



NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

JOINT APPLIED PROJECT

AN ANALYSIS OF MEDICAL IMAGING COSTS IN MILITARY TREATMENT FACILITIES

**By: David M. Lewis,
Jeremy H. Westcott
September 2014**

**Advisors: Robert Eger,
Wilhelmina Pizzini**

Approved for public release; distribution is unlimited

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			<i>Form Approved OMB No. 0704-0188</i>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE September 2014	3. REPORT TYPE AND DATES COVERED Joint Applied Project	
4. TITLE AND SUBTITLE AN ANALYSIS OF MEDICAL IMAGING COSTS IN MILITARY TREATMENT FACILITIES			5. FUNDING NUMBERS	
6. AUTHOR(S) David M. Lewis, Jeremy H. Westcott				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING /MONITORING AGENCY NAME(S) AND ADDRESS(ES) N/A			10. SPONSORING/MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government. IRB Protocol number ____ N/A ____.				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited			12b. DISTRIBUTION CODE A	
13. ABSTRACT This joint applied project examines costs of medical imaging within Continental United States military treatment facilities to determine cost effectiveness when compared to civilian facilities and determine whether there are differences among regions of the United States and whether there are differences among the branches of service. Historical data utilized to conduct analysis were collected from the Military Health System Management Analysis and Reporting Tool (M2), the Defense Medical Logistics Standard Support system (DMLSS), the CHAMPUS National Pricing System (CMAC), and the Centers for Medicare and Medicaid Services website (CMS.gov). Our conclusions regarding overall cost of radiology services at military facilities is hampered by the use of average cost per test as a basis for analysis. However, greater consolidation of radiologic imaging assets and increased volume at military facilities can do nothing but improve the cost effectiveness of insourcing this function.				
14. SUBJECT TERMS Imaging costs, Medicare Part B, Medicare provider utilization and payment data, Civilian vs. Military cost differences, Imaging cost trends, Enhanced Multi-Service Markets (eMSM), total beneficiaries by age group, beneficiaries by race, cost variation among military services,			15. NUMBER OF PAGES 73	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UU	

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release; distribution is unlimited

**AN ANALYSIS OF MEDICAL IMAGING COSTS IN MILITARY
TREATMENT FACILITIES**

David M. Lewis, Civilian, Department of The Army
Jeremy H. Westcott, Lieutenant Commander, United States Navy

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN PROGRAM MANAGEMENT

from the

**NAVAL POSTGRADUATE SCHOOL
September 2014**

Authors: David M. Lewis

Jeremy H. Westcott

Approved by: Dr. Robert Eger, Co-Advisor

Dr. Wilhelmina Pizzini, Co-Advisor

Dr. William R. Gates, Dean
Graduate School of Business and Public Policy

THIS PAGE INTENTIONALLY LEFT BLANK

AN ANALYSIS OF MEDICAL IMAGING COSTS IN MILITARY TREATMENT FACILITIES

ABSTRACT

This joint applied project examines costs of medical imaging within Continental United States military treatment facilities to determine cost effectiveness when compared to civilian facilities and determine whether there are differences among regions of the United States and whether there are differences among the branches of service. Historical data utilized to conduct analysis were collected from the Military Health System Management Analysis and Reporting Tool (M2), the Defense Medical Logistics Standard Support system (DMLSS), the CHAMPUS National Pricing System (CMAC), and the Centers for Medicare and Medicaid Services website (CMS.gov).

Our conclusions regarding overall cost of radiology services at military facilities is hampered by the use of average cost per test as a basis for analysis. However, greater consolidation of radiologic imaging assets and increased volume at military facilities can do nothing but improve the cost effectiveness of insourcing this function.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

I.	INTRODUCTION AND OVERVIEW	1
A.	IMPACTS OF RISING HEALTH CARE COSTS.....	1
B.	THE QUADRUPLE AIM STRATEGY	2
C.	SCOPE OF STUDY	3
D.	DATA SOURCES AND ORGANIZATION	4
E.	RESEARCH QUESTIONS	4
E.	SUMMARY	5
II.	METHODOLOGY AND FOCUS	7
A.	DEFENSE HEALTH AGENCY (DHA).....	7
1.	DHA Strategy	8
B.	ENHANCE MULTI-SERVICE MARKETS	9
C.	CURRENT PROCEDURAL TERMINOLOGY (CPT) CODES.....	10
1.	CPT Categories	11
2.	CPT Focus Area (Radiology)	12
D.	MILITARY HEALTH SYSTEM MANAGEMENT ANALYSIS AND REPORTING TOOL (M2).....	12
E.	CIVILIAN HEALTH AND MEDICAL PROGRAM OF THE UNIFORMED SERVICES (CHAMPUS) NATIONAL PRICING SYSTEM AND COST ANALYSIS	14
F.	APPLICABILITY OF OUR ANALYSIS.....	15
III.	DATA ANALYSIS AND COMPARISONS	17
A.	CIVILIAN VS. MILITARY COSTS DIFFERENCES	17
1.	Selected Data Sets and Sources.....	17
2.	Methodology	18
B.	ANALYSIS OF OVERALL COST DIFFERENCES.....	19
C.	SUMMARY OF OVERALL COST DIFFERENCES.....	26
D.	COST TREND ANALYSIS.....	27
1.	Overall Differences in Cost between MTF and Civilian Facilities.	27
2.	Differences among Types of Imaging, 2008–2012	30
E.	SUMMARY OF TREND ANALYSIS	36
F.	REGIONAL VARIATIONS	37
G.	VARIATIONS IN BENEFICIARY AGE	38
H.	VARIATIONS IN BENEFICIARY RACE	41
I.	RADIOLOGY COST DIFFERENCES AMONG MILITARY SERVICES.....	43

1.	Overall Cost Differences.....	43
2.	Differences among Types of Procedure	44
3.	Differences among Military Services within Regions	45
IV.	FINDINGS AND RECOMMENDATIONS.....	49
A.	FINDINGS	49
B.	RECOMMENDATIONS.....	52
	LIST OF REFERENCES.....	53
	INITIAL DISTRIBUTION LIST.....	55

LIST OF FIGURES

Figure 1.	The Quadruple Aim Strategy (from Tricare at tricare.mil , 2014).....	3
Figure 2.	Average Imaging Cost per Service Military vs. Civilian, 2008–2012.....	20
Figure 3.	CT Average Cost per Service Comparison, 2008–2012	21
Figure 4.	MRI Average Cost Per Service Comparison, 2008–2012	22
Figure 5.	NUC Average Cost Per Service Comparison, 2008–2012	23
Figure 6.	PET Average Cost Per Service Comparison, 2008–2012.....	24
Figure 7.	ULTRA Average Cost per Service Comparison, 2008–2012.....	25
Figure 8.	All Imaging, Percentage Change in Average Cost, 2008–2012	28
Figure 9.	All Imaging (Pet Excluded), Percentage Change in Average Cost 2008–12 ..	30
Figure 10.	CT, Percentage Change in Average Cost, 2008–12.....	31
Figure 11.	MRI, Percentage Change in Average Cost, 2008–2012	32
Figure 12.	NUC, Percentage Change in Average Cost, 2008–2012	33
Figure 13.	PET, Percentage Change in Average Cost, 2008–2012.....	35
Figure 14.	ULTRA, Percentage Change in Average Cost, 2008–2012	36
Figure 15.	eMSM Total Beneficiaries by Age	39
Figure 16.	eMSM Proportion of Beneficiaries in Each Age Group by Region	40
Figure 17.	Total eMSM Beneficiaries by Race	42
Figure 18.	Military Services, Average Radiology Costs (2008-2012).....	44
Figure 19.	Average Radiology Costs by Service and Region	46

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

Table 1.	eMSM Markets and Managers.....	10
Table 2.	Selected CPT Codes.....	18
Table 3.	CPI Medical Index and Factor (from U.S. Bureau of Labor Statistics at bls.gov, 2014).....	19
Table 4.	All Imaging, Detail of Percentage Change in Average Cost, 2008–2012	28
Table 5.	All Imaging (PET Excluded), Detail of Percentage Change in Average Cost, 2008–12	30
Table 6.	CT, Detail of Percentage Change in Average Cost.....	31
Table 7.	MRI, Detail of Percentage Change in Average Cost	32
Table 8.	NUC, Detail of Percentage Change in Average Cost	33
Table 9.	PET, Detail of Percentage Change in Average Cost.....	35
Table 10.	ULTRA, Detail of Percentage Change in Average Cost	36
Table 11.	eMSM Beneficiary Count by Region (Dec. 2012)	38
Table 12.	Military Services, Average Radiology Cost (2008-2012)	43
Table 13.	Military Branch Average Imaging Costs by Type	44
Table 14.	Military Services, Average Radiology Cost (2008-12); Excluding PET..	45

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

AMA	American Medical Association
BESS	Medicare Part B Extract Summary System
CBO	Congressional Budget Office
CDC	Centers for Disease Control and Prevention
CHAMPUS	Civilian Health and Medical Program of the Uniformed Services
CMAC	CHAMPUS National Pricing System
CMS	Centers for Medicare and Medicaid Services
CONUS	Continental United States
CPI	Consumer Price Index
CPT	Current Procedural Terminology
CT	Computed Tomography
DHA	Defense Health Agency
DMLSS	Defense Medical Logistics Standard Support system
DOD	Department Of Defense
eMSM	Enhanced Multi-Service Markets
FDA	Food and Drug Administration
GDP	Gross Domestic Product
GSA	General Services Administration
HCPCS	Healthcare Common Procedure Coding System
HIPAA	Health Insurance Portability and Accountability Act
IRB	Institutional Review Board
M2	Management Analysis and Reporting Tool
MDR	Military Health System Data Repository
Med B	Medicare Part B
Mil	Military
MHS	Military Health System
MILCON	Military Construction
MTF	Military Treatment Facility
MRI	Magnetic Resonance Imaging
MSIS	Medical Statistical Information System

NCR	National Capital Region
NMMC	National Military Medical Center
NUC	Nuclear Medicine
OCHAMPUS	Office of the Civilian Health & Medical Program of the Uniformed Services
PET	Positron Emission Tomography
TAD	Temporary Additional Duty
TDY	Temporary Duty
ULTRA	Ultrasound

ACKNOWLEDGMENTS

We would like to thank our advisors Dr. Robert Eger and Dr. Wilhelmina Pizzini for all of their time and effort provided in guiding us toward completion of this joint applied project. Their help and guidance was integral in formulating the completed project you see today. We would also like to thank all of our family and friends for their help and understanding as we worked through all of the ups and downs throughout this project process.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION AND OVERVIEW

“We’ll have well-paid, happy and healthy retirees, but we’ll also have no money for equipment, training or regular operations.” (Harrison 2012)

A. IMPACTS OF RISING HEALTH CARE COSTS

Health care costs in the United States (U.S.) have increased steadily every year since the federal government started keeping statistics in 1960. In 2012, U.S. health care expenditures totaled \$2.8 trillion, or \$8,915 person. This equated to 17.3% of the U.S. Gross Domestic Product (GDP) for that year (The World Bank Data 2014).

Rising health care costs directly impact the budget of the Department of Defense. Unlike other areas of defense procurement such as weapons systems, DOD purchases almost 100% commercial items for provision of health care provided within the U.S. For example, laboratory equipment and radiology equipment used in civilian hospitals are the same brands and types of equipment used in Military Treatment Facilities (MTFs). This equivalency extends to staff as well. Civilian employees and contract staff members who work in MTFs are trained in the same ways and generally demand salaries equivalent to those received by their private industry counterparts also working in the civilian medical world. Medical supplies and pharmaceuticals are purchased from the same vendors who supply every other hospital and clinic in the United States. There are some items developed specifically for medics and corpsmen working with our front-line troops but these particular pieces of equipment and supplies are relatively inexpensive and represent a small fraction of the overall DOD health care budget. For this reason, factors that cause increases in commercial sector medical spending have a direct and dramatic impact on the Defense budget.

Military health care costs have more than doubled since 2001 and now consume 9.5% of the base defense budget. The fiscal year 2014 budget includes \$49.4 billion to care for 9.6 million beneficiaries which include active duty military, family members, retirees, dependent survivors, and reserve personnel serving on active duty. Health care costs have increased quickly. According to the Congressional Budget Office:

Between 2000 and 2012, funding for military health care increased by 130%, over and above the effects of overall inflation in the economy. In 2000, funding for health care accounted for about 6% of the DOD's base budget, by 2012, that share had reached nearly 10% (Congressional Budget Office 2014).

During fiscal year 2012, the Department operated 56 hospitals, 363 clinics, and 273 dental clinics around the world. If the overall Defense budget were to increase at the rate of inflation and personnel costs including health care were to increase at their historical rates, the entire defense budget would be consumed by personnel costs by 2039—leaving no funding for equipment or operations (Harrison 2011). According to estimates by the Congressional Budget Office (CBO), the Defense Health Program will increase to \$65 billion by FY2017 at an average annual growth rate of 6 % (Jansen 2014).

B. THE QUADRUPLE AIM STRATEGY

The Department is pursuing several strategies to combat these rising costs. Central to these efforts is an initiative known as the Quadruple Aim. As depicted in Figure 1, the Quadruple Aim is comprised of the following goals:

- Readiness: Ensuring that the total military force is medically ready to deploy and that the medical force is ready to deliver health care anytime, anywhere in support of the full range of military operations, including humanitarian missions.
- Population Health: Reducing the generators of ill health encouraging healthy behaviors and decreasing the likelihood of illness through focused prevention and the development of increased resilience.
- Experience of Care: Providing a care experience that is patient and family centered, compassionate, convenient, equitable, safe, and always of the highest quality.
- Responsibly Managing the Total Cost of Health Care: Creating value by focusing on quality, eliminating waste, and reducing un-warranted variation; considering the total cost of care over time, not just the cost of an individual health care activity.



Figure 1. The Quadruple Aim Strategy (from Tricare at tricare.mil, 2014)

C. SCOPE OF STUDY

This study will examine the possible impact of another alternative for reducing costs not included in the Quadruple Aim: outsourcing medical care that DOD provides in certain regions and for certain services. A substantial amount of care provided to DOD beneficiaries occurs within or near larger metropolitan areas in the United States that each maintains robust civilian medical care systems. With this in mind, there may exist opportunities for outsourcing care resulting in the ability to either close existing military treatment facilities and/or move components of their care to civilian facilities if a comparison of costs proves this strategy efficacious.

