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14. ABSTRACT

The U.S. has the highest overall healthcare expenditures of any country in the world. In a cost-conscious, competitive environment the Operating Room (OR) is a major focus of change. OR patient throughput has become an issue for most hospitals across the United States, even more so for Academic Medical Centers (AMCs). All hospitals are bearing the burden of the BBA mandated cuts, however AMCs are also faced with increasing volumes, higher acuity, and, as a consequence, capacity issues, coupled with an increase in OR time due to the training of surgical residents. The purpose of this study is to determine if there is an increase in operative time due to medical education, and if so, how much? Using Wilford Hall Medical Center (WHMC) as the AMC and Nix Medical Center (NMC) as the Non-AMC a comparison of three categories identified for study: Inguinal Hernia Repair; Laparoscopic Cholecystectomy; and Carotid Endarterectomy was completed. The final results of the two-way factorial analysis of variance (ANOVA) conducted showed a significant main effect for facility ($F(5,354)= 76.05$, $p<.001$, partial $\eta^2=.176$), and treatment type ($F(5,354)= 10.27$, $p<.001$, partial $\eta^2=.055$). This study showed significant differences by facility and by procedure. NMC demonstrated significantly decreased time for all procedures, which can be attributed to time required for surgical training at WHMC.

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Implications of Surgical Training on Operating Room Throughput at Wilford Hall Medical Center

A Graduate Management Project Presented to: LT Suzanne Wood, PhD, MSC, USN

In partial fulfillment of the

Army-Baylor University Graduate Program in Health and Business Administration

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Abstract

The U.S. has the highest overall healthcare expenditures of any country in the world. In a cost-conscious, competitive environment the operating room (OR) is a major focus of change. OR patient throughput has become an issue for most hospitals across the United States, even more so for Academic Medical Centers (AMCs). All hospitals are bearing the burden of the BBA mandated cuts, however AMCs are also faced with increasing volumes, higher acuity, and, as a consequence, capacity issues, coupled with an increase in OR time due to the training of surgical residents. The purpose of this study is to determine if there is an increase in operative time due to medical education, and if so, how much? Using Wilford Hall Medical Center (WHMC) as the AMC and Nix Medical Center (NMC) as the non-AMC, a comparison of three categories identified for study: inguinal hernia repair; laparoscopic cholecystectomy; and carotid endarterectomy, was completed. The final results of the two-way factorial analysis of variance (ANOVA) conducted showed a significant main effect for facility ($F(5,354)= 76.05$, $p<.001$, partial $\eta^2=.176$), and treatment type ($F(5,354)= 10.27$, $p<.001$, partial $\eta^2=.055$). This study showed significant differences by facility and by procedure. NMC demonstrated significantly decreased times for all procedures, which may be attributed to the time required for surgical training at WHMC.

Acknowledgements

For my children Katelyn, Morgan and Zachary, there were many nights and weekends where you had to sacrifice family time so that I could study for a test, complete homework or write a paper. Although there were days when there just wasn't enough time to fit it all in, we made it work. You are my light and the end of the tunnel, thank you for standing beside me, you are all amazing and I am so fortunate to be your Mom. I love you with all my heart.

When selected for this program the first person I called was my biggest fan, my Dad. We celebrated over the phone and talked about him coming to graduation. He hadn't missed my boot camp graduation or commissioning, and he certainly wasn't going to miss this. A few weeks later he passed away. For my "Pop", Joe Gardiner, thank you for pushing me, guiding me and supporting me. I love you and miss you.

Jon and Aatif.... where do I begin? We started this journey as strangers and we ended it as family. On more than one occasion you came to my rescue, made me laugh, picked me up, brought me down, and tested my patience...I'll take three out of five. The kids and I are blessed to have you in our lives and you will always have a special place our hearts.

I would like to extend a special thank you to LT Suzanne Wood, PhD, MSC, USN for being exactly what I needed...a Kung Fu fighter. Okay maybe not that, but I couldn't have asked for a better mentor. LT Wood, thank you for being a great student advocate and advisor, your knowledge, patience, sense of humor, and wisdom make you invaluable and I will be forever appreciative for all the time and effort you put in to guiding me through this GMP.

My preceptor LtCol Stephen Larsen, USAF, took me under his wing when my original preceptor retired shortly after I reported onboard. LtCol Larsen, thank you for making me feel

like a part of your RM family, always having an open door, and supporting me through this endeavor.

Last but not least, JRW, I will be forever grateful that going to Baylor brought me to you. I love you.

Disclaimer

The views expressed in this study are those of the author and do not reflect the official policy or position of Brooke Army Medical Center, the Department of the Navy, the Department of the Army, Department of Defense (DoD), or the United States Government.

Statement of Ethical Conduct in Research

Patient confidentiality was strictly adhered to during this research study. All patients' medical information was protected at all times and under no circumstances will be discussed or released to any outside agency.

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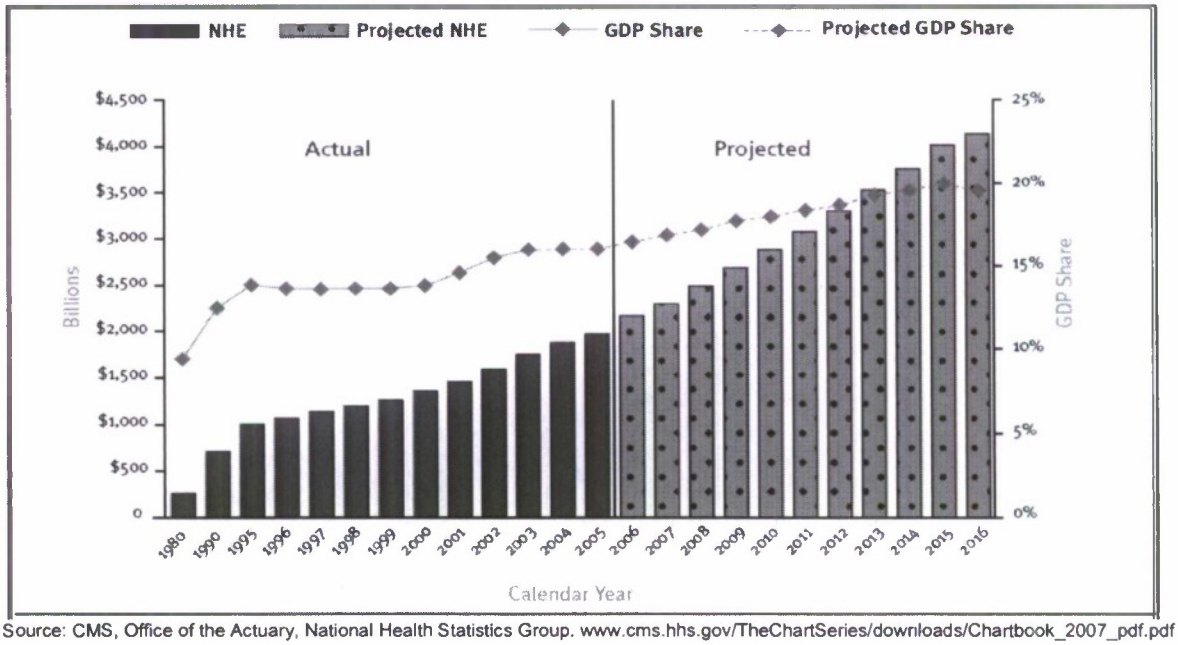
Introduction

