Security Officers (TASO) designated in writing? (AFR 205-16, Para 2-10, 2-11)

15. Were automated data processing (ADP) users receiving annual ADP security training? (AFR 168-4, Para 14-5f(1)(n); AFR 205-16, Para 16-8; AFR 700-10, Para 1-5m)

16. Were procedures for reporting ADP security incidents of fraud, waste, and abuse known to all users? (AFR 168-4, Para 14-5f(1)(n); AFR 205-16, Para 5-3f; AFR 700-26, Para 3-6b)

17. Did each individual user on every computer system have a user identification? (AFR 168-4, Para 14-5f(2)(a); AFR 205-16, Para 8-2, 11-5)

18. Was Privacy Act Information protected to avoid unauthorized access to information maintained on individuals? (AFR 700-10, Para 2-5b)

19. Was a "Risk-Analysis" of all computer systems (e.g., AQCESS, CHCS, MEDLOG, MEPRS, TMPS, TRILAB, etc.) completed and on file? (AFR 205-16, Para 2-9e, Atch 8, Para A8-7)

20. Was there a current security plan? (AFR 168-4, Para14-5f(1)(n); AFR 205-16, Atch 7)

21. If processing classified information:

a. Was a TEMPEST check of all equipment used to process, store or display classified information performed annually with the last two tests kept on file? (AFR 125-37, Para 15-1e; AFR 700-10, Para 2-8)

b. Was access to the computer restricted only to personnel who have a need to use it? (AFR 205-16, Para 8-2; AFR 700-10, Para 2-8a)

22. Had the security police and/or Resource Protection Executive Committee made a determination as to whether or not the computer room needed to be a controlled area? (AFR 125-37, Para 12-2c(3), 15-1c; AFR 700-7, Para 2-8a)

23. Was entry to the computer room controlled? (AFR 125-37, Para 15-1b)

YES NO

CONTINGENCY PLANNING:

24. Had contingency plans been developed to support operations under emergency conditions? (AFR 700-6, Para 1-4d; AFR 700-7, Para 2-11 through 2-14; AFR 700-26, Para 2-11, 3-6a(2))

25. Were the contingency plans exercised at least annually? (AFR 700-7, Para 1-5m)

STORAGE MEDIA MANAGEMENT:

26. Was magnetic media within the facility controlled adequately to avoid loss, theft, etc.? (AFR 700-7, Para 4-2; AFR 700-26, Para 2-11)

27. Were ADP storage media marked according to sensitivity or classification? (AFR 205-16, Para 2-12b, 13-4d)

28. Was the fire department aware of magnetic media storage locations? (AFOSH Std 127-64)

29. Had a suitable off-site backup storage location and rotation cycle been established for magnetic media and critical supplies? (AFR 700-7, Para 2-16b; AFR 700-26, Para 2-11)

FACILITY MANAGEMENT (ENVIRONMENT):

30. Were work areas clean, free of boxes and other clutter? (AFR 700-7, Para 2-8e)

31. Was smoking, eating, and drinking disallowed in the main computer room? (AFR 700-7, Para 2-8e(5))

32. Were emergency shut-offs for each main computer room located at each fire exit? (AFOSH Std 127-64)

33. Were circuit breakers in the power panels marked with individual pieces of equipment tied into them? (AFOSH Std 127-64)

34. Was the computer room environment adequate in terms of temperature humidity and dust control? (AFR 700-7, Para 2-8b)

35. Were thermometers/hygrometers calibrated semiannually and were the charts properly annotated and maintained for 3 years? (AFM 88-15)

36. Were hand-held fire extinguishers located in the computer room and were they easily accessible to the operators? (AFOSH Std 127-64)

	YES	NO
37. Were abort switches installed for controlled abort of automatic discharge of a total flooding Halon fire suppression system if installed? (AFM 88-15, Para 15-75(4)(c))		

Appendix C: CIO Survey

MEDICAL CENTER_____

INFORMATION SYSTEM OFFICER NAME_____

PHONE NUMBER_____

NUMBER ON MEDICAL CENTER STAFF_____

QUESTIONNAIRE DISTRIBUTION POC_____
PHONE #_____

IS OFFICE DEMOGRAPHICS

NUMBER ON IS OFFICE STAFF_____

SOURCE OF STAFF:

PROGRAMMERS
- # 906XXW _____
- # 49XXX _____
  - # MED CTR SUPERVISED _____ # SC SUPERVISED _____
- # CIVILIANS _____
  - # CONTRACTED _____
  - # CIVIL SERVICE _____
    - OCCUPATIONAL CODE TITLE AND NUMBER OF EACH _____

AVE NUMBER OF YEARS OF EXPERIENCE _____

LAN SPECIALISTS
- # 906XXW _____
- # 49XXX _____
  - # MED CTR SUPERVISED _____ # SC SUPERVISED _____
- # CIVILIANS _____
  - # CONTRACTED _____
  - # CIVIL SERVICE _____
    - OCCUPATIONAL CODE TITLE AND NUMBER OF EACH _____

AVE NUMBER OF YEARS OF EXPERIENCE _____

CUSTOMER SERVICE
- # 906XXW _____
- # 49XXX _____
  - # MED CTR SUPERVISED _____ # SC SUPERVISED _____
- # CIVILIANS _____
  - # CONTRACTED _____
  - # CIVIL SERVICE _____
    - OCCUPATIONAL CODE TITLE AND NUMBER OF EACH _____

AVE NUMBER OF YEARS OF EXPERIENCE _____

INDIVIDUAL SYSTEM SPECIALISTS

SYSTEM ______________________________

906XXW __________

49XXX __________

MED CTR SUPERVISED ________ # SC SUPERVISED __________

CIVILIANS ________

CONTRACTED ________

CIVIL SERVICE _______

OCCUPATIONAL CODE TITLE AND NUMBER OF EACH ________

AVE NUMBER OF YEARS OF EXPERIENCE ______________

SYSTEM ______________________________

906XXW __________

49XXX __________

MED CTR SUPERVISED ________ # SC SUPERVISED __________

CIVILIANS ________

CONTRACTED ________

CIVIL SERVICE _______

OCCUPATIONAL CODE TITLE AND NUMBER OF EACH ________

AVE NUMBER OF YEARS OF EXPERIENCE ______________

SYSTEM ______________________________

906XXW __________

49XXX __________

MED CTR SUPERVISED ________ # SC SUPERVISED __________

CIVILIANS ________

CONTRACTED ________

CIVIL SERVICE _______

OCCUPATIONAL CODE TITLE AND NUMBER OF EACH ________

AVE NUMBER OF YEARS OF EXPERIENCE ______________

SYSTEM ______________________________

906XXW __________

49XXX __________

MED CTR SUPERVISED ________ # SC SUPERVISED __________

CIVILIANS ________

CONTRACTED ________

CIVIL SERVICE _______

OCCUPATIONAL CODE TITLE AND NUMBER OF EACH ________

AVE NUMBER OF YEARS OF EXPERIENCE ______________

SYSTEM ______________________________

906XXW __________

49XXX __________

MED CTR SUPERVISED ________ # SC SUPERVISED __________

CIVILIANS ________

CONTRACTED ________

CIVIL SERVICE _______

OCCUPATIONAL CODE TITLE AND NUMBER OF EACH ________

AVE NUMBER OF YEARS OF EXPERIENCE ______________

SYSTEM_____

906XXW _____

49XXX _____

MED CTR SUPERVISED _____ # SC SUPERVISED _____

CIVILIANS _____

CONTRACTED _____

CIVIL SERVICE _____

OCCUPATIONAL CODE TITLE AND NUMBER OF EACH _____

AVE NUMBER OF YEARS OF EXPERIENCE _____

MANAGEMENT

MILITARY MSC _____ RANK _____

CIVILIANS _____

CONTRACTED _____

CIVIL SERVICE _____ GRADE _____

OCCUPATIONAL CODE TITLE AND NUMBER OF EACH _____

AVE NUMBER OF YEARS OF EXPERIENCE _____

SYSTEMS INFORMATION

NAME OF SYSTEM _____
NUMBER OF YEARS ON LINE _____
APPLICATION _____

NAME OF SYSTEM _____
NUMBER OF YEARS ON LINE _____
APPLICATION _____

NAME OF SYSTEM _____
NUMBER OF YEARS ON LINE _____
APPLICATION _____

NAME OF SYSTEM _____
