AN EXAMINATION OF FREQUENT EMERGENCY DEPARTMENT USE AND EMERGENCY DEPARTMENT RELIANCE AMONG OIF/OEF VETERANS

A Dissertation

by

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ABSTRACT

Frequent emergency department (ED) use has been studied for decades but frequent ED user subgroups have not been adequately studied, classified, and validated by the research community so designing clear, focused policies have remained problematic. This study used a cross-sectional design, using secondary data obtained from national Veteran Health Administration's (VHA) administrative databases for fiscal years 2010-2011 in order to inform and enhance the VHA's understanding about frequent ED users among the Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) veteran group through the classification of distinct subgroups within the frequent ED user group including examining factors that explain variation in ED utilization among OIF/OEF veterans, address whether using Department of Veterans Affairs (VA) secondary data sources can classify distinct subgroups within a frequent ED user population, and determine if prior fiscal year ED utilization and associated factors can be used to predict future ED utilization.

Using counts of ED visits as the dependent variable, results indicated that 5.2% of all ED OEF/OIF veteran users could be considered frequent ED users which is in alignment with previous studies. The adapted model of Andersen's Behavioral Model of Health Services Use was adept at selecting predisposing, enabling, and need variables for our predictive models with a Zero-inflated Negative Binomial (ZINB) regression model.

Results showed that veterans over 30 years of age within the OEF/OIF cohort had significant decreased odds of having another ED visit compared to the younger under 30 group. Compared to Whites, Blacks or African Americans were the only race group found to be significantly more likely to have increased numbers of ED visits. However, the final ZINB predictive regression model was unable to accurately predict future year utilization using only one prior year's utilization and associated factors.

Three distinct subgroups within ED users were identified, classified and characterized in this study: The Low ED-use/Low EDR subgroup constituted the majority of the sample, Based on primary care use, this subgroup has a primary care physician but never use the ED except in rare circumstances when they find themselves in the ED due to a traumatic event such as a broken bone, car accident or other type of true emergency; The Low ED-use/High EDR subgroup, which consisted of veterans who based on primary care use also have a primary care physician who helps them manage a chronic illness such as Asthma or Diabetes but had an incident where their chronic illness gets out of control after business hours and requires a trip to the ED for care. The High ED-use/High EDR subgroup consisted of those veterans who based on primary care use may or may not have a primary care physician and appear to use the ED as a source of usual care or as a method to access the VA system in order to obtain pain medications, care for their physical needs, or counseling for mental health needs since all of these services are in high demand within the VA system and often difficult to gain access to these services in a timely manner.

DEDICATION

I want to first dedicate this dissertation to my family. My coming to Texas A&M University to attain this degree would not have been possible without the faith and loving support of my wife, Jami. I am truly blessed to have such a remarkable partner in my life. She is a phenomenal mother and my best friend. I also dedicate this accomplishment to my five children; Erin, Dylan, Daniel, Noah and Jonah; and my three grandchildren; Emma, David, and Nicholas. The pride I feel about this accomplishment is dwarfed by the love I have for each of them. They are my treasures from God and constantly remind me that life is truly a gift to be cherished each and every day. I give special dedication to my son James Dylan Fish, who was taken from us prematurely and went to be with the Lord Jesus during this academic journey. He was truly a special man and I am proud to call him my son. I am constantly missing him and he is always in my thoughts. Similarly, I also dedicate this dissertation to my mother Mary, who was unable to see me complete this journey and graduate but went to be with the Lord just one month before my defense. During her life, she always gave me constant encouragement and was my champion throughout my life. I truly miss this amazing woman. Moreover, I dedicate this dissertation to my grandfather Taylor Maxwell Rushing, my father James Henry Fish. While living, each of these two men epitomized the personal strength, courage, integrity, and spirit of a true Aggie. Their mentorship and guidance and the fond memories I hold of them continue to inspire me to be the best person I can be each and every day.

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NOMENCLATURE

COPD	Chronic Obstructive Pulmonary Disease
ED	Emergency Department
EDR	Emergency Department Reliance
ER	Emergency Room
FY	Fiscal Year
FY10	Fiscal Year 2010 (October 1, 2009 – September 30, 2010)
FY11	Fiscal Year 2011 (October 1, 2010 – September 30, 2011)
IED	Improvised Explosive Device
NBR	Negative Binomial Regression
OIF	Operation Iraqi Freedom
OEF	Operation Enduring Freedom
OND	Operation New Dawn
PTSD	Post-Traumatic Stress Disorder
TBI	Traumatic Brain Injury
TRACC	Trajectories of Resilience and Comorbidity Clusters
USAF	United States Air Force
USA	United States Army
USMC	United States Marine Corps
VA	Department of Veterans Affairs
VHA	Veterans Health Administration
ZINB	Zero-inflated Negative Binomial Regression

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

1. INTRODUCTION

Statement of the problem

Frequent emergency department (ED) use has been studied for decades but frequent ED user subgroups have not been adequately studied, classified, and validated by the research community [1-6]. Clear, focused policies to reduce non-emergent use of ED services have remained problematic. A key objective of this study was to inform and enhance the VHA's understanding about frequent ED use among OIF/OEF veterans through the classification of distinct subgroups within the frequent ED user group in order to identify those veterans who use the ED as their usual source of care. This study provided opportunities to develop classification schemes to target veterans for interventions designed to encourage use of primary care providers for non-urgent care, reduce unnecessary ED-use, slow ED overcrowding, lower overall ED costs, and improve patient health [7-11].

Background/context

The U.S. Department of Veterans Affairs (VA) is responsible for caring for America's veterans, defined as those men and women who served in the U.S. Armed Forces. The U.S. Armed Forces consist of the Army, Navy, Marine Corps, Air Force, and Coast Guard. The VA provides a host of services and benefits, including compensation, education, home loans, and medical care. The VA currently serves a population of more than 22.3 million veterans which includes veterans who served in War World II (1.7 million), Korea (2.3 million), Vietnam (7.4 million), Gulf War (3.3 million), Iraq and

Afghanistan (2.6 million), and peacetime periods (5.7 million) [12]. These numbers include the reserve component, which has been used in unprecedented numbers in Iraq and Afghanistan. Veterans are disproportionately male (92%), with just under 2 million women making up the remaining eight percent [13].

The VHA is the largest public sector integrated health system in the nation and provides the medical, dental, and mental health care to eligible veterans through VHA medical centers, hospitals and community-based clinics. The VHA is also the largest provider of substance abuse treatment in the United States [14].

It is important to note that the VHA does not service all veterans. In fact, the majority of veterans have been excluded from VHA services based on a priority system established by the Veterans' Health Care Eligibility Reform Act of 1996. The order of priorities are based on a veteran's percentage of service-connected disability, their income level, or distinct status as specified by law, such as a prisoner of war [15].

Currently, 8.57 million veterans are enrolled in the VHA health care system, which accounts for 38% of the total veteran population. The VHA treats 70% of this enrolled population (6 million) annually, providing 692,000 inpatient and 80 million outpatient visits [13].

Changing demographics of veterans

Over the past century, the United States has been involved in six major wars and the demographics of veterans have changed considerably over that time. In Vietnam, which was the last American war to have conscript troops, most troops were younger, below 21 years of age and unmarried, with a predominantly male population [16]. According to the Department of Defense (DoD) data cited by Halfbinger, more than 35,000 of the 58,000 Americans killed during Vietnam were under 21 years of age [16].

Even though it has been decades since the war in Vietnam, the impact of these Vietnam veterans is still being felt in the VHA due to ongoing problems with substance abuse and mental illnesses such as PTSD. Substance abuse is tied into these physical and psychological dimensions. It has been reported that 36.1% of the 250,000 inpatient discharges for Vietnam veterans in 1999 were connected to substance abuse [17]. Substance abuse among homeless veterans is prevalent. It has been reported that 60% of homeless veterans enrolled into supported housing programs had a substance use disorder and 54% of those with a substance use disorder had both alcohol and drug use disorders [18]. It has also been widely reported that OIF/OEF veterans experience problems with substance abuse and mental illness as well. Burnett-Zeigler, et al., reported that almost 40% of U.S. military service members within the VA system have psychiatric disorders, exceeding the estimated rates for the general population [19].

In contrast to earlier wars, OIF/OEF veterans of the Iraq and Afghanistan wars come from an all-volunteer force with 46% coming from the reserve component, making the composition of the veteran population quite different from the veterans of World War II, Korea, and Vietnam. Veterans of the Iraq and Afghanistan war are much older with marriage rates among enlisted members in the low to mid 30 percentiles [16,20].

The advancement of medicine has contributed to reductions in the number of deaths from combat injuries. Combat Veterans wounded in World War II experienced a casualty rate of 22.8 percent, while Vietnam saw a reduced casualty rate of 16.5 percent [21]. The casualty rate for combat veterans wounded in Iraq and Afghanistan dropped even further to 8.8 percent [21].

Survival rates from the Iraq and Afghanistan wars differ from previous wars. Indeed, the wounded-to-killed ratio of 16 American soldiers wounded per soldier killed is the highest recorded to date, over 5 times higher than previous wars[20]. Indeed, technological advances in soldier body armor and innovative changes to in-the-field medical response strategies, including front line surgeries, have all been instrumental in larger numbers of soldiers surviving traumatic blasts, and other combat-related injuries.

However, this increased survival rate has brought with it a virtual "polytrauma" of traumatic brain injuries (TBI), amputations, and mental health illnesses, which when combined, make treatment difficult [22]. It is important to note that the wounds veterans

receive in combat environments, whether from improvised explosive devices (IEDs), military sexual assault, or direct combat situations do not always manifest immediately. Consequently, these wounds are often unseen or hidden for a time, as is the case with many mental health illnesses, especially in cases such as PTSD.

In effect, despite the progress made in detecting and diagnosing veterans with these types of traumatic mental health injuries, many veterans remain undiagnosed because of the delay in presentation of these symptoms or because of the masking of symptoms from other comorbid conditions such as TBI. Along with the increased survival rates of these combat veterans has been a corresponding increase in the amount of ongoing medical care required, often for the remaining lifetime of the wounded veteran.

Several previous studies have classified veterans as a vulnerable population [23-27]. We find it fitting that the word vulnerable is derived from *vulnus*, a latin word that means wound [28], as veterans suffer a disproportionately high number of 'wounds' due to the unique nature of their profession. Aday et al., classically defined a vulnerable population as a population at risk for poor health in any of the physical, psychological or social dimensions [28]. Indeed, research has shown that veterans are at risk in all three of these dimensions [23-27]. For this study, a vulnerable veteran was defined as an OEF/OIF veteran with at least one of the following characteristics: homeless, diagnosis of traumatic brain injury (TBI), post-traumatic stress disorder (PTSD), substance abuse, pain, amputation, or a service-connected disability rating.

A consequence of the injuries veterans received during the Iraq and Afghanistan wars (PTSD, TBI, chronic pain) is that treatment for these kinds of injuries take time to treat and are often difficult to get under control. Chronic pain is a good example. Veterans recently returned from combat suffering from wounds such as amputations, burns and TBI often experience chronic pain issues. With VA pain management clinics open only during the day, it is understandable that veterans with pain issues after hours will seek relief through the VA EDs, leading to increased use of ED services for pain issues after hours.

Veteran use of medical services

Studies show that overall, veterans use medical services at rates similar to those of the general population [29-31]. Wolinsky et al., reported no differences in the use of medical services between veterans and non-veterans [30]. Agha et al., found that although veterans had poorer health status and more medical conditions than the general population, veterans had similar use of medical services when compared to the general population after controlling for health and socio-demographic differences [29].

Veteran emergency department utilization and costs

While overall veteran utilization of medical services has been reported to be similar to the general population, Hunt et al., reported differences in ED utilization rates among frequent ED users[1] but the study was based on survey data and veteran data for frequent

veteran ED users was reported as insufficient with less than 100 survey participants so the results may be spurious because of the small number of veterans and not be generalizable to the veteran population. Since this study uses data about OIF/OEF veteran's use of VHA ED care, results of this study will update and better reflect a truer picture of current veteran ED utilization.

The peer reviewed literature has also documented the higher cost of ED care compared to primary care. For example, Baker and Baker found that charges for ED visits were two to three times more than charges for similar visits in other settings [32]. Williams et al., reported in his 1996 study on the costs of an ED visit that depending on whether the ED visit was non-urgent, semi-urgent or urgent, the cost of ED-visit ranged between 2.3 times and 11.7 times higher than a patient primary care office visit [33].

Increased numbers of surviving combat-wounded veterans coming into the VHA system over the past decade have led to a myriad of access to care and cost issues resulting in ED overcrowding and increased ED costs, adding onto an already stressed VA budget. Over time, this has led to a national VA focus on reducing costs and the perception that frequent Emergency Department (ED) visits are a needless misappropriation of resources. This perception is prevalent throughout extant literature; studies abound which focus on reducing frequent ED use in order to reduce ED utilization and costs [1-6,33-36]. However, other recent studies have begun to question these and other commonly held perceptions about frequent ED use [1,3,37].