The United States shoulders the highest overall health care expenditures, and boasts the greatest expenditures per capita of any country in the world. Manchikanti (2008) states that in 2005, the United States spent $1.9 trillion, or 16% of the gross domestic product (GDP), on health care. Though approximately $913 billion was spent in 1993, the figure is projected increase to $4.1 trillion by the year 2016. Consequently, the proportion of GDP is expected to rise from 13.7% to 19.6% over the same time period (Manchikanti). Figure 1 illustrates the magnitude of increases in national health expenditures (NHE) between 1980 and 2005, to include projected figures through 2016.

Figure 1. National health expenditures and their share of the GDP, 1980 - 2016.



Source: CMS, Office of the Actuary, National Health Statistics Group. www.cms.hhs.gov/TheChartSeries/downloads/Chartbook_2007_pdf.pdf

In response to double-digit increases in cost, health care industry stakeholders (policy makers, payers, providers, and patients) have mobilized to radically reduce costs by developing innovative ways to maximize efficiency. As a consequence, traditional fee-for-service (FFS)

reimbursement is no longer the rule, and managed care models have come to predominate. Subsequently, health care providers control fewer resources, yet practice in an environment defined by greater demands for cost-effective, quality care and accountability for the same (Cromwell, Adamache, & Drozd, 2006; Laszewski, 2003). In this cost-conscious, competitive environment, the operating room (OR) is considered to be a major focus of change. Surgery is a critical, often lifesaving, part of the healthcare delivery system, and may well be considered the financial lifeblood of the hospital. One estimate finds that 30.1% of all health care outlays are related to surgical expenditures (Munoz, 1994). As such, the operating room is revenue producer that cannot afford to be mismanaged or inefficient (Health Management Technology, 2005).

OR patient throughput has become an issue for most hospitals across the United States, even more so for Academic Medical Centers (AMCs). All hospitals are bearing the burden of the Balanced Budget Act (BBA) mandated cuts, and any hospital, regardless of organizational structure or mission, may well face losses. However, many of the BBA's provisions more seriously affect highly specialized institutions; thus, a comparatively greater share of the burden falls on teaching hospitals and faculty physicians. The impact of the BBA is far more than just financial. Its mandatory changes will have profound and far-reaching organizational and operational effects on providers, especially those committed to training residents and fellows; specifically the BBA limits the number of residents eligible for Medicare reimbursement to the number in place during a base year; 1996 is the baseline year for the BBA cap (Cromwell, Adamache & Drozd, 2006). This means that the number of residents that a hospital can claim reimbursement for, with some limited exceptions, is frozen in perpetuity (Dickler & Shaw, 2000).

AMCs are faced with increasing volumes, higher acuity, and, as a consequence, capacity issues. These issues can affect OR utilization and patient throughput. Due to the BBA, the financial environment in teaching hospitals and medical schools has changed significantly, and government teaching hospitals, especially in urban areas, average far lower GME subsidies at the margin because of their smaller Medicare caseloads (Cromwell, Adamache, & Drozd, 2006). Although costs for new technology, drugs, and personnel increased significantly, the passing of the BBA resulted in the removal of millions of dollars in financial support for resident training. As a result of this changing environment, individual departments are now expected to demonstrate better financial performance, resulting in the current increased emphasis on clinical productivity (Davis, et al., 2006).

According to McIntosh, et al (2006), it is a widely held belief among most experienced academic surgeons that training residents in the OR increases the time required to perform most surgical procedures. In surgical gathering places nationwide, anecdotal stories of the difference in procedure incision to closure time when procedures are performed with and without a resident are often told by senior surgeons. This increased time is an inherent inefficiency of the training process, though necessary to ensure adequate training and quality outcomes. There are few data and reports in the literature, however, that have attempted to define the precise amount of time associated with training a resident on a particular procedure. The few reports that do exist examine residents at different postgraduate levels performing various procedures with numerous surgeons. Therefore, it is difficult to quantify the amount of extra time a surgeon can reasonably expect to spend training a particular resident on a particular procedure (Babineau, Becker, Gibbons, Sentovich, Robertson, & Stone, 2004).

Statement of the Problem

WHMC social missions include teaching, research, the provision of rare and specialized services, innovation in patient care, the care of vulnerable populations, including the indigent, as well as their operational commitments to the Global War on Terror (GWOT) (WHMC, 2007). Like other AMC's, WHMC dedication to training in the operating room setting may lead to an increase in operative times, leading potentially to the perception of inefficiency. A major problem within the operating room environment is the length of procedures, by decreasing the duration of procedures, more cases may be scheduled, thus increasing patient volume and revenue generation, but at a cost to training. In an era when cost cutting for hospitals is vital to maintain an operating margin, solving this problem is crucial.

Literature Review

Overview

According to Wilkiemeyer (2005), Graduate surgical education in the United States follows a model of graded clinical responsibility and operative experience, with continuous evaluation, throughout a residency program. The program requirements for Residencies in Surgery, as defined by the Accreditation Council for Graduate Medical Education, state: "Operative skill is essential and can be acquired only through personal experience and training. The program must provide for sufficient operative experience to train qualified surgeons, taking into account individual capability and rate of progress" (p. 881). This training could lead to increased operative times, and according to Sharoky (2005), the length of time spent under general anesthesia during surgery determines the risk of postoperative complications and recovery periods for patients of all ages. There is not enough evidence, however, to prove that the risk is a result of the complexity of lengthy surgery itself. Sharoky also states that for

patients of all ages the risk of complications increases between 18 percent and 36 percent for each hour under anesthesia and complications range from fever to pneumonia and heart attack.

Charged with the responsibility for instructing, supervising, and evaluating surgery residents are attending surgeons who have both an ethical and a legal responsibility for the overall care of each patient and supervision of residents involved in care. While residents with limited experience require more intensive supervision than those at advanced levels, they must be provided with adequate opportunities to learn techniques and skills. Safeguarding patient welfare is the guarantee of appropriate supervision by more experienced surgeons (Wilkiemeyer, et al (2005).

In a study conducted by Babineau, et al. (2004), findings indicate there is an increase in the operative time when a resident was involved with the procedure due to training (hernia surgery, laparoscopic cholecystectomy, and carotid endarterectomy). For hernia surgery, the increase is a 8 minutes; for laparoscopic cholecystectomy, the increase is 23 minutes; and for carotid endarterectomy, the increase is 44 minutes. Of the procedures studied, all revealed statistically significant increases in operative times (hernia surgery [$p < .001$], laparoscopic cholecystectomy [$p < .002$], and carotid endarterectomy [$p < .03$]). The difference in operative times tended to increase with the greater complexity of the procedures: carotid endarterectomy took longer than laparoscopic cholecystectomy, which took longer than hernia surgery.

