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A MODEL FOR THE MANAGEMENT OF SUPPLEMENTAL CARE EXPENDITURES FOR COMPUTED TOMOGRAPHY (CT) SCANS AT IRWIN ARMY COMMUNITY HOSPITAL, FT. RILEY, KANSAS

A GRADUATE MANAGEMENT PROJECT
SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS
FOR THE DEGREE OF
MASTERS OF HEALTH ADMINISTRATION

BY

THOMAS S. WALKER,
MAJOR, MEDICAL SERVICES

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19. ABSTRACT (Continue on reverse if necessary and identify by block number) This paper describes an algorithmic model to guide the commander of a medium-sized Army medical treatment facility in attempting to control supplemental care fund expenditures for computed tomography services purchased from outside providers. The model is patterned after the Linnean taxonomic key process frequently used in the natural sciences to systematically evaluate alternatives in arriving at the identification of an organism. The steps described are designed to be useful, both as a prelude to the recognition of a requirement for on-site services and between submission of the requirement and delivery and installation of the equipment. They were designed to allow a systematic analysis of the process by which these services are ordered by the practitioner, scheduled by the "scans clerk", and vendors selected by the hospital administration. An analysis of this type is useful, both for an examination of procedures currently in place by which to contain costs and as an aid in exploring opportunities for further cost savings.

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DEPARTMENT OF THE ARMY
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REPLY TO
ATTENTION OF

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25 July 1989

MEMORANDUM THRU COL William H. Parry, Commander, U.S. Army Medical Department Activity, Fort Riley, KS 66442-5037

FOR Residency Committee, U.S. Army Baylor University Graduate Program in Health Care Administration, Academy of Health Sciences, U.S. Army, Fort Sam Houston, TX 78234-6100

SUBJECT: Submission of Graduate Management Project

1. In accordance with the instructions contained in the Administrative Residency Manual, subject project is submitted by MAJ Thomas S. Walker, Administrative Resident, Irwin Army Community Hospital.

2. Per conversation with MAJ Varney, this Graduate Management Project is hand-carried to the Residency Committee in four copies.

Thomas S. Walker

Enclosure

THOMAS S. WALKER
MAJ, MS
Administrative Resident

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DEDICATION

This project represents the culmination of two sometimes grueling and sometimes satisfying years. Throughout it all, I had outlets for the grueling parts, in my work and in the company of others who had gone through or were going through what I was. At the same time, I sometimes kept the satisfying parts to myself and failed to share them with those who are closest to me. During it all, my family got only that vicarious gratification that comes from watching someone we love succeed. As this experience comes to an end, I dedicate this work and, more fundamentally, I rededicate my life to the most important people I know:

> To our parents, both Geri's and mine, who continue to teach me so much and who, for the past two years, have frequently come to visit us to offer their loving support and I wasn't there.
>
> To my young son, Stephen, who deserves a better father than I have been the last two years and will get one.
>
> To my dear wife, Geri, who gave me a gentle prodding when I needed it and her unquestioning love all of the time. She is my best friend, my inspiration, and my strength.

ACKNOWLEDGEMENTS

For trusting me with free rein to learn about civilian and military healthcare without any preconceived expectations as to my interests and experience and for reminding me that there are still some real soldiers in Army hospitals, I would like to express my sincerest thanks to my former preceptor, COL Frank G. Gilliam. More than any other single factor, his gentle guidance, sense of humor, and consistent support reminded me that an invaluable educational experience does not have to hurt.

I would be sadly remiss if I did not mention the immense contribution made to my residency and to the hospital, as a whole, and the very material contribution made to this project by Ms. Jeannie Kerrigan, the secretary to the Deputy Commander for Administration. Her friendship, support, flexibility, and patient toleration of my occasionally manic frenzies went way beyond the requirements of her job description. It is, indeed, a fortunate manager at any level who has her to keep him straight.

For his friendship, for candidly sharing his perceptive observations and extensive knowledge with me, and for steering me toward valuable meetings and away from worthless ones, I would like to thank MAJ John Wilson, the Chief of Clinical Support Division. For the entire year, he has served as a sterling example of a young military healthcare statesman and I am honored that he thought enough of me to take me under his wing and, often, even ask my advice.

The people here at Irwin Army Hospital who have generously shared their time, their expertise, and their records to assist me in the completion of this project and throughout my residency are too numerous to mention. There are a few, however, whose help and support has been so significant that it cannot be overlooked. Ms. Linda Rudolph knows more about the purchase of CT scans here than anyone alive and willingly shared her knowledge with me. Likewise, Ms. Gayle Beffa brought her years of experience as our Health Benefits Advisor to me when I most needed a sense of direction. Ms. Virgina Riley, our Resource Manager, and Ms. Mary Anne Backschneider from her office gave me the cost data without which this project would have been impossible. Finally, to the entire staff of the hospital, my deepest thanks for a marvelous year. I have learned something from almost all of them.

I. INTRODUCTION

Conditions Which Prompted the Study

In just a few short years, the use of "computed tomography" or CT scanning as a diagnostic tool has gone from "state of the art" to "standard of practice" because of its ability to provide a clear, computer-enhanced view of any part of the body without the use of invasive techniques. Indeed, with the advent of the even more advanced, and more expensive, "magnetic resonance imagery" or MRI, CT has become a virtually essential part of any complete battery of diagnostic tests and a first resort in any case in which the diagnosis is not readily apparent. This trend has been exacerbated by the perception by many doctors of the need to practice "defensive medicine". In light of the current rash of malpractice litigation arising from claims of improper diagnoses, this may be a justifiable perception. Despite the legal protection afforded military physicians by the "Gonzalez Act" (10 USC § 1089), military physicians have also come to increasingly rely on CT technology to assist them in their diagnostic role.

Irwin Army Community Hospital at Ft. Riley, Kansas, currently has no CT scanner. A mobile CT scanner with transporter vehicle has been purchased for IACH by Defense Personnel Support Center as part of a multiple unit purchase contract. However, the actual date of its delivery to the hospital continues to be the subject of considerable disagreement because of the considerable lag time inherent in the procurement of high-cost, high technology medical equipment. Current indications are that the unit will be

installed some time in the fourth quarter of Fiscal Year 1989. This purchase is the result of a three year effort on the part of the hospital to provide a service on-site which otherwise consumes a significant portion of the hospital's supplemental care budget. In a climate of severely constrained resources and shifting priorities, judicious expenditure of these supplemental care monies has become an essential part of the commander's plan to provide optimum medical care to his eligible beneficiaries.

Since early 1987, the hospital has obtained limited routine CT support, one day per week, from a local contract source. All other requirements for CT testing and CT support of other diagnostic procedures must be met using other outside sources for which reimbursement is provided from limited supplemental care funds. The costs for these services during calendar year 1988 amounted to $246,000, approximately 32% of all fiscal year 1988 supplemental care fund expenditures for the hospital.

As in the case of Irwin Army Community Hospital, procedures by which new and emerging medical technologies are evaluated and their use monitored are subject to considerable variation between facilities. Long after these technologies become accepted and even essential to risk management in health care delivery, major capital investment expenditures for the equipment may be precluded by budgetary constraints facing Army medical treatment facilities (MTFs). Much has been written about the national policy options and economic implications of the rapid diffusion of high technology into all areas of health care. Likewise, the body of professional literature is replete with generic guidance on the considerations involved with capital investment decisions in the

private sector. Pending installation of these technologies in his facility, however, the commander is faced with the dilemma of having to provide diagnostic imaging from outside sources and having to minimize the costs of obtaining those services. For the commander of a medium-sized military medical treatment facility no single model is readily available to guide him in evaluating options for obtaining the services of expensive technologies.

Statement of the Problem

"To develop a model for the management of supplemental care costs for computed tomography (CT) diagnostic services, prior to receipt of an on-site unit, at Irwin Army Community Hospital, Ft. Riley, Kansas."

Research Methodology

An extensive review of contemporary military and civilian literature was conducted to discover alternative approaches to the determination of full costs of specific health care procedures. Specific attention was directed to cost determination and cost containment measures adopted by federal health care organizations, especially for the costs of military supplemental care. Attempts to evaluate the needs of facilities' specific service areas ("catchment area management") in both the federal and private sectors were reviewed but were found to be inconclusive. As the specific focus of this study, the technology of computerized

tomography (CT) and its associated costs is discussed. Likewise, in the search for current analogs in the private sector, other more recent diagnostic imaging modalities and similar high-tech, high-cost medical testing methods were evaluated for relevence. Facilities without all available diagnostic and therapeutic services must have provisions to obtain those services which are beyond their capabilities to deliver for their patients. Tested approaches employed by both federal health care providers and analogous, civilian, managed health care arrangements to control the costs of obtaining these services were evaluated. Finally, systems modeling methodologies were assessed for their applicability to this specific management problem.

Data upon which to base a model was collected from the records of Headquarters, United States Army Health Services Command (HSC), Irwin Army Community Hospital (IACH) and the Ft. Riley community. These data included, but were not limited to, supplemental care expenditures for the purchase of CT scanning services by IACH; IACH case mix for those cases requiring CT diagnosis to determine cost centers; and the civilian and federal health care sources of CT testing available to support IACH beneficiaries. These services were classified according to several criteria, including cost, distance from IACH, and services available. Willingness by their management to negotiate reimbursement agreements favorable to IACH was impossible to determine without actual authority to enter into such negotiations.

Based on a review of the data, an appropriate definition for various supplemental diagnostic radiography episodes was

determined in accordance with the Physicians' Current Procedural Terminology. To the extent possible, given the available data, the amount of CT diagnostic testing, both in dollar cost and numbers and types of episodes, purchased for military health services beneficiaries within the IACH catchment area was determined by type of services requested and provider.

The decision-making mechanisms and decision sequence currently employed in referring patients to outside sources for CT scans were noted and analyzed to evaluate possible cost saving opportunities. All applicable variables found to affect that decision process were considered and the presence or absence of incremental costs (including intangible opportunity costs to the patients) of each was determined to the extent possible.

From this analysis, a working algorithmic model (at App. B.) borrowed from the life sciences was adapted to provide a mechanism with which to enhance the decision-making process and thereby to control the costs of CT scans performed by supplemental care providers. Because capital equipment procurement within the Army Medical Department is so stringently regulated, up to and including Department of Defense oversight, the decision-making model was designed to take the commander up to the lease-purchase decision and to provide him necessary information upon which to develop requirements. The actual purchase or lease of high-cost medical equipment for use at the facility, although briefly discussed, is not addressed by the model.

II. REVIEW OF RELATED LITERATURE

Cost of Health Care

The continuous rapid escalation of the cost of health care and proposals to contain further cost increases have generated considerable interest in both technical journals and non-technical publications for much of the past two decades. Schramm, reporting on the 72nd meeting of The American Assembly quoted Robert J. Blendon and Drew E. Altman regarding the impact that the increasing cost of health care has had on the health care consumer and, simultaneously, how his perceptions of the value of good health have affected those costs (51). Schramm, in setting the agenda for that meeting, identified eight major issues central to any discussion of the cost of health care (6). Schnall and Figliola in their work on national health care issues, include a cogent article by Karen Davis citing factors behind the increase in health care and likely obstacles facing attempts at cost-containment (88).

Like all employers, federal agencies subsidize health care benefits to their employees and, therefore, are no less vulnerable to the impact of the increasing cost of health care than are other sectors of society who serve as consumers, payers, or providers of health care (OTSG Annual Report 1980, 30). The Department of the Army and the other uniformed services have a peacetime requirement to maintain a sufficient medical treatment capability to accomplish their readiness mission (U.S. Senate Armed Services Committee Manpower and Personnel Subcommittee Hearing, 1980, 1).

This provides them the flexibility to meet many of the medical needs of their "employees" and family members through the use of in-house medical assets. Conversely, the rapidly increasing size of the beneficiary population and the political fluctuations to which DoD medical care appropriations are subject preclude the services from providing all necessary care to all eligible beneficiaries using military resources alone (U.S. Senate Governmental Affairs Hearing, 1980, 3).

Army Regulation 40-3 is the primary document which establishes general definitive policies and procedures on the provision of medical, dental, and veterinary care to eligible beneficiaries in the support of the Army's readiness mission. As such, it provides guidance as to those medical services for which various categories of beneficiaries are eligible. Furthermore, it establishes procedures by which beneficiaries may obtain services which, for whatever reason, are not immediately available at their servicing military medical treatment facility. Among these procedures is the expenditure of local Operations and Maintenance, Army (OMA) funds to reimburse civilian providers or other federal providers for such supplemental episodes of care, not otherwise available through a more cost-effective alternative source. More recently, specific implementation guidance to ensure the judicious use of supplemental care funding has been provided by the Office of the Surgeon General of the Army (OTSG, Feb 2, 1988) and the Commander, Health Services Command (HSC, Feb. 22, 1988).

Public Law and Congressional guidance establishes eligibility parameters and provides the military services with several options by which to steward the taxpayers' funds as wisely as possible.