In order to determine the possible effectiveness of this alternative, our research will examine medical imaging costs within specific geographic areas in the continental United States. Medical imaging procedures will be examined because of their relatively high cost and the ease with which all of imaging procedures can be structured into five categories for analysis: Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Nuclear Medicine (NUC), Positron Emission Tomography (PET), and Ultrasound (ULTRA). Plain film radiology images will not be examined due to its relatively low cost and negligible impact on the overall radiology budget. The geographic regions will be examined individually as health care costs vary greatly by region in the United States. It may be possible that increased outsourcing of medical imaging services makes sense in some regions of the U.S. but not in others. The regions that will be analyzed are based on six Enhanced Multi-Service Markets (eMSM) selected by the Defense Health Agency:

- Tidewater, Virginia – encompassing Norfolk, Portsmouth, and Virginia Beach
- Hawaii
- Colorado Springs, Colorado
- National Capital Region – Washington, D.C., and the surrounding areas of Maryland and Virginia.
- Puget Sound, Washington
- San Antonio, Texas

Each eMSM encompasses multiple military facilities from more than one branch of service which are collocated with strong civilian network capabilities. For this reason, the eMSM regions provide a ready-made method of grouping facilities for comparison both with civilian treatment facilities and with each other.

D. DATA SOURCES AND ORGANIZATION

Data will be obtained from three sources: the Military Health System (MHS) Management Analysis and Reporting Tool (M2), Medicare Part B (Med-B) provider utilization and payment data available through the Centers for Medicare and Medicaid Services (CMS), and the CHAMPUS National Pricing System (CMAC). M2 provides raw data on total numbers of procedures and costs in each region by a standardized coding system for all medical procedures called Current Procedural Terminology (CPT). CPT codes are industry-wide codes used for billing, classifying, and tracking medical procedures. We will be using the fourth edition of the CPT list for our analysis. CMS will be used to collect the civilian cost of each procedure analyzed, again organized by CPT. Finally, CMAC rates will be compared to the M2 costs and Medical Statistical Information System (MSIS) costs to determine if current Tricare reimbursement rates equate to civilian or military costs for each procedure.

E. RESEARCH QUESTIONS

Our research analysis, conclusions and recommendations will be based upon answering the following four questions:

- Are there differences between civilian referral imaging costs and military treatment facility imaging costs within the continental United States (civilian vs. military cost differences)?
- Are there identifiable trends over the five-year period between January 1, 2008 and December 31, 2012 when comparing civilian and MTF imaging costs, when looking at overall cost, and types of imaging procedures (Cost Trends)?
- Are there differences between civilian and military medical imaging costs in the five enhanced multi-service market regions, and does the demographic of each region correlate with any identified cost differences (Regional Differences)?
- Are there disparities among services both within individual regional markets and nationally when comparing medical imaging costs (Service Differences)? Are there disparities among services both within individual regional markets and nationally when comparing medical imaging costs?

E. SUMMARY

The Department of Defense's overall health care mission is to provide high quality care to its beneficiaries in the most efficient manner. Determining the best structure for providing this care is a complicated question that cannot end with a discussion on costs. Access to care, quality of care, and the readiness of our military health care workers are all critical components that must be considered when shaping our future military health care system. Our goal with this analysis is to determine if there are opportunities for the provision of medical imaging care within the enhanced multi-service markets that may result in a decrease of overall cost. If there are cost differences, their magnitude and character may inform the decisions of policy makers when balancing the need for efficiency with quality, access, and readiness.

THIS PAGE INTENTIONALLY LEFT BLANK

II. METHODOLOGY AND FOCUS

“We must [be] responsive to the fiscal challenges facing the nation by achieving a sustainable health program budget.” (Deputy Secretary of Defense 2013).

A. DEFENSE HEALTH AGENCY (DHA)

In June 2011, Deputy Secretary of Defense Ashton Carter established a task force to examine alternatives for governance of the Military Health System (MHS). Although MHS governance has been studied repeatedly over the years, substantive changes in structure have been incremental and relatively small. The economic conditions in the health care market, coupled with the continued up-tempo pace of military operations around the world, made a conscious review of options for overall MHS governance imperative. The task force was comprised of representatives from each DOD military department, the Joint Staff, and the Office of the Secretary of Defense. Alternatives were examined in several areas:

- overall governance of the Military Health System
- governance of the multi-service markets.
- governance of the National Capital Region (NCR)

The overall imperative of the task force was to identify options and make recommendations to achieve integration of direct and purchased care delivery systems to accomplish the quadruple aim of achieving medical readiness, improving the health of DOD beneficiaries, enhancing the experience of care, and lowering healthcare costs.

The final recommendations did not result in unified control of the MHS, perhaps due to the fact that the task force was made up of representatives from each military service. Additionally, the recommendation failed to strip the services of long-term control of staffing or result in a loss of control over individual MTFs. Instead, the task force recommended replacement of the existing Tricare Management Authority with a new agency: the Defense Health Agency, headed by a three-star flag officer. Although not vested with authority to completely control the medical systems of each service, the DHA

was given management responsibility for specific shared services, functions and activities:

- the Tricare Health Plan
- pharmaceuticals
- medical education and training
- medical research and development
- medical logistics and acquisition
- other common clinical and business practices

1. DHA Strategy

Further refinement of DHA strategy during transition planning in the summer of 2013 identified several overarching objectives (Defense Health Agency Transition Team 2013):

- Promote more **effective and efficient health operations** through enhanced enterprise-wide shared services.
- Deliver more **comprehensive primary care and integrated health services** using advanced patient-centered medical homes.
- Coordinate care over time and across treatment settings to **improve outcomes** in the management of chronic illness, particularly for patients with complex medical and social problems.
- Match personnel, infrastructure, and funding to **current missions, future missions, and population demand**.
- Establish more inter-Service standards/metrics, and standard process to promote **learning and continuous improvement**.
- Create **enhanced value in military medical markets** using an integrated approach in five-year business plans.
- Align incentives with **health and readiness outcomes** to reward value creation.

In order to carry out these top level objectives, DHA further refined the list of shared services that will fall under central control:

- facility planning
- medical logistics
- health information technology
- Tricare health plan
- pharmacy programs
- public health
- acquisition
- budget and resource management
- medical education and training
- medical research and development

Although direct ownership of staffing and facilities was maintained by each service, significant control will be exerted by DHA over operations of each MTF. Perhaps the most powerful policy lever available to DHA is control of the defense health appropriation. Regardless of individual service ownership and control of MTFs, control of funding will give DHA a powerful tool for facilitating policy changes. When fully capable in 2015, the DHA will have the power to integrate service health care efforts in a more efficient manner by controlling critical services such as acquisition, logistics, and resource management.

B. ENHANCE MULTI-SERVICE MARKETS

A centerpiece of the task force's recommendations was an expansion of the powers of the already established Multi-Service Markets, resulting in enhanced Multi-Service Markets, or eMSMs. eMSMs are defined as geographic regions within the United States that are serviced by two or more services that maintain a robust civilian provider network. The six designated eMSMs (Deputy Secretary of Defense 2013) can be found in Table 1.

Table 1 eMSM Markets and Managers

Geographic Area	Market Manager
Tidewater, Virginia	Navy
Puget Sound, Washington	Army
Colorado Springs, Colorado	Rotate between Air Force and Army
San Antonio, Texas	Rotate between Air Force and Army
Oahu, Hawaii	Army
National Capital Region	NCR Directorate, DHA

eMSM market managers have been given wide ranging powers to integrate military medical services within their geographic areas. Primary among these powers is the ability to shift funding and manpower among MTFs within their region. The overall goal of each eMSM is to integrate the health care activities of each facility in order recapture care that is currently being sent to the civilian network (Perron 2013). In order to do so, eMSM commanders will integrate booking of appointments so that a shortage of appointments in one facility can be addressed by sending patients to another facility with open appointments. In addition, staffing can be shifted between the facilities on temporary (TAD/TDY) basis. If a particular specialty is needed in a facility and no provider of that type is assigned there or if the assigned provider is deployed, another provider from an eMSM facility can be sent to see those patients. It is important to highlight that the focus of the eMSM system is to recapture care from the civilian network while enhancing quality and gaining efficiencies from implementation of unified business practices. At present, there is no effort underway to identify when or if purchase of civilian medical care would be a more cost effective approach – which is the focus of this study.

C. CURRENT PROCEDURAL TERMINOLOGY (CPT) CODES

This study will examine cost differences between military facilities and civilian facilities within the enhanced Multi-Service Markets. In order to reduce the data set to a manageable level, only specific radiology procedures will be examined. All services provided to a patient can be described through the use of a CPT code. CPT codes were developed and are maintained by the American Medical Association (AMA) and are the

foundation, along with diagnosis codes, of our billing and payment system in the United States. In addition, CPT codes provide a ready means of tracking services provided to patients for public health analysis and health system research. According to the AMA, (American Medical Association 2014) the first CPTs were published in 1966 in an effort to facilitate billing for insurance claims and prepare for computer based tracking of health care services. The first edition of the CPT code list focused on surgical procedures but the code set has now been expanded to encompass any service that can be provided to a patient. Codes are divided into three categories (Advanced Healthcare Network 2004):

1. CPT Categories

- Category I: Codes used for widely used procedures that are accepted as the industry standard. Category I codes must be approved by the Food and Drug Administration (FDA) and their clinical efficacy must be well documented. When health care workers refer to CPT codes, they are generally referring to Category I codes.
- Category II: Category II codes are intended for collection of data on the quality of care provided. For instance, the current clinical standard is that all patients should have their blood pressure measured when accessing health care regardless of the purpose of their visit. A Category II code (0001F) can be used as a performance measure if this step was/was not completed during a visit. This has implications both as an internal monitoring tool for a health care facility as well as for payment. The use of the code set is optional. However, many health care payers are starting to tie payment rates to compliance with quality factors such as those measured by Category II CPT codes.
- Category III: Category III codes are temporary codes used for new technologies/procedures that are not FDA approved. In order for the AMA to list a Category III code, the procedure must be supported by peer reviewed literature and must have at least one

Institutional Review Board (IRB) approved protocol for testing the efficacy of the procedure.

For the purposes of this study, we will be using only Category I codes. Category I codes are subdivided into several broad categories:

- evaluation and management: 99201-99499
- anesthesia: 00100-01999; 99100-99150
- surgery: 10021-69990
- radiology: 700100-79999
- pathology & laboratory: 80047-89398
- medicine: 90281-99099; 99151-99199; 99500-99607

2. CPT Focus Area (Radiology)

We will be examining costs associated only with radiology codes – those between 70000 and 79999 for costs associated with advanced-technology imaging: Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Nuclear Medicine (NUC), Positron Emission Tomography (PET), and Ultrasound (ULTRA).¹

D. MILITARY HEALTH SYSTEM MANAGEMENT ANALYSIS AND REPORTING TOOL (M2)

The MHS Mart, or M2, is a business objects data reporting tool that we will use to obtain data for our analysis. M2 is a tri-service system that is currently managed and maintained by the Defense Health Agency. M2 pulls data from the MHS Data Repository (MDR) – a data warehouse that holds information on all interactions with patients that are required to be recorded. It's important to note that not all patient interactions are recorded. Only specific types are measured for performance, quality, and billing

1. The reader may also have heard of the Healthcare Common Procedure Coding System (HCPCS). Codes under this system were developed starting in 1978 by the Centers for Medicare and Medicaid Services (CMS) as a foundation for orderly and consistent processing of claims¹. Most HCPCS codes are simply a CPT code. However, Medicare had to expand the codes beyond what the AMA coded as procedures in order to reimburse care not typically considered as a procedure. Some examples are ambulance services and prosthetic devices. As of passage of the Health Insurance Portability and Accountability Act (HIPAA) in 1996, use of CPT/HCPCS codes is mandatory.

information. For instance, a patient admitted to a hospital will have all procedures by a physician recorded. In addition, the resources necessary to care for the patient in the hospital will be recorded through a global code based on the patient's diagnosis. However, individual routine interactions are not recorded. For example, interactions between a nurse and the patient are not tracked. Although these interactions are charted in the patient's record, the specifics of the interactions are not coded and tracked in the MDR. The cost of tracking too many data points would quickly exceed the benefit derived from the analysis itself. As it is, the MHS tracks over 40 million encounters with patients per year. The MDR contains data from many different sources, all of which can be accessed and linked to other data sources using M2. To answer our research questions, we will use data from multiple sources within the MDR. A list of the MDR data sources is included in Enclosure 1 (TRICARE Management Activity 2012).

The completeness and accuracy of data in the MDR is commonly known to be very strong in some areas and somewhat weak in others. Any data extracted from this system must be analyzed first for efficacy before its use to analyze a research question. Data input errors by health care workers who are busy caring for a patient is not uncommon. Careful examination of outliers in our data sets to identify issues that may skew our data will be integral to ensuring the veracity of our results and conclusions.

There are also limitations regarding the overhead cost data collected in M2. All direct and overhead costs that flow through the hospital's accounting system are allocated to applicable departments based on various drivers. Cost data for radiology includes the payroll of staff, service contract costs, supplies, and minor equipment that is expensed when purchased. Utility charges are applied proportionally based on square footage of the radiology facility. However, captured costs exclude some significant expenses born by any civilian facility. Rent (or building depreciation), insurance, and professional fees are not incorporated into indirect or overhead costs. In addition, there are obviously costs associated with medical malpractice that are being born by DOD. However, these costs are not allocated to radiology procedures by M2. These types of costs form a significant amount of the expense structure in a civilian imaging facility. They are very real costs for DOD as well so we will apply an adjustment percentage to all of our M2 cost data based on the civilian industry average for these costs.