Wilford Hall Medical Center Demographics

WHMC, in San Antonio, Texas, represents the largest medical facility in the United States Air Force. This acute care facility provides complete medical care to over 62,000 military healthcare beneficiaries in the south central United States and specialized care to patients from all over the world (WHMC, 2007). WHMC has four overall missions. The primary mission is

military readiness; to train, to plan for contingencies and to prepare to deploy elements to forward areas around the world. As a second mission, WHMC provides a worldwide referral center and operates a comprehensive community health care system for active duty military personnel and other beneficiaries. Third, WHMC is the Air Force's foremost provider of medical education, providing the Air Force with some 65 percent of its physician specialists, 85 percent of dental specialists, and a full spectrum of other training. The medical center's fourth mission is clinical investigations. WHMC's patient care mission includes approximately 15,000 inpatient admissions per year, more than 850,000 clinic visits and averages over 9,600 surgeries per year (WHMC, 2007).

WHMC provides an entire range of care, from primary to tertiary, and serves as the national center of excellence for a number of programs, such as specialized center for bone marrow transplantation, HIV evaluation, and the only Tri-Service program dedicated to training dental officers of the three services in one facility. The medical center's support of San Antonio's emergency medicine structure is unique in the nation. WHMC and Brooke Army Medical Centers (BAMC) participate fully in the trauma and emergency medicine care of the San Antonio and South Texas civilian communities, with each military medical center receiving approximately a fourth of the city's emergency ambulance transports. Since the two military centers receive almost 80 percent of the city's penetrating trauma, typically gunshot and knife wounds, the system provides excellent training for wartime situations (WHMC, 2007).

In 2005, BRAC recommended the consolidation of WHMC and BAMC in San Antonio into one medical region with two integrated campuses known as San Antonio Military Medical Center (SAMMC). SAMMC provides global medical readiness capability supporting Air Expeditionary Forces and in-garrison comprehensive healthcare in a world-class academic

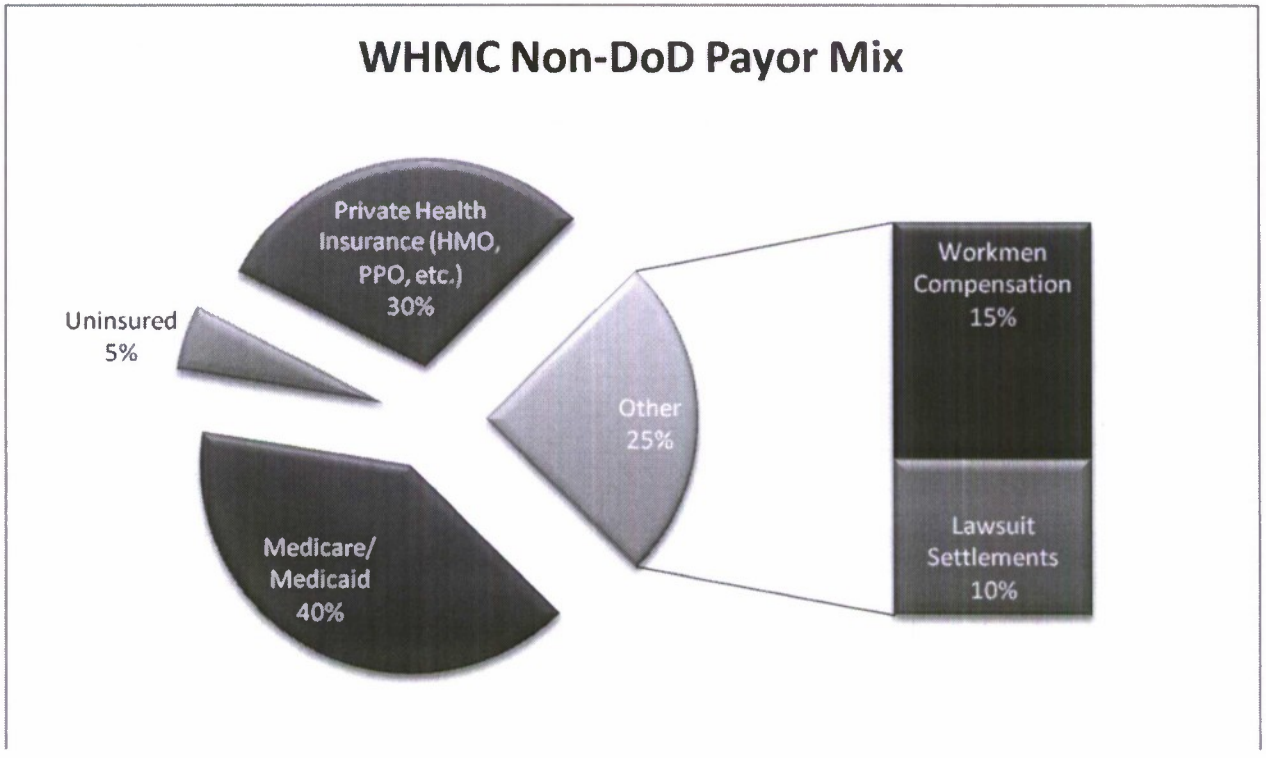
environment. Wilford Hall Medical Center, SAMMC-South, will serve as a large, full-service ambulatory care center with select medical and surgical outpatient specialties servicing a large beneficiary and trainee population (National Trauma Institute {NTI}, 2007). BAMC will serve as a world-class health science center for inpatient and ambulatory care, consisting of Graduate Medical Education (GME) and training, a Level I Trauma Center, and the only American Burn Association verified Burn Center within the DoD. The facility will be known as SAMMC-North. WHMC and BAMC support of San Antonio's emergency medicine structure is unique in the nation. The medical centers currently participate fully in the trauma and emergency medicine care of the San Antonio and south Texas civilian communities (NTI, 2007).

Wilford Hall Medical Center Payment System

The Office of the Assistant Secretary of Defense for Health Affairs is responsible for the management of the Military Health System (MHS). The MHS TRICARE system delivers health care through a worldwide network and supplements that care through a series of private sector contracts that provide physician and hospital networks, retail and mail order pharmacy benefits, claims processing, marketing, and medical management. The TRICARE program provides a triple option benefit, including Prime (a health maintenance organization (HMO) style benefit requiring beneficiary enrollment to a primary care manager (PCM)), Extra, a preferred provider organization (PPO) style benefit; and Standard, a fee-for-service (FFS) benefit. The MHS is currently implementing a prospective payment system that will change the allocation system to pay prospectively on the value of healthcare provided. To determine the prospective payment, MHS inpatient and outpatient facilities are required to build a business plan that projects their annual enrollment and healthcare delivery targets. The prospective payment system will be fully implemented for covered activities in FY 2008. Additional activities will be added over the next

few years until all healthcare delivery is covered by prospective payment. Currently, the value of health care is determined by healthcare workload but in the future, elements of a capitation payment system, as well as quality performance incentives, may be introduced (Tricare Management Agency [TMA], 2007). According to WHMC (2008), as a Level 1 Trauma Center the facility receives non-DoD eligible beneficiaries, reimbursement for these patients include government agencies, private insurance, etc. (See Figure 2).