The Armed Services Committee of the respective legislative bodies oversee the various programs by which the uniformed services provide medical care to eligible beneficiaries (U.S. Senate Armed Services Committee Hearing, 1985, 2). Extending the provisions of two previous laws encouraging intragovernmental sharing of resources, Public Law 97-174, the VA/DoD Health Resources Sharing Act, mandates that DoD medical treatment facilities attempt to procure services which they cannot otherwise provide from Veterans' Administration facilities, if possible (U.S. Senate Governmental Affairs Committee Hearing 1981, 1) (U.S. House of Representatives Veterans' Affairs Committee Oversight and Investigations Subcommittee Hearing 1986, 11).

Sophisticated Medical Technology

In exploring the causes of such an explosive increase in health care costs, many authors in the federal and civil sectors have focused on the ever-increasing reliance on sophisticated technological tools to enhance the accuracy of diagnoses and the efficacy of treatment. Schramm quotes H. David Banta and Annetine Gelijns who cite many of these works (253). These technologies are not limited to hardware advances. They also include revolutionary new pharmaceuticals developed through advances in bioengeneering and other techniques, altered concepts of clinical practice, and alternative delivery systems. Indeed, some of the new technologies which impact on the hospital are far-removed from diagnosis or treatment protocols. Sneider (137-142) and Schmitz

(53) cite the impact of information and communication technologies on the cost of providing health care.

Recognition of the role of new technologies in the rising national cost of health care has led to the establishment of several government and private agencies who seek to assess, among other things, the clinical and economic implications of emerging health care technologies on a national basis. Robinson states that among these groups are the National Center for Health Care Technology, Medical Technology and Practice Patterns Institute, the Congressional Office of Health Technology Assessment, and the National Advisory Council on Health Care Technology Assessment (18).

In recent years, the proliferation of expensive, albeit efficacious, health care technologies has precipitated numerous guides to the assessment of technologies from the standpoint of the medical benefits to be derived and the cost of other foregone services resulting from their use. Culyer and Horisberger reported on a 1982 symposium, held in Wolfsberg, Switzerland and sponsored by the World Health Organization, on the subject of "Economic and Medical Evaluation of Health Care Technologies". At this gathering, numerous noted authorities in the field outlined generic techniques of evaluation of all medical diagnostic and treatment technologies. Specifically, three subject matter experts on computed tomography employed case study approaches, presented by the editors, to illustrate the actual use of valuable evaluation tools on various aspects of this technology (288-342).

The Office of Technology Assessment (OTA) of the United States Congress commissioned a series of studies to examine the value of

applying traditional cost-analysis techniques to an examination of the acceptance of expensive medical diagnostic and treatment technologies by national policy makers. This series included case studies of specific diagnostic and treatment modalities (OTA, April 1981), general philosophical discussions of the necessary rationing decisions presented by scarce technologies (OTA, January 1981), and case studies of approaches taken by other industrialized countries (OTA, 1980) to these problems. These studies recognized that the tangible clinical benefits of medical technologies are enjoyed by a relative few and are difficult to quantify at the national level. On the other hand, the dollar costs are shared by all, to a lesser or greater extent, in a society in which the federal government is the leading payer for health care services (OTA, April, 1981, 3).

More recently, the Office of Technology Assessment has reported on the impact of medical technology on the costs to the federal government of one specific, if far-reaching, program - Medicare. Additionally, this 1984 work attempted to postulate on the effects of a prospective payment system under Diagnosis Related Groups or DRGs (which had just been implemented for Medicare) on the continued spread of life-saving technologies and the ability of technologies to reduce the effectiveness of DRG's as a cost-containment measure (OTA, 1984, 82).

Russell, writing for the Brookings Institute, provided an historical examination of the patterns of distribution of several early "prestige technologies". As a sociologist, he viewed the spread of medical technology within the financial and regulatory

framework facing individual hospitals and evaluated its impact using national sociological and demographic data (40).

Computed Tomography

One of the fastest growing areas of emerging health care technology is the burgeoning field of diagnostic imaging. These techniques have revolutionized medical care by providing a far greater possibility for accurate diagnosis than such long-standing techniques as traditional roentgenography. At the same time, the costs of equipment, facilities, and skilled technicians needed to establish these services represent a substantial capital outlay for providers and a substantial consequent cost to health care consumers and payors (Hessel, et al. 93). In 1987, the Economic Commission for Europe (ECE), reporting to the United Nations, compared and contrasted the current state of diagnostic imaging systems in use in twenty countries and suggested likely trends in the international growth of this area of medical technology.

Prior to the widespread acceptance of other than relatively primitive imaging systems (e.g., conventional x-ray), Maxmen foretold the near-universal use of sophisticated computer-assisted diagnostic tools (277). Among the first of these tools to be developed, computed tomography or "CT scanning" is a technique by which the human body can be viewed as a cross-sectional image. This is achieved by consolidating views, taken from different directions by an X-ray, through the use of a computer. The use of a cross-sectional image allows physicians to envision depth, thereby giving the clinical observation much greater precision and

providing an extra degree of safety to the patient. Kak and Slaney and Gabor and Herman provide technical explanations of the mathematical principles involved. Gambarelli et al. provided a somewhat more plebian explanation of the mathematical aspects of CT in their clinical atlas which used CT to demonstrate anatomical relationships (1-26).

Since its development, CT scanning has been evaluated for its potential impact on the delivery and cost of health care. As early as 1977, less than four years after its introduction into the United States, CT scanning was the subject of a policy statement by the Institute of Medicine of the National Academy of Sciences. Because of its high cost and growing potential for widespread clinical applications, computed tomography was one of the medical technologies used as a case study in the Office of Technology Assessment study to evaluate cost-effectiveness analysis in health care technology (OTA, April, 1981).

The use of computed tomography for clinical diagnosis is so widespread and so routine that few recent articles exist which question its validity as a clinical tool and many clinical investigations rely on its findings exclusively. Koehler argued that CT as a first resort in certain clinical situations actually reduces overall health costs by eliminating diagnostic doubt, preventing unnecessary tests and shortening hospital stays (1100). Initial uses of CT technology were restricted to neurological examination of the head. Expansion of its use into whole body testing was greeted by an editorial in Lancet suggesting that physicians' and patients' desires were actually a more important factor in the spread of CT than any tangible health benefits to be

realized by the patient (Lancet, 962). Finally, in a telling example of CT's acceptance, Reid and Dublin offered a satirical solution to the question of the cost-effectiveness of CT (845).

Analogous Diagnostic Imaging Methods

More recent advances in digital diagnostic imaging provide current analogs to a study of the impact and value of CT technology. Examples include Single Photon Emission Tomography (SPECT), Ultrasonography, Positron Emission Tomography (PET), and, most pervasive, Magnetic Resonance Imaging (MRI). Like CT, each of these technologies provides the practitioner substantially enhanced diagnostic capabilities but represents a significant capital expenditure for any health care provider seeking to incorporate these imaging services. Numerous authors have drawn this same analogy. Figley and Margulis reported on an international symposium on the impact of these new imaging techniques on health care, medical research and medical education (1111).

As with CT, the Office of Technology Assessment sought to explore the health policy implications of the Magnetic Resonance Imaging (MRI) (OTA Case Study #27, 1984). Pohost and Ratner gave evidence of some of the many clinical benefits currently offered by Magnetic Resonance Imaging and provided glimpses of the potential benefits promised by MRI and similar technologies (1304). Evens et al. reported on the rapid spread of MRI units into hospitals and analyzed their economic impact on the delivery of health care (393). Schwartz and Jarl explored some costing and

pricing considerations for radiology managers which they claim are unique to the establishment of MRI services (15).

Murphy (235), Schroeder (551), Goldsmith (869), Steinberg et al (Radiology, 279), and Bradley (AJR, 1307) compare the clinical efficacy and cost effectiveness of MRI with CT imaging. Steinberg et al (NEJM, 860), Evens (NEJM, 1184), and Durick and Phillips (239) compared the proliferation of MRI with the similar diffusion of CT technology ten years previously and explored the policy implications of the spread of effective, high cost medical technologies. Finally, Bradley (1302) and Dwyer et al. (313) explored economic considerations involved in selecting the diagnostic modality of choice.

Zimmer et al. compared the efficacy and cost effectiveness of CT and sonography in the evaluation of renal masses (285). Mullani addresses the cost effectiveness of SPECT imaging and the ethical considerations implicit in the use of such high cost diagnostic modalities (145). Evens et al. analyzed the relative costs of utilizing Positron Emission Tomography (PET) in clinical diagnosis (1073). Schultz compared a variety of new diagnostic technologies including Radioimmunoassay, CT and MRI in testing for thyroid dysfunctions (219).

The impact of prospective payment for diagnostic procedures on the use of digital imaging systems was explored by many authors, including Roberts and Settich (80), Kuntz (150), Muilenberg (1122), Yesukaitus (6), Osborn (3), Keefe (35), and Falck (29). Joseph and Dehn (89), McNeil et al. (57), and Levin et al. (823) propose strategies by which radiation managers may attempt to capitalize on the provisions of prospective payment systems.

Rayburn (315) suggested alternative sources of funding with which radiology operations could obtain capital diagnostic equipment. One of the outcomes of the implementation of prospective payment has been the establishment of imaging centers to take advantage of prospective payment system (PPS) incentives for outpatient diagnosis (Osborn, 6). In response, James et al. examined the legal and ethical implications of the use of outpatient radiological imaging (746).

Cost Containment

Any financial assessment of a capital investment must include options to reduce the cost and methods of possible revenue generation and service enhancement offered by the proposed acquisition. Stevens, Aikman and Schwartz, Helfert, and Aplin et al. wrote just a few of the numerous generic financial management texts providing models for the evaluation of options to reduce fixed and variable costs over the lifetime of the project. Some of these models are applicable to health care equipment decisions.

Health care organizations and the behaviors exhibited by their patients present a unique set of conditions under which medical capital equipment investment decisions must be evaluated. MacStravic cited a number of techniques for forecasting demand and use of selected medical services, including diagnostic services, based on the current health care environment. Doubilet points out that the term "cost-effective", although readily used by health care professionals, has an entirely different meaning than most people think when applied to health care investments. He argues

that, in most cases, this term is used inappropriately in such settings (827). Pegels and Rogers point out the importance of evaluating health care capital investment opportunities for high technology, not only for enhancement of productivity, but with an eye to the competitive advantage that such technology confers upon the organization and its contribution to the organization's strategic objectives (65). Kamath and Elmer reported on the results of a survey of hospital chief financial officers. In this survey, the CFOs responded to questions concerning capital budgeting, purchase methods, treatment of risk, consideration of equipment quality, and participation by the medical staff in the purchase decision. A similar survey of hospital buying groups by Healthweek magazine suggested that, when purchasing capital equipment, product quality is the first priority, followed by responsiveness of service, price, a broad product line, and incentives (3 Apr., 1989, 15).

Shaw and Miller suggest the use of outside sources for laboratory services as a means of containing costs rather than maintaining expensive services in-house purely for the marketing value of having these services (725). They suggest that their lessons might be equally applicable for other capital intensive services that have traditionally been maintained by the hospital, such as radiology. As another alternative to the purchase of capital equipment by a hospital, Snook and Kaye explore the use of joint ventures as a way of minimizing financial risk to a health care institution.

Once the decision has been made to purchase a CT scanner or any other high cost diagnostic imaging technology, other options

are available to facilities by which to contain costs associated with obtaining the unit. The advantages and constraints of group purchasing to obtain financial incentives from the vendor in return for a volume purchase were explored by Hatch (31) and Richards (81). The Emergency Care Research Institute (ECRI), Inc., a non-profit agency which specializes in conducting technical evaluations of high technology medical equipment, publishes periodic product comparisons of current models of CT systems, evaluating them on technical criteria to assist prospective purchasers in obtaining the system which best fits their needs.

Risk Reduction

No evaluation of any imaging system can be complete without an assessment of the health risks to the patient and the financial risks of liability to the provider. Very early in the development of computed tomography, Hendee cited concerns because of the radiation emissions of CT (151). Oftedal and Brogger, reporting on the proceedings of an international symposium on the subject of risk reduction, suggest a ten step process by which to minimize the risk inherent in the acquisition of high technology equipment or processes (37-38). Friddell, an attorney specializing in litigating high-technology contracts for tax-exempt organizations, suggested ways in which risk and the possibility of subsequent breach of contract litigation could be avoided in the purchase of diagnostic imaging systems.

III. BACKGROUND

CT Technology

The current technology in computed tomography had its start with the production of the first commercial head scanner in the early 1970s. This early model was based on the theoretical work of A. Cormack and prototype development by G. Hounsfield, for which they were awarded the 1979 Nobel Prize in physiology and medicine. In computed tomography, conventional X-ray radiation is used to illuminate the body from various angles and a computer algorithm is used to transform the collective absorption and attenuation values into an image which depicts a tomographic slice. Images are reproduced either in grey or in color generated by the computer to provide better differentiation of areas of different absorption values (ECE, 33).