Developing effective solutions to reduce frequent ED use is important to inform the development of clear, effective policy, design interventions to address patients with chronic medical conditions who require the continual management and monitoring of those conditions by a provider. A recent study underscored an important benefit of patient continuity of care warning that veterans may be putting themselves at risk by continually seeking care through the ED instead of accessing VA primary care services [38]. Grover et al., argued that repeated ED care was unfavorable to patients with conditions like chronic pain, opiate addiction, or psychiatric issues [38]. While using the ED provides a quick and easy fix by providing medication to mask the symptoms (eg., acute pain), it effectively does nothing to resolve underlying health issues [38]. This is especially true for the much tougher issues like drug dependence and drug seeking behavior which often go unnoticed by busy ED doctors [38].

The ability to classify distinct subgroups within the frequent ED user group strengthens our understanding of the characteristics of veterans who use the ED as their usual source of care. This study used a measure called Emergency Department Reliance (EDR) as one of the classification methods to identify distinct subgroups within the frequent ED user group. Previously, Kroner, et al., used EDR in conjunction with frequent ED use to identify distinct subgroups within the frequent ED user pediatric population [39].

A search of the literature revealed a paucity of EDR research and no studies were located that involved non-pediatric populations [39-43]. The EDR measure is calculated as the ratio of a patient's total number of annual ED visits compared to the total number of annual primary care visits. Kroner's conceptualization and use of EDR has reasonable face and construct validity. As such, it may serve as a proportional measure of a patient's reliance on emergency departments for care compared to primary care and used with any type of population, including this study's adult veteran population [39].

Study purpose

The purpose of this study was to examine factors related to frequent ED-use and reliance for FY10 and FY11, classify and identify subgroups within the high ED use population. Andersen's Behavioral Model of Health Services Use served as the theoretical framework that grounded this study to previous research and identified the important independent variables that best predicted ED utilization [44,45]. For purposes of this study, a vulnerable veteran was nominally defined as those with at least one of the following characteristics: homeless, diagnosis of traumatic brain injury (TBI), post-traumatic stress disorder (PTSD), substance abuse, pain, amputation, or a service-connected disability rating.

Research objectives

This study addressed several important gaps in the VHA's understanding of veteran frequent ED users:

1. What factors explain variation in ED utilization among OIF/OEF veterans?
2. Can VA secondary data sources be used to classify distinct subgroups within frequent ED users in order to identify veterans who use the ED as their usual source of care?
3. Can fiscal year 2010 (FY10) ED utilization, demographics, service-connected disability types, diagnoses and FY10 ED use classification be used to project fiscal year 2011 (FY11) ED utilization and FY11 ED use classification in this OIF/OEF veteran population?

Tables 1 and 2 summarize the study research objectives and hypotheses:

Table 1 - Research objective #1

RO1 - Research Objective 1	
Describe and classify OEF/OIF veterans according to ED use, Primary Care Use, and the ratio of ED to Primary Care visits (EDR) for FY10/FY11	
H1a	Utilization of VA services by OEF/OIF veterans will be associated with predisposing, enabling, and need variables
H1b	More than 50% of OEF/OIF veterans in the sample will fall in the low ED use/low EDR subgroup
H1c	A higher proportion of vulnerable OEF/OIF veterans will fall into the high ED use/high EDR subgroup than other veterans in the sample

Research objective 1

Research objective 1 of the study described and classified OEF/OIF veterans according to ED use, Primary Care Use, and the ratio of ED to Primary Care visits (EDR) for FY10/FY11. Pines et al., highlighted that the research community's failure to identify factors predicting future frequent ED use constituted a real gap in the current body of knowledge [34]. Research Objective 1 had three hypotheses:

Hypothesis 1a

Utilization of VA services by OEF/OIF veterans is associated with predisposing, enabling, and need variables. This hypothesis is in agreement with the findings of others from previous studies that found VHA medical services utilization associated with predisposing, enabling, and need variables [46].

Hypothesis 1b

More than 50% of OEF/OIF veterans in the sample will fall in the low ED use/low EDR subgroup

Hypothesis 1c

A higher proportion of vulnerable OEF/OIF veterans will fall into the High ED use/High EDR subgroup than other veterans in the sample. In this study, a vulnerable veteran is defined as those with at least one of the following characteristics: homeless, diagnosis of traumatic brain injury (TBI), post-traumatic stress disorder (PTSD), substance abuse, pain, amputation, or a service-connected disability rating.

Table 2 - Research objective #2

RO2 - Research Objective 2 *Evaluate the relationship between FY11 ED utilization and FY10 ED utilization using a regression model that accounts for predisposing, enabling and need variables*	
H2a	FY11 ED utilization can be predicted using FY10 ED utilization for OEF/OIF veterans
H2b	Vulnerable OEF/OIF veterans' use of EDs is the same as other, non-vulnerable OEF/OIF veterans

Hypothesis 2a

FY11 ED utilization can be predicted using FY10 ED utilization for OEF/OIF veterans. Specifically, this study tested whether FY11 ED utilization was equal to predicted utilization using FY10 ED utilization and associated factors of OEF/OIF veterans. The number of annual ED visits was further defined as high and low ED use by the distribution of the data. Similarly, high and low EDR was defined by the distribution of the data.

Hypothesis 2b

Vulnerable OEF/OIF veterans' use of EDs is the same as other, non-vulnerable OEF/OIF veterans.

2. REVIEW OF THE LITERATURE

Historical trends

Modern healthcare utilization studies were pioneered by Hochbaum, Kegeles, and Rosenstock in the late 1950's and early 1960's [47-50]. Following, Andersen published his initial theoretical framework to better understand the behavioral components of health care use by families in 1968 [44]. Andersen's theoretical framework was later expanded into a more general theoretical behavior model of health care utilization based on the concepts that predisposing, enabling, and need characteristics of individuals affect their behavior and subsequent utilization of healthcare [44,45]. A further refinement of Andersen's theoretical framework geared toward vulnerable populations was followed by Gelberg in 2000 [23].

The unprecedented growth in healthcare costs in the 1980-1990s influenced reforms which fueled the explosive growth in commercial managed care health plans and frequent emergency department utilization studies began to emerge in the 1990s in attempts to understand how better to control ED utilization and reduce healthcare costs [5,51-53].

What is known

The peer-reviewed literature reveals much that is known about frequent ED utilizers. In general, frequent ED utilizers are sicker than non-frequent ED users [46]. The literature

indicated that women have disproportionately higher ED utilization than men while Blacks or African Americans were found to be disproportionately and positively associated with frequent ED use than Whites despite the fact that Whites make up the majority (60%) of frequent ED users [3]. In a study of veteran utilization by Lasser and colleagues, having 5 or more primary care visits in the previous year or a service-connected disability was associated with repeat ED use [54].

Most frequent ED users are insured

LaCalle and Rabin revealed in their 2010 systematic review of the literature on frequent users of EDs that 85% were insured and the preponderance (60%) used public insurance like Medicare or Medicaid [3]. Conversely, veterans who used VA emergency rooms were 100% covered as if insured by their enrollment into the VHA integrated health system. Ruger et. al, reported that high frequent ED users were insured with Medicare much more than non-frequent ED users [35].

Frequent ED users comprise a disproportionately high percentage of ED use among the general population

Recent studies have reported that frequent ED users represent a disproportionately high percentage of all ED visits (25%) but account for only 5% of all patients [3,46]. Another

study related slightly higher percentages with frequent ED users comprising 8% of all ED users but using 28% of total ED visits [1].

Veteran frequent ED users are different from
the general U.S. population of frequent ED users.

A study by Ruger et al., in a large, tertiary hospital showed 65% of frequent ED users were women [35]. Hunt et al., used a nationally representative sample taken from the Community Tracking Study and reported that 65% of frequent ED users were women [1] while Doran, Raven & Rosenheck highlighted in their national VA study of veteran frequent ED users that 90.8% were male [46]. Hunt et al., estimated 23% of adults used at least 1 ED visit [1] while Doran et al., reported 16.8% of veterans had at least 1 ED visit [46].

Despite being enrolled in an integrated and coordinated healthcare system, percentages of veteran frequent ED users are similar to the percentages of frequent ED users in the general population.

What amount of ED utilization constitutes a frequent ED user has not yet been standardized or definitively determined in the literature [1,34,46] but the data shows that the VA experience with frequent ED users is similar to that of the general population. Hunt et al., defined frequent ED users as those having 4 or more visits in a single year with 8% being considered frequent ED users nationally [1]. Doran et al., reported that 7.9% of

veterans had 2 or more ED visits within a single year but did not report on what number of visits over what timeframe constituted a frequent ED user in their study. Pines et al., reported that 8% of ED users are considered frequent users and commented that there is lack of consensus on what number of ED visits determines a frequent user in the literature [34,46].

Frequent ED users are sicker than non-frequent ED users

Hunt et al., reported a positive correlation between the frequency of ED visits and the health status of ED users. The researchers found that as the frequency of ED visits increased, the proportion of those in poor health (both physical and mental) increased as well [1]. In a systematic review of frequent users of EDs, LaCalle and Rabin informed that frequent ED-users tend to be sicker than other ED users marked by a plethora of chronic illnesses and comorbidities [3]. A 2013 systematic review of studies on frequent ED users supported the premise that frequent ED users are sicker than non-frequent ED users and likely to present at the ED with multiple chronic medical conditions rather than trauma [55]. While this might suggest that frequent ED users have valid reasons for their visits to the ED, the study authors found that the majority of ED visits by frequent ED users were unnecessary, avoidable, and could have been deferred to a non-emergency care setting if available [55].

Frequent ED users are also frequent users of other outpatient services like primary care

Previous research has shown that individuals with frequent ED use tend to also be frequent users of other health services like outpatient care than low or non-frequent ED users [56]. A study by Lasser et al., showed that among a cohort of primary care patients in Boston, Massachusetts, those with 4 or more ED visits also were more likely to have more frequent outpatient primary care office visits than those without frequent ED use [57]. Additionally, a report using data from the Medical Expenditures Panel Survey demonstrated that those with frequent ED use (defined as 4 visits within a 2-year period) were more likely to use outpatient services at a greater rate than those who were not frequent users, with 86% of frequent users having 4 or more outpatient visits compared to 72% of those who were not frequent ED users [56].

What is not known

There is not agreement in the literature about what amount of ED utilization over what period of time defines a patient as a frequent or high ED utilizer.

Criteria for defining a patient or group as frequent ED users are still not standardized in the literature. For example, there is still no clear consensus on how many ED visits over what period of time define a frequent or high utilizer of ED services [3,34,46,56]. Pines et al.

recounted a wide range of visits defined as frequent ED use in their systematic review reporting that studies defined frequent ED use using from 2 to 20 visits [34].

Despite decades of research on frequent ED utilization, not enough is known about the subgroups within the frequent ED-user population

In a 2010 study using a nationally representative sample of children, Kroner, et al., used a measure called Emergency Department Reliance (EDR) to identify distinct subgroups within the frequent ED user population [39]. It is currently not known whether EDR, in conjunction with frequent ED use can reliably be used to classify different subgroups from within the frequent ED user group in non-pediatric populations. While a search of the extant literature unearthed three additional EDR studies using pediatric populations, the literature revealed a paucity of EDR research and I have been unable to locate any EDR studies involving non-pediatric populations [39-43]. Furthermore, the literature was silent, and revealed no empirical studies that validated or demonstrated the use of the EDR measure using adult or veteran populations.

3. CONCEPTUAL MODEL/METHODS

Research design

This research used a cross-sectional observational design using secondary data from a de-identified VA dataset. Sample data was derived from VHA administrative databases for fiscal year 2010-2011 encompassing the October 1, 2009 to September 30, 2011 timeframe. The data was compiled from two different databases, the Trajectories of Resilience and Comorbidity Clusters in OEF-OIF Veterans (TRACC) – Traumatic Brain Injury (TBI) study, protocol HSC20100395H, and the Department of Defense OIF/OEF file, which contains information on veterans that served in OEF/OIF/OND. TRACC study data was obtained from the VHA's Outpatient Encounter File, Patient Treatment File, and the Decision Support System Pharmacy File. The Outpatient Encounter File contained data on all VHA outpatient clinic and emergency department visits within the VHA system [46]. The Patient Treatment File consisted of inpatient care received within the VHA system and the Decision Support System Pharmacy File contained prescription data on prescriptions filled in VHA pharmacies.