E. CIVILIAN HEALTH AND MEDICAL PROGRAM OF THE UNIFORMED SERVICES (CHAMPUS) NATIONAL PRICING SYSTEM AND COST ANALYSIS

The CHAMPUS Nation Pricing System, commonly known as CMAC, is the official billing reimbursement pricing structure used by the Military Health System (MHS) for care that is provided in the civilian community. It provides reimbursement rates for CPT codes by locality. With only minor changes implemented, the MHS uses essentially the same reimbursement rates published by CMS. For the purposes of this study, we will be using the CMAC rates for cost comparison with the MHS costs of the studied radiology procedures. An important distinction to make is that the CMAC rates are not costs. Instead, CMAC rates are what the MHS *pays* for a specific procedure. The civilian provider's underlying costs are not known by the MHS nor are they considered a necessary data point. The only salient information is what the health care system must actually pay for the particular service. In contrast, the cost information obtained from M2 on care provided by the MHS is *actual cost* information. Each visit recorded in the MDR has the direct and overhead costs allocated as discussed above. Unfortunately, we do not have access to this same data for civilian health care providers.

For the purposes of this study, we will be comparing apples to oranges to a certain extent—internal costs compared with external pricing. However, we believe this is the most important comparison to make even if civilian provider cost information were available. In a “make versus buy” analysis, we should compare our cost to make something with the price of obtaining it from an outside source. CMAC rates are our best proxy for outsourcing costs for DOD health care. For this reason, underlying costs of civilian providers is of secondary interest. However, we will include in our analysis a comparison of CMAC rates to cost information available from CMS. All health care facilities who receive reimbursement from CMS are required to submit annual cost reports to the agency. CMS uses this data to publish cost data by procedure and by locality. We will include a comparison of this data to the CMAC rates to determine if the reimbursement rates have any relationship to the underlying cost estimates calculated by CMS.

F. APPLICABILITY OF OUR ANALYSIS

We are making a simple comparison among per service costs for specific procedures between the Military Health System and the civilian health system in specific geographic regions during specified periods of time using CMAC rates and Medicare allowed charges. This methodology will limit our ability to make definitive statements about military costs relative to civilian options as per service costing is variable based on the number of procedures (services) performed while reimbursement rates do not vary with volume. In addition to cost considerations, it is important to remember that a true “make versus buy” decision between military treatment facilities and their civilian counterparts requires consideration of quality and readiness of our forces. According to an article published by Dr. John Montgomery, former head of the Office of the Civilian Health & Medical Program of the Uniformed Services (OCHAMPUS) and current consultant to the Defense Health Agency: “[Make versus buy analysis] may be useful in conceptualizing the relationship between the direct care and purchased care components of the MHS, as a practical matter it represents a gross oversimplification of how the two components of the system relate to each other” (Montgomery 2012). As noted by Dr. Montgomery elsewhere, the mission of providing care and maintaining a ready force is paramount. Consideration for training of our military medical staff, residency programs, and the quality of the care we provide are all integral to accomplishment of the *mission* of military medicine. Ignoring these factors could result in a health care system that does not accomplish the mission. However, these are undoubtedly very complex questions that fall outside of the scope of this study. We will focus only on cost as this type of analysis may be informative for identifying opportunities for future savings. Further analysis would be necessary on any areas identified for potential cost savings to ensure the DOD can still accomplish its health care mission if care is realigned to rely more heavily on civilian treatment facilities.

THIS PAGE INTENTIONALLY LEFT BLANK

III. DATA ANALYSIS AND COMPARISONS

A. CIVILIAN VS. MILITARY COSTS DIFFERENCES

We will now investigate any potential differences that may exist among civilian CHAMPUS/Tri-Care referral imaging costs, military treatment facility imaging costs, and Medicare Part B allowed charges within the continental United States over the five-year period between January 1, 2008, and December 31, 2012.

1. Selected Data Sets and Sources

Data used in this analysis were extracted from the Military Health System (MHS) Management Analysis and Reporting Tool (M2), public use Medicare provider utilization and payment data available through the Centers for Medicare and Medicaid Services website (CMS.gov), and the CHAMPUS National Pricing System (CMAC). To manage the complexity of the analysis, the collected historical data were paired down to exhibit a representative sample of procedures for each separate type of imaging service. The basis for comparison for each provider type and type of imaging was comprised of the CPT code subsets identified in Table 2 with all codes derived from the overall historical sample. Codes were selected based on their relative frequency of use over the study period. These listed codes represent more than 90% of the total procedure sets under each category based on volume of procedures. There are different amounts of codes in each category as there are more procedures in some categories relative to others. For instance, there are relatively few different types of PET procedures.

Table 2. Selected CPT Codes

CPT Codes Utilized in Comparative Analysis				
CT	MRI	NUC	PET	ULTRA
70480	70540	78018	78459	76536
70486	70551	78070	78491	76645
70491	70552	78264	78608	76700
71250	70553	78300	78813	76705
71260	72141	78305	78814	76770
72125	72146	78306	78815	76775
72192	72148	78315	78816	76817
72193	72156	78320		76818
72194	72158	78451		76830
73700	73220	78452		76856
74150	73221	78472		76870
74160	73720	78473		
74170	73721	78707		
74177	74183	78806		
	77059			

2. Methodology

In an effort to conduct a comprehensive review and ensure a normalized comparison between M2 data and Medicare Part B provider utilization and payment data, a multiplier of 19.13% was added to all M2 data. This was done to account for rent and mortgage rates (11.97%), Insurance (6.06%), and professional fees (1.10%) (Medicaleconomics 2013) which are not included in military M2 cost data. Medicare data were extracted by HCPCS code from Medicare Part B Extract Summary System (BESS) Data reports for the years 2008, 2009, 2010, 2011 and 2012. The data were then further sorted by code type to categorize data by imaging type (CT, MRI, NUC, PET, and Ultra). CMAC data extracted from the CHAMPUS National Pricing System were obtained for years 2008–2012 by first obtaining available information for 2014 then adjusting costs in accordance with Consumer Price Index (CPI) data for medical inflation available from bls.gov as indicated in Table 3.

Table 3. CPI Medical Index and Factor (from U.S. Bureau of Labor Statistics at bls.gov, 2014)

Year	Medical Index	Factor
2014	434.874	1.000
2012	418.654	0.963
2011	400.258	0.920
2010	388.436	0.893
2009	375.613	0.864
2008	364.05	0.837

Once all data were obtained we then conducted an analysis to determine if exclusion of any data was necessary to eliminate outlier elements which had the potential improperly to skew results. We first attempted to use three standard deviations as an exclusion point to eliminate inaccurate results and found that we were unable to identify any candidates for elimination. On the other hand when we attempted to use two standard deviations in an effort to capture roughly 95% of our obtained data we found that we would be excluding quality data. Upon reflection we determined that our chosen data sets were not large enough to conduct exclusion based upon standard deviation and that the distributions are not normal distributions, due to the data sets being relatively small and less than 20 military facilities conducting each type of procedure. Due to this determination, we were not able to exclude any of the obtained data based on CPT cost using statistical analysis. Instead, individual data sets will be examined and specific data points excluded subjectively if they appear representative of data collection error.

B. ANALYSIS OF OVERALL COST DIFFERENCES

The following analysis breaks out each of the five imaging types by provider type and graphically displays the difference in overall average cost per service for each type of service. As Figures 2 demonstrates, Military (Mil) average costs per imaging services were by far less than costly than those allowed by Med B or CMAC. The graphic representation depicts the collective average of all five imaging types by provider over the five-year period 2008–2012. For the period, Mil average cost per service maintained a

rate 40.45% less than than the CMAC reimbursable cost and 44.29% less than the Med B average cost per imaging service.

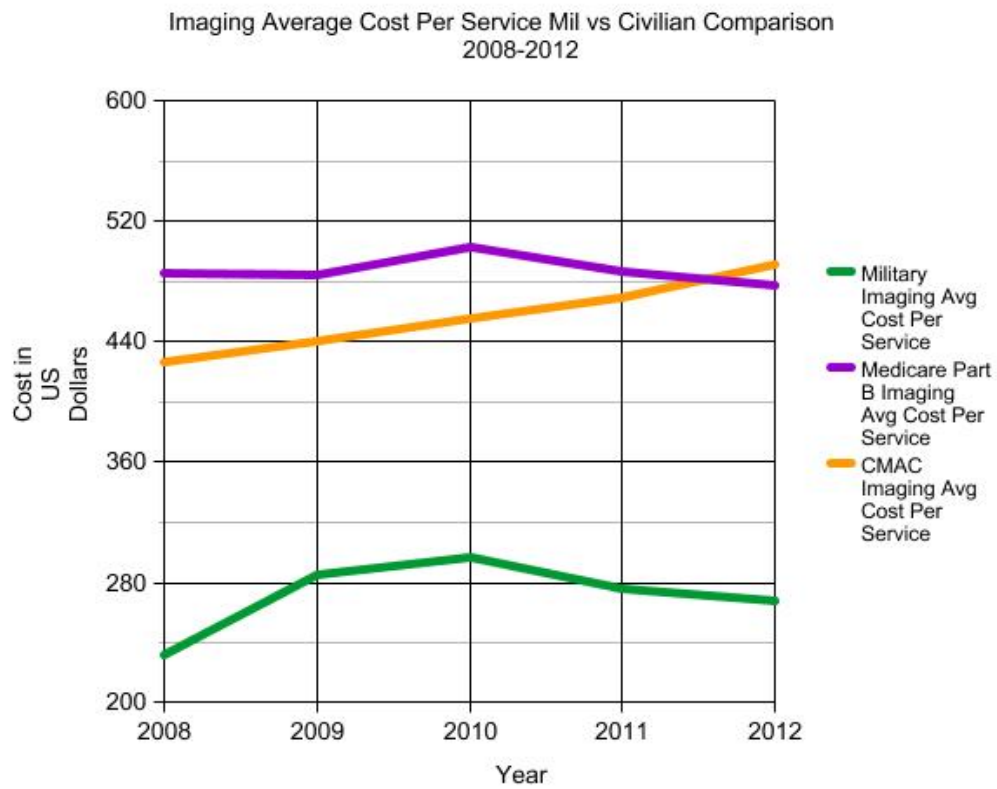


Figure 2. Average Imaging Cost per Service Military vs. Civilian, 2008–2012

As depicted in Figure 3, Military CT costs were initially 3% to 5% more costly than CMAC for the years 2008 and 2009 but were able to obtain an overall reduction towards the end of the five-year period, with the Military average CT cost being an average of 8.5% less than CMAC for the years 2010–2012. Medicare Part B allowed charges for services on the other hand maintained an average cost allowed approximately 30% more than Military consistently over the course of the entire period.

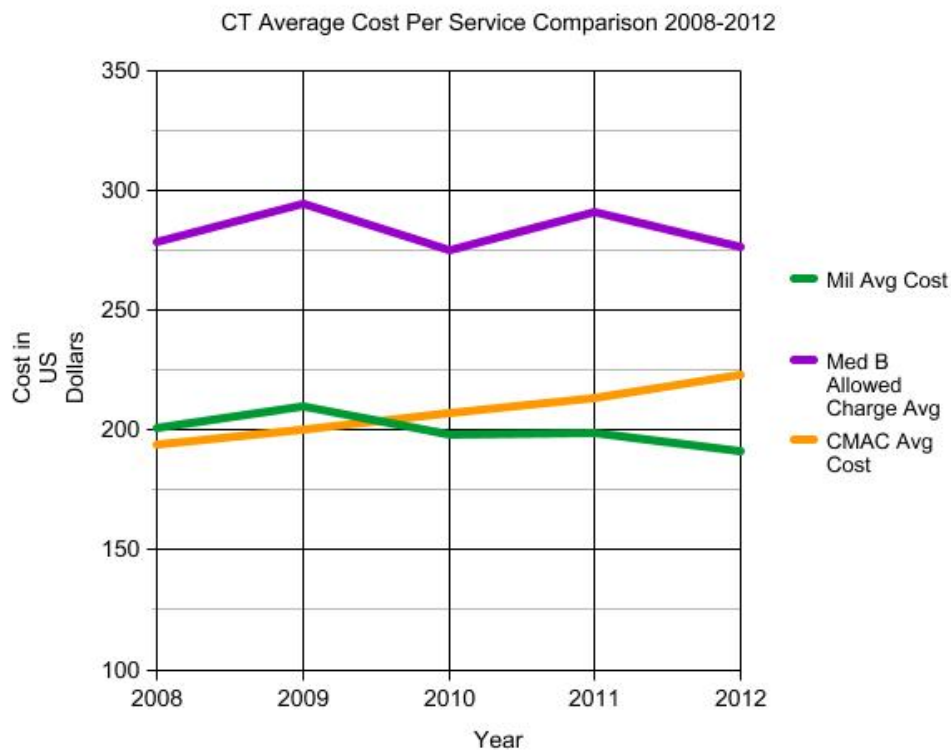


Figure 3. CT Average Cost per Service Comparison, 2008–2012

Figure 4 depicts Military MRI costs for the period 2008–2012 moving from 57% above the average CMAC cost in 2008 to 7% below the CMAC average cost in 2012, with military average cost per MRI service maintaining and average cost approximately 18% lower annually when compared to Med B allowed charges.

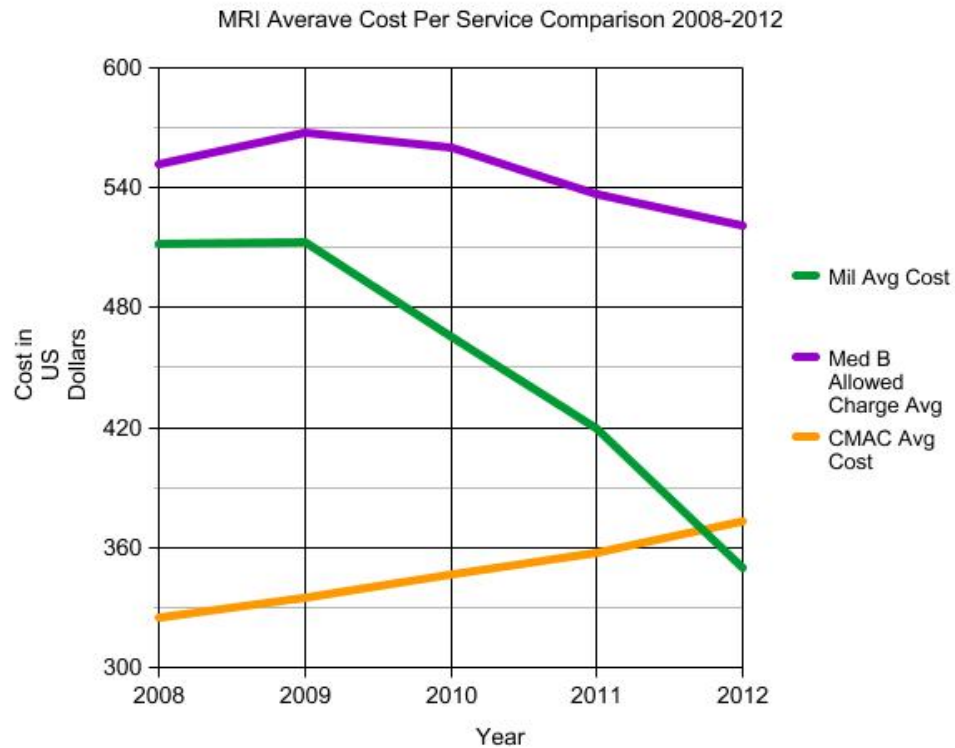


Figure 4. MRI Average Cost Per Service Comparison, 2008–2012

As depicted by Figure 5, between the years 2008 and 2012, Military average costs for NUC services maintained an average cost 40% less than the Med B average and 42% less than the CMAC average cost.