A camera is generally used to convert the image from the cathode-ray tube (CRT) to standard X-ray film and/or Polaroid film to allow for storage in the conventional manner. The content of these visual images is based on a predetermined setting of the filter or "window" through which absorption data are screened to provide the desired information. The specific setting is based on the fact that spatial definition of the final image varies inversely with density definition and that increased definition of both parameters requires increased radiation dosage. The Office of Technology Assessment found maximum radiation doses for a single scan to range from 0.5 rad to 10 rads for second generation systems (OTA, January 1981, 32). If it is necessary to store all

absorption data for possible future reexamination through different window settings, standard digital storage media, such as floppy disks and magnetic tapes, may be used (Gambarelli, 4). This allows additional images of the same slice to be generated without any further radiation exposure to the patient.

In early conventional axial tomography, either the patient remained stationary and the X-ray tube rotated around him or the examination table, containing the patient, rotated under a stationary tube. Early units were hampered by very slow scan times (several minutes) during which the patient could not move. Initially, this drawback effectively precluded whole body tomography because of the blurring caused by the patient's breathing. Since the first units were introduced into the United States, radical improvements in the scan time and resolution have occurred as a result of quantum advances in both imaging and computer technology, permitting whole body tomography. To reduce scan time, imaging is now accomplished using linear scanning in various positions by means of multiple moving X-ray tubes and detectors within the gantry (ECE, 33).

Current systems can be used to obtain a simple computed radiographic image for selection of the optimum slice location. This provides the operator with a more precise means of locating the internal structures of interest than reliance on anatomic landmarks. Consequently, the requirement for additional scans to locate the desired slice is virtually eliminated, further reducing examination time and patient radiation dose. Additionally, most third and fourth generation systems allow automatic repositioning

of the patient table using data from the radiographic image to align the patient for subsequent, preselected scans (ECRI, 5).

In evaluating CT technology, the term "generation" relates more to well-defined changes in the geometry of the movement of the X-ray tube and X-ray detector arrays than to stages of product enhancement. For that reason, it must be pointed out that subsequent generations are not necessarily "better" than their predecessors, only of a different design (ECRI, 4). Designs for fifth generations systems are now in production. This latest generation will reduce scan times to as little as 50 milliseconds, but with resulting decreases in image quality. Such short scan times allow imaging of a beating heart (ECRI, 6).

Clinical Uses of CT

The clinical uses of CT scanning go far beyond a simple enhancement of conventional X-ray imaging. The ability of CT to produce a cross-sectional view of the area of the body under examination allows the interpreter to mentally project a three dimensional image, giving a much clearer indication of spatial relationships of structures than a two dimensional X-ray (Gamberelli, et al. 2). The clinical efficacy of CT in evaluation and diagnosis of unexplained conditions of the head has been clearly demonstrated (B. J. McNeil and J. A. Handley in Culyer and Horisberger, 281). These conditions range from evaluation of unexplained seizures to confirmation of suspected subdural hemotomas to evaluation of the effectiveness of treatment of hydrocephalus following shunt emplacement (OTA, Jan 1981, 76-77).

Since the advent of whole body tomography, scanning of virtually all structures of the body has been found to be indicated in the presence of certain signs and symptoms. These structures include the spinal column and pelvis, most major organs, and the extremities. CT has been found to be particularly valuable in the search for tumors and in the differentiation of solid, cystic, inflammatory, and fatty lesions (OTA, Jan 1981, 84-87). A complete list of CT procedures from the Physicians' Current Procedural Terminology - 1989 is at Appendix C. In 1979, the Health Care Financing Administration published its first draft screening criteria to Professional Standards Review Organizations (PSROs), outlining appropriate indications for the use of computed tomography for which federal reimbursement would be sought (OTA, January 1981, 74).

Current Status of CT Imaging and Trends

Improvements in computed tomography technology, resulting in improved image resolution, have led to ever increasing use being made of CT in a clinical setting for diagnosis, procedural assistance, and post-procedural evaluation (ECE, 36). Most new physicians are trained in an environment in which CT is available to assist in the diagnostic process and are trained in the indications for use of CT (Figley and Margulis, 1121). As previously mentioned, increased financial incentives for both the practitioner and the hospital to ensure the correctness of the diagnosis, in the form of increased legal liability and threats to practitioner credentials and hospital accreditation, have led to

increasing reliance on CT as an important component of a complete battery of diagnostic tools. Reductions in the price of the CT scanning equipment, corresponding with improvements in the technology, have allowed for the rapid diffusion of the technology into many small community hospitals (AHA MediTrends, 20) and have led to the development of stand-alone imaging centers and mobile units which may serve many hospitals (Steinberg et al., 860).

The magnitude of this diffusion phenomenon can be judged by an examination of the rate of historical dissemination of CT technology. The Office of Technology Assessment reported that on January 1, 1975, there were only forty-five CT scanners operational in this country. During the next two years, this figure increased by almost eighteen per month and, during 1977, that rate increased to almost forty per month. In 1978, the rate at which new CT scanners were placed into operation began to fall slightly and continued to slow through 1980. By May 1, 1980, 1471 units existed in the United States and OTA predicted that economic considerations would cause the number of CT scanners being operated in this country to level off at a level of slightly more than 1500 units (Jan 1981, 9).

In retrospect, however, this forecast plateau did not materialize. Perhaps as a result of decreasing prices and a wider range of available equipment options, the 2 September 1983 issue of CLINICA reported that growth in the CT market had continued to the point that there were then 2400 CT scanners in the U.S (ECE, 36). In their 1987 survey of member hospitals, the American Hospital Association reported that, from among 6,281 reporting member hospitals, 3,300, or 52.5% had hospital-based CT service

(AHA Hospital Statistics, 209). These figures do not take into account non-member hospitals and non-reporting member institutions. Additionally, they do not account for mobile or fixed units operated by independent providers and radiology groups. Of 2034 reporting hospitals of over 200 beds, however, the percentage was much higher. The American Hospital Association reported 1663, or 81.8%, offered CT services (AHA Statistics, 215). The AHA found that CT procedures performed per day by hospitals of all sizes have more than doubled over the five year period between 1982 and 1987 (MediTrends, 20).

The fluctuating market for computed tomography equipment has resulted in a volatile environment for the manufacturers of CT scanners and related equipment. Changes in that demand and the rapid pace of technological change have resulted in a market dominated by only a few major manufacturers. These include several major multi-national electronics and diversified corporations, including General Electric, Siemens, Toshiba, and Philips. At least three corporations have developed specifically to meet the demand for diagnostic imaging equipment, including Picker, Elscint, Inc, and International Diagnostic Imaging. Other major manufacturers with a significant share of the American market are the Shimadzu Corporation and Medical High Technology International (MHTI), Inc (ECRI, 9). To increase the selection available to purchasers, each of these manufacturers provides several product lines providing a range of technical specifications, options, and prices (ECRI, 16-29).

Analysts of the diagnostic imaging industry appear to be in universal agreement in the belief that the direction of computed

tomography technology points toward greatly increased capability for lower costs in the future. In parallel with improvements in other forms of automation, prospective purchasers or users of CT in the near future can reasonably expect to see enhanced image clarity (with accompanying diagnostic accuracy), increased data storage capability, and smaller unit size with accompanying reductions in requirements for drastic facility modification (Fischer, 156-157). Furthermore, increased availability of options across product lines, lower fixed costs for the initial purchase of hardware and software, and lower variable costs for necessary supplies (floppy disks, magnetic storage tape, etc.) will make the purchase of CT technology a viable option for an ever larger number of hospitals (AHA Meditrends, 23). This places the prospective purchaser in a dilemma - at what point should he purchase a piece of equipment, with the reasonable expectation that a more capable piece of equipment would be available at a lower cost within the near future (ECRI, 7)?

At the same time, increased demand for the services of fully qualified operators can be expected to increase the variable cost of operation, especially if twenty-four hour operation is desired (ECRI PCS, 7). Meanwhile, independent vendors are capitalizing on the increasingly lucrative market for the servicing of units already in place by offering service contracts at more attractive rates than are offered by the manufacturers. In response, as service of the equipment becomes a proportionately larger share of the total cost to a facility, manufacturers of CT equipment are already seeking to preserve their share of the service market by incorporating penalties into the purchase contract which reduce

the incentive for self service or independent servicing (Friddell, 46-47).

Alternative Diagnostic Imaging Systems

The advent of CT marked the beginning of rapid development of an ever-expanding array of diagnostic imaging tools available to the diagnostician. These techniques may be divided into two categories; those which employ ionizing radiation in the generation of the image and those that do not. At present, those which do not are somewhat limited in their technical capabilities but, because of safety considerations, these also promise increasing acceptance for future applications (ECE, 23).

Although considerably older than CT technology, ultrasonography has experienced much slower growth in clinical applications and technological capability. Because it represents a considerably smaller financial outlay than CT, its use is already widespread in healthcare facilities (ECE, 46). Ultrasound is generally interpreted by physician specialties other than radiologists because of the professional consensus that ultrasound is without the risks associated with radiation. Its applications are still limited somewhat by the fact that, since it is based on the same theoretical principles of sound propagation through water as sonar, its use is restricted to certain organs and it has little imaging value on bone or the lungs. Additionally, images produced by ultrasound are of a type that defy verification or comparison with other imaging techniques.

Magnetic Resonance Imaging (MRI), sometimes called Nuclear Magnetic Resonance (NMR), is among the newest diagnostic imaging techniques and has excited considerable interest for its relative safety, good image resolution, and potentially widespread application. Using a combination of radio waves and magnetic fields, MRI has several advantages over earlier imaging systems. Unlike ultrasound, MRI provides excellent contrast between tissues without the use of hazardous radioisotopes and, like ultrasound, bone does not interfere with signal transmission and image generation (Bushong, 5-7). Conversely, like ultrasound, this currently precludes the use of MRI for bone studies (ECE, 51). Finally, MRI is sensitive to changes in the chemical and physical makeup of cells, allowing the potential for earlier diagnosis (ECE, 53).

Given current technology, MRI has several disadvantages for the facility seeking to install one. The enormous magnetic field generated by an MRI unit powered by either a resistive or superconductive electromagnet requires restrictive site selection criteria or extensive site preparation to avoid interference with automated equipment, certain video equipment, and even analog watches and credit cards . If a permanent magnet is used, the tremendous weight (up to 100 tons) of the magnet restricts potential sites (Bushong, 126-131). In either case, site preparation represents a sizeable portion of the total cost of the unit and the strength of the magnetic field prevents MRI use on any patient with a metal implant (Bogotay, 27).

Cited as "the most expensive medical technology ever developed" (Wagner, 44), positron emission tomography or "PET" is

a nuclear medicine technique by which the diffusion of injected pharmaceuticals which are marked with positron-emitting isotopes can be plotted by a large computer (OTA, Jan 1981, 63). The resultant image provides detailed, three dimensional information on the physiology, metabolism, and function of the target organ(s). The use of a variety of cyclotron-produced isotopes, tagged to naturally occurring compounds such as carbon dioxide or metabolically active compounds such as glucose, allows recording and measurement of specific biochemical reactions as they are taking place (Economic Commission for Europe, 45). A much more restrictive form of PET uses rubidium which can be generated without a cyclotron but its use is restricted to studies on coronary artery disease (Wagner, 58). The principal disadvantage of PET technology, as with so many other imaging systems, is its cost. Besides the tomography unit which measures the positron output and computer system which generates the image from that measurement and archives the data, the system requires ready access to a cyclotron to produce the isotopes, some of which have an extremely short half-life. Additionally, while few question its value in certain select cases, considerable disagreement exists in the professional community on whether the current understanding of the biochemical processes of the various organs is sufficient to allow accurate interpretation of the information produced (OTA, Jan 1981, 65).

Closely related to PET, single photon emission computed tomography or "SPECT" imaging is another nuclear imaging procedure which uses from one to three gamma cameras to detect the emissions of photons from thallium (TI^{210}). It is particularly useful in

the evaluation of coronary artery disease and sensitivity of the test can be increased or, conversely, the dose of the radioactive tracer can be reduced by using more cameras. The increase in cost of using more cameras is borne by the patients and, according to Mullani, presents some unique ethical dilemmas to the physician (145).

Ethical and Legal Implications of CT

The rapid growth in the availability of increasingly sophisticated and increasingly expensive diagnostic imaging techniques presents a variety of ethical and legal dilemmas for the members of society who, directly or indirectly, must pay for the availability of these services (OTA 1984, 3). At the time of development of a new technique, current regulations, designed to protect potential beneficiaries, require that the clinical efficacy and safety of the equipment and procedures be established and that clinical protocols be developed for their use. Although new applications of CT are constantly being explored, this process has, essentially, been completed (OTA Apr 1981, 3).