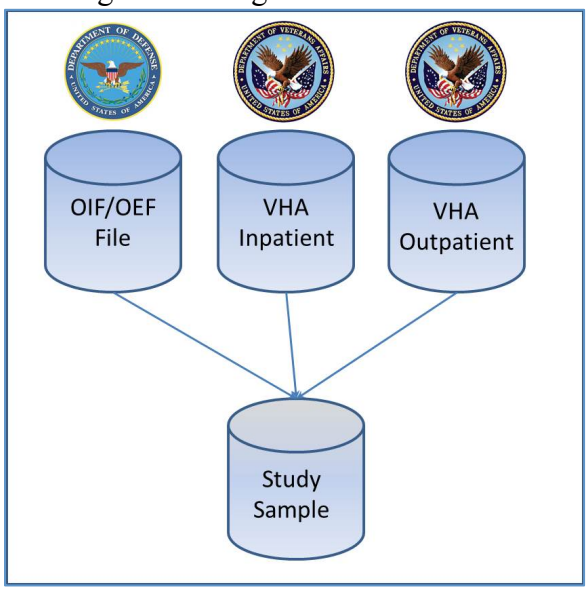
Data sources and population

The sample used for this study contained data for 311,377 OEF/OIF/OND veterans who received at least one health care visit at VHA facilities between October 1, 2009 and

September 30, 2011. The TRACC study protocol was previously approved by both VA and University of Texas Health Science Center-San Antonio (UTHSC-SA) IRBs. Approval for use of the de-identified data for this study was approved by the VA on April 15, 2015 and approved by UTHSC-SA IRB protocol number HSC20100395H amendment on May 9, 2014. Final study approval was received on November 3, 2014 from the Texas A&M University Institutional Review Board (IRB) under protocol IRB2014-0480D.

The de-identified analytic dataset provided by the VA for this study was created from the data sources represented in Figure 1 below: 1) The Department of Defense (DoD) OIF/OEF file and; 2) National VHA inpatient and outpatient data files. The OIF/OEF file represented the total cohort of veterans who were deployed in support of OIF/OEF. National VA inpatient and outpatient files represented any care received by veterans enrolled for care within the VHA system. Sampling Frame veterans who received care at least one time from the VHA in FY10 and FY11 were included in the sample. In order to maintain anonymity of individual veterans, discrete data for individual veterans was rolled up and summarized for FY10 and FY11 respectively prior to receiving the study sample.

Figure 1 - Diagram of data sources



VHA enrolled patients can present for care at any VHA facility [46]. Doran reported that 92% of 140 VHA facilities have EDs and the remaining 11 facilities have urgent care centers which are typically in rural areas [46]. Because an urban/rural variable was unavailable for the study, I followed the method outlined by Doran et al., and counted these urgent care center visits as ED visits for the research study.

Conceptual models

Choosing a theory or theoretical framework with which to ground our study was no small task. The veteran population of our study is heterogeneous with a wide variety of medical issues ranging from mental illness, homelessness, substance abuse, and a host of combat-related injuries including Traumatic Brain Injury (TBI), PTSD, and single or

multiple amputations. They also suffer with the typical chronic diseases one finds throughout the general population such as obesity, diabetes, COPD, arthritis, and hypertension. A search of the body of literature using Medline and Google Scholar included a wide range of disciplines, health service research, medicine, public health, psychology, and substance abuse and addiction, and uncovered multiple theories and conceptual frameworks, a number of which were applicable to guide research in health care utilization for a population. A non-inclusive list of these include Attachment Theory [58], Theory of Planned Behavior [59], Self-Regulation Model [60], Network Episode Model [61], Health Belief Model [47], and Behavioral Model of Health Services Use [44,47,58-63].

Since military veterans are at risk for homelessness, psychiatric disorders, and substance abuse, we evaluated these theoretical models and conceptual frameworks in the research literature to find those that best explained the association of these phenomena on health care utilization. Of these, we chose to review Bowlby's Attachment Theory, Hochbaum's Health Belief Model, and Andersen's Behavioral Model of Health Services Use.

Bowlby's attachment theory

Bowlby's attachment theory posits that early experience with health care providers influences how we perceive and act in our relationships with them, whether we perceive ourselves worthy of care, all of which influences health care utilization [58,64]. Attachment

theory holds that patients have one of two types of attachment that affect their use of medical care: 1) preoccupied attachment and; 2) fearful attachment [65].

The theory states that patients who have a positive point of view of the comfort and support received from others are more likely to utilize health care (Bowlby call this secure and preoccupied attachment), whereas patients with a negative perception about the support they receive from others are less likely to seek health care (called fearful and dismissing attachment) [65].

Confirming this result in their study of symptom reporting and primary care utilization using Attachment theory as the theoretical framework for their study, Ciechanowski et al., posited that the ability to trust their care givers would be positively associated with healthcare utilization and their study confirmed this. Patients with preoccupied attachment were associated with higher primary care utilization while patients with fearful attachment were associated with lower primary care utilization [65].

Unfortunately, employing Bowlby's attachment theory to predict ED utilization in our study would have been problematic because available data does not contain the required variables that provide insight into each veteran's experience with VA health care providers. Consequently, we could not identify which type of attachment the veteran patient was experiencing, thus preventing us from performing a meaningful analysis of critical theoretical variables to explain trends in the data.

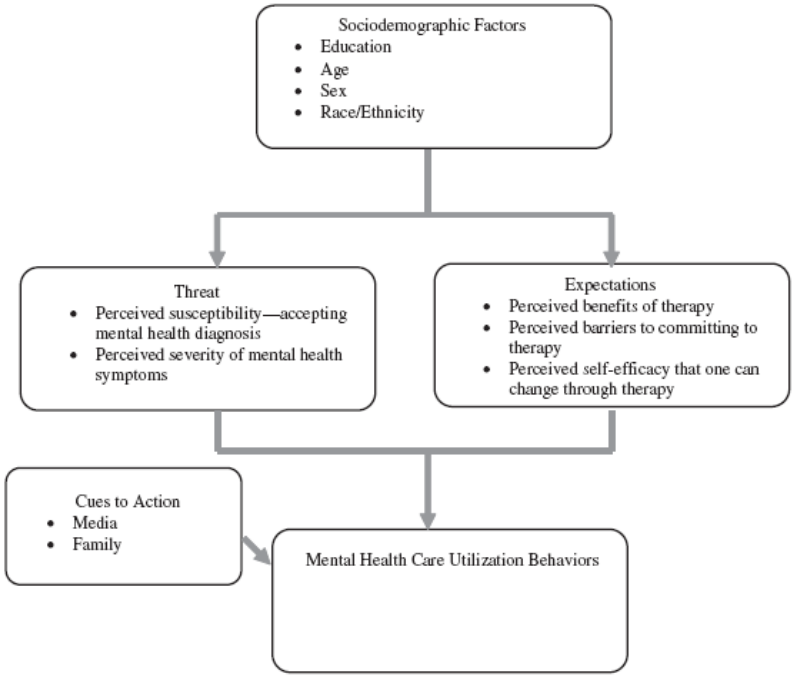
Health belief model

The Health belief model is an often used social-cognitive theory of health behavior [62]. It was originally developed through the research of Hochbaum in the early 1950s and Leventhal, Kegeles, and Rosenstock in the 1960s as a way to understand health behaviors, specifically preventive services for the detection of diseases, patient's responses to perceived disease symptoms, and the role of perceived severity and medical treatment compliance [48,50,66-68].

In a study of factors that influence individuals utilization of mental health services, Henshaw and Freedman-Doan (2009) explained the Health Belief Model as follows: "The Health Belief Model hypothesizes that people are likely to engage in a given health-related behavior to the extent that they (a) perceive that they could contract the illness or be susceptible to the problem (perceived susceptibility); (b) believe that the problem has serious consequences or will interfere with their daily functioning (perceived severity); (c) believe that the intervention or preventative action will be effective in reducing symptoms (perceived benefits); and (d) perceive few barriers to taking action (perceived barriers)" [62].

The Health Belief Model as originally proposed by Rosenstock (1990) was adapted by Henshaw et al., (2009) for mental health utilization and is reprinted in Figure 1 below:

Figure 2 -Health belief model for mental health utilization
(Reprinted from [62])

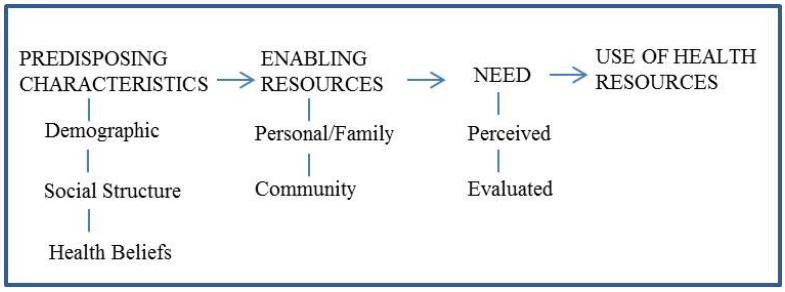


We found that utilizing the Health Belief model to predict ED utilization in our study would be problematic because available data does not contain the required variables in the domain of patient expectations above. As Henshaw et al., points out, without these critical theoretical variables to provide insight into each veteran's perceptions about: 1) the benefits of therapy; 2) barriers to committing to therapy and; 3) self-efficacy for change through therapy, this inhibits us from performing a meaningful analysis of the data and explaining mental health care utilization behaviors [62].

Andersen's behavioral model of health services use

As an alternative to Bowlby's Attachment Theory and the Health Belief Model, we turned our attention to Andersen's Behavioral Model of Health Services Use. Developed more than 50 years ago to help explain and better understand the reasons that families use health care services, the behavioral model of health services developed by Andersen has been the prevailing theoretical model to predict individual health service use [44,69,70]. The major components of the original model from the 1960s are reprinted in Figure 1. The model shows the use of health care services as a function of Predisposing, Enabling, and Need factors [45,70-72].

Figure 3 – Andersen's original behavioral model of health services use
(Reprinted from [73])



According to Andersen's original model, health services use or utilization occurs under three conditions: 1) where a family is 'predisposed', or inclined to receive medical care, (2) where health services are available to the family and; (3) where the family recognizes

the need for health care services and accesses it, with the ultimate outcome being the actual use or utilization of the health care service [44,73]. While the original model was developed with the family as the unit of analysis, Andersen changed the unit of analysis to the individual due to difficulties in "developing measures at the family level that take into account the potential heterogeneity of family members." [12] As pictured in Figure 2, this model sees predisposing characteristics as exogenous and unchanging and included sociodemographic characteristics such as age, sex, race/ ethnicity (White, Black, Hispanic, other, unknown), and marital status.

These predisposing characteristics lead to enabling resources, which provides the practical means for the family to provide remuneration for healthcare services. These enabling resources, which are considered more fluid and changeable than predisposing characteristics, include variables like family income or health insurance [70].

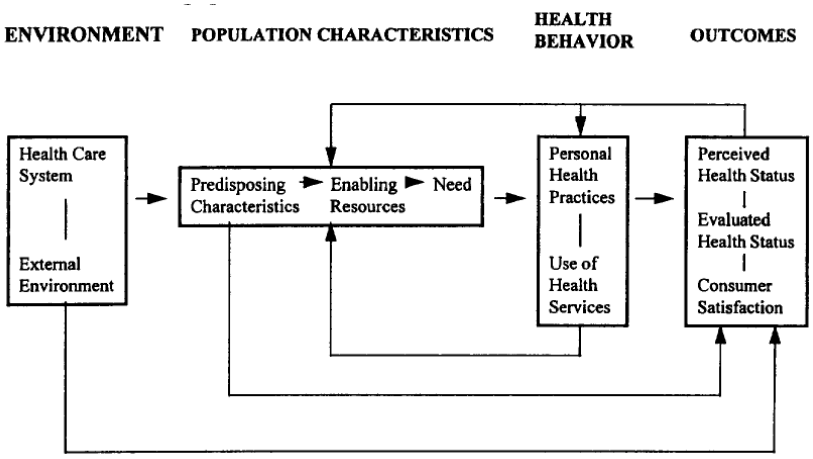
The enabling resources component then leads to the Need component. Two main subcomponents of Need are addressed in the model: 1) Perceived need and; 2) Evaluated need. Perceived need speaks to the individual's recognition of symptoms or illness which increases their desire to seek medical care. Evaluated need is the individual's recognition of symptoms or a medical diagnosis of illness [70].

The Andersen and Aday theoretical model has been revised, adapted, and applied by many researchers to many different populations, and in many different health settings to

explain important patterns and trends in health care utilization [23,46,73-75]. Significantly, Gelberg, Andersen and Leake (2000) collaborated on a variation of the original Behavioral Model of Health Services Use, now known as the Gellberg-Andersen Behavioral Model for Vulnerable Populations that explains health care utilization among populations among homeless populations in particular [23]. These predisposing, enabling, and need components that make up the core model have been added to and adjusted to reflect the vulnerable aspects of homeless people including homeless veterans [24,76,77].

The model's use and acceptance by the research community as evidenced by its use as a conceptual framework for healthcare utilization studies among the homeless is positive testimony of its applicability to our understanding of the vulnerable homeless population. Broader recognition and use of the Behavior model over the years has brought about a wider conceptualization of the original model. This revised Behavioral model now includes the influences of the environment and health behavior, and an expanded view of outcomes, all of which take into account these additional forces. Note in Figure 2 reprinted below, personal health practices and use of health services both have been theorized and subsequently proven to influence health outcomes and provides feedback back into the core component of the model and health behavior.

Figure 4 – Revised behavioral model of health services use
(Reprinted from [73])



Another variation of Anderson's Behavioral Model has been adapted for patients with mental illness and substance abuse as well [69,78,79].