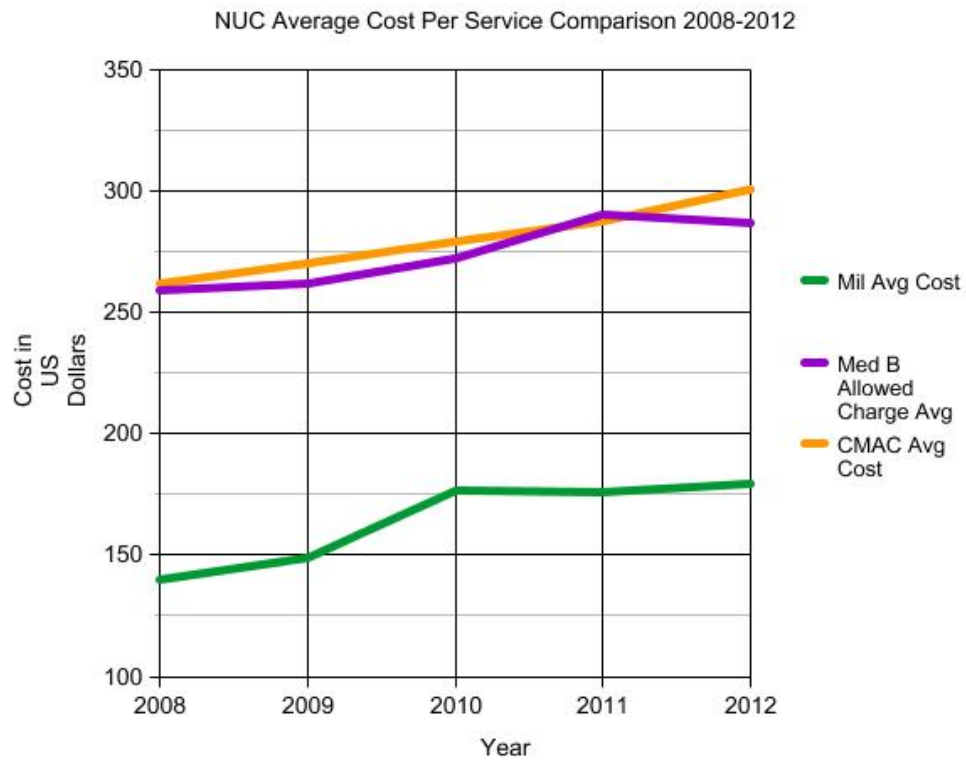


Figure 5. NUC Average Cost Per Service Comparison, 2008–2012

As depicted in Figures 6, Military PET procedure costs maintained an average cost 62% below the average cost of Med B allowed charges and 66% less than the CMAC average cost. For ULTRA procedures, Figure 7 demonstrates that Military costs maintained an average cost 27% lower than than the average cost allowed by Med B and 20% lower than the CMAC allowed average cost.

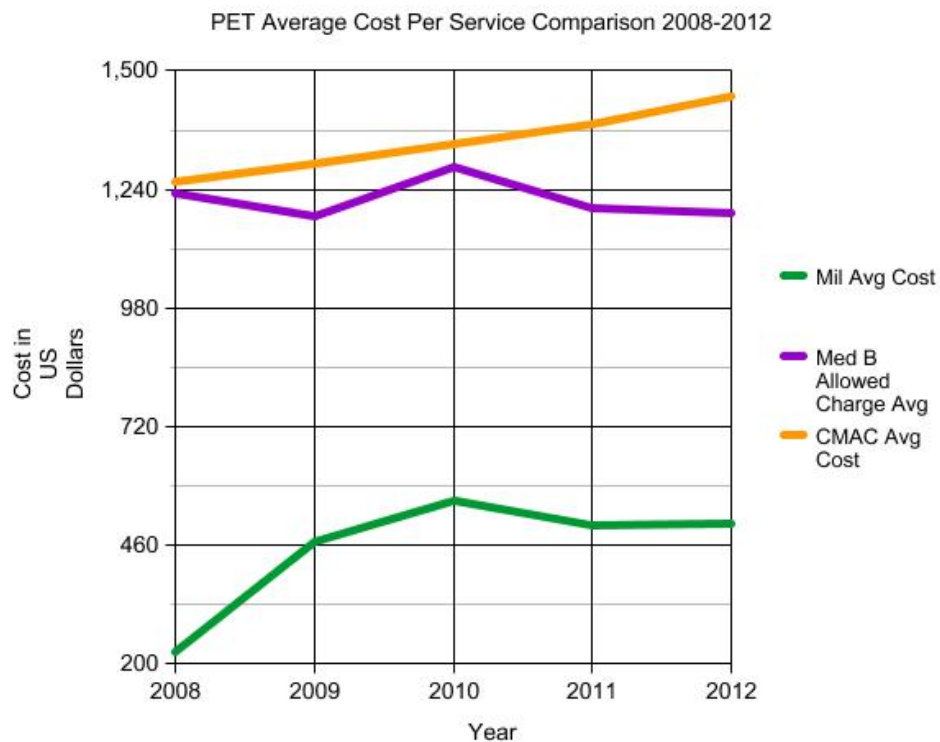


Figure 6. PET Average Cost Per Service Comparison, 2008–2012

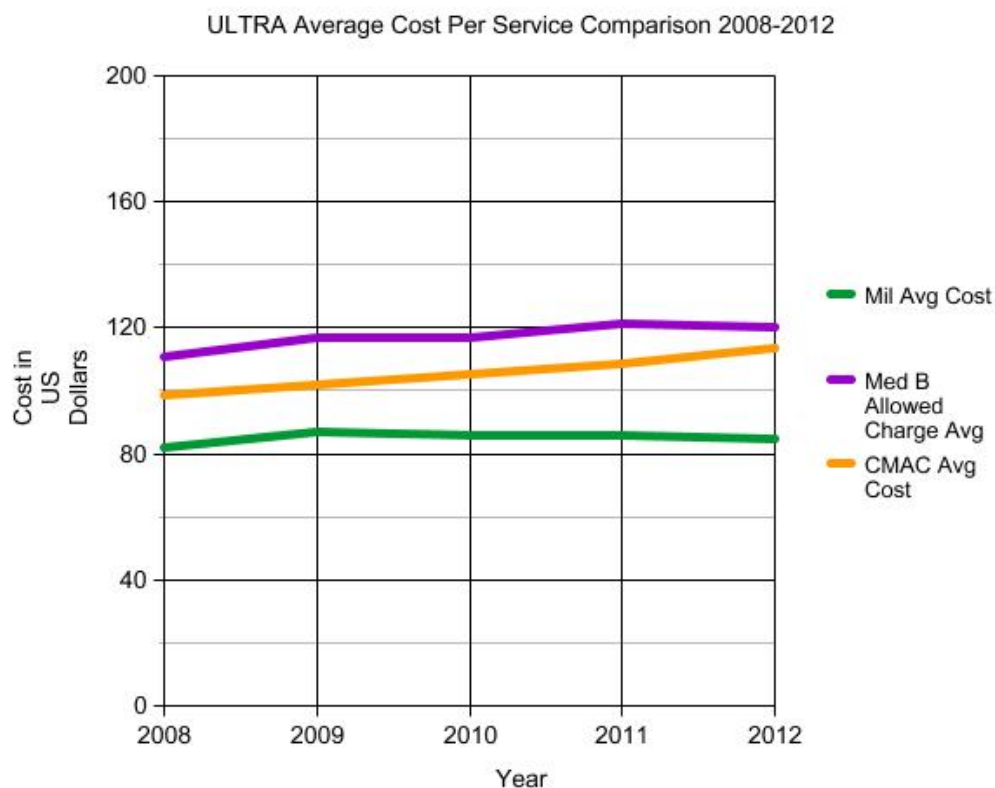


Figure 7. ULTRA Average Cost per Service Comparison, 2008–2012

As is indicated by Figures 2 through 7 independent of one another and collectively, it is apparent that Military (Mil) average costs per service are by far less costly than those allowed by Med B or CMAC in the areas of nuclear imaging, positron emission tomography, and ultrasound procedures by the end of the five-year period. The areas of computed tomography and magnetic resonance imaging on the other hand painted a different picture. When we looked at the overall collective imaging average by group (Mil, Med B, CMAC) the data showed that Military average imaging cost in general were dramatically lower than CMAC and MED B. The data showed that the average Military imaging cost was 44.29% lower than the MED B average cost and 40.45% lower than CMAC costs for the 2008–2012 timeframe. Two things that are important to remember however are that Military practitioners receive dramatically lower salaries than their counterparts in the private sector, and research and development cost data were not incorporated into the Military cost data. The median civilian radiologist salary in the United States is \$379,323 (Salary.com 2014) compared with a

maximum, with bonuses (if the physician obligates for four years beyond the initial obligated service period) of \$185,750 for an O-4 active duty physician. Assuming the military radiologist maximizes available bonuses, military pay is 49% of the civilian salary. According to a study published by the American College of Radiology, practice costs excluding physician compensation, average 39% for a non-academic radiology practice (Sunshine, Burkhardt and Mabry 2001). Using the inverse of this percentage, we can calculate that, on average, 61% of the cost of a procedure is the radiologist's fee. As military salaries are roughly half those of civilian radiology salaries, we would expect to see military costs to be 30% (half of 61%) lower than the CMAC or Medicare costs. The combination of the lower salary structures and the exclusion of R&D from our data could explain much of the differences noted in our analysis. These two factors alone will cause a dramatic difference to be displayed even with the 19.13% upward adjustment made to the M2 Military data.

C. SUMMARY OF OVERALL COST DIFFERENCES

When military collective imaging and separate type imaging costs were compared against both Med B and CMAC, it became apparent that the overall average cost of all imaging procedures by the military was dramatically less costly than that of Med B and CMAC for the years 2008–2012. Additionally, analysis concluded that by 2012 the military provided each type of imaging procedure (CT, MRI, NUC, PET and ULTRA) at the lowest cost against all other areas of comparison. It appears this is primarily due to the lower salary structure for active duty personnel—roughly 49% of the civilian radiologist's salary. However, the real cost of the active duty staff does not show up in the hospital's cost data as military radiologists are usually trained in the Health Professions Scholarship Program which pays 100% of tuition and provides a monthly stipend of \$2,179 (Navy Recruiting Command 2014). The median cost of four years of medical school is \$218,898 (aamc.org 2013). Coupled with the payment of the monthly stipend for four years, the cost of a military radiologist is \$323,490² higher than appears when measuring salary alone. It is difficult to determine the effect of this education cost

2. The total cost of \$323,490 is comprised of \$218,898 for tuition expenses plus 48 months of stipend at the rate of \$2,179 per month (\$104,542 over four years).

on our analysis, as the result would vary widely depending on the number of years a radiologist stays on active duty and on the number of procedures they perform over their military career. However, inclusion of tuition and stipend expenses would undoubtedly bring military costs closer to civilian costs.

D. COST TREND ANALYSIS

Having just looked at overall civilian vs. military cost differences, we will now attempt to identify whether or not there are any identifiable trends over the five-year period when comparing civilian and MTF imaging costs. Data utilized for this analysis were the same data previously utilized to conduct the analysis of “military vs. civilian cost” above.

1. Overall Differences in Cost between MTF and Civilian Facilities.

The starting point of military cost was below Medicare and CMAC across all studied areas and procedures as noted in the previous section. As depicted in Figure 8 and detailed in Table 4, Military change in average cost per service outpaced both CMAC and Med Part B with Military costs increasing at an average rate of 5.04% annually for the years 2008–2012. This however does not necessarily depict an overall trend in military imaging costs, as all of the unexplainable increases experienced occurred between the years 2008 and 2010.