Figure 2. Wilford Hall Medical Center Non-Department of Defense Payor Mix.



Wilford Hall Medical Center Operating Room Scheduling System

An automated scheduling process is necessary for effective OR scheduling, allowing managers to proactively monitor requested case length, evaluate utilization of block time, and coordinate equipment requirements; WHMC accomplishes this by utilizing the McKesson System. McKesson scheduling reports allow monitoring of operating room utilization during

available hours in peak and off-peak times and provide an historical data base from which to balance demand with resource availability. Other reports are available to track surgeon volumes, release dates, case delay, and cancellations, enabling proactive management of the operating room. This capability can result in an increased level of operating room utilization, more on-time case starts, and greater physician and patient satisfaction.

Wilford Hall Medical Center Operating Room Turnaround Policy & Procedures

Infection control is a major concern in health care in general, but it is a particularly important issue in the sterile environment of the OR where patients undergo surgical procedures and are at significant risk for perioperative nosocomial infection. Even the best OR design will not compensate for improper surgical technique or failure to adhere to infection control measures. To tackle infection control, WHMC contracts housekeeping services, adeptly trained in OR cleaning procedures. However, once housekeeping has completed their assigned cleaning, it is up to the nurses and surgical technicians to restock and prepare the room for their next scheduled case. With two independent sources responsible for room turnaround, the potential exists for an increased turnaround time.

Wilford Hall Medical Center Internal Strengths and Weaknesses

Although faced with high nursing and surgical technician turnover rates in lieu of operational requirements and deployments, WHMC has one thing going for them, GWOT funding. Contract backfills exist for individuals that deploy in support of GWOT, and are determined by the Air Force Specialty Codes (AFSC) that are deploying, for example, OR nurses and surgical technicians. WHMC receives a list from Readiness of AFSC's that are deploying and for how long. A standard of five months per service member is used to determine what they receive in GWOT funding. This figure is used because individuals complete two weeks of pre-

deployment requirements, and two weeks post-deployment leave after completing a four-month deployment. WHMC then determines the total number of months that an OR nurse or surgical technician will be deployed and divides that by 12 months to determine how many full time equivalents (FTEs) they earn, attaching to it a dollar figure for replacement costs. WHMC forwards the information to the Air Education and Training Command (AETC), located on Randolph Air Force Base, TX, to be included in a request to Air Staff for GWOT funding. WHMC Contract Services Flight then works the requirement to hire someone to fill vacancies. Annually, Group Administrators review the list from Readiness to determine if they are still deploying the same AFSCs, or if there have been any changes to vacancies they are filling (WHMC2, 2008).

Another strength identified at WHMC is the use of the operating room scheduling system, McKesson. WHMC chose McKesson solutions to automate OR processes. By implementing the McKesson system in its OR, WHMC hopes to increase resource efficiencies, reduce costs, and improve patient care, satisfaction and documentation. Yet, chronic staff turnover, deployments, military transfers, although backfilled by GWOT contract staff, still impact staff morale. A lack of continuity in staffing leads to procedural inefficiencies due to unfamiliarity with surgeons, OR layout, and consumable supply locations. Further, WHMC does not maximize effective use of the current OR scheduling system, McKesson, as the software may be used for improving OR efficiency by analyzing the most common causes of delays and cancellations.

Nix Medical Center Demographics

NMC is a non-academic, privately owned hospital that serves all of San Antonio, TX and the surrounding area. Consisting of 24 towering floors overlooking the city, NMC is a full

service hospital complete with a wide range of essential medical and surgical services. Nix continuum of services include: full inpatient and outpatient medical/surgical services; full skilled nursing services; full behavioral health services; full rehabilitation services; full home health care; and physician offices (all specialties) (NMC, 2007).

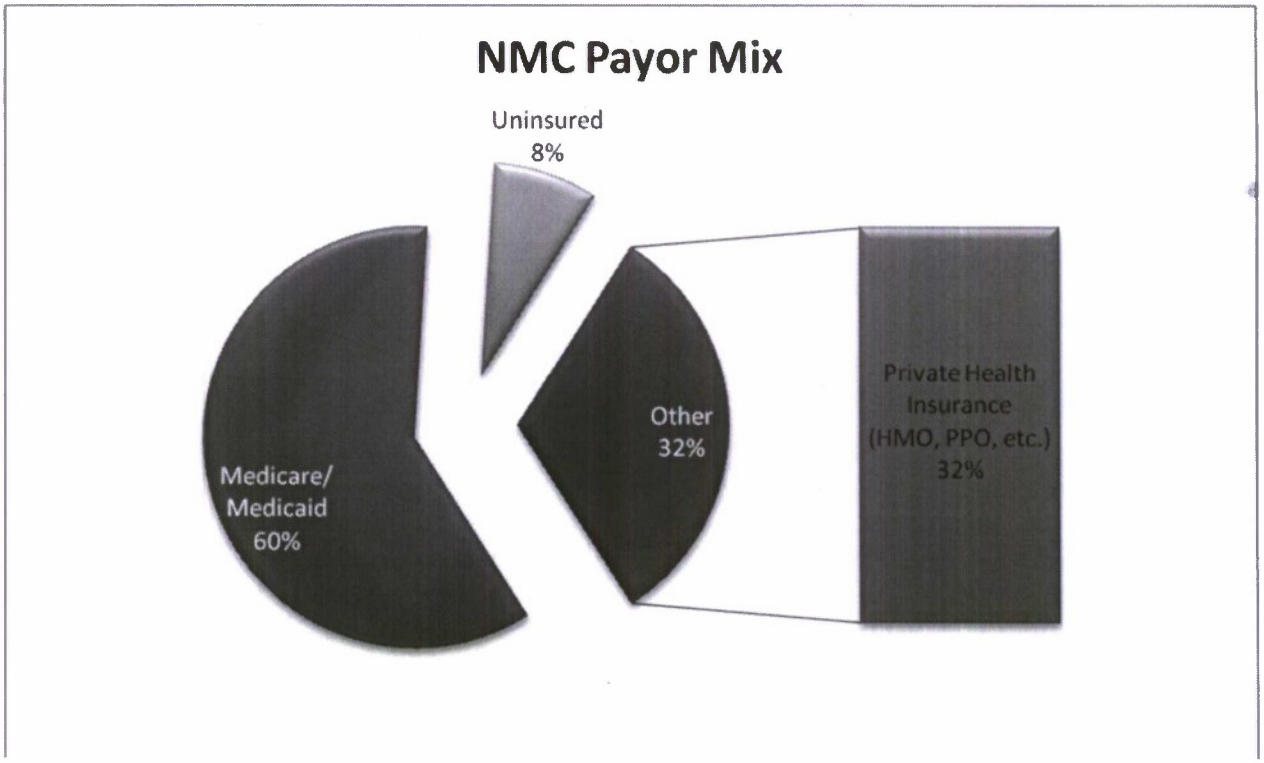
Services offered at Nix include: primary care physicians (family practice and internal medicine); specialists (cardiology, gastroenterology, general surgery, hand surgery, neurological surgery, obstetrics/gynecology, orthopedics, otorhinolaryngology (ENT), pain medicine, and podiatry); imaging services (mammography, MRI, nuclear medicine, CT scan and invasive procedures, routine x-ray, and ultrasound); and other services (laboratory services, physical therapy/rehabilitation, and senior health services) (NMC, 2007).