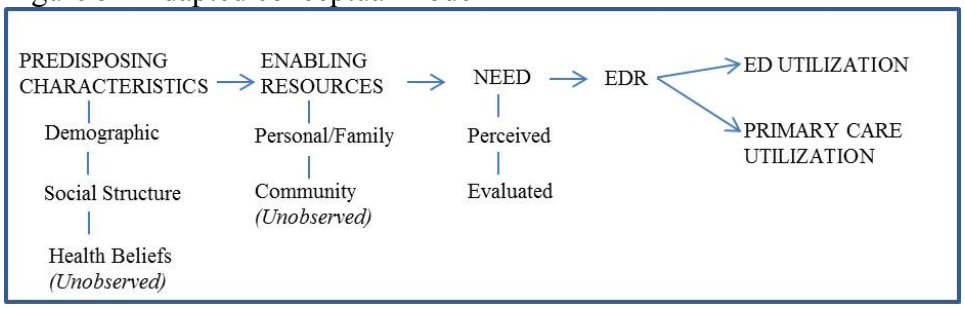
Theoretical model for this study

Ultimately, we chose Anderson's Behavioral Model of Health Services Use as the theoretical framework for this study because of its innate ability to ground our study to previous research, allowing comparisons with other non-veteran groups, and to identify the important independent variables to predict ED utilization. The model shows the use of health care services as a function of Predisposing, Enabling, and Need factors [45,70-72]. Guided by this theoretical framework, we applied this model to determine the applicable operational predictor variables for our study as directed by existing research.

Following Andersen's model, we expect that the variation in ED utilization will be influenced by variables such as patient demographic characteristics, social structure, and health beliefs in this study. There are no variables to address health beliefs available for this study. Furthermore, we expect to see variation in ED utilization affected by enabling resources such as income, and education level. Community variables were unavailable and as such will be considered as an ommitted variable for our study. Finally, we anticipate variation in ED utilization to be influenced by need variables such as previous diagnoses, ED visit type, and the number of physical and mental comorbidities.

We adapted Andersen's model for this study as shown in Figure 3. because I want to look at not just the use of health resources but the effect of emergency department reliance on the patient's use of primary care or the emergency department and the proportion of overall utilization as it relates to primary care visits vs. ED visits.

Figure 5 - Adapted conceptual model



Our adapted conceptual model based on Andersen's behavioral model of health services utilization affects our variable use according to our stated research objectives and hypotheses.

4. MEASURES

Outcome variables

An Emergency/ Urgent (ED) Care visit is defined using clinic stop codes (130, 131) in VA outpatient data. Because VA facilities in more rural areas offer urgent care but not ED care, the dataset combines ED with urgent care use. As has been reported in more recent studies highlighting the heterogeneous nature of the veteran population with multiple ED visits [46,80], I created a categorical measure of emergency visit counts for each fiscal year and classified these dichotomous measures as low use of emergency care, and frequent or high use of emergency care. This classification was based on the distribution of the ED counts variable across the sample. To facilitate descriptive analysis of ED utilization in the sample, I created another categorical variable that divided ED visit counts into categories encompassing the entire continuum of ED visits using the following frequency categories: Zero (0) ED visits, one (1) ED visit, two(2)-three(3) ED visits and four(4) or more ED visits.

The EDR measure is estimated as the ratio of ED visits to all primary care visits. Because "excessive EDR" has not been previously defined for adults, we analyzed EDR in two separate regression models: 1) as a continuous measure and; 2) as a dichotomous measure in order to classify EDR as low EDR and high EDR, for both FY10 and FY11.

This classification will be based on the distribution of the EDR variable across the sample.

Predisposing variables

Predisposing characteristics included age, sex, race/ ethnicity (White, Black, Hispanic, other, unknown), and marital status (married/ not married) [45,70,73]. Age was classified by the VA into four groups for de-identification purposes: 17-30, 31-40, 41-50, 51+ and above. A priori, I postulated that the relatively unchanging predisposing variables such as age, gender, and race used in the regression models would have only a minor effect on the numbers of ED visits [69].

Enabling variables

Enabling variables such as being married, branch of military service, rank, military service component (Active Duty and National Guard/ Reserve), along with education level were not expected to explain much of the variation in ED utilization and were expected to have a weak correlation with 2010 counts of ED visits [69]. I anticipated that veterans having a VA poverty designation would have a stronger association with ED counts as they have very little income which means they most likely lack transportation to VA facilities and must rely on friends and family.

Enabling variables included several military-specific variables obtained from the OEF/OIF/OND roster: component of armed forces (Active Duty vs. National Guard/ Reserve), rank at discharge (enlisted vs. officer/ warrant officer), and date of last deployment. Veteran homeless status was identified using VA clinic codes (528, 529 590) and ICD-9-CM codes (V60.0, V60.1) in FY10 and FY11 (homeless FY10, homeless FY11, ever homeless). Previous studies have reported that homeless veterans are high users of ED services [46,54,76,81-85]. Therefore, I performed a descriptive sub-analysis of the FY10 and FY11 homeless variables in order to better understand this group of vulnerable veterans.

Need variables

Need characteristics included clinical variables common in this population, and variables associated with emergency care in prior studies [1-6]. We expected need variables to be strong predictors of ED utilization [69]. Primary diagnosis (ICD-9-CM codes) were identified for each FY10 ED visit and classified using categories identified by the ICD-9-CM tabular index. Conditions included the polytrauma clinical triad of TBI, PTSD and pain. TBI codes are those used by the Armed Forces Health Surveillance Center, PTSD codes are those used to identify PTSD in the VA, and Pain codes included back and neck pain, and other chronic non-cancer pain (e.g., chronic pain, temporomandibular joint pain, neuropathic pain). Other conditions of interest included were headache, substance use disorder, and other mental illness.

Chronic conditions were also identified through ICD-9-CM codes: hypertension, diabetes, obesity, and chronic obstructive pulmonary disease (COPD). Since the extant literature speaks of the association of frequent ED use with the prescribing of opioid pain relievers in the emergency setting, veterans prescribed opioid pain medications in FY10 were also included [46].

I anticipated that certain need variables such as prior hospitalization would have a stronger effect on ED visits counts so I included hospitalization variables for all types of hospitalizations including specialty hospitals like psychiatric, substance abuse, surgical, etc. We also expected to see an increase in the frequency of ED visits post-hospitalization as well. Other important need variables such as the Selim and Elixhauser indexes of physical and mental comorbidities were also expected to have strong effect on the frequency of ED visits [86,87].

Utilization variables

Of the categorical and discrete primary utilization variables of interest in this study, I anticipated that variables used in the models to examine factors associated with utilization would agree with the findings of previous ED utilization studies.

Upon examination, FY11 ED visits had higher mean and variance then FY10 ED visits but lower skewness and kurtosis statistics. Conversely, FY11 Primary Care visits had a lower mean and variance but higher skewness and kurtosis. FY11 Mental Health visits had approximately the same mean, lower variance, and much higher skewness and kurtosis. FY11 Substance abuse clinic visits showed higher mean and variance but lower skewness and kurtosis. As evidenced by the median of zero for ED visits, Mental Health visits, and Substance Abuse Clinic visit counts, we suspected an overabundance of zeros in these variables might signal over-dispersion. I anticipated informative discussions with the student doctoral committee members regarding methods and ideas of how to deal with zero-inflated variables.

Finally, healthcare utilization measures from FY10 that indicated disease burden severity or patterns of healthcare utilization were included. Hospital care received during FY10 was coded as dichotomous measures and based on facility type: emergency care, psychiatric hospitalization, other hospitalization, mental health outpatient care, and substance abuse.

Transformation of utilization variables

The proportion of zeros in the count variables was high, making transformation of these counts into a normal distribution difficult. Transforming zero-inflated variables was problematic. I carefully considered that no may be necessary to truncate the zeros from

the variable before graphing and attempting transformation. Some of the transformations considered were cubic, 1/cubic, square, 1/square, square root, log, 1/square root, inverse, and box cox. I anticipated that interpretation would be a concern for those variables already successfully transformed into normally-distributed variables. Variables that could not be transformed were either left untransformed, carefully evaluated for bias, or divided into categories.

Veteran-specific variables

I expected the Veteran-specific predisposing variables, like the number of years that the veteran has been enrolled in the VA healthcare system, and the number of years since the last deployment, to have a comparatively larger effect. We posited that as a veteran's experience with the VHA grows, so would his knowledge of how to better navigate the system and access the VHA healthcare services. Older veterans tended to have a lot of history in the VHA comparatively, so we had more institutional knowledge and resources to get into the primary care system.

In the case of the variable, *number of years in the VA*, the greater number of years a veteran has been enrolled in the VA healthcare system, the better the veteran understands how to navigate the VA health system and have an increased understanding of the services available. Therefore, I expect to see increasing amounts of primary care

for veterans that have been enrolled for a greater number of years than recent veteran enrollees.

Despite the embarrassment that veterans meeting the VA poverty designation do not pay any copays for healthcare at the VA, we did not anticipate high utilization of VA services for these veterans with the exception of the ED because of lack of transportation. Increased poverty and homelessness were associated with mental illness among veterans [88]. While taking a veteran in need of emergency medical care to the ED was a reasonable request of family and friends, requesting rides for multiple, frequent visits to other services such as primary care or mental health care were not looked upon as favorably.

The exception to this is in cases where these older veterans have a catastrophic event occur that puts them in the ED for care. On the other hand, younger veterans may not be married or have this kind of institutional history with the VHA but because of the nature of the combat during OEF/OIF, they suffered from chronic pain as a result of their combat injuries. As mentioned previously, chronic pain takes time to properly manage and until this pain is adequately managed, these younger veterans may use the ED, seeking prescription pain medications to get symptom relief.

Prior studies that have used the Andersen conceptual model or other common variations like the Gelberg-Andersen model have shown that homeless veterans and those with

pain diagnoses have strong association with frequent ED visits [46]. In keeping with the published results from recent studies of frequent ED users and based on the unique physical and mental illnesses such as TBI, headaches, chronic pain, amputations, and mental illnesses such as PTSD, substance abuse, depression, suicidal ideation, I expect to see a stronger relationship between ED visits for these types of conditions. Furthermore, in line with previous studies, reasons why veterans present to the ED to be for consultative visits, counseling, pain management, prescriptions, headaches, substance abuse, and various mental illnesses [46].

5. ANALYSIS

Understand the data

My plan to provide a comprehensive description of veteran ED use for FY10 used the following analytic methods:

1. *Evaluate the distribution of all variables*:

- For categorical variables, I assessed dispersion, mode, outliers and frequency distributions using histograms/boxplots. Outliers were handled by examining each of four ways: (a) remove, (b) transform, (c) leave as they are, and (d) report results with and without outliers. After all four methods were examined, the option to leave the outliers as they were since attempting to transform them was unsuccessful and removing them made no difference to the results.
- For dichotomous variables, I assessed ranges, measures of central tendency (means, medians, modes), outliers, and frequency distributions using histograms/boxplots.
- For discrete and count variables, I assessed ranges, dispersion, variances, measures of central tendency (means, medians, modes), skewness, kurtosis, outliers, quartiles, and frequency and density distributions using histograms.
- For continuous variables, I assessed ranges, dispersion, variances, standard deviations, measures of central tendency (means, medians, modes), skewness,

kurtosis, and frequency distributions using histograms/scatterplots to check if normal distributed.

2. *Perform and assess pairwise correlations and plot bivariate relationships between the outcome variable and all predictors.* I calculated the covariance statistic to show the direction of the relationship (positive, negative, or 0, meaning no relationship), along with the correlation coefficient, which measures the degree of linearity of the bivariate relationship and is bounded from -1 to +1.

3. *Test bivariate relationships between the outcome variable and all predictor variables*:

- For normally distributed continuous predictor variables, I planned to use t-tests of mean differences in outcomes but there were no normally distributed continuous predictor variables.
    - For non-normally distributed continuous predictor variables, I planned to transform the predictor into a normally distributed variable and if successful, apply the t-test of mean differences in outcomes. If unsuccessful, I planned to use the non-parametric counterpart to the t-test, the Wilcoxon Rank Sum test or categorize the variable based on biologically significant categories and/or categories used in prior studies found in the literature base and then test accordingly. Unfortunately, there were no continuous predictor variables.
- For categorical (nominal) independent variables, I used Chi-squared tests

Because multiple comparisons were performed to find the largest differences among all the bivariate comparisons so I adjusted the significance level using the Bonferroni correction in order to control for the increased false positive error rate [89].

Testing research objective #1

The overall plan to answer RO1 was to run appropriate regression models for the count outcome variable, number of ED visits, and finalized independent variables using Poisson Regression, and if overdispersion is present, use a Negative Binomial Regression model or if overdispersion is present and a overabundance of zeros in the data, then it would be appropriate to use Zero-inflated Poisson or Zero-inflated Negative Binomial Regression models. Zero-inflated regression models consider that there are different types of zeros present in the data and use both Poisson regression and logistic regression to account for these different types of zeros.