Once the potential benefits of the technique are recognized and acceptable procedures arrived at, more vexing questions of the economic impact of the technology must be addressed. At the root of these questions is the matter of access to the enhancements in diagnostic accuracy afforded by such services. On one side is the understandable desire by those who might benefit from the procedure to ensure near universal access. Opposing this position is the reality of the high financial cost of the technology to

third party payers. Ultimately, through higher insurance rates, reduced insurance benefits, and taxation, this higher financial cost is passed on to the wage-earners. The use of such expensive technologies by military beneficiaries, as recipients of medical care that is almost completely subsidized from the tax base, represents an important issue in any such debate. Based on studies by the Office of Technology Assessment, the government has sought to reduce the total costs of such services by providing financial incentives to guide providers and practitioners toward "appropriate" behaviors in applying this technology in clinical situations involving federally insured patients. Other third party payers have followed suit.

A hearing before the Senate Committee on Labor and Human Resources in June of 1984 attempted to address the question of how and in what forum new health care technologies should be assessed for clinical efficacy, cost effectiveness, and reimbursement by third party payers. Among the experts testifying was the Director of the National Center for Health Services Research of the Department of Health and Human Services. One mission of this agency is to conduct an assessment of health care technologies from which to advise the Health Care Financing Administration on reimbursement under the provisions of MEDICARE. The director shared the consensus of that committee that a new "National Institute for Health Care Technology Assessment" should be established, composed of experts from the private and public sector. Its membership would seek to represent all various stakeholder groups in order to attempt to resolve some of the ethical issues presented by the proliferation of new health care

technologies (Senate Committee on Labor and Human Resources Hearing, June 1984, 8).

The impact of restrictive actions by both public and private sector third party payers is obviously felt by patients but is also keenly felt by individual practitioners (Pozgar, 57) and providers (Pozgar, 38) seeking to provide the most accurate possible diagnoses in a climate of finite resources. In an increasingly litiginous and fiscally constrained environment for healthcare providers, hospitals and physicians are faced with two undesirable options. Use of expensive technology in situations in which the same diagnosis might be rendered with less certainty by less expensive means subjects the hospital and the physician to critical utilization review by a representative of the third party payer and possible non-reimbursement. An analog in military facilities to non-reimbursement by third parties is command pressure not to exceed budgetary authority.

The opposing option of erring on the side of restraint in the use of expensive technology can have an equally damaging effect on the financial situation of the healthcare provider. Failure to accurately diagnose a patient's problem is likely to subject the practitioner and the hospital to protracted and expensive litigation. Under the provisions of the Federal Tort Claims Act, the federal government, as the proponent for military healthcare, is not immune to bonafide claims and possible legal action by certain categories of beneficiaries. While military physicians are financially protected by the Gonzalez Act from direct pecuniary liability, these costs are borne by the government and, as a result, the practitioner involved may be subjected to

administrative action. Such a case involving Irwin Army Community Hospital, over the alleged failure to make available the alpha feta-protein test to an expectant mother, is currently pending (IACH records).

It is the expressed goal of the leaders of the military healthcare system to make available to military beneficiaries the best possible medical care (AR 40-3, 5, para. 2-1). This includes many high technology and high cost diagnostic procedures. It is also clear that the Department of Defense can ill-afford to squander its resources (OTSG, 6), either by unrestrained use of such diagnostic services or by establishing overly stringent controls on their use. The individual medical treatment facility commander, operating within limits established by higher headquarters and supported by its assets, is the person charged with balancing these two opposing forces at the local level (AR 40-3, 5, para. 2-3).

Irwin Army Community Hospital

Irwin Army Community Hospital (IACH) is a 129-bed general, acute care facility located at Ft. Riley, Kansas. With an average inpatient census of 85 and approximately 1100 clinic visits per day (IACH records), it is the largest medical treatment facility, military or civilian, within a radius of fifty miles (AHA Guide, A132-A138). Its eligible beneficiary population includes all active duty military, their family members, retired military, and their family members. Its service area includes all of Nebraska and all of Kansas, with the exception of an eleven county area

surrounding Ft. Leavenworth, Kansas. This area is believed to include approximately 75,000 eligible beneficiaries. The only other military medical treatment facilities within its area are the McConnell Air Force Base Hospital in Wichita, Kansas and Ehrling Bergquist Air Force Strategic Hospital at Offutt Air Force Base, Nebraska. Other federal facilities in the hospital's service area include Veterans Administration Medical Centers located in Topeka, Leavenworth, Wichita, and Ellsworth, Kansas and Grand Island, Lincoln, and Omaha, Nebraska and the U.S. Public Health Service Indian Hospital in Winnebago, Nebraska (AHA Guide, A132-A138 and A201-A205).

The assigned active medical staff includes forty physicians out of forty-four authorized positions, representing most of the specialties. Of these, only the chief of the Exceptional Family Member Program is a Department of the Army civilian. In addition, CHAMPUS partnership agreements have been negotiated with seven full-time civilian physicians practicing in our facility. Additionally, the hospital augments its staff with contract physicians in emergency services, radiology, and the general outpatient clinic. Finally, periodic subspecialty care is available at the hospital, under contract in the areas of neurology, dermatology, endocrinology, pediatric cardiology, otorhynolaryngology, and podiatry. In recent years, the hospital has had an assigned military radiologist only sporadically. The most recent military radiologist was assigned to the facility only one year and left the Army on July 1, 1989 (hospital records).

Radiology services available at IACH include diagnostic X-ray, fluoroscopy, mammography, and ultrasonography. Additionally,

a mobile CT scanning unit is currently scheduled to visit the hospital every Friday for routine scan requests and those priority and emergency requirements which happen to arise during the unit's visit to the hospital. This unit is operated by MobilScan, Inc. of Manhattan, a joint venture between the town's radiology group and local hospitals. The mobile unit is a second generation, seven year old, General Electric Model 8800. Among the hospital's radiology staff, considerable disagreement exists over the quality and adequacy of the images produced by that unit. Additionally, given the age of the unit and the transporter and the extra demands on the equipment resulting from daily relocation, actual availability of the unit, even on Fridays, is increasingly sporadic.

Other facilities within a reasonable distance which have CT scanners which might be made available to the commander of IACH include Stormont-Vail Regional Medical Center, St. Francis Medical Center and a Veterans Administration Medical Center in Topeka (sixty miles), and Asbury Medical Center in Salina (forty-five miles). The nearest military referral center is Fitzsimons Army Medical Center (FAMC) in Aurora, Colorado. The distance of 400 miles to Fitzsimons dictates that patients be transported by means of the Air Force aeromedical evacuation system for all but the most routine cases.

As previously stated, the hospital is scheduled to receive its own CT system sometime later this year, although the exact date of its arrival is still subject to considerable conjecture. The unit will be a Model 1200SX Expert, a fourth generation system manufactured by Picker International, Inc. and will be installed

in a mobile transporter provided by Calumet Coaches, Inc. of Calumet City, IL. While this unit will meet most of the hospital's needs for CT services, CT scans involving the use of radioisotopes will still have to be referred to outside providers because the hospital has been given no mission by Headquarters, Health Services Command (HSC) to provide nuclear medicine services.

Use of Federal Funds to Pay for CT Services

For beneficiaries of care at IACH, outside providers of authorized CT services, including civilian providers and the Veteran's Administration hospitals, are reimbursed from one of two sources of funds. The tri-service Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) reimburses providers for allowed inpatient and outpatient care delivered to family members of active duty and retired military and the retired military members themselves (CHAMPUS Handbook, 14-15). Under the provisions of a "cooperative care" arrangement, CHAMPUS funds may be used to reimburse non-military providers for certain types of care delivered to CHAMPUS beneficiaries that are beyond the capability of the servicing military MTF. Diagnostic medical services, such as CT services, are not authorized, however (CHAMPUS Claims Processing Manual, 1-38). Reimbursement for CT scans using DoD CHAMPUS funds is allowed only when the services are received by a patient who is a CHAMPUS inpatient in a civilian facility or when that beneficiary is referred for the diagnostic test by a civilian practitioner. By direction of Congress,

CHAMPUS reimburses providers of inpatient care from joint service funds at a prospectively determined rate based on the patient's diagnosis-related group (DRG) (CHAMPUS Claims Processing Manual, 1-12).

For active duty soldiers, who are not eligible for CHAMPUS care under any circumstances, CT scans obtained from outside providers are paid for with "supplemental care funds". These monies are a special category of Operation and Maintenance, Army (OMA) funds used to reimburse non-military providers for care rendered to eligible beneficiaries which is beyond the capability of the member's servicing medical treatment facility. As such, supplemental care funds must also be used to reimburse providers for all diagnostic procedures performed by outside sources on CHAMPUS eligible beneficiaries which do not fall within the criteria listed above. These include CT procedures provided to eligible CHAMPUS beneficiaries who are inpatients of IACH at the time of referral (AR 40-3, 9, para 2-29). Unlike CHAMPUS, reimbursement of providers from supplemental care funds is paid at 100% of charges billed by the provider. As one of the last sources of reimbursement on this basis, supplemental care of patients referred by military hospitals represents a potentially lucrative source of revenue for providers who are in a position to treat large numbers of DoD beneficiaries.

VA-DoD Resource Sharing

Under the provisions of the Veterans Administration and Department of Defense Health Resources Sharing and Emergency

Operations Act of 1982 (Public Law 97-174), the uniformed services and the Veterans Administration (VA) are directed to explore all opportunities for cost savings to be gained by the sharing of health care delivery resources. Prior to the passage of this law, many examples were cited of cases in which two or more federal hospitals, often operating only a few miles apart, sought to offer identical, very high-cost services only to their respective categories of beneficiaries. At the same time, cases existed in which the facility of one agency already offered a service which operated at suboptimal utilization rates while, because of a lack of interagency cooperation, the other was prohibited by statute from being able to purchase that service from the other federal provider (House of Representatives Veterans' Affairs Committee Oversight and Investigations Subcommittee Hearing, 1986, 5).

As a result of this law and the implementing Memorandum of Understanding between the two agencies, many VA-DoD sharing agreements have been negotiated at the facility level. Such agreements result in substantial cost savings for both agencies through favorable rates for needed services and reduction in the establishment of new but duplicative services. At a hearing before the Subcommittee on Oversight and Investigations of the House Committee on Veterans' Affairs in June of 1986, the Director of the Veterans Administration cited sharing agreements between 97 VA medical centers and 120 military MTFs as evidence that the law had been successful and had the desired effect of encouraging closer cooperation between the agencies (18). The most frequently shared service was diagnostic imaging. According to testimony provided to that committee, however, at the time of that hearing

and four years after passage of the law, no such agreement had been negotiated between IACH and the VA medical center in Topeka (87-91).

Demand for CT Services at IACH

Demand for CT services for patients originating at IACH may be summarized as follows:

1.) Active duty patients and CHAMPUS beneficiaries whose scans are conducted by other DoD medical treatment facilities (not reimbursed).

2.) Active duty patients and CHAMPUS beneficiaries whose scans are conducted by the Mobilscan unit at IACH (paid for by supplemental care funds).

3.) Active duty patients and CHAMPUS beneficiaries whose scans are conducted by the VA Medical Center in Topeka under the terms of the VA-DoD Sharing Agreement (paid for by supplemental care funds).

4.) Active duty patients whose scans are conducted by all other civilian providers, on either an inpatient or outpatient basis (paid for by supplemental care funds).

5.) CHAMPUS beneficiaries whose scans are conducted by all other civilian providers on an outpatient basis when referred by a DoD physician and when there is no expectation that follow-up care will be provided by the civilian provider (paid for by supplemental care funds).

6.) CHAMPUS beneficiaries whose scans are conducted by all other civilian providers, during a CHAMPUS allowable episode of inpatient care (paid for by CHAMPUS).

Reflecting the nationwide trend toward increased reliance on computed tomography as a valuable diagnostic tool, practitioners at Irwin Army Community Hospital have increasingly ordered CT during the recent past. Besides being subject to many of the same pressures as civil sector practitioners, many of the military physicians assigned to IACH are recent graduates of internship and residency programs in which CT technology was readily available in the teaching program and so, are accustomed to requesting the assistance of CT in clinical decision making. The increase in the use of CT scans by IACH physicians over the past year and a half is shown at App. D.

IV. DISCUSSION

Assessment of the Problem

The development of a model by which to address a problem must begin with an assessment of the magnitude of the problem. In order to analyze the expenditure of supplemental care funds for CT services purchased from outside vendors, the following historical data, at a minimum, should be available:

1.) Total expenditures for CT scans categorized by:
   a.) Specific procedures performed per episode.
   b.) Provider conducting the procedures.
   c.) Provider interpreting the results, if different.
   d.) Referring practitioner.
   e.) Beneficiary category.
   f.) Inpatient vs. outpatient.
   g.) Procedures performed while an inpatient at a civilian facility.
2.) Available providers and price lists for CT services.
3.) Constraints governing selection of a provider (hours service is available, quality of results, etc.).