In 2007, NMC had an average daily census of 108, a total of 443 deliveries, 4,069 surgeries, 43,090 imaging procedures, and 40,179 clinic visits. According to their mission statement, the NMC "is dedicated to providing an environment for health care excellence where the patients are cared for with compassion, physicians prefer to practice and employees are valued" (p. 2). NMC vision is to be the health care system of choice in San Antonio and the surrounding communities, and NMC values include: total patient focus, teamwork, integrity, and leadership (NMC, 2007).

Nix Medical Center Payor Mix

NMC is a privately owned hospital that relies solely on government agencies, personal health insurance, and out-of-pocket expenses for health care reimbursement of medical expenditures (See Figure 3).

Figure 3. Nix Medical Center Payor Mix.



Nix Medical Center Operating Room Scheduling System

NMC currently does not use any commercial OR scheduling system. NMC is in the market for an electronic medical record system and OR scheduling system, but in the interim use Microsoft Excel to manage their OR schedules, to include data collection (NMC, 2008).

Nix Medical Center Operating Room Turnaround Policy & Procedures

Rigorous cleaning procedures must be adhered to even in the most austere environments. Cleaning should be performed on a regular basis to reduce the amount of dust, organic debris, and microbial load in surgical environments. Proper cleaning of surfaces can greatly reduce the risk of nosocomial infections by eliminating pathogens on commonly touched areas. The ultimate responsibility for ensuring a clean surgical environment at NMC rests with nurses and

surgical technicians. Once cleaning and sterilization is complete, the nurses and surgical technicians then restock and prepare the room for the next patient. This provides for a seamless transition and the opportunity for a decreased turnaround time.

Nix Medical Center Internal Strengths and Weaknesses

The staff members are highly experienced and skilled nurses and surgical technicians who have been working at NMC for years. The result is a seamless workflow among the members of the NMC team; for example, during routine procedures, there is little need for spoken communication to facilitate quick completion of a surgical procedure. In addition, nurses and surgical technicians are dedicated specifically to NMC and the successful completion of surgical procedures. The increased efficiency of the OR turnaround process allows NMC to schedule more procedures, resulting in increased revenue for the hospital.

A major weakness associated with NMC is staffing, the same burden found in most health care organizations, especially with regard to nursing shortages. According to the Texas Center for Nursing Workforce Studies (Texas Department of State Health Service, 2006), hospitals are the largest employers of registered nurses (RNs) in Texas. Turnover and vacancy rates of RNs in hospitals are important factors in measuring the severity of nursing shortages in hospitals. From an economic perspective, the Nursing Executive Center estimates the average cost of replacing a specialty nurse at 156 percent of their annual salary, and unlike the WHMC there exists no additional funding for this source of pain.

A second major weakness is administrative in nature. With no operating room scheduling system in place, NMC relies on Microsoft Excel to schedule operative times. NMC is currently scanning the market for the appropriate OR scheduling system that would fit their needs; in the interim, they rely on spreadsheets.

Purpose

As a Level I Trauma Center, WHMC faces many challenges. This paper focuses on one in particular, OR patient throughput. WHMC is also an AMC; however, it differs from its civilian counterpart, NMC, in that it maintains wartime and peacekeeping missions that impact resources and services offered. In an attempt to identify similiarities and/or differences, this study will compare procedure times, generally known as throughput, for hernia surgery, laparoscopic cholecystectomy, and carotid endarterectomy between WHMC and NMC, a privately owned non-academic hospital in San Antonio, Texas. The purpose of this study is to determine if there a statistically significant difference in incision to closure times between an academic medical center, WHMC, and a non-academic medical center, NMC. The intent of the study is to answer the following research questions: "Does operative time increase due to the conducting of medical education?" and, if so, "How much of an increase exists?" It is important to note, however, that arbitrary time limitations cannot be placed on procedure length, as figures may indicate individual provider comfort and pace preferences.

In answering these research questions, the following hypothesis was tested:

H_a: There is a significant increase in the amount of time required to perform an operation when the procedure involves training a surgical resident.

Methods

This study was a retrospective analysis of collected data on patients undergoing common procedures, hernia surgery, laparoscopic cholecystectomy, and carotid endarterectomy, at WHMC and NMC. Operative times were retrospectively collected from an OR information system and inpatient records present in the each OR and completed at the time of the procedure. Operative times were defined as the time from skin incision to the time of wound closure. During

the study period, surgeons and residents were blinded to the study's purpose and no protected patient health information was used.

Data Sources

Retrospective data used in the process measurement was derived from WHMC operating room scheduling system, McKesson. The contents of the databases originates from the OR schedule and the electronic intraoperative patient record. The McKesson data was extracted and reformatted in Microsoft Excel.

Retrospective data used in the process measurement was derived from NMC operating room scheduling management tool, Microsoft Excel. The contents of the database originated from the OR schedule and the hard copy intraoperative patient record. Data from the inpatient records at the NMC was obtained solely by appropriate NMC staff.

Specific data elements were extracted from these databases, a de-identification of protected health information was conducted by both facilities, meeting the requirements for privacy of individually identifiable health information, outlined by the the Health Insurance Portability and Accountability Act (HIPAA) of 1996. According to HIPAA the de-identification of data should lead to no reasonable basis to believe that the information can be used to identify an individual is not individually identifiable health information.

Operational Definitions

The Dependent Variable is throughput (Time) and the Independent Variables are: facility and procedure. The code sheet for patient throughput can be located in Appendix A, Table 1.

Dependent Variable

- Throughput (Time) is a continuous variable displayed in the form of minutes, and captures the time from incision to closure of surgical site.

Independent Variables

- Facility a dichotomous variable which identifies at which hospital the procedure took place, where "0" is WHMC and "1" is Nix. All cases conducted at WHMC were with a surgical resident present and all cases conducted at NMC were without surgical resident present
- Procedure is a dichotomous variable, three procedures for this hypothesis were identified for this study, where 0 = Inguinal Hernia Repair, 1 = Laparoscopic cholecystectomy, and 2 = Carotid endarterectomy

Unit of Analysis

Facility procedure served as the unit of analysis for this study, the purpose of which was to answer the question, was there an increase in operative time due to medical education, and if so, how much?