Then, I constructed 2x2 tables for each FY using the dichotomized variables for high/low ED use and high/low EDR, as shown in table 21 and table 22 below. Furthermore, to better understand the use of primary care versus the use of the ED by fiscal year, ED visit counts and primary care clinic visit counts for FY10 and FY11 were categorized as 0 visits, 1 visit, 2-3 visits, and 4+ visits and located in tables 19 and 20. The primary group of interest is the group that intersects the 4+ visits for both primary care and ED showed a subgroup that was a frequent ED user but also used similar

amounts of primary care, which may highlight this group. A descriptive analysis was performed to help better understand the characteristics of this group. Groups were compared in tables by fiscal year and assessed for policy implications at the end of the study.

I performed a univariate and bivariate analysis of the data variables through univariate and bivariate analysis, then provided a descriptive analysis of all variables of the OIF/OEF veteran cohort. As a reminder, Table 3 and Table 4 show the study research objectives and associated hypothesis:

Table 3 - Research objective #1 and associated hypotheses

RO1 - Research Objective 1 *Describe and classify OEF/OIF veterans according to ED use, Primary Care Use, and the ratio of ED visits to Primary Care visits (EDR) for FY10/FY11*	
H1a	Utilization of VA services by OEF/OIF veterans will be associated with predisposing, enabling, and need variables
H1b	More than 50% of OEF/OIF veterans in the sample will fall in the low ED use/low EDR subgroup
H1c	A higher proportion of vulnerable OEF/OIF veterans will fall into the high ED use/high EDR subgroup than other veterans in the sample

To answer RO1, I created regression models using counts of each veteran's FY10-FY11 ED visits and independent variables identified from the adapted theoretical model to identify those factors associated with high and low ED use. I then classified ED visits and primary care visits using 0 visits, 1 visit, 2-3 visits, and 4+ visits to create the tables. Finally, I constructed 2x2 tables of High/Low ED use and High/Low EDR for each fiscal year in order to identify distinct subgroups within the frequent ED user group, focusing on veterans with high ED use and high EDR. Characteristics of the High ED use/High

EDR group were quantified and followed up with a descriptive analysis to identify and better understand this subgroup.

Testing hypothesis 1a

To find the most appropriate regression model, I used Poisson regression as the starting point for an outcome variable with count data. I created a Poisson regression model using ED visits as the outcome variable, which consisted of non-negative count data. The Poisson regression model used was:

$$\Pr(Y = y) = \frac{\exp(-\mu)\mu^{y}}{y!}, y = 0, 1, 2, \ldots \quad (1)$$

where

Y = outcome variable of counts of ED visits for the fiscal year

y = non-negative counts of ED visits

μ = the expected number of ED visits for given veteran in a given fiscal year.

An main assumption of the Poisson distribution is that the mean equals the variance. Table 5 revealed that the variance for ED visits for FY10 and FY11 variables were greater than 3 times the mean so we were concerned about overdispersion in the data and decided to investigate further.

Table 4 - Summary of primary dependent variables

Variable	Obs	Mean	Std. Dev.	Min	Max
ed_visits_10	311,377	0.7675551	1.68603	0	67
ed_visits_11	311,377	0.7957171	1.706479	0	45

We decided to exponentiate regression equation results to get incident rate ratios so the results would be easier to interpret. The structure used for the final Poisson regression model we was found below in Equation 2 below:

Equation 1 - Structure of the Poisson regression model equation

$$\boldsymbol{\mu_i = \exp\left(a + X_{1i}\, b_1 + X_{2i}\, b_2 + \ldots + X_{ki}\, b_k\right)} \quad (2)$$

where

μ_i is the expected number of ED visits for the ith observation,

$\alpha = the\ intercept$

b = parameter estimate

X = the parameter estimate

i = the number of the observation

Because we suspected overdispersion, we considered a Negative Binomial Regression model as a solution for the overdispersion in the count data. The Negative Binomial Regression model can be considered a generalized Poisson model since it is the same as the Poisson model but with a parameter for overdispersion.

The equation for the Negative Binomial regression model is:

$$\Pr(Y = y) = \frac{\exp(-\mu)\mu^y}{y!} + \alpha, y = 0, 1, 2, \ldots \quad (3)$$

There is one additional parameter in the negative binomial regression equation: α

α = the over dispersion parameter

Note that when α = 0, the negative binomial distribution is the same as a Poisson distribution. This is because the mean is effectively equal to the variance, which is an assumption of the Poisson distribution.

Long and Freese have stated that over-dispersion commonly occurs with count data in circumstances where there is an excessive amount of zeros in the data [90]. As shown in table 5, since the variance is so much larger than the mean, using a Poisson regression model would not be appropriate. In light of this and the large proportion of zeros in the dependent variable, ED Visits, I anticipated using either a negative binomial or zero-inflated negative binomial regression model to correct for the overdispersion along with the predisposing, enabling, and need independent predictor variables that were found to have the strongest correlations with FY10 and FY11 ED visit counts based on the results of the tests of bivariate relationships performed.

Testing hypothesis 1b

Hypothesis 1b was answered by the 2x2 table shown in table 6 below by comparing the frequencies of cell "D" with the other cell frequencies in table 4. Power was assessed through the chi-squared goodness of fit test. Figure 5 showed the a priori sample size required was 142 for a chi-squared test at 80% power and a significance of 0.05 to show an effect size of 0.3.

Figure 6 - Sample size for 2x2 contingency tables

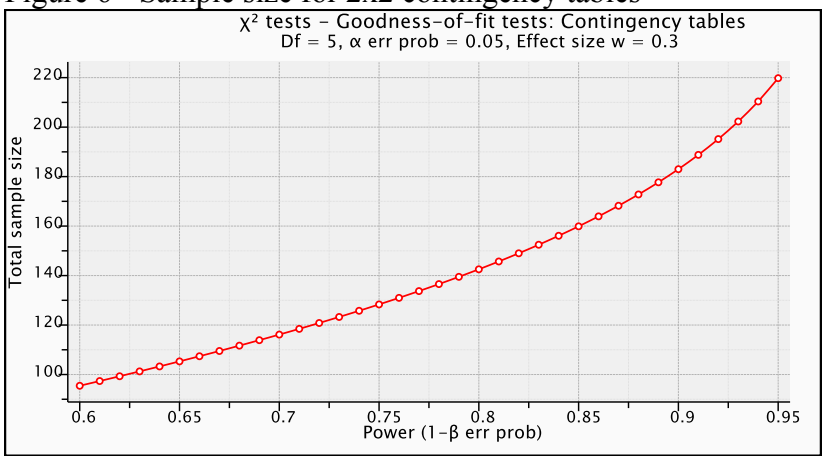


Table 5 – 2x2 table - hypothesis 1b

		ED Use		
		High	Low	Total
EDR	High	A	B	A+B
	Low	C	D	C+D
	Total	A+C	B+D	A+B+C+D

Testing hypothesis 1c

Hypothesis 1c was answered by comparing the frequencies of cell "A" in table 5 with the other cell frequencies for vulnerable veterans and then comparing the frequencies of cell "A" with the other cell frequencies for non-vulnerable veterans.

Figure 5 shows the a priori sample size required is 142 for a chi-squared test at 80% power and a significance of 0.05 to show an effect size of 0.3.

Table 6 – 2x2 table – hypothesis 1c

		ED Use		
		High	Low	Total
EDR	High	A	B	A+B
	Low	C	D	C+D
	Total	A+C	B+D	A+B+C+D

Testing research objective #2

Table 7 - Research objective #2 and associated hypotheses

RO2 - Research Objective 2 *Evaluate the relationship between FY11 ED utilization and FY10 ED utilization using a regression model that accounts for predisposing, enabling and need variables*	
H2a	FY11 ED utilization can be predicted using FY10 ED utilization for OEF/OIF veterans
H2b	Vulnerable OEF/OIF veterans' use of EDs is the same as other, non-vulnerable OEF/OIF veterans

To answer RO2, regression models using FY10 ED visits as the outcome variable along with associated predisposing, enabling, and need variables were used to predict FY11 ED visits followed by a t-test of mean differences to determine if they were statistically

the same. Lastly, I compared vulnerable OIF/OEF veterans' use of EDs with non-vulnerable OIF/OEF veterans' use of the EDs to see if they were the statistically the same using a t-test of mean differences.

Testing hypothesis 2a

I tested hypothesis 2a with a ZINB regression model using FY10 ED visits count outcome variable, adjusted for predisposing, enabling and need variables followed up by an independent t-test of the differences between two dependent means (groups): 1) mean of actual FY11 ED visit counts and; 2) the mean of the predicted FY11 ED counts. A significant test was expected to show differences and that predicted and actual utilizations were not equal.

A prioi power analysis using poisson regression with a significance level of 0.05 and power of 0.80 showed that a sample size of 372 would be required to show a 30% change in effect. This is in line with what Signorini et al., found in his study of sample sizes for Poisson Regression reporting that 406 observations were required with a significance of 0.05 at 80% power [91].

Figures 6 and 7 show the minimum sample sizes required for a t-test of independent means with detectable changes of greater than 0.5 visits and 1 visit (effect size) with zeros and without zeros. The Type I error probability associated with these test of this null hypothesis was 0.05. The N showed the minimum total sample size required to be able to reject the null hypothesis that the population means are equal with probability (power) of 0.8.

Figure 7 - t-test FY10 vs FY11 ED visits (w/zero visits)

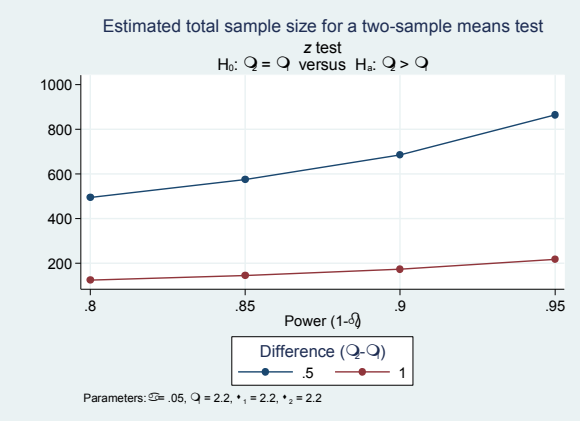


Figure 8 - t-test FY10 vs FY11 ED visits (w/o zero visits)

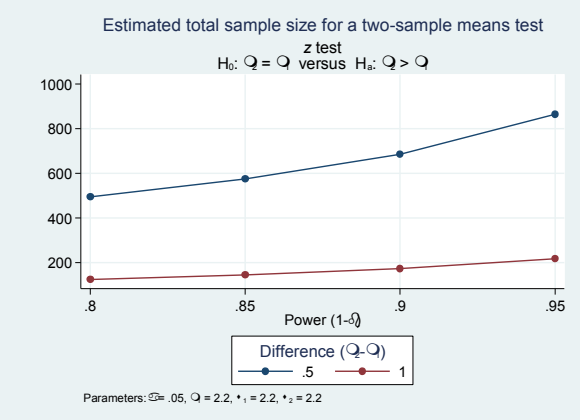


Table 8 – Minimum required sample size for t-test of independent means

	alpha	*power*	*Minimum Sample Size (N)*	*delta (Effect Size)*	*m1*	*m2*	*diff*	*sd1*	*sd2*
With Zeros	0.05	0.8	286	0.5	0.7676	1.268	0.5	1.686	1.706
	0.05	0.8	72	1	0.7676	1.768	1	1.686	1.706
Without Zeros	0.05	0.8	494	0.5	2.214	2.714	0.5	2.235	2.228
	0.05	0.8	124	1	2.214	3.214	1	2.235	2.228

Taking the most conservative estimate, we required a sample size of 494 to detect a difference of 0.5 visits and a sample size of 124 to detect a difference of 1 visit.

Testing hypothesis 2b

To test hypothesis 2b, I created two separate ZINB regression models using ED visit counts from FY10 and FY11 as the outcome variables adjusted by predisposing, enabling, and need independent predictor variables in my final model. Controlling for all other predictors, a significant parameter estimate of the independent dichotomous predictor variable *er_10,* ED visits in FY10 was expected to show that prior utilization significantly affected future utilization.

A prioi power analysis using poisson regression with a significance level of 0.05 and power of 0.80 showed that a sample size of 372 would be required to detect a 30% change in effect.

6. DATA AND SAMPLE

Effect size

My study used a large secondary dataset of national VA data with a very large N of 311,377 veteran patients. Fleiss et al., stated that when using very large sample sizes, even the smallest of differences (effects) will show as statistically significant [92]. For the t-tests of dependent means, I tested for a difference in 0.5 visits and 1 visit. For the regression models, I tested for a 30% change. Because of the large proportion of zeros in the ED count variables, the zeros may heavily influence the mean and standard deviations of the data and where applicable, I performed my a priori sample size calculations using a two-step process: 1) with zeros and; 2) without zeros. I selected the largest, most conservative sample size estimates at a significance level of 0.05 and power at 0.80 for all a priori calculations. All power calculations were performed using G*Power software version 3.1.7. or StataCorp software version 13.1 [93,94].