NUMBER OF YEARS ON LINE _____
APPLICATION _____

NAME OF SYSTEM _____
NUMBER OF YEARS ON LINE _____
APPLICATION _____

NAME OF SYSTEM _____
NUMBER OF YEARS ON LINE _____
APPLICATION _____

CONTROL STATISTICS

MEASUREMENT _____
FREQUENCY OF MEASUREMENT _____
LAST SIX MONTHS DATA

MEASUREMENT _____
FREQUENCY OF MEASUREMENT _____
LAST SIX MONTHS DATA

MEASUREMENT _____
FREQUENCY OF MEASUREMENT _____
LAST SIX MONTHS DATA

MEASUREMENT _____
FREQUENCY OF MEASUREMENT _____
LAST SIX MONTHS DATA

MEASUREMENT _____
FREQUENCY OF MEASUREMENT _____
LAST SIX MONTHS DATA

MEASUREMENT _____
FREQUENCY OF MEASUREMENT _____
LAST SIX MONTHS DATA

INFORMATION SYSTEM BUDGET

FISCAL YEAR 1992 BUDGET _____

NEW SYSTEMS CURRENTLY BEING IMPLEMENTED

SYSTEM _____
BUDGETED AMOUNT _____

SYSTEM _____
BUDGETED AMOUNT _____

BREAKDOWN OF BUDGET APPROPRIATION ITEMS

ITEM TITLE_____
BUDGETED AMOUNT _____

ITEM TITLE_____
BUDGETED AMOUNT _____

ITEM TITLE_____
BUDGETED AMOUNT _____

ITEM TITLE_____
BUDGETED AMOUNT _____

ITEM TITLE_____
BUDGETED AMOUNT _____

ITEM TITLE_____
BUDGETED AMOUNT _____

Appendix D: Information System Users Survey

SURVEY INSTRUCTIONS

Please completely fill in your answers to questions 01 through 61 on your computer answer sheet WITH A NUMBER 2 PENCIL

EXAMPLE:

1 ① ② ③ ● ⑤ ⑥ ⑦ ⑧ ⑨ ⑩

For those questions requiring a written answer, please respond on the survey itself.

Please do not write your name on either the answer sheet or the survey. Please avoid any stray marks on the computer answer sheet and do not fold the computer answer sheet.

After you have completed the survey, please place your SURVEY and your ANSWER SHEET in the envelope provided and return them to us through your medical center's distribution system. No postage is necessary.

THANK YOU FOR YOUR PARTICIPATION!!

INFORMATION SYSTEMS QUESTIONNAIRE

PLEASE COMPLETELY FILL IN YOUR ANSWERS TO QUESTIONS Ø1 THROUGH 61 ON YOUR COMPUTER ANSWER SHEET WITH NUMBER 2 PENCIL.

PART 1

Ø1. Indicate your sex.
1. Female.
2. Male.

Ø2. Find the choice number below that includes your age.
1. 25 or less.
2. 26 to 32.
3. 33 to 39.
4. 4Ø to 46.
5. 47 to 53.
6. 54 to 6Ø.
7. 61 or more.

Ø3. Indicate the highest level of education you have achieved.
1. Did not complete high school.
2. High school graduate or equivalent.
3. Some courses beyond high school but no degree awarded.
4. Associate's Degree, technical or trade school certificate.
5. Bachelor's Degree.
6. Some graduate courses.
7. Master's Degree or higher.

Ø4. Select the number below that describes your status.
1. Active duty military (go to question # Ø5).
2. Civilian civil service (go to question # Ø6).
3. Civilian other (go to question # Ø7).

Ø5. (Active duty military only) Find the number below that includes your rank.
1. E-1 to E-4 (go to question # 1Ø).
2. E-5 to E-6 (go to question # 1Ø).
3. E-7 to E-9 (go to question # 1Ø).
4. O-1 to O-3 (go to question # Ø8).
5. O-4 to O-5 (go to question # Ø8).
6. O-6 or higher (go to question # Ø8).