Data Analysis

Using the Statistical Package for Social Sciences (SPSS), version 16, data were coded, and verified for accuracy. No missing data was identified. Data was then examined for normality using histograms and scatter plots. Linear regression was used to examine the relationship between the dependent variable, throughput, and the independent variables, facility and procedure type. A *t* test was employed to determine whether there was a significant difference between the mean throughput for each facility. Alpha levels were set at $p<.05$.

Limitations

Secondary data sources were used. Though the advantages were cost, timeliness, and impartiality of information, potential disadvantages included accuracy, as data was entered by

hand and from various sources. Consequently, there was no standardized procedure for entering or coding the data. The lack of standardization created the need for additional research to ensure procedures were selected and categorized appropriately regardless of the facility. Similar problems were encountered at each.

A second limitation includes a standardized definition of throughput. Although both facilities assumed that throughput was considered to be skin-to-skin, or incision to closure, neither facility had standard operating procedures to outline the data tracking systems, with reference to this guidance.

Due to the difficulty in obtaining data coupled with time constraints other confounding variables that could have influenced the outcomes were not used.

Results

A two-way factorial analysis of variance (ANOVA) was conducted to determine the accuracy of the independent (Facility and Procedure Type), predicting procedural times for WHMC and NMC. Data screening led to the elimination of 5,623 cases due to procedural type not falling into one of the three categories identified for study, which were as follows: Inguinal Hernia Repair, Laparoscopic Cholecystectomy, and Carotid Endarterectomy. The purpose in using a two-way factorial analysis of variance (ANOVA) was to test for mean differences with respect to the dependent variable, OR throughput, taking into consideration that there were two independent variables, facility (2) and procedure type (3). Data were screened to ensure that the assumptions of factorial ANOVA were met. A review of normality revealed that OR throughput was slightly skewed to the right; therefore, a log transformation was completed and the new dependent variable was labeled logtime. Descriptive statistics are outlined in Table 2.

Table 2. *Descriptive Statistics*

TX	Facility	Mean	Std. Deviation	N
.00	.00	4.1123	.57354	131
	1.00	3.7659	.35122	35
	Total	4.0392	.55197	166
1.00	.00	4.2035	.46182	136
	1.00	3.4561	.56276	42
	Total	4.0271	.58076	178
2.00	.00	4.7324	.33973	11
	1.00	4.2260	.07527	5
	Total	4.5741	.37041	16
Total	.00	4.1814	.52635	278
	1.00	3.6353	.50786	82
	Total	4.0570	.56970	360

Dependent Variable: logtime

Tables 3 and 4 below present output from conducting the Univariate ANOVA, pairwise comparisons, and a Bonferroni's post hoc test. Levene's test for equal variances is presented in Table 3 and indicated homogeneity of variance among groups, $F(5,354)=1.77$, $p=.118$.

Table 3. *Levene's Test of Equality of Error Variances(a)*

F	df1	df2	Sig.
1.773	5	354	.118

Dependent Variable: logtime
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: TX+Facility

A two-way ANOVA was conducted to investigate differences in OR throughput, the dependent variable, by facility and procedure type, independent variables. ANOVA results, presented in Table 4, showed a significant main effect for facility ($F(5,354)= 76.05$, $p<.001$, partial $\eta^2=.176$), and treatment type ($F(5,354)= 10.27$, $p<.001$, partial $\eta^2=.055$). The calculated

effect size for each factor indicated a small proportion of OR throughput (incision) time was accounted for by each factor.

Table 4. *Tests of Between-Subjects Effects*

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Model	5949.612(a)	4	1487.403	5736.405	.000	.985
TX	5.325	2	2.662	10.268	.000	.055
Facility	19.720	1	19.720	76.053	.000	.176
Error	92.308	356	.259			
Total	6041.920	360				

Dependent Variable: logtime
a R Squared = .985 (Adjusted R Squared = .985)

Since ANOVA results indicated only group differences and did not identify which groups were different, pairwise comparisons of treatments by facility type were conducted. Table 5 presents mean differences for every possible paired combination of procedure type by facility. Significant mean differences at the .05 level are indicated by an asterisk.

Table 5. *Pairwise Comparisons*

(I) TX	(J) TX	Mean Difference (I-J)	Std. Error	Sig.(a)	95% Confidence Interval for Difference(a)	
.00	1.00	-.002	.055	1.000	-.134	.130
	2.00	-.592(*)	.133	.000	-.913	-.271
1.00	.00	.002	.055	1.000	-.130	.134
	2.00	-.590(*)	.133	.000	-.910	-.270
2.00	.00	.592(*)	.133	.000	.271	.913
	1.00	.590(*)	.133	.000	.270	.910

Dependent Variable: logtime
Based on estimated marginal means
* The mean difference is significant at the .05 level.
a. Adjustment for multiple comparisons: Bonferroni.

Bonferroni's post hoc test was conducted to determine which procedure types were significantly different by OR throughput, the dependent variable (coded logtime). Results revealed that OR throughput for each procedure type was significantly different from all other procedure types, see Table 6.

Table 6. *Multiple Comparisons*

	(I) TX	(J) TX	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Upper and Lower Bounds	
Bonferroni	.00	1.00	.0121	.05494	1.000	-.1200	.1443
		2.00	-.5349(*)	.13330	.000	-.8555	-.2143
	1.00	.00	-.0121	.05494	1.000	-.1443	.1200
		2.00	-.5470(*)	.13290	.000	-.8667	-.2273
	2.00	.00	.5349(*)	.13330	.000	.2143	.8555
		1.00	.5470(*)	.13290	.000	.2273	.8667

Dependent Variable: logtime
Based on observed means.
* The mean difference is significant at the .05 level.

Discussion

The United States has the highest overall healthcare expenditures of any country in the world. In a cost-conscious, competitive environment the OR is a major focus of change, as one estimate finds that 30.1% of all health care outlays are related to surgical expenditures (Munoz, 1994). OR patient throughput has become an issue for most hospitals across the U.S., even more so for AMCs. All hospitals are bearing the burden of the BBA mandated cuts, and any hospital, regardless of organizational structure or mission, may well face losses, and the number of residents that a hospital can claim reimbursement for, with some limited exceptions, is frozen. AMCs are faced with increasing volumes, higher acuity, and, as a consequence, capacity issues, coupled with an increase in OR time due to the training of surgical residents.

GME is the keystone supporting the entire voluntary military medical structure for quality health care delivery in time of peace and war. GME is the well thought out clinically based education by which physicians obtain those additional qualifications, beyond medical school graduation, required for certification in a medical or surgical specialty. The primary mission of Air Force medical organization is clearly that of readiness. In this era of restrained resources the most pressing problem is how to balance the building and maintenance of a combat ready medical force with the peace time requirements to satisfy the health care needs of the operating forces and other entitled constituents. It is no over statement to define GME as the essential prop supporting the entire voluntary military medical structure for quality health care delivery in lime of peace and quality combat care in time of war.