Missing data

A summary of missing data revealed only eight variables with missing data in the dataset as shown in Table 9 below. The 11 unique values in the variables with missing data range from 0 to 100 in 10 point increments and represent the percentage of VA service-connected disability for veterans over each of the eight years preceding the FY10-FY11

study period (FY02 through FY09). As would be expected, the proportion of missing data dropped over time as veterans become better integrated into VA system and more veterans were coded with a service-connected disability rating.

Table 9 – Summary of missing data

				Obs<.		
Variable	Obs=.	Obs>.	Obs<.	unique values	Min	Max
svcpct_02	298,776		12,601	11	0	100
svcpct_03	294,568		16,809	11	0	100
svcpct_04	278,004		33,373	11	0	100
svcpct_05	255,004		56,373	11	0	100
svcpct_06	225,770		85,607	11	0	100
svcpct_07	194,508		116,869	11	0	100
svcpct_08	152,447		158,930	11	0	100
svcpct_09	99,730		211,647	11	0	100

Sensitivity analysis

I performed a sensitivity analysis to see if the number of visits experienced by an OEF/OIF veteran were consistent from one year into the next year. Looking at raw data in table 10 to see if the number of ED visits matched exactly or a higher number, we found that 78% of veterans had at least the same number of visits from FY10 to FY11. Unsurprisingly, as I lowered the sensitivity as shown in table 11 (+/- one ED visit) and table 12 (+/- two ED visits), the proportion of veterans that showed consistency increased accordingly.

Table 10 - Continuity of ED visits from FY10 to FY11 using raw data

FY10 to FY11 ED Continuity
(Sensitivity = Exact number of ED visits)

	Freq.	Percent	Cum.
No	69,964	22%	22%
Yes	241,413	78%	100%
Total	311,377	100%	

Table 11 - Continuity of ED visits from FY10 to FY11 within +/- one ED visit

FY10 to FY11 ED Continuity
(Sensitivity = +/- one ED visit)

	Freq.	Percent	Cum.
No	56,779	18%	18%
Yes	254,598	82%	100%
Total	311,377	100%	

Table 12 - Continuity of ED visits from FY10 to FY11 within +/- two ED visits

FY10 to FY11 ED Continuity
(Sensitivity = +/- two ED visits)

	Freq.	Percent	Cum.
No	27,042	9%	9%
Yes	284,335	91%	100%
Total	311,377	100%	

7. RESULTS

The goal of this dissertation was to examine and classify distinct high frequency ED user subgroups within the VA to identify those veterans who used the ED as their usual source of care.

After data cleaning, distributions and descriptive statistics of all variables were examined. Utilization variables such as counts of ED visits (dependent variable), ED visits in first year with VA, primary care visits, mental health visits and substance abuse visits were subsequently graphed to visually inspect and view their distributions. Ranges, dispersion, variances, measures of central tendency (means, medians, modes), skewness, kurtosis were also analyzed. Quartiles and and quintiles were created and analyzed as were outliers for influence.

Visual inspection of graphs of utilization variables showed frequency distributions that were non-normally distributed and highly skewed to the right. Each utilization variable was also found to have a predominance of zeros. Use of transformation techniques such as ladders of power and box cox were unsuccessful in normalizing these distributions and each utilization variable was subsequently divided into categories based on the visit frequencies of zero visits, one visit, two to three visits, and four or more visits.

Bivariate and nominal variables were graphed using histograms/boxplots. Ranges, measures of central tendency (means, medians, modes) and outliers were also examined. Significant outliers were handled by running regression models both with and without the significant outliers. In all cases, results were found to be the same so the outliers were kept in the data.

Selection of study variables

Selection of variables for the study was based on predisposing, enabling, need variables found in the adapted theoretical model based on Andersen's Behavioral Model of Health Services Use. Bivariate chi-squared analysis was performed to assess whether there was significant association between the dichotomous dependent variable of high/low ED visits, and other dichotomous and nominal independent variables. Of the bivariate pairs, those combinations with the greatest chi-squared contributions were high ED use, high EDR. The combination of Low ED use/High EDR had the highest chi-squared statistic of the pairings.

I performed bivariate chi-squared tests to reveal the independent variables that had statistically significant associations with high and low ED use. Because the chi-squared statistic does not assess the strength or direction of the relationship between the pairs, I followed up with a correlation analysis of those various pairs of variables. The largest chi-squared contributions in these 2x2 relationships in the chi-squared analysis revealed

the strength of each of these relationships along with the covariance statistic which showed the direction of the relationship between the dependent and independent variables.

An overview of the veteran population in the United States is helpful to properly frame the study sample population as a subset of this larger group. As of 2013, there were approximately 22.3 million living veterans [95]. The National Center for Veterans Analysis and Statistics (NCVAS) reported Post 9-11 OIF/OEF/OND veterans numbered 2.6 million in 2013 and has projected this population to increase roughly 36% to 3.9 million by the year 2019 [96].

Overall, OIF/OEF veterans are younger than Vietnam veterans but still older on average than other veterans were during the time they served in prior conflicts. As mentioned previously, most troops during the Vietnam era were younger, below 21 years of age and unmarried, with a predominantly male population [16]. This study sample revealed no significant differences with the median age of Post 9-11 male veterans having a median age of 33 and females a median age of 32 [96]. The median age for all other current living veterans was reported to be significantly older with the median age for males at 65 and 55 for females [96].

The numbers of Post 9-11 women veterans grew an average of 1.2% annually from 2005 through 2013 and the number of women users of VA benefits grew by 4.7% during that same time period [96].

As to the use of VA healthcare, NCVAS reported that fewer Post-9/11 veterans enrolled in VA health care compared to all other veteran groups and utilized the VA health care system at a lower rate than all other veterans [96].

Selected predisposing variables

Predisposing variables were characterized by demographic variables such as gender and race. Predisposing variables were personified by their unchanging nature and are often described as immutable at the individual level. Although age did change at the individual level over time, the age variable was categorized, and as such, changed from one category to another category relatively infrequently. The variable married would have been included in Andersen's original model as a predisposing variable because at that time, divorce was an infrequent occurrence. Based on changing demographics and a significantly higher divorce rate in the U.S., I decided to move the dichotomous variable married in our adjusted model to an enabling variable type instead of a predisposing/. Table 13 below shows the frequencies and percentages of the predisposing variables selected for this study.

According to the 2010 National Survey of Veterans (NSV), the projected veteran population for FY10 was 23,067,000 with 1,824,000 total female veterans accounting for approximately 8 percent of the total veteran population [97]. The study sample of OIF/OEF women veterans using VHA healthcare accounted for 40,944 or 13.1% of the sample population, showing a much higher percentage of women than the national veteran population, perhaps revealing that higher percentages of women from this cohort use the VA healthcare system more than other women veterans. The study sample showed a lower percentage of whites (63.4%) had at least one visit in the VHA in FY10 compared to national-level veteran race/ethnicity statistics showing whites comprising 79.3% of the veteran population. Minorities, including Blacks and Hispanics, were over-represented in the sample with 17.1% of Blacks and 11.8% of Hispanics having at least one visit in the VHA healthcare system in FY10 compared to only 11.3% of the total veteran population in FY10 being Black and 5.8% being Hispanic.

Table 13 – Selected predisposing variables

Predisposing Variable	Freq	%
Age		
Ages 17-30	127,740	41.0%
Ages 31-40	86,789	27.9%
Ages 41+	96,848	31.1%
Gender		
Female	40,944	13.1%
Male	270,433	86.9%
Race/Ethnicity		
White	197,421	63.4%
Black	53,250	17.1%
Hispanic	36,621	11.8%
Other	24,085	7.7%

Looking at demographic or predisposing variables, out of 311, 377 veterans in the sample, 127,740 or 41.0% were age 30 and younger; and 183,637 were over 30 years of age. Looking at gender revealed 270,433 or 86.9% of veterans were male; and 40,944 or 13.1% were female. Examination of race revealed 197,421 or 63.4% characterized as white; 53,250 or 17.1% as Black or African American; 36,621 or 11.8% as Hispanic or Latino; and 24,085 or 7.7% characterized as Other (Asian, Pacific Islander, American Indian, 2 or more races, or unknown). Veterans meeting the a priori criteria established for a vulnerable veteran numbered 247,242 (79.4%) while 64,135 or 20.6% did not meet the criteria to be considered vulnerable.

Selected enabling variables

Enabling variables distinguish those characteristics that help to facilitate access to health care. Marriage, Health insurance and family income are common enabling variables. As opposed to predisposing variables, enabling variables are more changeable and fluid at the individual level and can change over time. Table 14 reveals the frequencies and percentages of the enabling variables selected for this study by the theoretical model.

Table 14 – Selected enabling variables

Enabling Variable	Freq	%
Married		
No	170,522	54.8%
Yes	140,855	45.2%
Vulnerable Veteran		
No	64,135	20.6%
Yes	247,242	79.4%
Service Connected Disability		
No	104,223	33.5%
Yes	207,154	66.5%
Poor		
No	82,950	26.6%
Yes	228,427	73.4%
Homeless		
No	306,108	98.3%
Yes	5,269	1.7%

NCVAS highlighted the differences between Post-9/11 male and female veterans revealing that male veterans were more likely to be married while women veterans were more likely to be divorced, widowed or separated [96]. In the remaining category, "never married", there was no significant differences reported between Post 9-11 male and female veterans in that category [96]. Indeed, of the 311,377 veterans in the sample, 140,855 or 45.2% were married while (170,522 or 54.8%) were not married (single, divorced, separated, or widowed).

Being designated by the VA as having a service-connected disability was seen as a type of health insurance as the VA provides care for all service-connected conditions without cost to the veteran. Since VA service-connected disability or homelessness were major factors in identifying a veteran as vulnerable in this study, the variable "vulnerable" was

also be used as a proxy for health insurance and therefore was considered an enabling variable. Vulnerable veterans as defined in this study comprised the majority of the sample with 247,242 (79.4%). 64,135 veterans or 20.6% of the sample were not defined as vulnerable. Slightly less or 207,154 (66.5%) veterans were found to have a VA service-connected disability while 104,223 or 33.5% did not have a VA service-connected disability.

The VA poverty determination was used as a proxy for whether or not a veteran was considered "poor". In this study, veterans identified as exempt from the VA copays were considered to be in the "poor" category. The descriptive analysis revealed 65,767 or 21.1% were considered exempt from the VA copay and therefore "poor" as opposed to 245,610 or 79% who were not exempt from the VA copay requirement. Another variable used as a proxy for whether or not a veteran is considered "poor" is homelessness. Homeless veterans numbered 5,269 (1.7%) while 306,108 or 98.3% were not designated as homeless.

Selected need variables

Need variables are characterized by two main components: 1) Perceived need – an individual's recognition of symptoms or illness that increases their desire to seek medical care and; 2) Evaluated need – an individual's recognition of symptoms or illness

or receipt of a medical diagnosis of an illness. Both of these components act as an impetus to increase an individual's desire to engage in the medical care process.

There are many reasons that veterans seek ED care. Perceived needs are revealed in the veteran's reason for their ED visit while evaluated needs are revealed in the medical diagnosis veteran patients received at the ED visit along with the health status indicators showing numbers of comorbidities, and hospitalizations by facility type. Table 15 shows the frequencies and percentages of perceived need variables selected for this study.

Table 15 – Selected Need Variables (Perceived)

Perceived Need Variable	Freq	%
Counseling ED Visit		
No	262,318	84.2%
Yes	49,059	15.8%
Pain ED Visit		
No	293,041	94.1%
Yes	18,336	5.9%
Symptoms & Signs ED Visit		
No	294,748	94.7%
Yes	16,629	5.3%
Consultation ED Visit		
No	299,619	96.2%
Yes	11,758	3.8%
Injury/Poison ED Visit		
No	297,854	95.7%
Yes	13,523	4.3%
Prescription ED Visit		
No	307,462	98.7%
Yes	3,915	1.3%
Headache ED Visit		
No	308,016	98.9%
Yes	3,361	1.1%
Health Status ED Visit		
No	307,897	98.9%

Table 15 Continued

Perceived Need Variable	Freq	%
Yes	3,480	1.1%
Other Mental Illness ED Visit		
No	308,538	99.1%
Yes	2,839	0.9%
Substance Abuse ED Visit		
No	309,134	99.3%
Yes	2,243	0.7%
PTSD ED Visit		
No	308,649	99.1%
Yes	2,728	0.9%
Depression ED Visit		
No	308,832	99.2%
Yes	2,545	0.8%
Anxiety ED Visit		
No	309,607	99.4%
Yes	1,770	0.6%
Respiratory System ED visit		
No	298,211	95.8%
Yes	13,166	4.2%

Table 16 displays the frequencies and percentages of evaluated need variables selected for this study.