Ø6. (Civilian civil service only) Find the number below that includes your grade.
1. Wage grade (go to question # 1Ø).
2. GS-1 to GS-4 (go to question # 1Ø).
3. GS-5 to GS-8 (go to question # 1Ø).
4. GS-9 to GS-12 (go to question # 1Ø).
5. GS/GM-13 or higher (go to question # 1Ø).

07. (Civilian noncivil service only) How would you describe your status with the medical center?
    1. contracted service (go to question # 10).
    2. volunteer (go to question #10).
    3. other. Please specify _____.
       (go to question #10).

08. (Active duty officers only) To which corps do you belong?
    1. Medical Corps (go to question # 10).
    2. Dental Corps (go to question # 10).
    3. Nurse Corps (go to question # 09).
    4. Medical Service Corps (go to question # 10).
    5. Biomedical Service Corps (go to question # 10).
    6. None of the above. I am a nonmedical officer (go to question # 10).

09. (Nurse Corps only) Where do you spend the majority of your time performing your duties?
    1. In an in-patient setting.
    2. In an out-patient setting.
    3. My time is spent approximately equally in both settings.

10. Select the statement below that best describes your work.
    1. Direct inpatient care duties.
    2. Direct outpatient care duties in a clinic.
    3. Direct patient care duties in an ancillary service (pharmacy, laboratory, physical therapy, etc.).
    4. Medical administration duties.
    5. Duties related to medical logistics.
    6. Duties not specified above.
       Please specify. _____

11. How long have you used a computer on or off the job?
    1. Less than 1 year.
    2. 1 to 3 years.
    3. 3 to 5 years.
    4. 5 to 10 years.
    5. 10 years or more.

12. Indicate the highest level of computer training you have completed.
    1. None.
    2. Self taught.
    3. High school course(s).
    4. Adult, continuing education.
    5. College course(s)
    6. Associate Degree in Computer Science, Information Resource Management, or Management Information Systems.
    7. Bachelor Degree in Computer Science, Information Resource Management, or Management Information Systems.
    8. Master Degree or higher in Computer Science, Information Resource Management, or Management Information Systems.
    9. Other. Please specify _____.

13. How long have you been in your current assignment at the medical center?
    1. 0 to 1 year.
    2. 1 to 2 years.
    3. 2 to 3 years.
    4. 3 to 4 years.
    5. more than 4 years.

14. How long have you been in your current occupation or profession?
    1. 0 to 5 years.
    2. 5 to 10 years.
    3. 10 to 15 years.
    4. 15 to 20 years.
    5. more than 20 years.

For Questions 15 through 23, rate how confident you feel using that application in your duties at the medical center. Use the following scale for each question.

1. I do not recognize this application.
2. I do not use it at all.
3. I can perform only basic functions following prompts or menus; I usually need help recovering from mistakes.
4. I can perform all of the basic functions and follow instructions in a manual for more advanced functions; I sometimes require help in performing the more advanced functions.
5. I can perform all of the basic and advanced functions; I rarely, if ever, require assistance.
6. I can perform all of the functions of the application; others seek my help in using the application.

15. Word Processing.

16. Graphics.

17. Electronic Mail (email).

18. Appointment System.

19. Applications specific to my department.

20. Medical Records Access.

21. Report Production.

22. Decision Support Systems.

23. Spreadsheets.

For Questions 24 through 28, specify and rate your confidence with other applications you use in your duties at the medical center using the choices listed for Questions 15 through 23. If you do not use other applications in your duties, leave Questions 24 through 28 blank on your answer sheet.

1. I do not recognize this application.
2. I do not use it at all.
3. I can perform only basic functions following prompts or menus; I usually need help recovering from mistakes.
4. I can perform all of the basic functions and follow instructions in a manual for more advanced functions; I sometimes require help in performing the more advanced functions.
5. I can perform all of the basic and advanced functions; I rarely, if ever, require assistance.
6. I can perform all of the functions of the application; others seek my help in using the application.

24. Other. Please specify _____.
25. Other. Please specify _____.
26. Other. Please specify _____.
27. Other. Please specify _____.
28. Other. Please specify _____.