If these data elements are unavailable, the commander may be reasonably certain that a problem exists with the ways in which the hospital is spending supplemental care funds. Implementation of better data collection procedures should begin at once but other corrective actions need not be delayed until extensive historical data have been collected and analyzed. The prudent

commander, however, will proceed slowly in the absence of other than intuitive impressions of CT referral behavior.

Military Considerations

To be useful to the commander of a military medical treatment facility, any decision-making sequence must account for factors which are unique to the military. Furthermore, those factors which, if not military unique, at least present different challenges to the MTF commander than they would to a similarly situated chief executive officer of a civilian hospital should be accounted for. Such factors may work to the commander's benefit or to his detriment in attempting to arrive at a solution to the problem at hand. These factors include, but might not be limited to, the following:

1.) Compliance with applicable Federal laws and military regulations.

2.) Accordance with priorities established by higher echelons of command.

3.) The existence of categories of eligible beneficiaries and the limited freedom available to the commander to establish priorities of beneficiaries to whom care is delivered.

4.) Operation under a cost-based, allocation resourcing system (MCCUs) which provides rewards for inpatient care, rather than a system based on a prospectively determined, case mix-adjusted (DRGs), reimbursement

system, designed to provide disincentives for inpatient care.

5.) The existence of select funding sources which higher headquarters might be expected to augment due to their entitlement status (e.g., CHAMPUS).

6.) The existence of data, through records of the Defense Eligibility Enrollment System (DEERS), by which to determine a demographic profile, however limited in accuracy, of the hospital's patient base.

7.) The relative inability of most eligible beneficiaries (those within the 40 mile catchment area) to select sources of care.

8.) The access of military health care beneficiaries to mechanisms for redress of grievances resulting from their episode of care through the military chain of command, Congressional inquiries, and Presidential communications.

9.) Considerations impacting on the mobilization mission of the hospital.

10.) The negotiating leverage afforded to the commander by the ability of DoD to purchase goods and services in high volume.

Appropriateness of the Procedure and its Use

Whether in a military or civilian setting, any model which seeks to arrive at a way of saving money expended for a given medical procedure must first evaluate, at least cursorily, the

efficacy of the procedure. In the case of computed tomography, the overwhelming body of literature demonstrating the clinical applicability of the procedure to a variety of diagnostic situations may appropriately be regarded as sufficient to allow this factor to be readily established.

Given the demonstrated efficacy of the procedure itself, the appropriateness of referrals by physicians at the facility should be evaluated. Current utilization management and peer review techniques are sufficiently sophisticated to enable this. Irwin Army Community Hospital and most other Army facilities have the automation support and committee mechanisms in place to support such an evaluation. Adequate evaluation of physician behavior with respect to a certain procedure, however, requires the targeting of that procedure for special attention by reviewers. Care must be taken to ensure that such an evaluation does not detract from other ongoing quality assurance and utilization studies.

The determination that modification of practitioner behavior could save money may be used as a basis on which to immediately initiate action but may be only partially effective, due to the legal and ethical constraints already addressed. In the absence of the financial and professional incentives that might be offered by a civilian hospital administration in conjunction with the medical staff, examples of measures that might be taken by the commander of a military medical treatment facility include:

1.) Education.

2.) Strict accountability for all scan referrals, such as a requirement for an ex post facto written

justification to the Deputy Commander for Clinical Services (DCCS).

3.) Counseling.

4.) Administrative action.

At this point, it should be pointed out that inappropriate modification of practitioner behavior or otherwise appropriate steps responded to inappropriately by the practitioner may expose the Army to risk of litigation. The financial costs of such exposure, while not borne by supplemental care funds, still fail to achieve the desired result of overall cost savings to the payer. Additionally, the potential for less tangible, political costs to the commander of this risk exposure may serve to vitiate the effectiveness of any such steps. Finally, the extent that this perceived restraint of professional discretion may have as a disincentive to the practitioner to remain on active duty should be evaluated. Such measures should be taken with the knowledge that their implementation may result in both professional and financial costs to the hospital and to the Army Medical Department (AMEDD). These may include the loss of vital professional services to the hospital's patient population, the financial costs required to compensate for the loss of services by the contractual procurement of civilian physician services, and the financial impact to the Army in recruitment and training costs.

Addressing the Needs of the Patient

The next step is an objective assessment of the effectiveness of current procedures used in the facility to refer patients to

specific providers of CT services. From the clinical perspective, it is axiomatic that any such referral decision must be based first on the medical needs of the patient. These needs take two forms.

The first need, obviously, is dependent upon the acuity of the patient. For an emergent patient, the patient's condition would necessitate the use of the facility which could provide clinically useful images in the shortest possible time. For the practitioner and the provider treating such a patient, this criterion supercedes all others. Failure to meet the medical needs of the patient may risk the exacerbation of his condition. Additionally, failure to provide appropriate care that is reasonably available may place the practitioner at professional risk of censure, and the hospital at risk of litigation and loss of accreditation.

The second medical need for certain cases may be for specific slices, procedures, or services deemed necessary by the referring physician and available only from certain providers. Particularly in rural areas, such as those surrounding Ft. Riley, because of the limited presence of special equipment or specially-trained personnel, this need may dictate a single suitable provider for selected cases and so create a seller's market for the service. Subject to mechanisms already in place to steer that practitioner toward a less expensive provider, the referring physician must be the authority in determining these aspects of the decision-making process. It is he, after all, who bears legal and professional responsibility for the accuracy of the diagnosis and the outcome of treatment.

In a case in which there exists no medical contraindication for provision of the required service by any given vendor, the non-medical needs of the patient should also be taken into account. It could be argued that military patients are generally understanding and supportive of the commander's attempts to conserve resources in the delivery of their care. Nevertheless, few patients, military or civilian, would willingly allow themselves to be subjected to considerable inconvenience without any tangible return for their support of these efforts. This becomes a problem, for example, when an outpatient is directed to bypass one known provider of CT services for another provider at the patient's own expense and for the sole purpose of saving the hospital money.

Failure to recognize the patient's personal needs in this respect and to address them, even if only by an *a priori* explanation of the reasons for the action, is likely to elicit a complaint. This may be registered either informally, through the Patient Representative or the Commander's "Open Door" policy, or through one of the several formal avenues available to the beneficiary for redress of grievances, such as a Congressional or Presidential inquiry or, at Ft. Riley, use of the "9-BOSS" telephone line to the Commanding General. The political costs in loss of community goodwill of this kind of marketing failure and the tangible financial costs in employee time spent responding to complaints should be reflected in hospital procedures.

Stewardship of Hospital Resources

After the needs of the patient have been satisfied, hospital procedures should address the need for the facility to spend its funds judiciously. To facilitate this, the person(s) responsible for obtaining appointments and coordinating episodes of care obtained from outside sources should be able to make decisions based on complete information of the services available and the costs to the facility of obtaining those services. The price lists should reflect any discounts available and, when volume discounts are offered by one or several vendors, that person should be maintaining a running total of procedures purchased against the target volume.

A 1988 memorandum from the Surgeon General gives authority to the facility commander to determine "appropriate MTF personnel" to schedule treatment purchased under the provisions of the Supplemental Care Program (2). To provide personal accountability for the effective control of costs in the routine purchase of large numbers of CT scans and other procedures obtained from outside providers, all routine requests should be funneled through only one person or office. For purposes of this discussion, that person will be called the "scans clerk."

At Ft. Riley, the scheduling of other than emergency CT referrals, as well as other tests and treatments paid for with supplemental care funds, is the responsibility of the Clinical Support Division. The assignment of "scans clerk" responsibility to CSD works well, but is only one among several possible alternatives. Other feasible alternatives include personnel from

Radiology Service, Supply and Services Branch of Logistics Division, and the Resource Management Division. More important than who is responsible for this task is that the responsible office is clearly identified in hospital policy and that this policy is well-known by all hospital staff members. Ignorance of this policy might place a staffmember in the position of financially obligating the government improperly.

The widespread availability of office automation allows the person responsible for the assignment of CT referrals access to exceptionally powerful tools with which to monitor and influence provider selection on behalf of the commander. The commander, in the course of his evaluation of ways to conserve supplemental care dollars, should ensure that these tools are being effectively used. Maintenance of historical records should include all of those data elements necessary for the initial assessment of the magnitude of supplemental care expenditures and for continued monitoring of the effectiveness of efforts to control those costs.

Implementing guidance to the Surgeon General's directive on Supplemental Care, published by Health Services Command (1), suggests a format for the maintenance of historical records which includes the following data elements:

Civilian Provider Facility

CPT-4 Code of the procedure performed

Billed Rate

CHAMPUS Prevailing Rate

Amount Paid

Date of Service

Date Verified

Analysis of the incremental costs involved, however, suggest that the maintenance of additional data might identify further opportunities for cost savings and facilitate the accounting function. Radiology procedures, for example, include a technical component (conducting the test) and a professional component (interpreting the results). In many cases, these two components are performed by separate vendors (for example, a hospital and a radiology group practice, respectively) for which two separate bills are rendered. While the cost of one component may be the most favorable for the MTF, the cost of the other component, delivered by an associated vendor, may force the total cost of the procedure above that available from some other source(s). A graphic representation of the possible incremental components of a CT scan procedure are shown at Fig.1.

Total Cost of a CT Scan

Variables:	Notes:
Agreed upon charge for procedure (technical component)	May or may not be favorable to the referring facility.
+	
Charge for interpretation (professional component)	May or may not be included in "agreed upon charge".
+	
"Hidden" charges	May or may not be present.
+	
Intangible cost to the patient (and, thus, to the referring facility)	Likely to be present, if only negligible, in all cases.
= Total cost	

Fig. 1

Separation of these incremental costs may allow the commander to seek the high-cost component elsewhere or provide him additional leverage in negotiating with the high-cost vendor. Additionally, the presence of qualified physicians on his staff to perform the professional component may allow the commander to negotiate a separate agreement with the provider of the technical component, thereby saving the entire cost of interpretation.

Selection of the preferred vendor will, at least initially, be based on pricing schedules provided by the vendors. Actual

expenditures, however, will probably differ from estimates derived by the scans clerk and based only on these schedules. These differences may be based on "hidden" incremental costs for associated supplies and services (such as injection of a contrast medium), confusion over the referring physician's requests, charges for clinically unusable images, or emergency room charges for emergent patients referred by the MTF. Unless responsibility for the scheduling of outside CT services rests with the Comptroller, priority should be given to networking the automation systems of the scans clerk and of the disbursement officer to allow all records to be maintained in a single database. From this database, one office should be given responsibility to monitor and investigate deviations by vendors from established pricing structures. Continuous monitoring of the discrepancies between pricing schedules and billed charges, and confrontation of offending vendors, will help to ensure that billed charges are consistent with pre-arranged pricing structures.

Likewise, maintenance of data citing the ordering physician and service might allow the commander to determine the presence of practitioner behavior patterns which lead to the purchase of unnecessary diagnostic tests. The monitoring of these patterns and the use of incentives previously mentioned to adjust the behavior of identified practitioners would facilitiate the utilization management process. Associated with the identification of the clinical service ordering the tests is assignment of the costs to the appropriate cost center by use of the Uniform Chart of Accounts (UCA) code. Identification in this way would facilitate the budget management process.

An additional data element worthy of consideration is the inclusion of a subjectively derived weighting system for the intangible costs, such as mileage costs and personal time expended, incurred by the patient in the selection of a particular vendor. As previously stated, these costs are real, both to the patient and to the servicing MTF, and must be considered in the selection process. Such a weighting system might be based on quantitative factors such as the government authorized mileage rate and local wage rates, on responses to a patient survey, or intuitively derived by the commander.

Examination of the total costs, adjusted by such a weighting factor, may suggest means by which the commander might reduce those intangible costs and so take advantage of the vendor offering the lowest financial costs. For example, for routine scans, blocks of appointment times might be arranged with the vendor and patients transported to the vendor in groups by bus ambulance to preclude the use of privately owned vehicles and, possibly, to reduce waiting times for the procedure. Additionally, the use of such a weighted factor may indicate that the total cost of a contracted mobile unit servicing the facility is less than a less expensive fixed provider sixty miles away.

Price Negotiation

In guidance provided by the Army Surgeon General, facility commanders were directed to use "the prevailing change schedule and fee setting procedures used by the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) as the guide to price

reasonableness." In order to comply with the spirit of this guidance, therefore, commanders should ensure that negotiations for fees incorporate these figures as a non-negotiable upper limit. The inability of a facility to procure services below these figures should provide a valuable "flag" to indicate that options other than the purchase of services with supplemental care funds should be pursued vigorously. Factors which might preclude arriving at favorable rates, relative to CHAMPUS fee schedules, include monopoly by a single reasonably available provider, "rate fixing" between two or more providers in the local area, or the presence of local factors which tend to make the CHAMPUS schedule inapplicable.