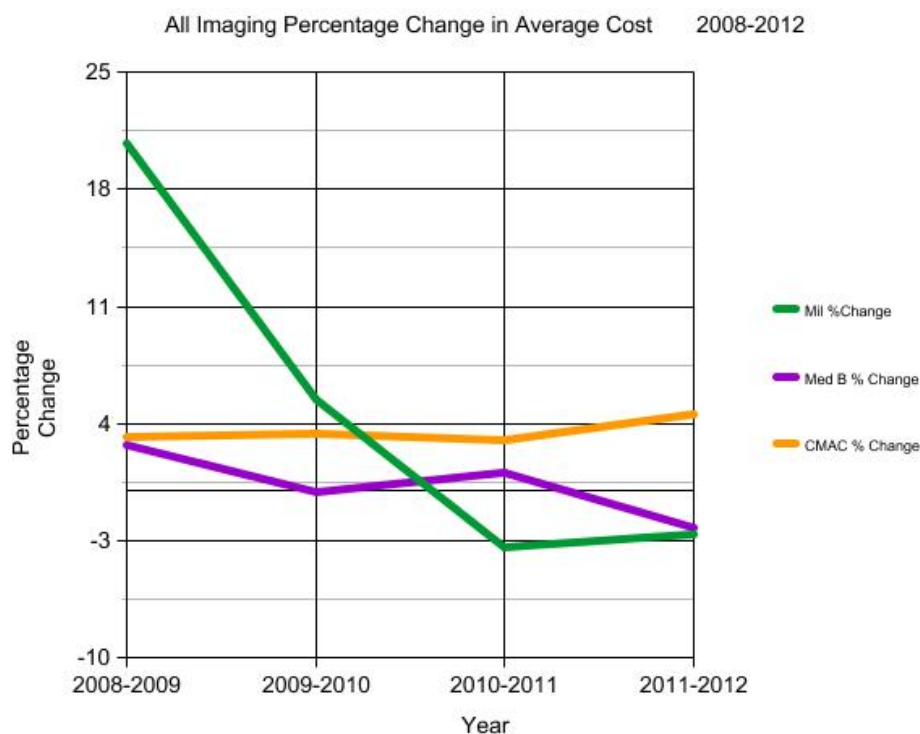


Figure 8. All Imaging, Percentage Change in Average Cost, 2008-2012

Table 4. All Imaging, Detail of Percentage Change in Average Cost, 2008-2012

All Imaging; Percentage Change In Average Cost Per Service 2008-2012						
Provider	Average% change 08-12	Average % change 10-12	Average% change 08-09	Average % change 09-10	Average % change 10-11	Average % change 11-12
Military	5.04%	-3.00%	20.74%	5.40%	-3.40%	-2.60%
CMAC	3.56%	3.82%	3.18%	3.41%	3.04%	4.60%
Med Part B	0.36%	-0.60%	2.70%	-0.07%	1.06%	-2.25%

The following two-year period 2010-2012 saw military costs decrease an average of 3% annually. A large part of the 2008-2009 increase in military imaging costs can be attributed to the 87.8% increase in the average cost for service in PET procedures for the same period. With two periods of cost percentage increases followed by two periods of percentage cost decreased it does not appear that there is any specific trend occurring other than a slight correct back to the overall collective average. When looking at Med Part B, there is also no discernable trend occurring as Med Part B average cost per

service only increased an average of 0.36% annually over the course of the period. As occurred with military overall costs, percentage increases that occurred in the first two periods of the study were mitigated by cost percentage decreases in the second period. The depiction of CMAC charges shows an upward cost trend across the entirety of the five-year period, initially indicating an obvious upward trend in cost. This however can be explained by the fact that the CPI index multipliers were utilized to develop costs for all years under review and that the CPI increased each year from 2008 through 2012. When we change the sample period to eliminate anomalous Military PET cost increases and focus just on the years 2010–2012 we observe a different picture entirely. For the period 2010–2012, both Military and MED Part B experienced average cost percentage decreases of -3.00% and -0.60%, respectively. As this three-year period is not an adequate length of time to assess trending as intended, we can say that overall both Military and Med Part B experienced declines in average cost over the period. When available, inclusion of data from 2013 and 2014 can be utilized to fully analyze this subject matter for true trend existence.

Following a different course when we isolated PET from the comparison entirely as exhibited in Figure 9 and detailed in Table 5, we found that overall average percentage change for imaging procedures experienced only a slightly positive trend in average cost per procedure over the five-year period. The data showed that the average cost per Military imaging and Med Part B imaging procedure increased in cost an average of less than 1% annually over the course of the five-year sample period.

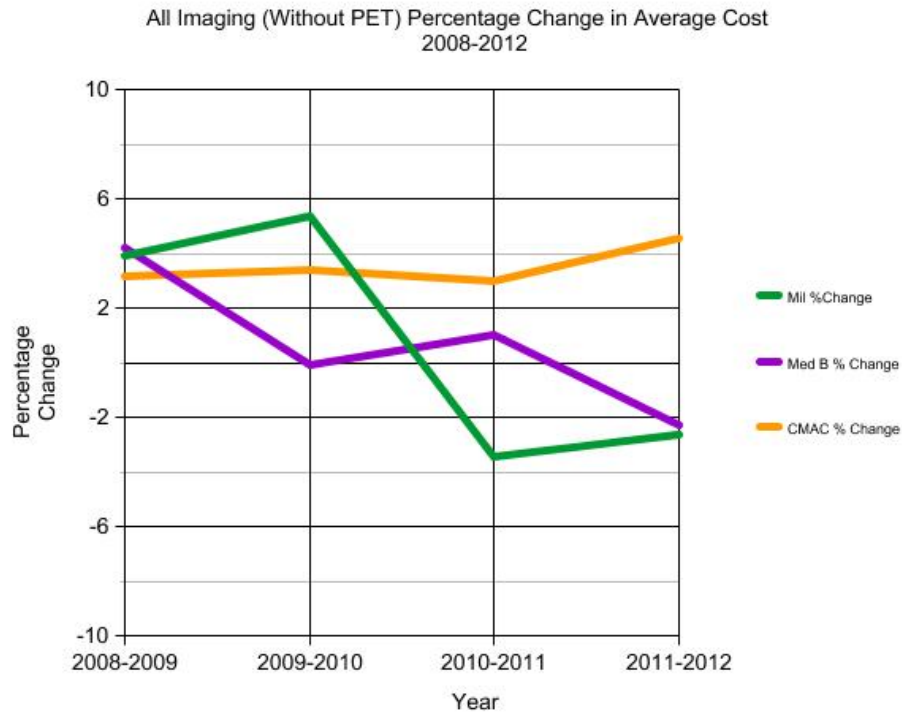


Figure 9. All Imaging (Pet Excluded), Percentage Change in Average Cost 2008–12

Table 5. All Imaging (PET Excluded), Detail of Percentage Change in Average Cost, 2008–12

All Imaging (PET Excluded); Percentage Change In Average Cost Per Service 2008–2012					
Provider	Average % change 08–12	Average % change 08–09	Average % change 09–10	Average % change 10–11	Average % change 11–12
Military	0.84%	3.97%	5.40%	-3.40%	-2.60%
CMAC	3.56%	3.18%	3.41%	3.04%	4.60%
Med Part B	0.73%	4.21%	-0.07%	1.06%	-2.25%

2. Differences among Types of Imaging, 2008–2012

Utilizing the same data as were utilized in the above analysis; we then looked at each type of imaging separately and conducted a comparison among provider types.

As you can see in Figure 10 and detailed in Table 6, both Military and Med Part B exhibited a similar curve structure over the sample period, with both ultimately experiencing a reduction in cost percentage over the sample period. When removing CMAC from the equation, the overall trend for CT average cost per service appears to be

on a continual and gradual decline, with similar positive and negative spikes experienced in both public and private sectors.

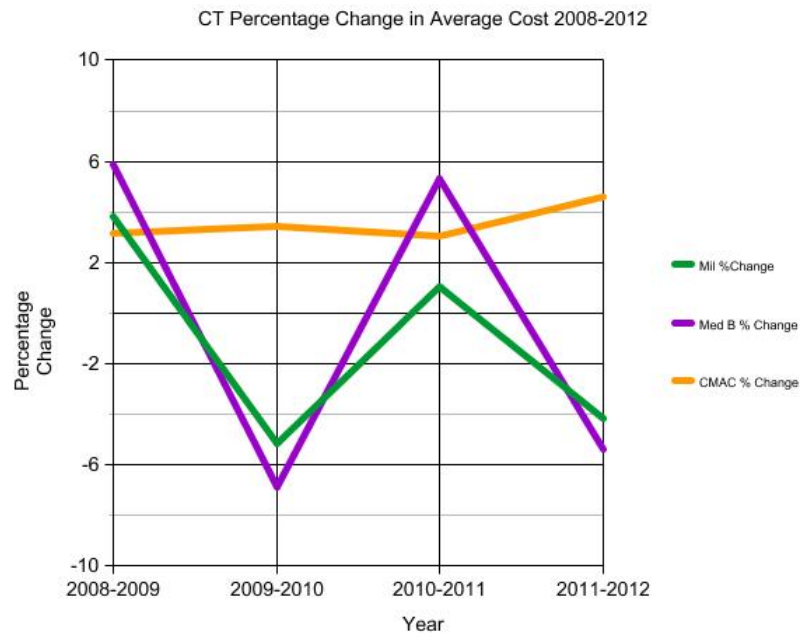


Figure 10. CT, Percentage Change in Average Cost, 2008–12

Table 6. CT, Detail of Percentage Change in Average Cost

CT; Percentage Change In Average Cost Per Service 2008–2012					
Provider	Average % change 08–12	Average % change 08–09	Average % change 09–10	Average % change 10–11	Average % change 11–12
Military	-1.11%	3.84%	-5.17%	1.06%	-4.17%
CMAC	3.56%	3.18%	3.41%	3.04%	4.60%
Med Part B	-0.25%	5.89%	-6.85%	5.32%	-5.38%

As indicated by Figure 11 and detailed in Table 7 MRI average cost per procedure for both Military and Med Part B exhibited a downward cost trend over the course of the sample period with the military average annual percentage change being 5.77% lower than that of Med Part B. The only area to experience an upward trend in cost was CMAC which again is based upon cost data derived from the CPI.

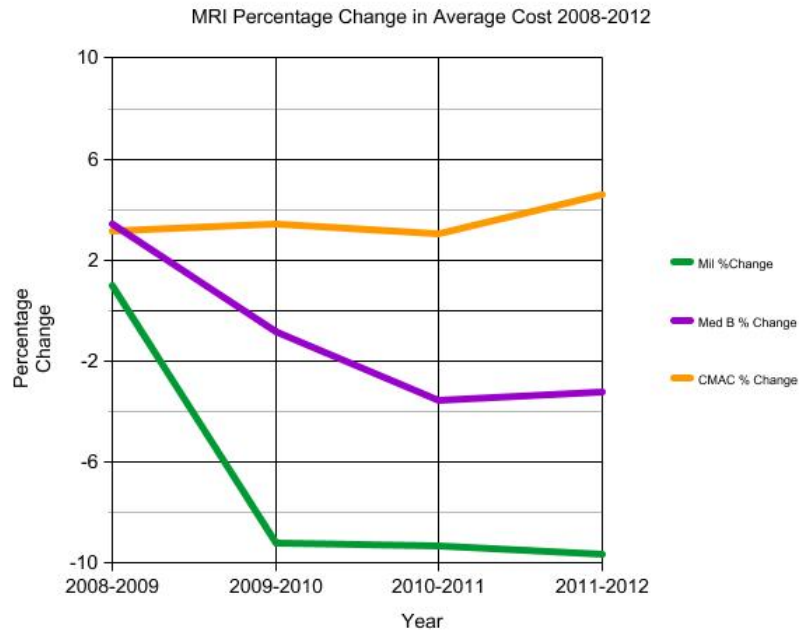


Figure 11. MRI, Percentage Change in Average Cost, 2008–2012

Table 7. MRI, Detail of Percentage Change in Average Cost

MRI; Percentage Change In Average Cost Per Service 2008–2012					
Provider	Average % change 08–12	Average % change 08–09	Average % change 09–10	Average % change 10–11	Average % change 11–12
Military	-6.81%	0.98%	-9.20%	-9.33%	-9.66%
CMAC	3.56%	3.18%	3.41%	3.04%	4.60%
Med Part B	-1.04%	3.46%	-0.85%	-3.54%	-3.22%

As depicted by depicted by Figure 12 and detailed by Table 8, all providers experienced a slight upward trend in average cost per NUC procedure over the course of the sample period. Military average cost per procedure realized the largest increase at 2.45% annually exceeding the collective average by 0.07% for the five-year period.

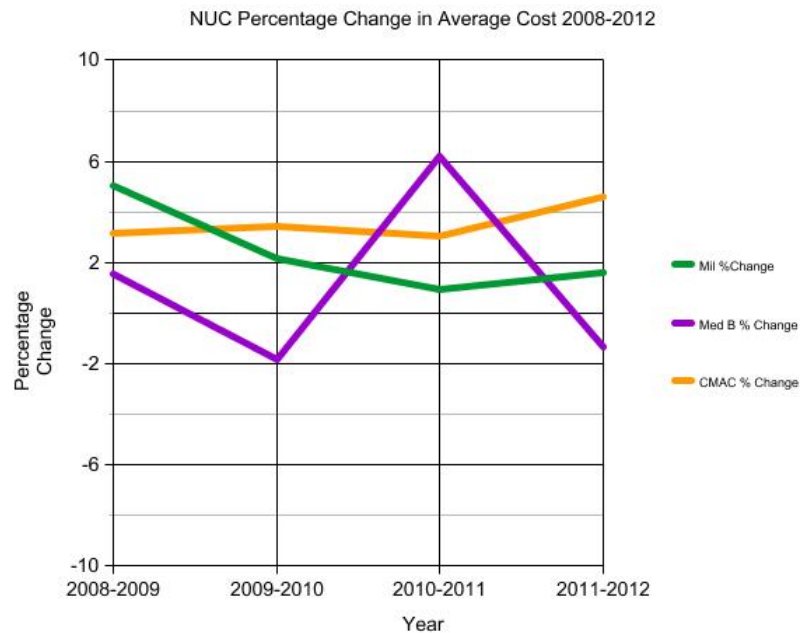


Figure 12. NUC, Percentage Change in Average Cost, 2008–2012

Table 8. NUC, Detail of Percentage Change in Average Cost

NUC; Percentage Change In Average Cost Per Service 2008–2012					
Provider	Average % change 08–12	Average % change 08–09	Average % change 09–10	Average % change 10–11	Average % change 11–12
Military	2.45%	5.04%	2.18%	0.94%	1.62%
CMAC	3.56%	3.18%	3.41%	3.04%	4.60%
Med Part B	1.14%	1.56%	-1.84%	6.19%	-1.34%

As depicted in the Figure 13 and detailed by Table 9, Military PET average costs per procedure saw a dramatic percentage cost increase for the years 2008–2009 and 2009–2010. Detailed analysis of the available M2 data indicated that this spike was due to drastic cost increases in whole body PET procedures, limited area PET procedures, and whole body PET procedures with CT in each period. This anomaly thus caused the average percentage change to increase accordingly for the periods 2008–2009, 2009–2010. Further analysis into the specific cause of cost increase experienced by each respective CPT code for 2008, 2009, and 2010 was unfortunately not possible with the available data. As this unexplainable anomaly affected 50% of the CPT codes utilized for comparison in the 2008–2009 and 42% of the CPT codes utilized for comparison in the 2009–2010, we chose to conduct a comparison isolating all data from both periods. After eliminating data we were then able to obtain an average percentage change comparison for the period 2010–2012. With all anomalies removed it became apparent that there was a downward shift in cost for PET procedures exhibited by both Military and Med Part B over the course of the last three years of the sample period. Unfortunately we were unable to declare this a trend due to breaking our ground rule of utilizing data from all five sample years for comparison. We were however able to identify a slight downward trend in Med Part B costs over the five year period as Med Part B data for all years were deemed to be acceptable for comparison. One item worth pointing out is that all 3 (CMAC, Med B, and Mil) experienced dramatic decreases in overall cost per procedure between the years 2010 and 2011. This dramatic decrease in cost can partially be attributed to the common implementation and utilization of combined PET-CT systems across medical providers in this time frame. Common implementation of this new technology has allowed practitioners to save upwards of “20 to 30 minutes per patient and increase patient output by approximately 40%” (Muhammad, et al. 2010) ultimately reducing the average cost per procedure.