29. Select the statement which most accurately describes your use of the available applications at the medical center.
    1. Most often, I directly access a computer terminal, keying in information myself.
    2. Most often, I directly access a computer terminal, keying in information and producing reports myself.
    3. Most often, I do not directly access a computer terminal, but rather use the information keyed in by someone else.
    4. Most often, I do not directly access a computer terminal, but rather use the information and reports produced by someone else.
    5. I directly access a computer terminal, keying in information and producing reports about as often as I use the information and reports keyed in by someone else.
    6. None of the above. I do not access the computer terminal, nor do I use the information and reports keyed in by someone else.

30. Has using a computer improved the QUALITY of your work?
    1. I don't know.
    2. Very little improvement.
    3. Little improvement.
    4. Moderate improvement.
    5. Much improvement.
    6. Very much improvement.

31. Has using a computer improved the QUANTITY of work you are able to do?
    1. I don't know.
    2. Very little increase.
    3. Little increase.
    4. Moderate increase.
    5. Much increase.
    6. Very much increase.

32. How much confidence do you have using medical center computers to meet the needs of your job?
    1. I don't know.
    2. Very low confidence.
    3. Low confidence.
    4. Moderate confidence.
    5. High confidence.
    6. Very high confidence.

33. Do you feel that you could be more productive in your job if you had stronger computer skills?
    1. I don't know.
    2. Very little more.
    3. A little more.
    4. More.
    5. Much more.
    6. Very much more.

PART 2

From the following list please choose the three information systems you use most in performing your duties at the medical center. Please put your answers on the questionnaire. If you use fewer than three systems, leave the remaining ones blank.

Example: If Tripharm is one of the systems you use most, write a "4" in the blank to the right of "SYSTEM #1" below. The blanks to the right of "SYSTEM #2" and "SYSTEM #3" should be filled in with the numbers of two other systems you use most in performing your duties.

SYSTEMS LIST

1. Aqcess
2. Managed Health Care (ATT)
3. Trilab
4. Tripharm
5. Trirad
6. Wang Office
7. Wang PAS (Appointment System)
8. CAPOC
9. MEPERS
10. EAS III
11. AMMS
12. PCIII
13. MEDLOG
14. MEDNET
15. CHCS (Malcolm Grow only)
16. CMIS (Keesler only)
17. LAB (Wilford Hall only)
18. Local area network
19. Sun Workstations
20. Other (please write the system name)_____
21. Other (please write the system name)_____
22. Other (please write the system name)_____

SYSTEM #1 _____
(This will be referred to as SYS1 in Questions 34 through 57)

SYSTEM #2 _____
(This will be referred to as SYS2 in Questions 34 through 57)

SYSTEM #3 _____
(This will be referred to as SYS3 in Questions 34 through 57)

This part of the survey examines the types of computer support you may require in performing your duties at the medical center and the importance of that type of support. **PLEASE USE THE THREE SYSTEMS YOU SELECTED ON THE PREVIOUS PAGE TO ANSWER QUESTIONS 34 THROUGH 57 (REFERRED TO AS SYS1, SYS2, AND SYS3).** There are 4 support areas about which you will be asked. Each support area is identified in bold letters followed by its definition.

To answer the questions in this section of the questionnaire, please use the following scale to mark your answers on the answer sheet.

1	2	3	4	5	6
no opinion	very low	low	moderate	high	very high

DEFINITION: **PERFORMANCE** is a measure of how well you think the computer system does what you think it should do, such as readability and usefulness of reports and printouts, availability of necessary information, and correctness of output.

Please rate your level of satisfaction with the performance of each of the three systems you selected.

34. SYS1
35. SYS2
36. SYS3

How much importance do you place on the performance of each of the three systems you selected?

37. SYS1
38. SYS2
39. SYS3

DEFINITION: **ADDITIONAL FEATURES** are those options that add to the computer system's functionality, but are not required in performing your duties at the medical center. Examples of additional features include menus, on-line help, and virus scanning.

Please rate your level of satisfaction with the additional features of each of the three systems you selected.

40. SYS1
41. SYS2
42. SYS3

How much importance do you place on the additional features of each of the three systems you selected?

43. SYS1
44. SYS2
45. SYS3

1---------2---------3---------4---------5---------6
no opinion | very low | low | moderate | high | very high

DEFINITION: **SERVICEABILITY** is the amount of time the computer system is in full service to the users and the degree to which the medical information system specialists provide prompt, knowledgeable, and courteous maintenance.