Table 16 – Selected Need Variables (Evaluated)

Evaluated Need Variable	Freq	%
Rx-Opioid Analgesics		
No	253,491	81.4%
Yes	57,886	18.6%
Dx-COPD		
No	300,665	96.6%
Yes	10,712	3.4%
Dx-Diabetes		
No	302,506	97.2%
Yes	8,871	2.8%
Dx-HBP		
No	267,114	85.8%

Table 16 Continued

Evaluated Need Variable	Freq	%
Yes	44,263	14.2%
Dx-Low Blood Pressure		
No	233,773	75.1%
Yes	77,604	24.9%
Dx Pain		
No	203,253	65.3%
Yes	108,124	34.7%
Dx Headache		
No	275,819	88.6%
Yes	35,558	11.4%
Dx Bipolar		
No	300,671	96.6%
Yes	10,706	3.4%
Dx Depression		
No	245,090	78.7%
Yes	66,287	21.3%
Dx Substance Abuse		
No	279,732	89.8%
Yes	31,645	10.2%
Dx Anxiety		
No	277,687	89.2%
Yes	33,690	10.8%
Dx PTSD		
No	214,347	68.8%
Yes	97,030	31.2%
Dx Elix 33		
No	281,115	90.3%
Yes	30,262	9.7%
Dx-Alcohol		
No	285,717	91.8%
Yes	25,660	8.2%
Dx-Anxiety		
No	277,687	89.2%
Yes	33,690	10.8%
# of Physical Comorbidities		
0 comorbidities	175,355	56.3%
1 comorbidity	91,550	29.4%
2-3 comorbidities	41,148	13.2%
4+ comorbidities	3,324	1.1%
# of Physical Comorbidities Ever		
0 comorbities	134,036	43.0%

Table 16 Continued

Evaluated Need Variable	Freq	%
1 comorbidity	104,434	33.5%
2-3 comorbidities	62,738	20.1%
4+ comorbidities	10,169	3.3%
# of Mental Health Comorbidities		
0 comorbidities	174,067	55.9%
1 comorbidity	66,692	21.4%
2-3 comorbidities	65,832	21.1%
4+ comorbidities	4,786	1.5%
Any Hospitalization in First VA Year		
No	302,600	97.2%
Yes	8,777	2.8%
Any Hospitalization		
No	299,161	96.1%
Yes	12,216	3.9%
Psychiatric Hospital		
No	304,630	97.8%
Yes	6,747	2.2%
Surgical Hospitalization		
No	309,628	99.4%
Yes	1,749	0.6%

Comparing the frequencies and percentages of perceived and evaluated need variables was instructive and yielded some interesting results. An analysis of direct comparisons between matched perceived need variables and the same evaluated need variables, revealed the percentages of those veterans with perceived needs to be much lower than the corresponding evaluated needs.

In FY10, 18,336 veterans perceived pain as the reason for their ED visit, which accounted for only 5.9% of the sample while almost six times as many veterans (108,124 or 34.7%) were given a diagnosis of pain stemming from a visit to the ED. Interestingly,

18.6% of the sample or 57,886 veterans were given an opioid prescription for pain during their ED visit accounting for 53.6% of veterans given a diagnosis of pain and three times the number of veterans whose reason for the ED visit was pain.

Reasons for mental health visits to the ED by veterans in the sample were for perceived mental illness (2,839 or 0.9%) while specific mental health illness reasons for visits to the ED such as substance abuse, PTSD, depression, and anxiety were all found to have both matching perceived needs (reason for ED visit) and evaluated needs (diagnosis).

Only a small percentage of OIF/OEF veterans (2,243 or 0.7%) had substance abuse as the reason for their ED visit while the number of veterans diagnosed with substance abuse was over fourteen times greater (31,645 or 10.2%). A similar result was found when examining depression. 2,545 or 0.8% of veterans used the ED for the reason of depression. Likewise, veterans were shown to have 26.6 times more veterans diagnosed with depression by the ED (66,287 or 21.3%). Other mental health variables that had similar results with 2,728 (0.9%) veterans going to the ED visit for PTSD while 97,030 or 31.2% of veterans were diagnosed with PTSD.

Results for FY10 show that 49,059 or 15.8% of veterans in the sample went to the ED in need of a counseling visit. 16,629 (5.3%) had signs or symptoms that prompted them to go to the ED. 11,758 (3.8%) went to the ED for a consultation visit, while 13,523or 4.3% went for an injury or poison-related issue. While a small amount of veterans (3,915

or 1.3%) went to the ED to get a prescription, slightly smaller numbers of veterans (3,361 or 1.1% and 3,480 or 1.1%) went to the ED for Headache or a Health Status visit respectively. Respiratory system concerns had 13,166 veterans (4.2%) seeking care in the ED.

The veterans in the study sample were diagnosed with a medical condition in the ED or had a hospitalization in FY10. Also, numbers of diagnosed veteran comorbidities were calculated using a popular measure of health status created by Selim et al. [87].

Results spotlighted that 108,124 (34.7%) of the 311,377 veterans in the sample received a pain diagnosis. Just over half of those veterans (57,886 or 18.6%) received a prescription for opioids. In the ED, 10,712 or 3.4% received a diagnosis of COPD. 8,871 (2.8%) were diagnosed with diabetes. 44,263 veterans (14.2%) of the sample were diagnosed with high blood pressure while 77,604 or 24.9% were given a diagnosis of low blood pressure. Headache was diagnosed for 35,558 or 11.4% of veterans in the sample.

Mental health diagnoses given to veterans during FY10 are presented. 10,706 or 3.4% of veterans in the sample received a diagnosis of bipolar disorder. A diagnosis of depression was given to 66,287 (21.3%) veterans. 31,645 or 10.2% were diagnosed with substance abuse issues. Anxiety was diagnosed for 33,690 veterans comprising 10.8% of the study sample. PTSD was diagnosed for 97,030 or 31.2% of veterans in the sample

The number of diagnosed comorbidities that a veteran has may provide important information about the health status of veterans. In this study, the widely used index from Selim was available and used to assess the health status of veterans. The two types of comorbidities available in the sample data were physical and mental health comorbidities. I found that in general, the greater the number of physical and/or mental comorbidities present, the poorer the expected health status of the veteran.

Results showed that a majority of veterans in the sample (175,355 or 56.3%) had zero physical comorbidities, 91,550 (29.4%) had a single physical comorbidity, 41,148 or 13.2% were found to have two or three physical comorbidities, and 3,324 (1.1%) had four or more comorbidities. Looking over the lifetime of the veteran, 134,036 (43.0%) of veterans had zero physical comorbidities, 104,434 (33.5%) had one comorbidity, 62,738 veterans or 20.1% of the sample had two or three comorbidities, and 10,169 (3.3%) had four or more comorbidities indicating an overall poorer health status.

Results for veterans with mental health comorbidities were similar in that the majority (174,067 or 55.9%) had zero or mental health comorbidities. 66,692 (21.4%) had only one mental health comorbidity, while a similar number (65,832 or 21.1%) had two or three comorbidities. Finally, those with four or more comorbidities numbered 4,786 or 1.5% of the veterans in the sample. Hospitalizations also fell under the category of evaluated need variables. Results indicated that in FY10, 8,777 veterans or 2.8% of the

sample had experienced a hospitalization during their first year in the VA healthcare system. 12,216 (3.9%) veterans in the sample had at least one hospitalization in FY10 along with 6,747 (2.2%) hospitalizations in a psychiatric hospital and 1,749 or 0.6% hospitalized in a surgical hospital.

Selected utilization variables

Utilization variables showed the total number of medical visits by clinic over FY10 by veterans in the sample. Table 17 below shows the descriptive statistics for the VHA outpatient services utilization count variables in this study. As displayed, the outcome variable, ED visits, had a mean (M) of 0.77 ED visits with a standard deviation (SD) of 1.69. Primary care visits had a mean of 2.29 visits (SD = 2.43); Mental Health visits had a mean of 2.61 visits (SD = 8.29); and Substance Abuse visits had a mean of 0.79 (SD = 7.69).

Table 17 - Descriptive statistics of selected utilization variables

Utilization Variable	N	M	SD	min	max	var	skew	kurtosis
Emergency Room visit	311377	0.77	1.69	0	67	2.84	5.59	69.40
Primary Care visit	311377	2.29	2.43	0	115	5.93	4.14	57.35
Mental Health visit	311377	2.61	8.29	0	1098	68.79	21.95	1489.29
Substance Abuse visit	311377	0.79	7.69	0	547	59.10	21.65	796.59

The distribution of utilization variables were also graphed revealing that the distribution of the outcome variable, ED visits, and other utilization variables (primary care visits, mental health visits, substance abuse visits) were all found to be highly skewed to the right and revealed an abundance of zero visits, which is very often seen in count data. In this case, the predominance of zeros was expected since the majority of veteran patients seen by the VHA are managed through a primary care physician and only presented for care occasionally according to the mean number of visits. Table 18 shows the frequencies and percentages of utilization variables selected for this study.

Table 18 – Selected utilization variables

Utilization Variable	Freq	%
ED Visits First Year in VA		
0 visits	226,514	72.7%
1 visit	48,598	15.6%
2-3 visits	27,347	8.8%
4+ visits	8,918	2.9%
ED Visits		
0 visits	130,059	62.8%
1 visit	38,448	18.6%
2-3 visits	25,711	12.4%
4+ visits	12,936	6.2%
Primary Care Clinic Visits		
0 visits	50,649	16.3%
1 visit	91,039	29.2%
2-3 visits	107,058	34.4%
4+ visits	62,631	20.1%
Mental Health Clinic Visits		
0 Visits	174,714	56.1%
1 Visit	39,649	12.7%
2-3 visits	36,624	11.8%
4+ visits	60,390	19.4%

Table 18 Continued

Utilization Variable	Freq	%
Substance Abuse Clinic Visits		
0 Visits	296,870	95.3%
1 Visit	4,127	1.3%
2-3 visits	2,550	0.8%
4+ visits	7,830	2.5%

An examination of a veteran's utilization in their first year in the VA healthcare system is helpful because it may provide an indication of their initial health status at the time of entry into the VA system. Looking at the number of ED visits in veteran's first year in the VA indicated that 226,514 or 72.7% had zero visits, 48,598 or 15.6% had a single ED visit, 27,347 or 8.8% had either two or three visits to a VA ED and 8,918 or 2.9% had four or more visits. In FY10, veterans experienced increased proportions of ED visits compared to their first year in VA system. While about 10 percent fewer veterans, or 130,059 (62.8%) had zero ED visits, 38,448 (18.6%) had a single ED visit, 25,711 (12.4%) had either two or three visits to a VA ED and 12,936 (6.2%) had four or more visits.

The primary care clinic was identified as a usual source of care for veterans in this sample of 311,377 veterans as evidenced by 50,649 or 16.3% of veterans in the sample having zero primary care visits in FY10. 91,039 (29.2%) had a single primary care clinic visit while 107,058 (34.4%) had two or three visits, and 62,631 or 20.1% had four or more visits.

A look at FY10 mental health visits found that 174,714 or 56.1% of veterans did not have any mental health clinic visits, while 39,649 or 12.7% had a single visit, 36,624 (11.8%) had either two or three visits to a VA ED and 60,390 (19.4%) had four or more visits.

While the data showed that the vast majority of veterans (296,870 or 95.3%) did not have any Substance abuse clinic visits in FY10. 4,127 or 1.3% of veterans had a single visit. A smaller number of veterans (2,550 or 0.8%) had two or three visits, and 7,830 or 2.5% had 4 or more visits.

Research objective #1 results

Table 19 - Research objective #1 results

RO1 - Research Objective 1 *Describe and classify OEF/OIF veterans according to ED use, Primary Care Use, and the ratio of ED visits to Primary Care visits (EDR) for FY10/FY11*	
H1a	Utilization of VA services by OEF/OIF veterans will be associated with predisposing, enabling, and need variables
H1b	More than 50% of OEF/OIF veterans in the sample will fall in the low ED use/low EDR subgroup
H1c	A higher proportion of vulnerable OEF/OIF veterans will fall into the high ED use/high EDR subgroup than other veterans in the sample

Research objective #1 was to describe and classify OEF/OIF veterans according to ED use, primary care use, and the ratio of ED to primary care (EDR) for FY10/FY11. Below

in table 19, we show FY10 ED visits and FY10 primary care visits for 0 visits, 1 visit, 2-3 visits and 4+ visits.

Table 20 – Crosstab of FY10 ED and FY10 Primary Care visits

		FY10 Primary Care Visits				
		0 Visits	1 Visit	2-3 Visits	4+ Visits	Total
FY10 ED Visits	0 Visits	34,391***	68,902***	69,701	30,419***	203,413
	1 Visit	10,502***	3,230***	19,708	12,977***	56,417
	2-3 Visits	4,607***	6,789***	12,678**	11,276***	35,350
	4+ Visits	1,149***	2,118***	4,971***	7,959***	16,197
	Total	50,649	91,039	107,058	62,631	311,377

chi2(9) = 1.8e+04, Pr < 0.0001
Note: ***p<0.0000, **p<0.01, *p<0.05

Table 21 – Crosstab of FY11 ED and FY11 Primary Care visits

		FY11 Primary Care Visits				
		0 Visits	1 Visit	2-3 Visits	4+ Visits	Total
FY11 ED Visits	0 Visits	42,793***	69,150***	62,449***	25,967***	200,359
	1 Visit	12,065***	14,145***	19,342***	11,852***	57,404
	2-3 Visits	5,343***	7,550***	12,994***	10,715***	36,602
	4+ Visits	1,367***	2,281***	5,270	8,094***	17,012
	Total	61,568	93,126	100,055	56,628	311,377

Pearson chi2(9) = 2.1e+04 Pr = 0.000
Note: ***p<0.0000, **p<0.01, *p<0.05

Results of the cross-tabulation of ED visits and primary care visits above showed an overall significant relationship between ED visits and primary care visits (chi2(9) = 1.8e+04, Pr < 0.0001). Veterans with zero ED visits were most strongly associated with 4+ primary care visits (chi2(9) = 2692.5, Pr < 0.0001) followed by 1 primary care visit (chi2(9) = 1494.9, Pr < 0.0001). Zero ED visits was also associated with zero primary

care visits (chi2(9) = 51.4, Pr = 7.534e-13) but was not significantly associated with 2-3 primary care visits (chi2(9) = 0.8, Pr = .3711).