Wilford Hall Medical Center (59th Medical Wing), the Air Force's largest medical facility, as a national resource, provides complete medical care to military healthcare beneficiaries in the United States as well as specialized care to patients referred from all over the world, as well as GME. WHMC relies on funding from the Office of the Assistant Secretary of Defense for Health Affairs, who is responsible for the management of the MHS. The MHS is currently implementing a prospective payment system that will change the allocation system to pay prospectively on the value of healthcare provided. Although faced with high nursing and surgical technician turnover rates in lieu of operational requirements and deployments, WHMC utilizes GWOT funding to contract backfills for individuals that deploy in support of GWOT.

WHMC uses the operating room scheduling system, McKesson to automate OR processes, and by implementing the McKesson system in its OR, WHMC hopes to increase resource efficiencies, reduce costs, and improve patient care, satisfaction and documentation. Although implementing McKesson in stages, WHMC does not maximize effective use of the

current OR scheduling system; however, they are phasing in all aspects of McKesson in a controlled effort.

In direct comparison, the NMC is a non-academic, privately owned hospital that serves all of San Antonio, TX and the surrounding area, and its continuum of services include: primary care physicians, specialists, imaging services, and ancillary services. NMC relies solely on government agencies, personal health insurance, and out-of-pocket expenses for health care reimbursement of medical expenditures. Staff members are highly experienced; skilled nurses and surgical technicians have been working at NMC for years. In addition, nurses and surgical technicians are dedicated specifically to NMC and the successful completion of surgical procedures. The increased efficiency of the OR turnaround process allows NMC to schedule more procedures, resulting in increased revenue for the hospital. NMC is faced with nursing shortages that seem to plague all areas of healthcare, especially hospitals. The Nursing Executive Center estimates the average cost of replacing a specialty nurse at 156 percent of their annual salary, and unlike the WHMC there exists no additional funding for this source of pain. Coupled with nursing shortages the NMC currently functions without a formal operating room scheduling, and relies solely on Microsoft Excel to schedule operative times.

As a Level I Trauma Center, WHMC faces many challenges. This paper focuses on one in particular, OR patient throughput. WHMC is also an AMC; however, it differs from its civilian counterpart, NMC, in that it maintains wartime and peacekeeping missions that impact resources and services offered. In an attempt to identify similiarities and/or differences, this study will compare procedure times, generally known as throughput, for hernia surgery, laparoscopic cholecystectomy, and carotid endarterectomy between WHMC and NMC, a privately owned non-academic hospital.

This study was a retrospective analysis of collected data on patients undergoing common procedures, hernia surgery, laparoscopic cholecystectomy, and carotid endarterectomy, at WHMC and NMC. Operative times were defined as the time from skin incision to the time of wound closure. Retrospective data used in the process measurement was derived from WHMC operating room scheduling system, McKesson and reformatted in Microsoft Excel, retrospective data used in the process measurement from NMC was derived from Microsoft Excel. For both databases all protected health information was de-identified, where an individual is not individually identifiable through the data used.

The dependent variable is throughput (time) and independent variables are facility and procedure. The code sheet for patient throughput can be located in Appendix A, Table 1. Facility procedure served as the unit of analysis for this study, the purpose of which was to answer the question: *Is there an increase in operative time due to medical education, and if so, how much?* Using SPSS, version 16, data were coded, and verified for accuracy. No missing data was identified. Data was then examined for normality using histograms and scatter plots. Linear regression was used to examine the relationship between the dependent variable, throughput, and the independent variables, facility and procedure type. A univariate (factorial) ANOVA was employed to determine whether there was a significant difference between the mean throughput for each facility. Alpha levels were set at $p<.05$. Secondary data sources were used.

Secondary data were used, though the advantages were cost, timeliness, and impartiality of information, potential disadvantages included accuracy, as data was entered by hand and from various sources. Consequently, there was no standardized procedure for entering or coding the data. The lack of standardization created the need for additional research to ensure procedures

were selected and categorized appropriately regardless of the facility. Similar problems were encountered at each. A second limitation includes a standardized definition of throughput. Although both facilities assumed that throughput was considered to be skin-to-skin, or incision to closure, neither facility had standard operating procedures to outline the data tracking systems, with reference to this guidance.

Due to the difficulty in obtaining data coupled with time constraints other confounding variables that could have influenced the outcomes were not used. This analysis of the implications of medical training on operating room throughput showed that teaching a surgeon accounted for an increase in operative times for all three procedures: inguinal hernia repair, laparoscopic cholecystectomy, and carotid endarterectomy.

Our society today enjoys high medical standards and a reputation for ethical practice and to ensure a pipeline for surgeons is not compromised we rely on AMC's and the like. AMC's must set standards for the practice of surgery, put in place processes to ensure that these standards are safeguarded, set directions for growth, promote collegiality, all while train the next generation of surgeons. An appropriate supply of well-educated and trained physicians is an essential element to assure access to quality health care services for all Americans.

According to the Association of American Medical Colleges (AAMC, 2006), in the 1980s and 1990s, workforce analysts and public policymakers, with few exceptions, predicted the United States would experience a substantial excess of physicians by the beginning of the 21st century. In light of these studies, the AAMC and other national organizations recommended steps to reduce physician supply in order to obviate the predicted surplus. Over the past two decades, enrollment at allopathic medical schools has been essentially flat. It is now evident that those predictions were in error, in part because of the assumption that managed care would

drastically change the way that healthcare is organized, and delivered. The AAMC believes that sufficient evidence is at hand to recommend that entry level positions in both U.S. medical schools and GME programs should be increased over the coming decade, placing an even heavier burden on AMC's.

While the addition of a surgical resident into a hospital certainly adds value to patient care and residency training, is also resulted in an increase in operative times due to medical training. The findings of this research demonstrate that there is a statistically significant increase in operative times due to medical education when comparing WHMC an Academic Medical Center and NMC a non-Academic Medical Center. An increase in time overall associated with surgical training exists, and one must consider, "What did this increased time cost, with reference to opportunity costs, probability of increased mortality due to longer anesthesia times, as well as increased infection rates?" To help overcome some of these obstacles, some AMC's are testing virtual reality in medical training, with patient safety an increasing concern and with more sophisticated simulations available, a growing number of educators are pushing for simulations to play a larger role in medical and nursing school curricula and internship training, as with Stanford University (Raths, 2006). Given the impending BRAC that will leave WHMC as a super outpatient clinic, virtual medicine certainly would not be a valid option in the OR at this time.