Please rate your level of satisfaction with the serviceability of each of the three systems you selected.

46. SYS1
47. SYS2
48. SYS3

How much importance do you place on the serviceability of each of the three systems you selected?

49. SYS1
50. SYS2
51. SYS3

DEFINITION: **AESTHETICS** are a measure of the degree the computer system appeals to your senses in such things as monitor screen colors, appearance of reports and printouts, location of computer terminals, and operator comfort at computer work stations.

Please rate your level of satisfaction with the aesthetics of each of the three systems you selected.

52. SYS1
53. SYS2
54. SYS3

How much importance do you place on the aesthetics of each of the three systems you selected?

55. SYS1
56. SYS2
57. SYS3

PART 3

58. Please rate your level of confidence in the medical center's information system office staff.
    1. No opinion.
    2. Very Low.
    3. Low.
    4. Moderate.
    5. High.
    6. Very High.

59. Please rate your level of satisfaction with any assistance you may have received from the medical center's information system office staff with computer-related problems or questions.
    1. I have not received any assistance.
    2. Very Low.
    3. Low.
    4. Moderate.
    5. High.
    6. Very High.

60. Please rate your level of satisfaction in the medical center computer system's ability to help you perform your job.
    1. No opinion.
    2. Very Low.
    3. Low.
    4. Moderate.
    5. High.
    6. Very High.

61. At which USAF Medical Center do you perform your duties?
    1. David Grant Medical Center
    2. Keesler AFB Medical Center
    3. Malcolm Grow Medical Center
    4. Scott AFB Medical Center
    5. Wilford Hall Medical Center
    6. Wright-Patterson AFB Medical Center

62. Please provide below any additional comments pertaining to the medical center computer system's quality and the quality of service provided to you by the medical center information system staff that you think might be useful.

THANK YOU FOR YOUR VALUABLE PARTICIPATION!

Appendix E: Survey Distribution Instructions

INSTRUCTIONS FOR SURVEY DISTRIBUTION

FOR MEDICAL SYSTEMS OFFICER

Give each of your TASOs 1 survey per 7 users assigned to them. Please round this number *up* to the nearest whole number.

Please ask your TASOs to distribute the surveys as soon as they possibly can following the instructions below. We would appreciate your encouragement of the TASOs to solicit maximum participation.

FOR TASOs

Please choose any number between 1 and 7. Begin selection of survey participants with the name of that person on your list of users assigned to you corresponding to the number you have chosen. Then give one survey to every 7th name on the list counting from the first name.

For example, if you chose the number 4, distribute surveys to the 4th, 11th, 18th, 25th, 32nd people on your list until the list is exhausted.

If you have exhausted your list and you still have surveys left, choose another number between 1 and 7 and begin again until all surveys are distributed.

Once the surveys have been completed, the participants should place their *computer answer sheets and surveys* in the envelopes provided and send them to us through distribution channels.

Please encourage maximum participation. Also, we would appreciate responses as soon as possible.

THANK YOU FOR YOUR HELP IN OUR RESEARCH

Appendix F: Information System Summaries

Managed Health Care

Managed Health Care was contracted with Computer Data Systems, Inc., for development and implementation at Wright-Patterson USAF Medical Center. It first became operational in 1991. Its functions are in three categories:

1. Program Management - health care finders, Veteran's Administration sharing, partnership agreements, marketing and recruitment
2. Beneficiary Referrals - CHAMPUS, tracking referrals and disengagements, management indicators, catchment area tracking, area-wide medical service tracking
3. Alternative Care - appointments tracking, budgeting, in-house clinic service availability and waiting periods.

The system does not currently interface with any other systems and no proliferation among other Air Force facilities is planned. Some of Managed Health Care's functionality will be taken over by CHCS (Wheeler,1992).

Commander's Medical Information System (CMIS)

This information system was developed by in-house staff members for implementation at Keesler USAF Medical Center. It was designed to automate many personnel functions previously performed manually. Its functions include: personnel management and orderly room functions, medical readiness (training tracking, mobility and recall management), nursing management (credentials, training and continuing medical education tracking, nurse staffing), public health tracking, and hospital services (supplemental care and payments). Additionally, it provides cytology-histology reporting and genetics clinic reporting and tracking.