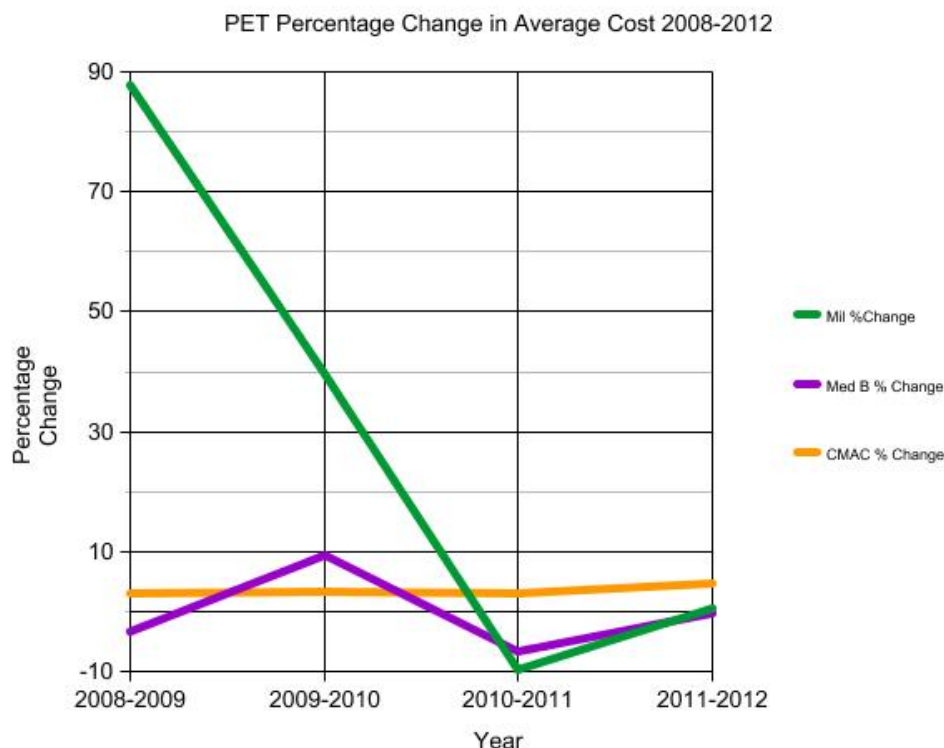


Figure 13. PET, Percentage Change in Average Cost, 2008–2012

Table 9. PET, Detail of Percentage Change in Average Cost

PET; Percentage Change In Average Cost Per Service 2008–2012						
Provider	Average % change 08–12	Average % change 10–12	Average % change 08–09	Average % change 09–10	Average % change 10–11	Average % change 11–12
Military	29.59%	-4.54%	87.80%	39.62%	-9.67%	0.59%
CMAC	3.56%	3.82%	3.18%	3.41%	3.04%	4.60%
Med Part B	-0.29%	-3.55%	-3.34%	9.30%	-6.72%	-0.39%

Unlike PET procedures discussed previously, ULTRA did not exhibit any anomalies over the course of the sample period. As depicted by Figure 14 and detailed in Table 10, all providers exhibited an average positive increase in average cost per ULTRA procedure over the reporting period. In addition to the relatively consistent upward trend in cost experienced by all three providers, this was the first time we identified either Military or Med Part B exceeding percentage price increases incurred by CMAC. The period 2008–2009 saw both Military and Med Part B exceed CMAC increases by 2.85%

and 2.74%, respectively. In addition to the 2008–2009 period, Med Part B also exceeded CMAC percentage increase by 0.98% in the 2010–2011 period.

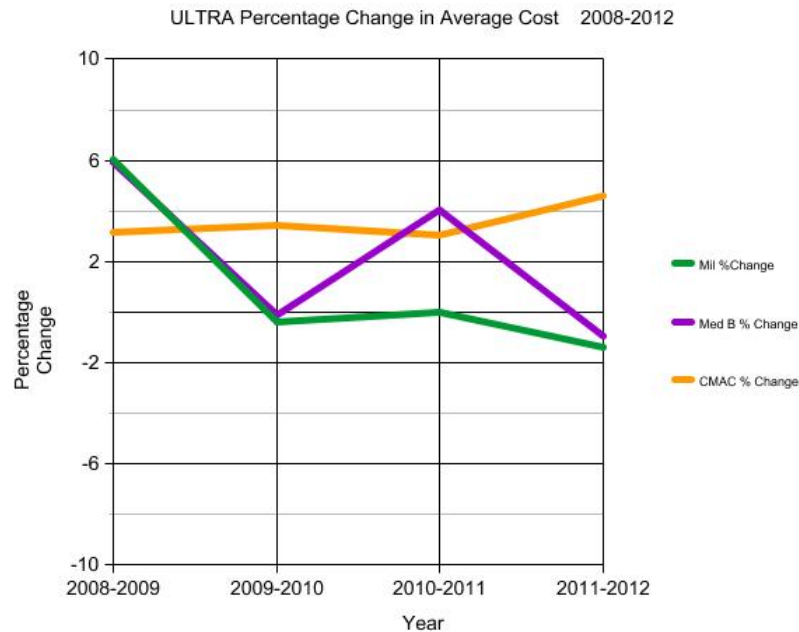


Figure 14. ULTRA, Percentage Change in Average Cost, 2008–2012

Table 10. ULTRA, Detail of Percentage Change in Average Cost

ULTRA; Percentage Change In Average Cost Per Service 2008–2012					
Provider	Average % change 08–12	Average % change 08–09	Average % change 09–10	Average % change 10–11	Average % change 11–12
Military	1.07%	6.03%	-0.41%	0.02%	-1.38%
CMAC	3.56%	3.18%	3.41%	3.04%	4.60%
Med Part B	2.22%	5.92%	-0.13%	4.02%	-0.94%

E. SUMMARY OF TREND ANALYSIS

A thorough analysis of the selected Military, Medicare Part B, and CMAC data sets for the sample period 2008–2012 concluded the existence of identifiable trends over the five-year period when comparing civilian and MTF imaging costs. Initial comparative analysis of overall imaging average cost percentage changes per procedure indicated a dramatic spike in Military cost percentage change for the periods 2008–2009 and 2009–2010. Further investigation revealed that this behavior was caused by cost anomalies in

Military PET data for the years 2008, 2009, and 2010. In an effort to obtain an un-skewed comparison between all providers we first isolated the suspect years entirely for all providers, resulting in a finding that over the period 2010–2012 both Military and Med Part B experienced cost percentage decreases of -3.00% and -0.60% over the period. We were, however, unable to assess this as a trend as our ground rule of utilizing five years of data for comparison had been breached when we removed the periods 2008–2009 and 2009–2010 from the comparison. In an effort to obtain a useful comparison for the sample period we decided to isolate PET from the comparison entirely and conducted an overall comparison utilizing just CT, MRI, NUC and ULTRA. Results of this analysis indicated that for the sample period 2008–2012 a slight trend of annual average cost increase was visible for both Military and Medicare Part B imagining procedures overall.

Analysis of individual imaging categories indicated that NUC and ULTRA both exhibited the existence of an upward trend in average cost per procedure by both military and civilian providers over the period. In contrast to these findings both CT and MRI each exhibited a downward trend in average cost per procedure by both military and civilian providers. As indicated in the prior discussion, PET analysis uncovered the existence of anomalous pricing data for Military and required a change in methodology to conduct this portion of the comparison. In an effort to achieve a valid result data from the affected periods were excluded and only data from periods 2010–2011 and 2011–2012 were utilized for comparison. Resulting analysis indicated that for the period 2010–2012 Military experienced a downward shift in average cost; unfortunately we were unable to declare this a trend due to breaking our ground rule for comparison. We were however able to identify a slight downward trend in Med Part B costs over the five-year period as Med Part B data for all years were deemed to be acceptable for comparison.

F. REGIONAL VARIATIONS

We will now examine differences among the eMSM regions in terms of the basic demographics of the beneficiary populations. Radiographic imaging utilization rates among certain segments of the population vary and the demographic make-up of the beneficiaries in each region may be informative regarding where cost savings may be realized. As the number and makeup of beneficiaries enrolled in each eMSM changes

continually, a specific point needed to be chosen for measurement. We utilized December 2012 as the measurement point as it is the most up-to-date data available without going outside of our cost measurement period (January 2008, to December 2012). Overall beneficiary numbers are shown in Table 11. The National Capital Region had the most beneficiaries and Hawaii had the fewest. There appears to be 3 different types of market based on size of beneficiary population. A large market (Capital and Tidewater) has over 400,000 beneficiaries. A medium market (Puget Sound and San Antonio) has roughly 250,000 beneficiaries. The small market (Colorado and Hawaii) has fewer than 200,000 beneficiaries. These summary counts may be informative for cost saving efforts as focusing on the Capital and Tidewater regions may make the most sense. They are both geographically small areas but they also have the highest number of beneficiaries. This may make them ideal for a restructured diagnostic imaging system/network that would maximize use of radiology assets and drive the average cost of a procedure down.

Table 11. eMSM Beneficiary Count by Region (Dec. 2012)

<u>eMSM Region</u>	<u>Beneficiary Count (December 2012)</u>
National Capital	450,951
Tidewater (Virginia)	403,067
Puget Sound	262,627
San Antonio	224,732
Colorado	171,297
Hawaii	157,739

We will now examine additional demographic data that may be informative for cost savings efforts in each eMSM region.

G. VARIATIONS IN BENEFICIARY AGE

Data pulled from M2 is automatically categorized to fit beneficiaries into one of eight age groups: less than 4 years old, 5 to 14, 15 to 17, 18 to 24, 25 to 34, 35 to 44, 45 to 64, and 65 and over. When examining the data, the ages of beneficiaries show some common trends amongst all of the regions. The distribution appears to be tri-modal with one group of beneficiaries clustered in the 5 to 14 age group. This group consists of the dependent children of the active duty members. There are also some small groups of

other beneficiaries in this category such as dependents of surviving spouses but the vast majorities are active duty dependents. The second group is from age 18 to 34 and consists primarily of the active duty members and their spouses. Again, there are some other small categories of beneficiaries also in this age group but their numbers do not impact the overall distribution. Lastly, the largest group of beneficiaries are those age 45 to 64. This group consists primarily of retirees and their spouses. After age 64, the number of beneficiaries drops as they become eligible for Medicare and move on to other non-DOD facilities. Utilization by beneficiaries over 64 does not drop to zero, however, as many people live near military bases and access care through the DOD despite eligibility for civilian care under their Medicare benefits. Figure 15 shows the raw numbers of beneficiaries in each age category by eMSM region.

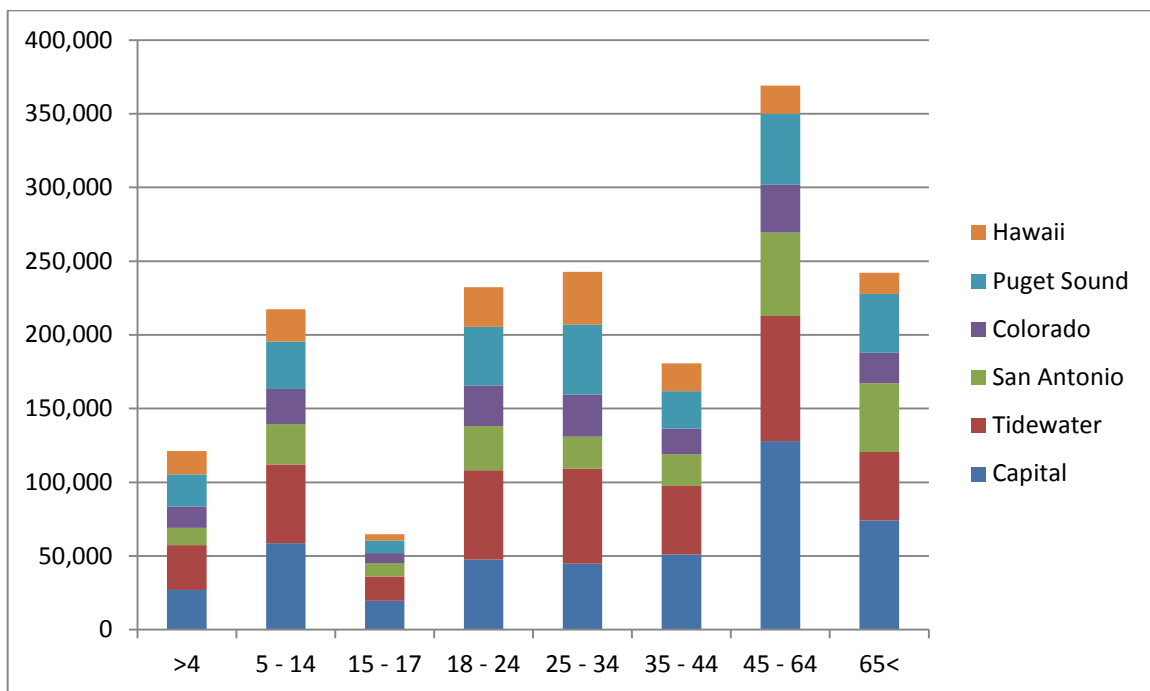


Figure 15. eMSM Total Beneficiaries by Age

The tri-modal distribution is easy to see on this chart. In addition, the graphic shows that the National Capital Region has the highest number of beneficiaries overall as well as the highest number of retirees and Hawaii has the lowest numbers as discussed earlier. However, it is not possible from looking at this graphic to see the proportional

distribution of beneficiaries between the age groups within the regions. Are there differences in the age-group make-up of the beneficiaries among the regions? Do some regions have a relatively older population of beneficiaries? To answer these questions, we recalculated the age group distributions for each region as a proportion of all beneficiaries within the respective region. These proportions are shown as a percentage and each region sums to 100% when all of the age groups are added up.