Assuming that several vendors of CT services are available, even a cursory assessment of the pricing structures submitted by them should make clear any previous failure by the facility to bargain from a position of strength. To take full advantage of this position, the commander must have an accurate historical record of CT referrals. The commander should seek to capitalize on the negotiating leverage to be gained by the potential size of the market which the hospital's patient base represents. The demographic data available from the DEERS database, the number of medical records for which the facility has custody, and history of outpatient visits may be used to impress upon the skeptical vendor the market potential of the hospital.

In attempting to negotiate favorable rates, commanders should not fail to draw upon projections which incorporate long range plans of the installation and potential changes in the size or demographic composition of the patient population. Any

hypothetical assumptions on which these long range projections are based should be stated and should be credible to the representatives of the vendors. In the case of Ft. Riley, for example, one such projection might be based on the assumption that widely-publicized proposed decreases in the troop strength in Europe would result in the return of the forward deployed brigade of the 1st Infantry Division to Ft Riley, with a corresponding increase in the number of soldiers supported by IACH.

Negotiation of Payer

Besides the negotiation of agreements for favorable discounts based purely on volume of patients referred, the hospital may be able to control other factors of equal or greater importance to the prospective vendor which serve to make the hospital an attractive client and may be used to elicit additional price concessions. Accounts receivable represent a significant cost to any vendor (Weston and Copeland, 341). Any action that the facility can take to control these costs for the provider, therefore, is likely to increase the hospital's attractiveness as a purchaser and its leverage in seeking discounts. Such an opportunity may present itself for non-active duty patients who are also covered by other health insurance.

Department of the Army policy requires that, in cases in which the patient is covered by other health insurance, the government will always be the secondary payer of health care costs. For dependents and retirees so covered, these provisions allow the facility to bill the other health insurance carrier a

reasonable, fixed amount (currently $494.00) for inpatient stays in Army medical treatment facilities (DA Message, 28 Sep 88, 2). Funds thus generated, however, are not returned to the facility for use in enhancing the care at that hospital, but are remitted to the General Fund (DA Message, 28 Sep 88, 3).

Vendors of CT scans with astute business managers are likely to maintain records of the payment histories of frequently billed third party payers, including the U.S. Government. Information on other health insurance provided to these vendors for beneficiaries so covered will provide the vendors an opportunity to bill the other carrier first. This provides him with two potential payers, in case the first claim is denied, and allows him to seek reimbursement from a carrier with a better record for prompt payment than the government can offer. In turn, reimbursement by the other carrier saves the hospital supplemental care money which can be used by commanders to enhance care at the facility.

As an additional incentive to the prospective vendor, the hospital might even offer its own personnel to bill the other insurance carrier on behalf of the vendor. Depending on the number of beneficiaries with other health insurance receiving care from that vendor, the savings to him in administrative costs of process bills could be significant. Additionally, this might sway those vendors, who would not otherwise accept assignment from the government because of the administrative burden, to participate in the bidding process.

To ensure that the savings to the hospital would justify the additional manpower required, a cost-benefit analysis should be performed prior to commitment. Such a cost-benefit analysis must

be based on accurate historical records of the number of beneficiaries with other health insurance who require CT scans purchased from that vendor.

"Recapture" of Supplemental Care Inpatients

Because supplemental care pays full billed charges, the incentive for a non-military hospital providing inpatient care to a military beneficiary in a supplemental care situation differs from the financial incentive for care reimbursed by most other third party payers. Care provided under the prospectively-determined payment system, based on diagnosis related groups (DRGs), used by most third-party payers, rewards the provider who admits a patient under the highest appropriate DRG and provides high quality treatment with the least expenditure of resources. Conversely, reimbursement of billed charges rewards the provider who expends the most resources in the total care of the patient and provides no incentive for the provider to be either efficient or timely in the delivery of that care.

Ongoing, case-by case monitoring of individual patients referred to nearby civilian hospitals for supplemental care allows the commander to return patients to a military facility as soon as their medical condition allows. Besides the basic per diem room charge, reduction in the length of stay in a civilian facility by as little as one day is also likely to reduce the billed charges for associated services, including additional diagnostic tests to determine the patient's progress, that could be performed at no cost to the referring facility in a military referral center.

Such a reduction is likely to result in substantial savings for the hospital's supplemental care budget. Without encouragement from an aggressive commander, however, the civilian provider has no financial incentive to return the patient to military care.

For a commander to effectively encourage a civilian provider to override its financial disincentive to release military patients in a timely manner, a good working relationship should exist between the facilities. This relationship should be based upon mutual trust and a mutual understanding of the constraints affecting the respective facilities. The attending medical staff member in the civilian facility must trust that the care received by the patient in transit and at the destination military facility will adequately meet the needs of the patient and protect him from liability. This relationship can be fostered between the medical staffs through such activities as continuing medical education, consultations, and tours of the facilities. Carefully nurtured and in the absence of adverse experience, this relationship is likely to strengthen over time.

The development of an understanding by the civilian provider of the financial constraints on the relationship, however, is best accomplished from a bargaining position of strength. Part of the process of monitoring supplemental care inpatients should include accumulation of data on lengths of stay by DRG and by provider. Comparisons between providers may be used to demonstrate to a recalcitrant provider the wisdom of releasing military patients to military control in a timely manner. The presence of several suitable referral centers available to the MTF commander strengthens his bargaining position.

Use of VA/DoD Sharing Agreements

Since late 1988, a comprehensive agreement has existed between Irwin Army Community Hospital and the Colmery-O'Neil VA Medical Center in Topeka. This agreement lists the numerous inpatient, outreach, and outpatient services that the VA medical center can provide to IACH beneficiaries and in what amounts. The fees charged for these services are very favorable, when compared with rates charged by "competing" civilian tertiary providers. Certain resource and legal constraints at the VA Medical Center limit the ability of IACH to obtain all of their CT services from the VA. However, within these limits, the VA is currently the least expensive provider available to support the needs of IACH beneficiaries. A lack of such an agreement must be addressed before VA facilities may be reasonably looked upon as an opportunity for substantial cost savings.

Any such agreement should include the range of specific services that each party can provide to the patients of the other and in what volumes, a specific rate schedule that includes all associated charges, and reimbursement and scheduling instructions. The needs of one facility (in this case, the VA hospital) to make use of the other (IACH) may be slight but both facilities should seek to make available to the other the widest possible range of services. In seeking to take advantage of cost savings inherent in a VA-DoD sharing relationship, the commander should evaluate the completeness of the document.

With the benefit of a workable sharing agreement, the commander should evaluate the extent to which each hospital is

complying with the spirit of the agreement by aggressively implementing its provisions. This can be expected to take some time after the actual execution of the agreement. The limits currently imposed on IACH in its attempts to maximize the use of Colmery-O'Neil VA Medical Center for the procurement of CT services include the fact that the CT facility at the VA is not staffed except during the normal work day. Other factors which serve to limit the extent to which IACH can use the CT services of VA facilities include regulatory restrictions which prevent the VA from performing CT procedures on patients less than fifteen years of age and limitations on the CT equipment which preclude the performance of EENT diagnostic procedures. These factors are not likely to change in the foreseeable future.

An additional factor that may be at least partially controlled by the administrations of the respective hospitals is the institutional inertia that often accompanies an important change in procedures. In the case of the Colmery-O'Neil/IACH agreement, this factor presents itself as confusion among staffmembers at both facilities concerning who to contact for an appointment, specific reimbursement procedures, and inability to identify patients being treated under the provisions of the agreement. Overcoming these obstacles to effective sharing of resources requires continuous procedural refinement at each facility throughout the life of the agreement, periodic reevaluation of the sharing agreement, and incorporation of lessons learned into subsequent updates.

The Decision to Obtain On-site Equipment

Having taken all steps within his control to efficiently manage the purchase of CT procedures from outside sources, the commander may still arrive at the inescapable conclusion that the total costs of purchasing those services justifies the financial cost of acquiring at least some of those services on-site. An in-depth discussion of the cost-benefit calculations and the lease-purchase considerations inherent in such a decision is outside the scope of this work and these topics have been well treated by numerous authors. Additionally, the complexities of the military medical capital equipment procurement processes are largely beyond the control of the individual MTF commander and are best left to logisticians to decipher. Nevertheless, no examination of cost control options available to the commander would be complete without at least a cursory discussion of the impact of a lease or purchase decision on interim measures to provide those services.

Under Army MEDCASE program procedures, the purchase of a piece of capital equipment of the cost and capabilities of a CT scanner can require years between recognition of the requirement and actual use of the equipment on a patient. In many cases, the same holds true in the civilian sector (Alvarez, 48). To illustrate inherent delays in acquisition under the MEDCASE program, an abbreviated chronology of the acquisition process for the still to be delivered mobile CT unit programmed for IACH is shown at Appendix E.

In lieu of on-site delivery of CT services, the technical suitability of services purchased from an outside source is no

less important than the technical decision criteria evaluated in a purchase decision. As a part of the decision-making process for obtaining or continuing an interim service agreement with available vendors, the technical specifications of the services required by the practitioner should be considered in much the same way that purchase requirements were generated. The Emergency Care Research Institute, better known as "ECRI" is an independent non-profit organization which conducts research on high technology medical equipment. ECRI publishes a variety of product comparison studies which objectively describe the technology and state the technical specifications of current models. The criteria for which ECRI publishes specifications to compare CT scanners are shown at Appendix F.

The process by which vendors are evaluated for the technical suitability of their product should be similar to, but simpler than, the process by which a requirement for purchase of a CT unit is developed. However, in evaluating the technical suitability of equipment operated by a prospective vendor ordinary purchase considerations involving ease of use, installation (e.g. weight, size, etc.), operator training, and maintenance may be dismissed as the burden for these will be borne by the vendor. Rather, the commander would be well advised to call upon his radiology staff to advise him on technical considerations which would affect the patients and the practitioner, such factors as camera type, slice thickness, field of view, and, of course, radiation exposure to the patient.

When the decision has been made to either lease or purchase a CT scanner for use on-site, much of the background work needed to

generate specific requirements should have been accomplished during the process by which vendors of purchased services were initially evaluated and periodically reevaluated. For both processes, however, it should be pointed out that the technical requirements should be generated by technical experts. To avoid placing the technical staffmembers in a position of possible conflict of interest, these personnel should be given as little prior information on available vendors and models under consideration as possible.

Genesis of the Final Model

From an assessment of those actions currently being taken at Irwin Army Community Hospital and areas in which those actions were inadequate to effectively manage costs associated with the procurement of CT scans, an attempt was made to distill the findings into a simplified form for use by the commander. The result of that attempt is the synthesis of the preceding discussion which is found at App. B.

While the need for ease of use was recognized, to be of real value to the commander any resulting model must address his need for a systematic means by which to assess the process technology at work in his organization. Evaluation of the process technology by an organization manages another technology suggests a requirement for a sequential guide which provides detailed information on how to conduct such an evaluation. A simplistic wire diagram would fail to meet this need.

The solution to this problem was found in the writings of Peter Drucker who wrote:

> During those three centuries (preceding World War II) the model for technology was a mechanical one. For these three centuries advances in technology meant - as it does in mechanical processes - more speed, higher temperatures, higher pressures. Since the end of World War II, however, the model of technology has been the biological process, the events inside an organism. And in an organism, processes are not organized around energy in the physicist's meaning of the term. They are organized around information (3).

In keeping with that analogy, a model was developed which represents an attempt to evaluate a process technology, that of managing the costs of another technology, using a modification of the sequential system by which organisms are evaluated and grouped into taxa. The original model for this system is generally attributed to Carolus Linnaeus (né Carl von Linné) who, in the eighteenth century, developed the principles of taxonomic genera and species and devised an hierarchical system by which to identify a given organism by sequentially eliminating all other species. The system is generally referred to as a taxonomic or "Linnaean" key.

Such a key is little more than a more detailed written description of the logical process generally employed in the

familiar "decision tree", commonly employed in management. A simplistic example, using organisms, is shown at Fig. 2 and the, taxonomic or "family" tree which might graphically represent it is shown at Fig. 3.