It is capable of on-line real-time reporting of laboratory test results to remote sites via modem. Future plans for this system include CAP tracking for pathology, interface with PCIII, and conversion to open architectural environment for implementation at all Air Training Command bases (Williams,1992).

Regen Strief Clinical Laboratory System (LAB)

This system was adapted for use at Wilford Hall USAF Medical Center by The Regen Strief Institute from a similar

system at Wishard Memorial Hospital in Indianapolis. It became operational at Wilford Hall in 1982. Two of its modules, the gynecology cytology module and anatomical physiology module, were programmed and developed by Wilford Hall pathology department staff members. Through the use of barcoding, it can unidirectionally and bidirectionally interface with laboratory test instruments. It is capable of database searches for research purposes, electronic result transfer via modem interface to 60 remote locations, and some laboratory CAP workload tracking. It does not handle ward order entry or donor center and blood bank functions.

Future plans include automatic coupling without human intervention. There are no plans for the proliferation of this system to other Air Force facilities (Mills,1992).

Composite Health Care System (CHCS)

The CHCS is a comprehensive and fully integrated information support system designed to enhance the quality of care provided in military medical treatment facilities by providing automated clinical support to health care providers and administrators. It supports functional work centers throughout the hospital including pharmacy, laboratory, patient administration, patient appointment and scheduling, nursing, clinical dietetics, anatomical pathology, and blood bank. This system will interface with other standard DOD and service-specific medical automation initiatives including medical logistics (MEDLOG), food service (Trifood), DEERS, and the Medical Expense and Performance Reporting System (MEPRS).

The first Air Force beta testing sites of CHCS were at Sheppard AFB, Keelser AFB, and Eglin AFB. Presently, some of the CHCS modules are still undergoing beta testing while others have been approved for full implementation. Implementation is planned at all Air Force medical treatment facilities, with many scheduled through 1997 (Air Force Medical Information Systems Plan,1989;III20-III25).

Tri-Service Pharmacy System (Tripharm)

This is an Air Force, Army, and Navy based initiative to provide pharmacies with complete automation. Tripharm provides automated data processing support for pharmacy operatins in the following areas: census registration, order entry, inventory management, doctor database, drug interaction screening and allergy notification, UCA reporting, drug utilization reports, maximum dose screening, clinic issues, patient profiles, and inventory management and ordering.

Bakercells (an automated tablet dispensing system) can be interfaced with the system. The AQCESS system has been tested and can act as an interface for DEERS checking. Modems are used for connecting satellite pharmacies.

Tripharm will eventually be replaced with CHCS (Air Force Medical Information Systems Plan, 1989;III39-III41).

Local Area Network (LAN)

A local area network is a datacommunications system that allows many independent devices (printers, terminals, other networks) to communicate directly within a moderately sized geographic area over a communications medium. Networking allows sharing of word processing, financial analysis, order processing, and many other applications (Martin,1989;3-4).

Local area networks are required for many of the systems mentioned in this appendix.

Medical Expense and Performance Reporting System (EASIII/MEPRS)

This is a program designed to report unique workload and expense data for each free standing medical facility and dental clinic to the Office of the Assistant Secretary of Defense for Health Affairs. It has interactive capability with MEDLOG. Initial installation in an Air Force facility was in 1983 and there are no formal plans for future of this system at present (Air Force Medical Information Systems Plan, 1989;III9-III10).

Wang Patient Appointment and Scheduling (PAS)

This system is an on-line program for scheduling patient appointments in the Wang operating environment. All clinics are able to schedule appointments and provider time independently and print daily appointment listings for management purposes. The system has been in operation at several locations throughout the Air Force since approximately 1983. It is a stand-alone system and does not interface with any other systems (Newell,1992).

Automated Quality of Care Evaluation Support System (AQCESS)

The quality assurance function of this system is used to monitor the quality of treatment provided at medical treatment facilities. Quality assurance enables authorized users to identify numerous types of QA indicators and provides a standard, documented methodology for monitoring these items.