The results shown in Figure 16 show that each region has roughly the same proportions of beneficiaries from age 0 to 24. Between ages 25 and 35, the proportions vary widely with Hawaii having the highest proportion of beneficiaries in this age category and the Capital having a low proportion. This trend may reflect that many active duty personnel (and their accompanying spouse) are stationed in Hawaii earlier in their careers and may move to headquarters jobs in the Capital region when they are more senior. Most important for this analysis is the variation in the 45 to 64 year old category among the regions. The top three regions in terms of proportion of beneficiaries in this category are (in descending order) the Capital region, San Antonio, and Tidewater.

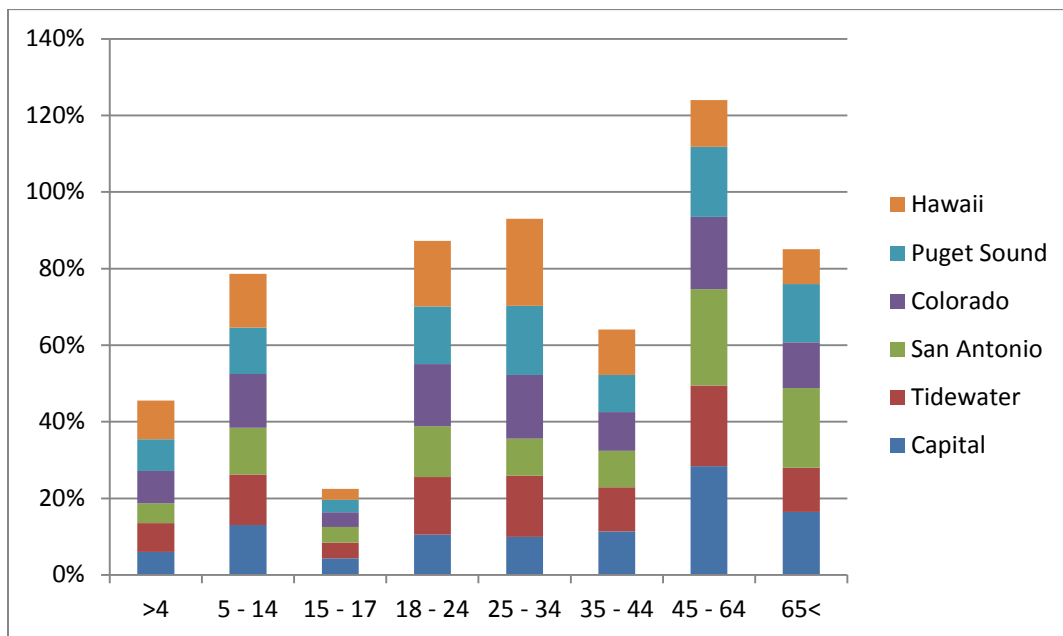


Figure 16. eMSM Proportion of Beneficiaries in Each Age Group by Region

Age of the beneficiaries has an impact on utilization of advanced radiology services such as CT, MRI, PET, ULTRA, and NUC medicine as these types of procedures are used to make diagnosis or track treatment progress for more illnesses and injuries often experienced later in life. In fact, the utilization of these “high-technology” imaging modalities in Medicare eligible patients has been increasing when compared to radiography (simple x-ray). From 1998 to 2001, utilization by Medicare enrollees increased between 7% and 16% for MRI, CT, ULTRA, PET, and NUC medicine compared with just a 1% for radiography (Bhargavan and Sunshine 2005). The significance of this for our analysis is that cost saving measures may have more impact in regions such as the National Capital and Tidewater with a relatively high proportion of older beneficiaries.

H. VARIATIONS IN BENEFICIARY RACE

Variations in race may also point to regions that may offer higher potential efficiencies when looking at imaging costs. According to the Centers for Disease Control and Prevention (CDC), blacks have the highest incidence rates of cancer across all cancer sites combined (U.S. Cancer Statistics Working Group 2014). Detection and treatment of cancer involves heavy use of imaging of various types depending on the type of cancer and the severity. As such, we examined data from M2 on the self-selected race of DOD beneficiaries in each region. However, the data in Figure 17 did not show any measurable trends that can be informative for the purposes of this paper.

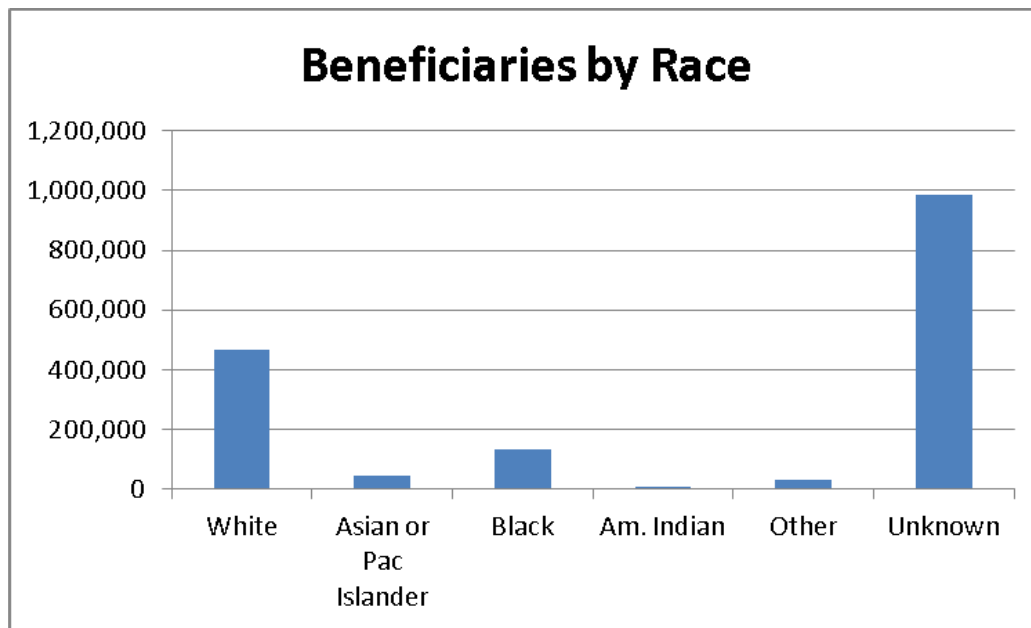


Figure 17. Total eMSM Beneficiaries by Race

There are two reasons why we feel this analysis does not inform our questions on imaging costs. First, nearly half (48%) of all beneficiaries are listed as an “unknown” race. This is because race can be self-identified as “unknown” or it can be left entirely blank. When half of the data cannot be used to answer a question, we do not feel the other half can be relied on for conclusions of any sort. The “unknown” beneficiaries could completely change any conclusion we may make. The second reason we feel this analysis does not inform our questions on imaging costs is that the differences among races on incidence of cancer is not large. Incidence for blacks is 553.2 while it is 502.7 for all races and 495.2 for whites. Blacks have an 11.7% higher cancer incidence. While this is statistically significant for public health concerns, it probably would not be a great enough difference to effect decisions regarding placement and type of imaging equipment or to address questions of military vs. civilian provision of imaging services. For these reasons, we have concluded that measurement of variations among the regions based on race is not fruitful for our discussion.

I. RADIOLOGY COST DIFFERENCES AMONG MILITARY SERVICES

1. Overall Cost Differences

We will begin first by examining average aggregate cost differences between military services over the examined years (2008 – 2012). The data in Table 12 shows average, per visit costs comprised of all examined CPT codes: CT, Ultrasound, MRI, PET, and Nuclear Medicine. On average, the Air Force has provided these services at the lowest cost and the Navy has been the high cost provider until 2011 when the National Military Medical Center (NMMC) at Bethesda took over the top position. NMMC is a joint facility that is managed outside of each service's medical command infrastructure. The sharply increasing costs experienced at NMMC are probably due to procurement of new equipment during 2011 and 2012 to fully equip the new facility. While these costs are depreciated over the useful life of the machinery, they would still have the effect of driving up costs in the short term as radiology equipment is often utilized past its depreciation period so that benefit is derived from the equipment but no expense is associated with it.

Table 12. Military Services, Average Radiology Cost (2008-2012)

Military Service	Average Cost over 5 Years (2008 – 2011)
Air Force	\$199.49
Army	\$254.69
Navy	\$316.83
Joint (NMMC)	\$317.28

For purposes of this analysis, we can exclude consideration of NMMC as the facility required massive initial start-up costs to open its doors and its costs are, in all likelihood, not indicative of long term cost trends for the facility. With that in mind, we can see a fairly wide disparity in costs among the branches of service. The Navy's average imaging costs at \$316.83 are 59% higher than the Air Force's at \$199.49 and the Army comes in-between at \$254.69. If we examine these costs as depicted in Figure 18 over the five years from 2008 to 2012 we can see some trends:

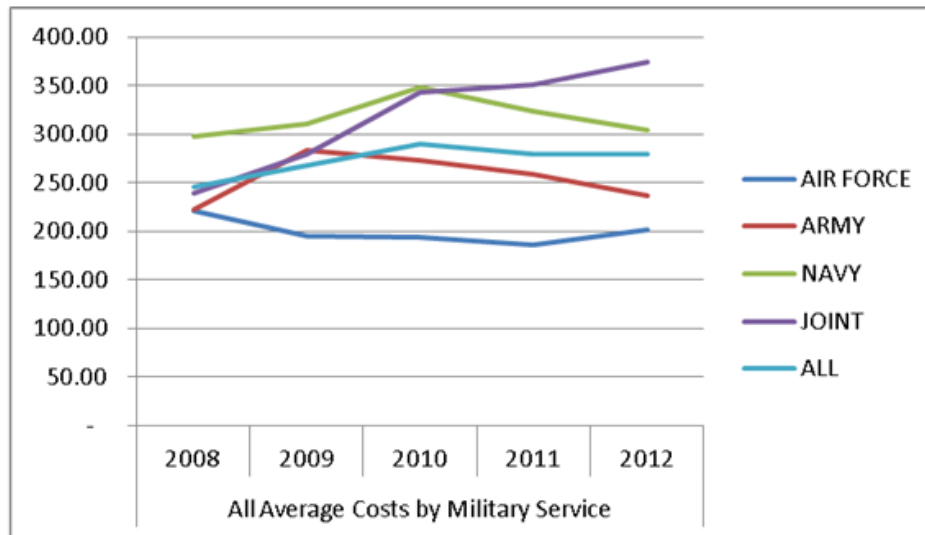


Figure 18. Military Services, Average Radiology Costs (2008-2012)

As can be seen in Figure 18, Air Force costs have stayed relatively flat over the five-year period while both the Army and the Navy have experienced declining costs after a period of increase from 2008 to 2010. It is not apparent from these figures why there is such wide disparity among the services. We will look at these numbers in greater detail in an effort to theorize a cause.

2. Differences among Types of Procedure

Table 13 points to a possible cause for the disparity between Air Force average costs and the average costs of the Army and Navy.

Table 13. Military Branch Average Imaging Costs by Type

Branch	CT	MRI	Ultrasound	NUC	PET
Air Force	\$209.93	\$404.21	\$98.17	\$161.40	\$123.73
Army	\$192.24	\$388.60	\$76.13	\$165.30	\$451.18
Navy	\$323.83	\$473.40	\$124.81	\$231.18	\$430.96

As seen in Table 13, the Air Force PET costs appear to be abnormally low (\$123.73 per test). Average charges for PET scans in the United States more than a decade ago were \$900 to \$1400 (Keppler and Conti 2001). The costs for PET scans at Army and Navy facilities are \$451 and \$431, respectively. These figures indicate that there is probably an

underlying measurement issue on Air Force PET costs and the expense amounts available in the M2 system are incomplete. If we exclude PET costs from our analysis of overall imaging costs for each branch we see the cost disparity shrink significantly. Table 14 shows the Army with the lowest average cost, followed by the Air Force and finally by the Navy.

Table 14. Military Services, Average Radiology Cost (2008-12); Excluding PET

Military Service	Average Cost over 5 Years (2008 – 2011) Excluding PET
Air Force	\$218.43
Army	\$205.57
Navy	\$288.30
Joint (NMMC)	\$327.69

The NMMC still has the highest costs but we are excluding this facility from our analysis for the reasons discussed previously. The disparity between the highest cost (Navy) and the lowest cost (Army) is now 40% rather than the previous disparity of 59%. While this is still a significant difference in cost, we believe it is more indicative of actual cost differences rather than an inaccurate measurement. In order to further examine possible reasons for these costs differences, we will now examine the military service's costs in relation to regional cost differences among the eMSM areas.

3. Differences among Military Services within Regions

We would expect to see the relationships between costs discussed above to continue at the regional level if indeed the services have different inherent costs for providing radiology services. For example, we would expect to see the Army as the low-cost provider in the Colorado region since the Army is the low-cost provider on a national basis. If indeed the Army is the low-cost provider, the service should be capable of providing efficient services regardless of region in the United States relative to its service brethren. Indeed, comparing costs within regions should correct for the fact that healthcare costs vary widely amongst areas in the United States. If we ignore regional data, we risk attributing cost differences to the services that is more accurately explained by regional cost differences.