This study showed significant differences by facility and by procedure. NMC demonstrated significantly decreased time for all procedures, which can be attributed to time required for surgical training at WHMC. Although WHMC showed an increase in operative times, this should not be construed as inefficient. There are many factors that contribute to the amount of time required to perform a procedure, such as physician pace and comfort level;

however, the results of this study clearly show that surgical training can lead to an increase in operative times, which may have a domino effect in the amount of surgical cases scheduled or performed. This study also shows when studying the efficiency in the OR, consideration must not be given solely to OR availability, approximate number of cases scheduled, or manning ratios; decision-makers must dig deeper to determine the impact of surgical training on the overall caseload presented. More importantly, when studying throughput, AMC's can not be compared equally to that of a non-AMC, given their mission to educate, train and provide future generations of surgeons.

Epilogue

The premise of this study was to determine was there an increase in operative time due to medical education, and if so, how much? I chose WHMC as the AMC and NMC as the non-AMC, this selection was made based on the employee resource sharing agreement between these two facilities, where attending surgeons at WHMC conducted surgeries (for population 65 years and older) without residents at NMC. Six months after NMC agreed to participate in this study I finally received data that met the basic requirements of this study. Because of this delay, I was faced with time constraints which limited my ability to obtain subsequent data that may have additionally influenced this study, to include provider specialty, years of experience, co-morbidities, and possible complications that could lead to an increase in operative time. With reference to WHMC, ensuing data that may have offered more substantive findings included, the attending surgeons specialty, years of experience, residents post graduate year, and residents training specialty, co-morbidities, and possible complications that could lead to an increase in operative time. A well-planned research study usually produces many valid questions; accordingly, the lack of these confounding variables caused major limitations in this study, and

for future studies should be considered when attempting to evaluate the impact of medical education on operative times.

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Appendix A

Table 1: *Code sheet for dependent and independent variables for patient throughput.*

DV	Procedure Time	Continuous data from 0 to ∞ Defined as start time (incision) to stop time (closure)
IV	Facility	0=Wilford Hall Medical Center 1=Nix Hospital Dichotomous
IV	Procedures	0= Inguinal Hernia Repair 1= Laparoscopic cholecystectomy 2= Carotid endarterectomy

Appendix B

AMC: Academic Medical Center

BAMC: Brooke Army Medical Center

BBA: Balanced Budget Act of 1997

CPT: Current Procedural Terminology Codes

DoD: Department of Defense

FFS: Fee-For-Service. A traditional form of reimbursement in healthcare where payment is based on services rendered to the patient. Whether payment is based upon usual, customary, and reasonable charges, allowable costs, or variations on these formats, health care providers are used to receiving reimbursement at some level for doing "things" (tests, procedures, etc.) for patients. With payers moving toward prospective pricing methods, such as DRGs and Capitation, providers are adjusting to bearing greater risk and responsibility for appropriate resource allocation and usage.

GDP: Gross Domestic Product

GME: Graduate Medical Education

GWOT: Global War on Terror

HMO: Health Maintenance Organization. An organization that has management responsibility for providing comprehensive healthcare services on a prepayment basis to voluntarily enrolled persons within a designated population.

MCO: Managed Care Organizations. A form of health insurance coverage where enrollee utilization patterns and provider service patterns are monitored before (prospectively), during (concurrently), and after (retrospectively) the actual delivery of services. The insurer or other assigned intermediary engages in evaluation of providers to contain costs and ensue appropriate health service utilization by its members. Traditional indemnity insurance usually covered whatever the healthcare professional decided to do for the individual. However, managed care has the insurer playing a much more active role in determining what is done for a beneficiary, where it will be done, who will do it, and what they are willing to pay for it. Most businesses have determined managed care to be the best mechanism in controlling their healthcare costs. Managed care entities can be designated as PPOs, HMOs, IPAs or other alternative delivery systems.

MHS: Military Health System

NHE: National Health Expenditures

NMC: Nix Medical Center

OR: Operating Room

Payor: The person, institution of government who is responsible for making of the payment to the payee as mentioned in the promissory note or bills of exchanges.

PCM: Primary Care Manager

PPO: Preferred Provider Organization. A term applied to a variety of direct contractual relationships between hospitals, physicians, insurers, employers, or third-party administrators in which providers negotiate with group purchasers to provide health services for a defined population, and which typically share three characteristics: a negotiated system for payment for services that may include discounts from usual charges or ceilings imposed on a charge, per diem, or per discharge basis; financial incentives for individual subscribers (insured) to use contracting providers, usually in the form of reduced copayments and deductibles, broader coverage of services, or simplified claims processing; and an extensive utilization review program.

PPS: Prospective Payment System. A generic term applied to a reimbursement system that pays prospectively rather than on the basis of charges. Generally, it is used only to refer to hospital reimbursement and applied only to DRGs, but it may encompass other methodologies as well.

SAMMC: San Antonio Military Medical Center

SE: Standard Error

SPSS: Statistical Package for Social Sciences

t- test: A **t test** is any statistical hypothesis test in which the test statistic has a Student's t-distribution if the null hypothesis is true

TAT. Turnaround Time is defined as the interval between the previous patients departure from the OR to the next patient's arrival in the OR.

TRICARE EXTRA. The civilian preferred provider network organized by the contractor. To join the network, doctors and other providers agree to charge lower fees and to handle all claims-filing. To use TRICARE Extra and to benefit from the lower fees and claims-filing, a beneficiary needs only to make an appointment with a network member. There is no enrollment or registration requirement, nor is there any commitment to use the network again in the future. Seeing network providers will save beneficiaries money. One reason is because the network providers charge lower fees. Another reason is, TRICARE sets the patient's share of the cost for TRICARE Extra services at a level five percentage points lower than for TRICARE Standard. Patients are still responsible to pay annual CHAMPUS deductibles.

TRICARE PRIME. Operates like a civilian health maintenance organization or HMO. It offers the most comprehensive coverage at the lowest cost to the beneficiary. TRICARE Prime provides healthcare primarily at the Military Treatment Facility, augmented by the contractor's network. Beneficiaries are assigned to primary care managers who may be an individual provider, such as a Family Practice, Internal Medicine or General Practitioner; or it may be a clinic or panel of practitioners and, where possible, those primary care managers will be part of the MTF. However, some beneficiaries may be assigned network providers as their primary-care managers. Beneficiaries must enroll for TRICARE Prime. They are committed to it for one year, then they may choose another option. Beneficiaries must agree to follow the plan for obtaining healthcare. If they do not, they may be liable for large deductibles and up to 50 percent of the cost of services they obtain from outside the plan on their own.

TRICARE STANDARD. Operates in the same way as the basic

CHAMPUS program. As such, it is the most expensive option for beneficiaries because it gives the greatest freedom of choice in selecting civilian providers. An annual deductible is paid for each individual with a maximum paid per family before TRICARE pays anything in the same manner as Standard CHAMPUS. In addition to the deductible, active duty family members' cost shares or co-payments, the portion paid by patients themselves, are 20-percent of the CHAMPUS allowed charge. Retirees and their families' co-payments are 25-percent. Another potential cost under TRICARE standard--patients may be responsible for paying the difference between a provider's billed charges and the CHAMPUS allowable rate, known as balanced billing, and, beneficiaries may have to file their own claims.

WHMC: Wilford Hall Medical Center