A Simplified Example of a Taxonomic Key (after Linnaeus)

1. a. Organism stationary; chlorophyll present.....Plants...2
   b. Organism can move voluntarily; chlorophyll absent..Animals.3
2. a. Chlorophyll-containing structures needle-like.....Evergreens
   b. Chlorophyll-containing structures flat.....Decidous plants
3. a. Organism possesses no bony spinal column.....Invertebrates
   b. Organism possesses bony spine.....Vertebrates....4
4. a. Hair present, females possess mammary glands....Mammals....5
   b. Not as above.....328
5. a. Fully aquatic, breathing orifice on top of head..Cetaceans.6
   b. Not fully aquatic or, if fully aquatic, nostrils immediately superior to mouth.....31
6. a. Adult weight in excess of 1000 Kg.....Whales...7
   b. Adult weight less than 1000 Kg.....Dolphins/Porpoises..19
7. a. Bony teeth present.....Toothed Whales...8
   b. Teeth absent, dentition consists of cartilaginous filters... .....Baleen Whales..14
8. a. Adult weight less than 10,000 Kg.....9
   b. Adult weight greater than 10,000 Kg.....12
9. a. Color uniform.....10
   b. Distinct pattern present.....11
10 a. Color white.....Delphinapterus leucas (White Whale)
   b. Color black or dark gray.....Globicephala spp. (Pilot Whale)
11 a. Vivid black and white markings.....Orca orca (Killer Whale)
   b. Leopard pattern, tusk present....Monodon monoceros (Narwhal)

Fig. 2

Taxonomic "Tree" Diagram (see Fig. 2)

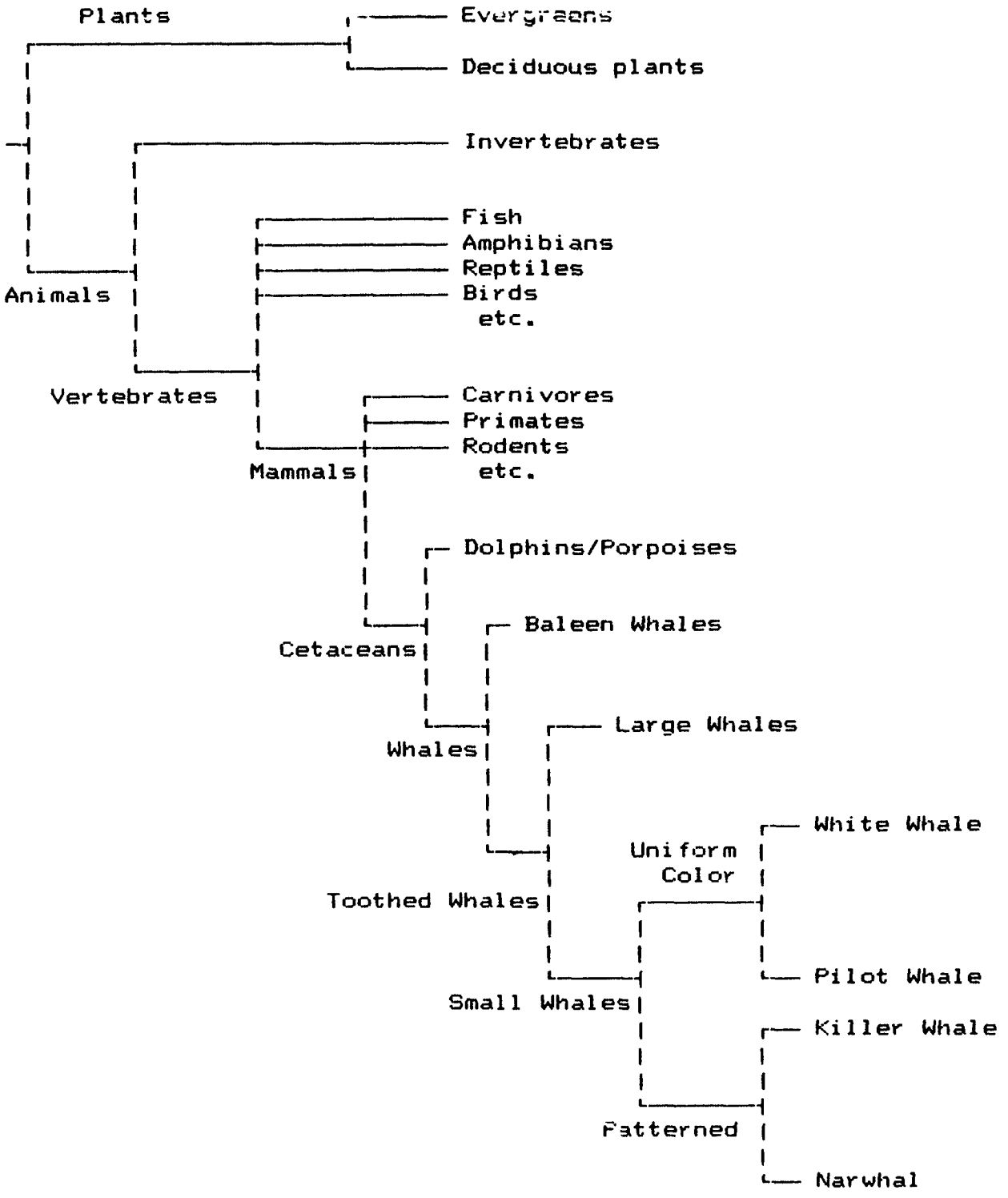

Fig. 3

V. CONCLUSIONS AND RECOMMENDATIONS

This same methodology may be modified for application to any other task which involves the methodical elimination of unsuitable alternatives. As such, it lends itself to quickly narrowing the scope of the investigator's search to those criteria which are important for identifying the organism or any other alternative course of action or item desired. If designed to represent a sequential task, the resulting product constitutes a sort of checklist of sorts for the user, in which the subcomponents of a task which has been completed to the satisfaction of the user may be bypassed in the sequence. Conversely, if the user seeks more information on the subcomponents of that task, he may follow that course through the key.

The steps described are designed to be useful, both as a prelude to the recognition of a requirement for on-site services and between submission of the requirement and delivery and installation of the equipment. They were designed to allow a systematic analysis of the process by which these services are ordered by the practitioner, scheduled by the "scans clerk", and vendors selected by the hospital administration. An analysis of this type is useful, both for an examination of procedures currently in place by which to contain costs and as an aid in exploring opportunities for further cost savings.

The analysis of a process, such as management of CT scan expenditures, is not truly sequential inasmuch as many of the steps involved are independent of each other and some may be performed simultaneously. As shown in Figure 3, when used with

the strictly sequential process by which organisms are identified this methodology sequence could be represented by a bifurcated decision tree. For a management problem with the complexity of this study, the resulting decision tree would be an extremely convoluted and confusing diagram or would give the illusion of a strictly sequential process. For this reason, the methodology generally used in the biological sciences has been modified in this case to allow several of the steps to arrive at the same place in the key.

While many of the steps described may be accomplished simultaneously, it cannot be stressed enough that the first step in such a process analysis must be the ongoing collection and a case by case examination of historical data on services purchased. Individual deviations from pre-established fee schedules should be identified in a timely manner and investigated to determine whether these deviations result from inaccurate fee schedules, practitioner ordering behavior, or noncompliance with fee schedules by the vendor. This requires strictly established procedures to permit communication between the scheduler and the comptroller and consistent oversight of the monitoring of CT scan expenditures.

As written, these steps are specific to the purchase of CT services at Irwin Army Community Hospital at Ft. Riley, Kansas. Nevertheless, many of the steps and decision-making considerations might be applicable to the purchase of other high technology and/or high cost services currently being procured by other Army hospitals from outside vendors. For example, any high-cost procedure routinely ordered by physicians might be examined in

light of the considerations for determining the appropriateness of the procedure. The most obvious examples of another service for which a modified version of this model might be applicable is the purchase of other high-cost diagnostic imaging procedures, such as MRI. Additionally, modified applications might be generated for services for which the high cost derives only from a professional component of service, such as psychiatric consultation, only from a technical component, such as high volume laboratory procedures.

The algorithmic model generated is only one of several different algorithmic models which might be applied to this decision-making process. It was designed and presented to be used manually to allow for the differential availability of automated tools used in management activities within Health Services Command facilities. The model allows for the fact that consideration of many of the factors presented rely on intuitive judgments by the commander and his staff and on inferential determination of practitioner and vendor behaviors. According to Keim and Jacobs, these attributes of the decision making process lend themselves to application of emerging automated technology in "artificial intelligence" or "AI". The formulation of the model in this way may offer the possibility of incorporation into an "expert" decision support automated system within the facility at some future time.

APPENDICES

APPENDIX A. - Glossary

AI - Artificial Intelligence; an emerging technology in automation which allows computers to assist in decison making through application of heuristic knowledge.

AR - Army Regulation.

Brigade - The immediately subordinate unit of an Army division. A standard division, like the 1st Infantry Division, has four brigades. Including the divisional assets required to support it, an infantry brigade normally has approximately 4000 soldiers assigned in peacetime.

CRT - Cathode-ray tube; the monitor device on which the derived image of a CT is depicted.

CAT - Computerized Axial Tomography; another name for CT

CT - Computed Tomography.

CPT-4 - Physicians' Current Procedural Terminology, 4th ed.; published by the American Medical Association, prescribes numeric codes for most established diagnostic and therapeutic procedures to provide standardization, commonly used in billing procedures of civilian healthcare providers.

CPU - Central Processing Unit; the information processing component of an automated system, including CT systems.

DEERS - Defense Eligibility Enrollment System; a triservice database containing information on all eligible beneficiaries for DoD health care.

Division - The largest unit in the Army with a fixed number of organizational elements. A complete mechanized infantry division, like the 1st Infantry Division, normally has approximately 16,000 soldiers assigned in peacetime.

DLA - Defense Logistics Agency; DoD agency which meets joint services logistical requirements.

DoD - Department of Defense.

DPSC - Defense Personnel Support Center; subordinate agency of DLA which acquires common equipment for all services.

DRG - Diagnosis-Related Group; set of closely related diagnoses grouped by structure(s) or organ(s) involved, patient's age, and presence or absence of complications, for which the mean resource input required to treat is assumed to be similar. Used by most third party payers to arrive at prospectively determined reimbursement rates for care provided.

ECE - Economic Commission of Europe; a U.N. Agency.

ECRI - Emergency Care Research Institute; a non-profit agency which conducts independent research on sophisticated medical technology.

Gantry - Large circular component of a CT which holds the X ray tube, detectors, rotation motors, and positioning aids.

Gonzalez Act - Public Law 94-464; provides limited personal protection from malpractice liability for DoD medical personnel operating within the scope of their duties.

HQ - Headquarters.

HSC - Health Services Command; IACH next higher HQ.

IACH - Irwin Army Community Hospital; The Fort Riley, Kansas hospital.

MCCU - Medical Care Composite Unit; unit of measure for hospital workload, derived from bed-days, births, admissions, and clinic visits.

MEDCASE - Medical Care Support Equipment; an AMEDD program for procurement of high-cost medical equipment.

MEDCEN - Medical Center; HSC tertiary care facility and referral center for MEDDACs, with teaching missions and limited regional responsibilities.

MEDDAC - Medical Department Activity; hospital and associated HSC medical agencies located at most Army installations.

MRI - Magnetic Resonance Imaging; a form of diagnostic imaging which employs magnetic fields to derive a tomographic image.

MTF - Medical Treatment Facility.

NMR - Nuclear Magnetic Imaging; another term for MRI.

OMA - Operations and Maintenance, Army; One of several specific types of restricted funds available to commanders of Army facilities.

OTA - U.S Congressional Office of Technology Assessment.

PET - Positron Emission Tomography; a nuclear medicine imaging procedure which measures differential emission of atomic particles to derive a tomographic image.

Rad - A unit of measure for radiation dose received by a patient.

Slice - The plane through the body which a given CT image depicts.

SPECT - Single Photon Emission Computed Tomography; a nuclear medicine imaging procedure which measures the emission of thallium photons to derive a tomographic image.

TSG - The (Army) Surgeon General.

USAMMA - United States Army Medical Materiel Agency; responsible for acquisition of medical supplies and equipment for the Army.

VA - Veterans Administration (now Veterans Department).

APPENDIX B. - COMMANDER'S GUIDE TO REDUCING SUPPLEMENTAL CARE EXPENDITURES FOR CT SCANS

1a. The existence and magnitude of a problem with management of supplemental care funds is unknown because of insufficient data 2

1b. Sufficient data available to determine existence and extent of problems with management of supplemental care expenditures . 5

2a. Data regarding expenditures for CT scans are inadequate for assessment of problem . . . . . .
Gather additional necessary expenditure data categorized by:
a.) Specific procedures performed per episode.
b.) Provider conducting the procedures.
c.) Provider interpreting the results, if different.
d.) Referring practitioner.
e.) Beneficiary category.
f.) Inpatient vs. outpatient.
g.) Procedures performed while an inpatient at a civilian facility. 3

2b. Data regarding expenditures for CT scans are adequate for assessment of problem. 3

3a. Data regarding available providers of CT services are inadequate for assessment of problem . . . . . .
Gather additional necessary data on providers 4

3b. Data regarding available providers of CT services are adequate for assessment of problem 4

4a. Data regarding constraints affecting provider selection are inadequate for assessment of problem . . . . . .
Gather additional necessary data on selection constraints 5

4b. Data regarding constraints affecting provider selection are adequate for assessment of problem 5

5a. Commander believes that all military specific considerations may not have been taken into account in the development of procedures by which to manage supplemental care expenditures for CT scans. 6

5b. Commander believes that all military specific considerations have been taken into account in the development of procedures by which to manage supplemental care expenditures for CT scans. 11

6a. Current procedures for expending supplemental care funds for CT scans are in accordance with applicable Federal laws. . . 7

6b. Current procedures for expending supplemental care funds for CT scans are not in accordance with applicable Federal laws. .
Immediately amend procedures. 7

7a. Current procedures for expending supplemental care funds for CT scans are in accordance with priorities established by higher headquarters. 8

APPENDIX B. - COMMANDER'S GUIDE TO REDUCING SUPPLEMENTAL CARE EXPENDITURES FOR CT SCANS (cont.)