In order to examine the military services' costs within regions, we grouped average radiology costs for the services from all the radiology procedure types into an average for each respective region *by service*. Each region has a different makeup of services operating in them so it was not possible to do a straight across comparison between regions. For instance, the Air Force and the Army are the only two branches providing imaging services in Colorado. The Navy and the Army are the only two branches providing imaging services in Hawaii. Tidewater (the greater Norfolk region) is the only area where all three branches are operating. Despite this, it is possible to look for trends among the branches of services using this analysis. Figure 19 provides an overview of our findings:

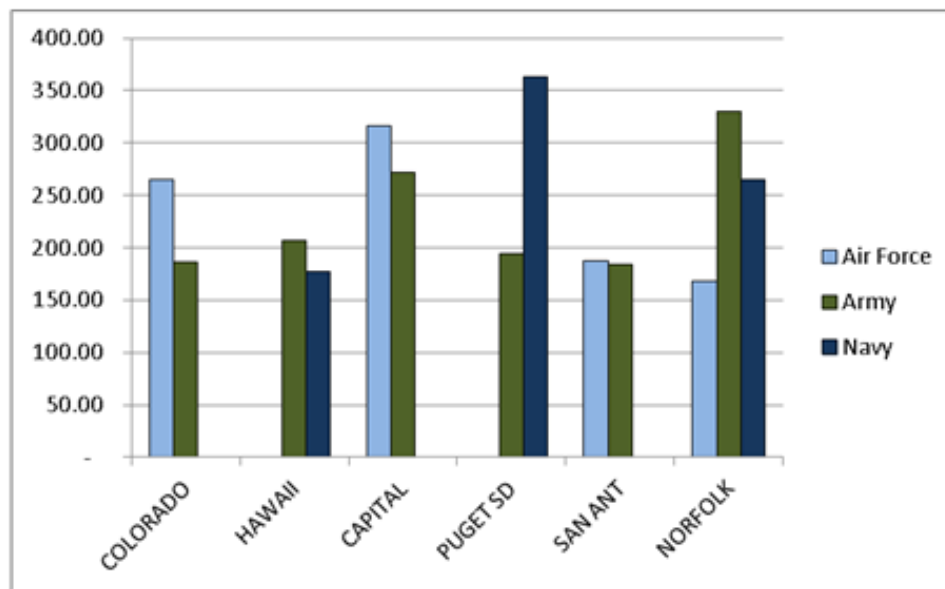


Figure 19. Average Radiology Costs by Service and Region

As can be seen, there is no consistent “winner” in low-cost provision of radiology services. Each service branch is the low cost producer in at least one region. Each branch is also the high cost producer in at least one region. This fact indicates that, while there may be real differences in costs among the services, the variable bringing the most influence to bear on average procedure costs is *the number of procedures each service is performing in the respective region*. As average costs are calculated by dividing total

costs for imaging services by the number of services provided, we should not forget that the cost of imaging is only half of the equation.

Why do we conclude that the volume of procedures is the primary explanation of the average cost variation? Each service hires new employees, purchases equipment, contracts for maintenance, builds facilities, and pays for utilities on its own—there is no central management of these functions at this time. As discussed in the introductory chapters, the Defense Health Agency will work to centralize many of these functions over the next few years. However, this initiative has not been fully implemented and the costs examined here (the calendar years 2008 to 2012) do not include any centralized management decisions. Because of this, we would expect to see cost differences among the branches of service be consistent among the regions if one or more of the branches were doing a better job of controlling costs. Instead, we see no consistent pattern at all. This leads us to conclude that the volume of procedures is a much bigger factor in explaining average costs differences among the three branches of service than any effort at controlling costs on the part of individual services.

Over the course of this research analysis, we examined costs of medical imaging within Continental United States (CONUS) military treatment facilities to determine cost effectiveness when compared to civilian facilities and determine if there are differences among Enhanced Multi-Service Markets (eMSM) regions within the United States. Further examination was then conducted to identify the existence of any differences in the cost of imaging services among the military branches of service. Historical data utilized to conduct all analysis for the period January 1, 2008, through December 31, 2012 were obtained from the Military Health System Management Analysis and Reporting Tool (M2), the Defense Medical Logistics Standard Support system (DMLSS), the CHAMPUS National Pricing System (CMAC), and from public use Medicare provider utilization and payment data available through the Centers for Medicare and Medicaid Services website (CMS.gov). Extracted data were then right-sized to provide a representative sample for each provider and separate type of imaging. Analysis of the representative data was then conducted to determine the civilian vs. military cost

differences, cost trend existence, regional differences among enhanced multi-service markets, and cost differences between military service branches.

IV. FINDINGS AND RECOMMENDATIONS

A. FINDINGS

Based upon our analysis, the findings listed below should be considered in developing and implementing any changes to the current DOD radiographic imaging capability to effectively maximize utilization of limited resources, reduce the overall price per imaging service and enhance the overall quality of health care service to all clients:

- DOD should consider internal and external partnering efforts to develop methods to ensure imaging facilities are located in areas where potential users can easily access them.
- DOD as a whole spends far less per procedure on imaging services on in-house procedures than is allowed by either Medicare Part B or authorized as payment by CMAC for care of military members at civilian facilities. We hypothesize this difference is attributable to the lower salaries paid military radiologists when compared with civilian doctors. As the military generally has physicians soon after their training is completed and their pay rates are tied to the regular military pay scales (with several small bonuses), this makes intuitive sense and would make an interesting topic for further research. So the obvious question here would be, why not just treat all military members and dependents at Military facilities? The answer to that of course is that, Military facilities simply do not have the overall capacity and availability of facilities nationally to handle all needs at all times.
- Further study is needed to identify military construction and infrastructure development costs necessary to support all needs at military facilities.
- Obtaining General Services Administration (GSA) leased space to be staffed by military personnel (Active, Reserve or National Guard) may aid in potential expansion of military offerings at military facilities, both local

to active installations and within communities not currently served or underserved. Consideration here would certainly need to focus on the break-even point between investment/operating cost and cost savings realized per procedure against CMAC to ensure expansion still made fiscal sense.

- Sustained upward trend in imaging cost by CMAC vs. a relatively stable downward trend in Military in-house imaging costs compounded with overall cost differences could justify incurring additional capital investment costs to expand the military's in-house offerings; a cost sharing opportunity if the National Guard were taken on as a partner in staffing of new facilities.
- Current CPT coding allows capture and tracking of the cost of health care to DOD specific clients for future analysis of cost effective delivery of such access when focused on differences in imaging costs exhibited among regional Enhanced Multi-Service Markets (eMSM) our overall findings were very similar to what we found in the comparison between military and civilian markets. We found:
There is a definite need to look at overall capacity of current facilities, to ensure maximum utilization, as well as look at potentially expanding or relocating existing facilities and/or acquiring new facilities to increase overall capacity for imaging services nationally.
- Partnering opportunities should be explored with other military components such as the Reserves and National Guard in an effort to share cost on construction and infrastructure development and operations and sustainment. One of the key considerations with possible expansion however is the potential for a reduction in force that may limit the need for facilities utilization; this is why it is important to look partnering efforts that will allow for maximum utilization of facilities which will ultimately drive down the cost per procedure.

- Partnering efforts with other government agencies such as the Department of Health and Human Services should be explored in an attempt to maximize utilization of facilities and existing capabilities.

There is one central conclusion that can be drawn from this analysis of regional variations: the services should centralize decisions regarding where to place radiology capabilities within regions to maximize the volume of patients using the imaging resources. In order to drive down the average cost per test, each piece of machinery and each staff person working in radiology should be used to the maximum extent possible. This makes sense intuitively without examining the data. As imaging services involve a fairly high proportion of fixed rather than variable costs (large, expensive pieces of equipment and expensive staff who must be in the hospital regardless of how busy they are)—the more volume the better from a cost standpoint. As such, it appears that the focus of the Defense Health Agency to focus services within eMSM markets to maximize utilization is the correct strategy.

Of course, real-world considerations may hamper the ability of the services to follow this strategy fully. First, patients must be able to access radiology services within a reasonable time and physicians must have the diagnostic results from radiology services in a timeframe which allows for timely treatment. This means that DHA would not be able to purchase one CT scanner and funnel all of the patients within the Puget Sound region through one location. Any such move would lead to delays in treatment that would be unacceptable to DOD beneficiaries and doctors. In addition, patients would have to travel distances that could be a significant burden on both their time and wallets. Second, readiness of our active duty radiology staff could be impaired by centralization. Military radiology providers and technicians must have somewhere to work and have patients to see in order to maintain the skills they use when deployed in support of combat operations. Any reduction in radiology locations must be carefully balanced against the need to maintain our operational readiness.

B. RECOMMENDATIONS

Differences among services exist but we conclude that cost differences stem from differences in patient volume rather than real differences in expenses as there was no consistency among regions on which service(s) was relatively more efficient. In addition, greater consolidation of management and resource allocation decisions under the Defense Health Agency and the eMSM structures should further reduce costs differences between the services.

In summary, our analysis leads us to several recommendations:

- Our conclusions regarding overall cost of radiology services at military facilities is hampered by the use of average cost per test as a basis for analysis. However, greater consolidation of radiologic imaging assets and increased volume at military facilities can do nothing but improve the cost effectiveness of in-sourcing this function.
- Continue to form partnerships with Veterans Administration facilities and other organizations external to DOD to keep access high for patients.
- Consider investments in Military Construction (MILCON) projects or renovations at existing facilities to further reduce network imaging costs.
- Go “purple” with imaging services: pool resources among Army, Navy, and Air Force. There is no real “winner” in the battle on costs. However, real gains can be made by keeping all of our imaging assets working at their maximum capacity.

The provision of medical care is a notoriously complex business that, at times, makes development of weapons systems look comparatively simple. Despite this complexity, the Department of Defense appears to be doing a good job of holding imaging costs down when compared to the prices charged by civilian counterparts and the costs allowed by CMS. For this reason, the services should continue pulling this care away from the network and back into our Military Treatment Facilities wherever possible.

LIST OF REFERENCES

- Aamc.org. 2014. "Medical Student Education: Debt, Costs, and Loan Repayment Fact Card.". <https://www.aamc.org/download/152968/data/debtfactcard.pdf>.
- Advance Healthcare Network. 2004. "Understand the Three CPT Code Categories.". <http://health-information.advanceweb.com/Article/Understand-the-Three-CPT-Code-Categories-2.aspx>.
- American Medical Association. 2014. "CPT® Process - How a Code Becomes a Code." <http://www.ama-assn.org/ama/pub/physician-resources/solutions-managing-your-practice/coding-billing-insurance/cpt/cpt-process-faq/code-becomes-cpt.page>.
- Bhargavan, M., and Sunshine, J. 2005. "Utilization of Radiology Services in the United States; Levels and Trends in Modalities, Regions, and Populations." <http://www.ncbi.nlm.nih.gov/pubmed/15681686>.
- Congressional Budget Office. 2014. *Approaches to Reducing Federal Spending on Military Health Care*. Report. Washington, DC: U.S. Government Printing Office. <http://cbo.gov/sites/default/files/cbofiles/attachments/44993-MilitaryHealthcare.pdf>.
- Defense Health Agency Transition Team. 2013. "Defense Health Agency Transition – Briefing to the Defense Health Board." http://www.ncdba.com/files/members/05_dha_middleton.pdf.
- Deputy Secretary of Defense. 2013. *Implementation of military health system governance reform*. DoD Memorandum. Washington DC: Deputy Secretary of Defense. <http://www.ausn.org/Portals/0/pdfs/Deputy SECDEF Carter Memo on DHA - MHS Transformation 3-2013.pdf>.
- Deputy Secretary of Defense. 2013. *Defense Health Agency (DHA)*. DoD Directive 5136.13. Washington DC: Deputy Secretary of Defense,. <http://www.tricare.mil/tma/ams/downloads/513612p.pdf>.
- Harrison, Todd. 2011. "Analysis of the FY 2012 Defense Budget." Center for Strategic and Budgetary Assessments. <http://www.csbaonline.org/publications/2011/07/analysis-of-the-fy2012-defense-budget/>
- Jansen, Don. 2014. "Military Medical Care: Questions and Answers." Congressional Research Service. <http://fas.org/sgp/crs/misc/RL33537.pdf>.
- Keppler, J., and Conti, P. 2001. "A Cost Analysis of Positron Emission Tomography." *American Journal of Roentgenology*. 177(1): 31-40 <http://www.ncbi.nlm.nih.gov/pubmed/11418393>.

- Medicaleconomics. 2014. "Radiology Practice Costs on the Rise." Accessed February 5, <http://medicaleconomics.modernmedicine.com/medical-economics/news/clinical/practice-management/radiology-practice-costs-on-the-rise>.
- Montgomery, John. 2012. "Focus on the Integration of Direct and Purchased Care." *Healthcare Analytics in Navy Medicine*. November – December 2012 ed: 1-3.
- Muhammad, Wasif Saif, Ifigenia Tannou, Nektaria Makrilia, Kostas Syrigos. 2010. "Role and Cost Effectiveness of PET/CT in Management of Patients with Cancer." *Yale Journal of Biology and Medicine*. 83(2): 53-65.
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2892773/>.
- Navy Recruiting Command. 2014. "Medical Education Programs."
<http://www.navy.com/joining/education-opportunities/graduate-professional.html>
- Perron, Rebecca. 2013. "Tidewater Enhanced Multi-Service Market to Focus on Cost Savings." http://www.navy.mil/submit/display.asp?story_id=75490.
- Salary.com. 2014. "Physician - Radiologist Salaries." Accessed September 3.
<http://swz.salary.com/salarywizard/Radiologist-Salary-Details.aspx?&hdcxbonuse=off&isshowpiechart=false&isshowjobchart=false&isshowsalarydetailcharts=true&isshownextsteps=true&isshowcompanyfct=true&isshowaboutyou=true>.
- Sunshine, Jonathan, Jeffrey Burkhardt, and Michael Mabry. 2001 "Practice Costs in Diagnostic Radiology." *Health Policy and Practice*. 218(3): 854-865.
<http://www.acr.org/Membership/Residents-and-Fellows/Resident-Resources/~media/7EA6C39EDF524EC0825F7A2F34A8C72A.pdf>.
- Tricare Management Activity. 2012. "Guide for DoD Researchers on Using MHS Data." Office of the Assistant Secretary of Defense for Health Affairs.
[http://www.tricare.mil/tma/privacy/hrpp/downloads/Guide for DoD Researchers on Using MHS Data.pdf](http://www.tricare.mil/tma/privacy/hrpp/downloads/Guide%20for%20DoD%20Researchers%20on%20Using%20MHS%20Data.pdf).
- U.S. Cancer Statistics Working Group. (2014). "*United States Cancer Statistics: 1999–2011 Incidence and Mortality Web-based Report*." Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute. <http://apps.nccd.cdc.gov/uscs/cancersbyraceandethnicity.aspx>.
- The World Bank Data. 2014. "World Development Indicators." Accessed February 23.
<http://databank.worldbank.org/data/home.asp&xgt>.

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
Ft. Belvoir, Virginia
2. Dudley Knox Library
Naval Postgraduate School
Monterey, California