This system has the capability to interface with the Defense Eligibility Enrollment System (DEERS) and Tripharm. It was first implemented in approximately 1985 and is in operation at virtually all Air Force medical treatment facilities. Its functions will be replaced by CHCS (Air Force Medical Information Systems Plan, 1989;III62).

Wang Office

This is an electronic mail system installed on the local area networks at several medical sites. In addition to electronic mail and messaging, the system enables users to access distributed word processing, calendar, and other automated office applications (Newell,1992).

Medical Logistics System (MEDLOG)

The MEDLOG System is an integrated peacetime and wartime logistics system that includes capabilities to control and manage medical supplies, medical equipment, quality assurance of war reserve materiel, biomedical equipment maintenance management, excess reporting and funds control. Although MEDLOG was initiated as two separate systems (MEDRAMS and MMMS-OL), the Air Force needed to operate the same way in peacetime as it does in wartime. MEDLOG is an on-line interactive system on a distributive mini-computer network and was first implemented in 1989.

The system has operational interfaces with the Base Contracting Automated System (BCAS), Medical Materiel Accounting System (MMAS), Medical Expense and Reporting System (MEPRS), Base Level Autodin Message Extract System (BLAMES), Automated Data Report Submission System (ADRESS), Military Standard Requisition and Issue Procedure System (MILSTRIP), Medical Network (MEDNET), and Defense Data Network (DDN). Planned interfaces include the Standard Base Supply System (SBSS) and the Tri-Service Central Processing and Distribution System (CPD) as well as CHCS.

The MEDLOG System is projected to be replaced by a new system called C-LOG which is still in the development stages (Air Force Medical Information Systems Plan, 1989;III59-III61).

Personnel Concept III (PCIII)

The PCIII system is a personnel management system designed to fully automate orderly room functions. When fully implemented at all locations, it will redistribute and decentralize current Central Base Personnel Office functions out to the orderly rooms. The system will be operational in

all base orderly rooms, including those in the medical treatment facilities. All personnel actions, such as military record entry, locator and survivor information, and performance evaluation notification, will be performed through the orderly room rather than the central office.

The system is still being implemented or planned for implementation at many Air Force bases. It will be connected directly on-line with mainframes at the base central offices and the Military Personnel Center. It first became operational in 1988 (Air Force Medical Information Systems Plan, 1989;III14-III15).

Tri-Service Laboratory System (Trilab)

The Trilab system provides automated support to clinical laboratories. It supports specimen processing, order processing, results reporting, UCA and CAP workload tracking, quality control management, and other administrative functions. The system has the capability to interface with a wide variety of automated laboratory instrumentation. Modems can be connected to the central processing unit for dial up diagnostics and software downloads.

The twelfth system was installed in late 1987 with no further proliferation scheduled. Its contract expired as the end of fiscal year 1989 and will be replaced by the laboratory module of CHCS (Air Force Medical Information Systems Plan, 1989;III36-III38).

Tri-Service Radiology System (Trirad)

This system performs the functions of automated patient radiology scheduling, film tracking and management, procedure result and management reports, thus reducing manual clerical tasks and human error, produces standardized interface for radiology/pathology reporting, and automates description, diagnosis, and analysis of patient radiographs.

The system will be replaced in functionality by CHCS and no plans have been made for its proliferation beyond the four Air Forces sites where it is presently in operation (Air Force Medical Information Systems Plan, 1989;III42-III43).

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13. ABSTRACT (Maximum 200 words)
This study measured the relationship between Medical Systems Office staffing source (i.e., military medical, military communications/computer, civilian government, and contractor personnel) and quality of automated information services provided at CONUS USAF medical centers. A literature search determined that information system quality is best measured on eight dimensions: performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality. The CIO at each medical center was surveyed to determine the level of system conformance to Air Force standards and to gather data on each MSO staff. Users at the medical centers were also surveyed in order to measure performance, features, reliability, serviceability, aesthetics, and perceived quality. The users were given the opportunity to evaluate up to three different information systems in operation at their medical center. Approximately 42.5 percent of the user survey population responded. No relationship was evident between MSO staffing source or source of staff supervision and the level of quality of information services. Further, the level of quality was unrelated to the types of information systems in operation.

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