7b. Current procedures for expending supplemental care funds for CT scans are not in accordance with priorities established by higher headquarters. . . . . .
Immediately amend procedures or request exception 8

8a. Current procedures for expending supplemental care funds for CT scans are specific to beneficiary categories established by higher headquarters, if necessary. 9
8b. Current procedures for expending supplemental care funds for CT scans are could be improved by being made specific to beneficiary categories established by higher headquarters. . .
Amend procedures, if necessary. 9

9a. Current procedures for expending supplemental care funds for CT scans seek to minimize patient complaints and local agents for addressing complaints are sensitized to procedures. . . 10
9b. Current procedures for expending supplemental care funds for CT scans are could be presented to better minimize patient complaints and/or local agents for addressing complaints are not fully aware of procedures. . . . . .
Amend procedures, if necessary. 10

10a. Current procedures for expending supplemental care funds for CT scans are consistent with the facility's mobilization requirements. 11
10b. Current procedures for expending supplemental care funds for CT scans are not consistent with the facility's mobilization requirements. . . . . .
Immediately amend procedures. 11

11a. Current procedures for expending supplemental care funds for CT scans and/or hospital utilization review program include effective mechanisms by which to determine the appropriateness of physician referrals for CT services. 12
11b. Effective mechanisms by which to determine the appropriateness of physician referrals for CT services do not exist within the facility. . . . . .
Amend procedures. 12

12a. Current procedures for expending supplemental care funds for CT scans and/or hospital utilization review program include effective mechanisms by which to modify physician referral behavior for inappropriate referrals for CT services. . . . 13
12b. Effective mechanisms by which to modify physician referral behavior for inappropriate referrals for CT services are not in place in the facility . . . . . .
Amend procedures. 13

13a. Current procedures for selecting supplemental care sources of CT services subordinate all other considerations to the medical needs of the patient and the needs of the practitioner for the services necessary to facilitate the most accurate possible diagnosis. 14

APPENDIX B. - COMMANDER'S GUIDE TO REDUCING SUPPLEMENTAL CARE EXPENDITURES FOR CT SCANS (cont.)

20a. Hospital has clearly presented to potential providers the current and projected the size, demographic characteristics, and clinical profile of its patient population in negotiations for more favorable rates. 21
20b. Hospital has not developed a clear presention of current and projected size, demographic characteristics, and clinical profile of its patient population for use in negotiations with potential providers for more favorable rates. . . . . .
Develop such a presentation. 21

21a. Vendors with price schedules which are competitive with CHAMPUS prevailing fee schedules are clearly identified and prioritized in source selection procedures. 22
21b. Vendors with price schedules which are competitive with CHAMPU. prevailing fee schedules are not clearly identified and/or price schedules are not routinely used in source selection procedures. . . . . .
Amend procedures. 22

22a. Hospital has sought to present other third party payers as primary payers, as a cost saving measure and as an additional incentive to potential providers to concede favorable rates. 23
22b. Hospital has not developed a innovative options using other third as primary payers. . . . . .
Develop and present such options. 23

23a. Hospital has sought to present options which include the provision of hospital personnel to perform administrative tasks involved with the filing of claims against other third party payers, as a cost saving measure and as an additional incentive to potential providers to concede favorable rates.24
23b. Hospital has not developed a innovative options to induce potential providers to use other third as primary payers. . .
Develop and present such options. 24

24a. Hospital has in place an aggressive program to monitor the progress of patients receiving supplemental inpatient care and seek their return to military care as soon as clinically indicated. 25
24b. Hospital has no program to monitor the progress of patients receiving supplemental inpatient care and return them to military care as soon as clinically indicated or that program is not completely effective. . . . . .
Institute such an aggressive program. 25

25a. CT services provided by VA medical facilities are not reasonably available or, if reasonably available, MTF and VA facilities have current, comprehensive VA/DoD Sharing Agreements favorable to both are in place and are stringently complied with. 27

APPENDIX B. - COMMANDER'S GUIDE TO REDUCING SUPPLEMENTAL CARE EXPENDITURES FOR CT SCANS (cont.)

25b. CT services provided by VA medical facilities are reasonably available but current, comprehensive VA/DoD Sharing Agreements are not in place or are not being complied with. 26

26a. CT services provided by VA medical facilities are reasonably available but current, comprehensive VA/DoD Sharing Agreements do not exist. . . . . .
Begin negotiations with nearby VA facilities to ensure compliance with PL 97-174. 27

26b. CT services provided by VA medical facilities are reasonably available but current, comprehensive VA/DoD Sharing Agreements are not being complied with. . . . . .
Provide command guidance and establish monitoring mechanisms to ensure compliance with PL 97-174. 27

27a. Study of the feasibility of lease or MEDCASE purchase of on-site equipment is underway. . . . . .
. . . . . .Continue study and take action as indicated

27b. Study of the feasibility of lease or MEDCASE purchase of on-site equipment has not been initiated. . . . . .
. . . . . Begin study and take action as indicated

APPENDIX C. - CPT-4 Codes for CT Scan Procedures
SOURCE: Physicians' Current Procedural Terminology, 1989

CODE	DESCRIPTION	
70450	CAT, head or brain	without contrast material
70460	CAT, head or brain	with contrast material
70470	CAT, head or brain	w/o contrast material, followed by contrast material(s) and further sections
70480	CAT, orbit, sella, or posterior fossa or outer, middle, or inner ear	without contrast material
70481	CAT, orbit, sella, or posterior fossa or outer, middle, or inner ear	with contrast material
70482	CAT, orbit, sella, or posterior fossa or outer, middle, or inner ear	w/o contrast material, followed by contrast material(s) and further sections
70486	CAT, maxillofacial area	without contrast material
70487	CAT, maxillofacial area	with contrast material
70488	CAT, maxillofacial area	w/o contrast material, followed by contrast material(s) and further sections
70490	CAT, soft tissue neck	without contrast material
70491	CAT, soft tissue neck	with contrast material
70492	CAT, soft tissue neck	w/o contrast material, followed by contrast material(s) and further sections
71250	CAT, thorax	without contrast material
71260	CAT, thorax	with contrast material
71270	CAT, thorax	w/o contrast material, followed by contrast material(s) and further sections
72125	CAT, cervical spine	without contrast material

APPENDIX C. - CPT-4 Codes for CT Scan Procedures (cont.)
SOURCE: Physicians' Current Procedural Terminology, 1989

CODE	DESCRIPTION	
72126	CAT, cervical spine	with contrast material (IV)
72127	CAT, cervical spine	w/o contrast material, followed by contrast material(s) (IV) and further sections
72128	CAT, thoracic spine	without contrast material
72129	CAT, thoracic spine	with contrast material (IV)
72130	CAT, thoracic spine	w/o contrast material, followed by contrast material(s) (IV) and further sections
72131	CAT, lumbar spine	without contrast material
72132	CAT, lumbar spine	with contrast material (IV)
72133	CAT, lumbar spine	w/o contrast material, followed by contrast material(s) (IV) and further sections
72192	CAT, pelvis	without contrast material
72193	CAT, pelvis	with contrast material
72194	CAT, pelvis	w/o contrast material, followed by contrast material(s) and further sections
73200	CAT, upper extremity	without contrast material
73201	CAT, upper extremity	with contrast material
73202	CAT, upper extremity	w/o contrast material, followed by contrast material(s) and further sections
73700	CAT, lower extremity	without contrast material
73701	CAT, lower extremity	with contrast material
73702	CAT, lower extremity	w/o contrast material, followed by contrast material(s) and further sections

APPENDIX C. - CPT-4 Codes for CT Scan Procedures (cont.)
SOURCE: Physicians' Current Procedural Terminology, 1989

CODE	DESCRIPTION	
74150	CAT, abdomen	without contrast material
74160	CAT, abdomen	with contrast material
74170	CAT, abdomen	w/o contrast material, followed by contrast material(s) and further sections
76070	CAT, bone density study	
76355	CAT, guidance for stereotactic localization	
76360	CAT, guidance for needle biopsy	supervision & interpretation only
76361	CAT, guidance for needle biopsy	complete procedure
76365	CAT, guidance for cyst aspiration	supervision & interpretation only
76366	CAT, guidance for cyst aspiration	complete procedure
76370	CAT, guidance for placement of radiation therapy fields	
76375	CAT, coronal, sagittal, multiplanar, oblique and/or 3 dimensional reconstruction	

APPENDIX D. - Comparison of CT Scans Purchased by Irwin Army Community Hospital Between 1988 and First Six Months of 1989 (Calendar Years)

	1988		Jan - Jun 1989	
Type	Scans	Cost	Scans	Cost
Undifferentiated	377	$155,000	21	$ 6,000
Head/Neck	148	$ 56,000	233	$ 96,000
Pelvis	12	$ 6,000	13	$ 4,000
Abdomen	39	$ 21,000	108	$ 46,000
Chest	14	$ 8,000	29	$ 14,000
Totals	590	$246,000	404	$166,000
Projection (Straight line)	590	$246,000	808	$332,000

NOTES:

1. Because of nonspecific record-keeping, the following categorizations apply:
   "Undifferentiated" includes scans with no specific site listed.
   "Head/Neck" also includes brain, orbits, and C-spine.
   "Pelvis" also includes sacrum and lumbar/sacrum.
   "Abdomen" also includes renal, abdomen/pelvis, and L-spine.
   "Chest" also includes chest/abdomen.
2. These figures do not include an additional number of scans (approximately 15% in each period) which were ordered but, for unknown reasons, were not charged to the hospital.

APPENDIX E. - Partial Chronology of CT Acquisition Action for Irwin Army Community Hospital (extracted from hospital records)

DATE	ACTION
21 Apr 1986	MEDCASE Program Requirement submitted by Chief, Radiology Service to MEDDAC commander for a CT scanner.
11 Jun 1986	Request for CT scanner forwarded to HSC for concurrence.
10 Oct 1986	TSG Diagnostic Imaging and Radiology Board disapproved IACH request for a CT scanner pending clarification of supplemental care expenditures and staffing plan.
19 Nov 1986	IACH submitted revised request for CT scanner with additional information requested by TSG Diagnostic Imaging and Radiology Board.
08 Jan 1987	TSG Diagnostic Imaging and Radiology Board reconsidered IACH request for a CT scan and granted limited approval, based on limited availability of assigned radiologists.
19 Jun 1987	Hospital informed that requisition had been funded and action was forwarded to DPSC for acquisition.
04 Nov 1987	Hospital informed that IACH was in second purchase cycle, scheduled to begin April, 1988.
13 Dec 1988	Hospital informed that contract had been awarded for purchase of a CT scanner for the hospital.

APPENDIX E. - Partial Chronology of CT Acquisition Action for Irwin Army Community Hospital (cont.)

(extracted from hospital records)

DATE	ACTION
31 Oct 1989	Contract delivery date for CT scanner to Calumet Coach Company for installation in transporter.

APPENDIX F. - Characteristics of CT Evaluated by

ECRI Product Comparison System, May 1989

COMPONENT	UNITS OR NORMAL RESPONSES.
GANTRY	
Geometry	Rotate-rotate, rotate-stationary
Number/type of detectors	Solid-state, xenon, cadmium-tungsten
Scan time	Seconds
Slice thickness	Millimeters
X-ray fan beam angle	Degrees
Gantry tilt	Degrees from vertical
Gantry aperture	Centimeters
Scan localizer	Incandescent, laser
Tube heat storage	Heat units
Tube focal spot	Millimeters
PROCESSING	
Computer CPU	Manufacturer/model names
Scan fields of view	Centimeters
Reconstruction time/slice	Seconds
Localization radiograph time	Seconds
Orthogonal plane time/slice	Seconds
STORAGE	
Standard disk	Megabytes
Standard on-line	Number of images
Archival storage devices	Optical disk, floppy disk, mag tape

APPENDIX F. - Characteristics of CT Evaluated by ECRI Product Comparison System, May 1989 (cont.)

COMPONENT	UNITS OR NORMAL RESPONSES.
STORAGE (cont.)	
Multi-format film size	Inches by inches
DISPLAY	
Matrices	Pixels, vertical by horizontal
Shades of gray	Number of shades
CT numbers (density coeff.)	Range, most between -3000 to +4000
Range of pixel sizes	Millimeters
Image enlargement (zoom)	Powers of magnification
Max # of simultaneous slices	Number of slices
TABLETOP	
Height range	Centimeters, expressed as a range
Longitudinal travel	Centimeters
PERFORMANCE	
Min. interscan time	Seconds
Dynamic scan rate	Scans per minute
Hi-contrast spat. resolution	Line pairs per minute
Lo-contrast dens. resolution	Mm. at which contrast can be seen
Max noise (electronic)	Heat units or CT numbers
Typical dose	Rads or rads at 100 milliamperes

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