Veterans with one ED visit were most strongly associated with 1 primary care visit (chi2(9) = 646.3, Pr = 1.42e-142) followed by 4+ primary care visits (chi2(9) = 233.9, Pr = 8.411e-53). One ED visit was also associated with zero primary care visits (chi2(1) = 191.3, Pr = 1.654e-43). One ED visit was also associated with 2-3 primary care visits (chi2(9) = 5, Pr = 0.0253).

Those veterans with 2-3 ED visits were most strongly associated with 4+ primary care visits (chi2(9) = 2440.4, Pr < 0.0001) followed by 1 primary care visits (chi2(9) = 1216.9, Pr = 1.30e-266). 2-3 ED visits was also associated with zero primary care visits (chi2(9) = 227.2, Pr = 2.432e-51) as was 2-3 primary care visits (chi2(9) = 22.6, Pr = 1.995e-06).

Finally, results highlighted that veterans that utilized 4 or more ED visits in a year were most strongly associated with 4+ primary care visits (chi2(9) = 6783.6, Pr < 0.0001) followed by 1 primary care visits (chi2(9) = 1446.9, Pr < 0.0001). 4 or more ED visits were also associated with zero primary care visits (chi2(9) = 837.7, Pr = 3.43e-184) and was also significantly associated with 2-3 primary care visits (chi2(9) = 64.2, Pr = 1.124e-15).

Previous studies on frequent ED use were considered and the ED visits variable was scrutinized using quartiles, centiles, along with mean and median of the 4th quartile and the 95th percentile. 4 or more ED visits in a year was determined to be the cutoff to identify high or frequent ED use. High FY10 ED use was defined as 4 or more annual ED visits based on the top 5% of ED visits and the mean of the number of visits in the 4th quartile of the distribution.

After an examination of the EDR variable using quartiles, centiles, and the mean and median of the 4th quartile and 90th percentile, High FY10 EDR was defined as greater than or equal to an EDR of 1.28. This value fell within the top 10% of the data and the mean of the 4th quartile of the distribution for FY10 EDR.

Table 21 presents the cross tabulation of the FY10 dichotomous variables High/Low ED use and High/Low EDR. This 2x2 table was created to identify distinct subgroups within the frequent or high ED user group. The resulting grids in tables 15-20 are characterized by the four cross sections: 1) Low ED use and Low EDR; 2) Low ED use and High EDR; 3) High ED use and Low EDR and; 4) High ED use and High EDR. Because the results from the FY10 and FY11 tables are almost identical and in order to spare the reader from having to read very similar results from both FY10 and FY11, we will only discuss the detailed results of the various FY10 2x2 tables.

All four of these pairwise comparisons were statistically significant with Low ED and Low EDR (chi2(1) = 513.5, Pr = 1.10e-113), Low ED use and High EDR (chi2(1) = 850.4, Pr = 5.95e-187), High ED use and Low EDR (chi2(1) = 9358.9, Pr < 0.0001) and High ED use and High EDR (chi2(1) = 15498.6, Pr < 0.0001). Overall, High ED use and High EDR pair was the most significant.

Table 22 – Crosstab of FY10 ED use and FY10 EDR

		ED Reliance (EDR)		
		Low	High	Total
ED use	Low	193,766***	101,414***	295,180
	High	377***	15,820***	16,197
	Total	194,143	117,234	311,377

Pearson chi2(1) = 2.6e+04 Pr < 0.0001
Note: ***p<0.0000, **p<0.01, *p<0.05

Table 23 – Crosstab of FY11 ED use and FY11 EDR

		ED Reliance (EDR)		
		Low	High	Total
ED use	Low	182,354***	112,011***	294,365
	High	695***	16,317***	17,012
	Total	183,049	128,328	311,377

Pearson chi2(1) = 2.2e+04 Pr < 0.0001
Note: ***p<0.0000, **p<0.01, *p<0.05

Hypothesis 1b stated that more than 50% of OEF/OIF veterans in the sample would fall into the low ED use/low EDR subgroup. Results of the 2x2 cross tabulation of ED visits

and EDR showed that hypothesis 1b was supported in that the majority of veterans (193,766 or 62% for FY10 and 182,354 or 59% for FY11) in the sample fell into the low ED use/Low EDR subgroup. An overall significant relationship was found between ED visits and EDR (chi2(1) = 2.6e+04 Pr < 0.0001).

Table 24 - Crosstab of FY10 ED use and FY10 EDR for vulnerable veterans

		ED Reliance (EDR)		
		Low	High	Total
ED use	Low	156,370***	76,044***	232,414
	High	374***	14,454***	14,828
	Total	156,744	90,498	247,242

Pearson chi2(1) = 2.5e+04 Pr = 0.000
Note: ***p<0.0000, **p<0.01, *p<0.05

Table 25 - Crosstab of FY10 ED use and FY10 EDR for non-vulnerable veterans

		ED Reliance (EDR)		
		Low	High	Total
ED use	Low	37,396***	25,370***	62,766
	High	3***	1,366***	1,369
	Total	37,399	26,736	64,135

Pearson chi2(1) = 1.9e+03 Pr = 0.000
Note: ***p<0.0000, **p<0.01, *p<0.05

Table 26 - Crosstab of FY11 ED use and FY11 EDR for vulnerable veterans

		ED Reliance (EDR)		
		Low	High	Total
ED use	Low	147,294	84,636	231,930
	High	676	14,636	15,312
	Total	147,970	99,272	247,242

Pearson chi2(1) = 2.1e+04 Pr = 0.000
Note: ***p<0.0000, **p<0.01, *p<0.05

Table 27 - Crosstab of FY11 ED use and FY11 EDR for non-vulnerable veterans

		ED Reliance (EDR)		
		Low	High	Total
ED use	Low	35,060	27,375	62,435
	High	19	1,681	1,700
	Total	35,079	29,056	64,135

Pearson chi2(1) = 2.0e+03 Pr = 0.000
Note: ***p<0.0000, **p<0.01, *p<0.05

Hypothesis 1c stated that a higher proportion of vulnerable OEF/OIF veterans would fall into the high ED use/high EDR subgroup than other veterans in the sample

Results of the 2x2 cross tabulation of ED visits and EDR for vulnerable veterans and non-vulnerable veterans showed that hypothesis 1c was not supported in that the proportion of vulnerable veterans in the high ED use/high EDR subgroup was a mere 6% for vulnerable veterans in both FY10 and FY11. The remaining proportions of vulnerable veterans were 63% for the FY10 low ED use/low EDR subgroup (59% for

FY11), 31% for the FY10 low ED use/high EDR subgroup (34% for FY11) and 0% for both the FY10 and FY11 high ED use/Low EDR subgroups.

The proportions of non-vulnerable veterans in the high ED use/high EDR subgroup were 2% (3% in FY11). The proportions in the remaining categories for FY10 non-vulnerable veterans was 58% for the low ED use/low EDR (55% for FY11) subgroup, 40% for the low ED use/high EDR (43% in FY11) subgroup and 0% for FY10 and FY11 in the high ED use/Low EDR subgroups. An overall significant relationship existed between ED visits and EDR for both vulnerable veterans (chi2(1) = 2.5e+04, $P < 0.0001$) and non-vulnerable veterans (Pearson chi2(1) = 1.9e+03, $P<0.0001$) was found.

Table 24 showed that for vulnerable veterans, all four pairwise comparisons were statistically significant with Low ED and Low EDR (chi2(1) = 553, $P < 0.0001$), Low ED use and High EDR (chi2(1) = 958, $Pr < 0.0001$), High ED use and Low EDR (chi2(1) = 8667, $Pr < 0.0001$) and High ED use and High EDR (chi2(1) = 15,012, $Pr < 0.0001$). For vulnerable veterans, the High ED use and High EDR pair was the most significant. Similarly, Table 25 showed that for non-vulnerable veterans, all four pairwise comparisons were statistically significant with Low ED and Low EDR (chi2(1) = 17.3, $P < 3.191869e-05$), Low ED use and High EDR (chi2(1) = 24.2, $Pr < 8.683228e-07$), High ED use and Low EDR (chi2(1) = 792.3, $Pr < 0.0001$) and High ED use and High EDR (chi2(1) = 1108.3, $Pr < 0.0001$). Comparing results between FY10 and FY11,

all veterans and both vulnerable and non-vulnerable veterans had the most statistically significant relationship in the High ED use/High EDR subgroup.

Multivariate regression model results

To answer hypothesis 1a, which stated "Utilization of VA services by OEF/OIF veterans will be associated with predisposing, enabling, and need variables", multivariate regression models were explored in order to determine whether the various factors were associated with those independent predisposing, enabling, and need variables from the theoretical model and to see if they were able to predict ED utilization in the sample.

The initial Poisson multivariate regression model used was:

Expected FY10 ED Visits = exponentiated (a + (Age)* b_1 + (male) * b_2 + (married)* b_3+ (race)* b_4 + (vulnerable)* b_5 + (service disabled)* b_6 + (poor)* b_7 + (homeless)* b_8 + (counseling ED visit)* b_9 + (pain ED visit)* b_{10} + (symptoms ED visit)* b_{11} + (consultation ED visit)* b_{12} + (Injury/Poison ED visit)* b_{13} + (Prescription ED visit)* b_{14} + (Opioid prescription ED visit)* b_{15} + (headache ED visit)* b_{16} + (health status ED visit)* b_{17} + (other mental health ED visit)* b_{18} + (substance abuse ED visit)* b_{19}+ (PTSD ED visit)* b_{20} + (Depression ED visit)* b_{21} + (Anxiety ED visit)* b_{22} + (Dx-respiratory)* b_{23} + (Dx-COPD)* b_{24} + (Dx-Diabetes)* b_{25} + (Dx-hypertension)* b_{26} + (Dx-low blood pressure)* b_{27} + (Dx-pain)* b_{28} + (Dx-bipolar)* b_{29} + (Dx-anxiety)* b_{30} +

(Dx-Depression)* b_{31} + (Dx-substance abuse)* b_{32} + (Dx-PTSD)* b_{33} + (Dx-headache)* b_{34} + (# of Selim physical comorbities)* b_{35} + (# of Selim mental comorbities)* b_{36} + (# of Selim physical comorbities - ever)* b_{37} + (Any hospitalization – VA year 1)* b_{38} + (Any hospitalization – FY10)* b_{39} + (Any hospitalization - phychiatric)* b_{40} + (Any hospitalization - surgical)* b_{41} + (any medical hospitalization – not neuro)* b_{42} + (substance abuse hospitalization)* b_{43} + (ED visits – VA year 1)* b_{44} + (FY10 mental health visits)* b_{45} + (FY10 substance abuse visits)* b_{46} + (FY10 primary care visits)* b_{47})

In order to best determine the appropriate regression model for this count outcome variable, ED visits, I graphed observed proportions of the counts of ED visits with both Poisson and Negative Binomial probabilities using the Stata command "nbvargr" in figure 10 below [93,98]. Upon initial inspection of the graph, the poisson regression model significantly under predicted the proportion of patients that had zero ED visits, while it over predicted the proportion of one and two ED visits. The model did accurately predict three visits and then slightly under predicted 4 or more visits. The negative binomial regression model predicted the observed data almost exactly, with only a slight under prediction of the proportion of patients that had only one visit.

Poisson probabilities were computed using the mean of ED visits of 0.7675551 and rounded to 0.7676. Negative binomial probabilities were calculated using this same mean to estimate the alpha (over dispersion) parameter. The alpha parameter estimate

was calculated at 2.647 showing a high probability of over dispersion in the count data., I would have expected the alpha statistic to be close to 0 if over dispersion was not a concern. When the alpha is effectively zero, the entire model collapses into a Poisson regression model. However, there was an overabundance of zeros (65.33%) in the outcome variable ED visits, and as such, I was not surprised to find the condition of over dispersion, which is common in count data with a high number of zeros. The parameter estimate of 2.65 indicated significant over dispersion of the data.

The statistical solution that I used to account for the over dispersion in the count data was to use a negative binomial regression model [99]. However, because the data also had over dispersion with an overabundance of zeros, I decided to investigate using a zero-inflated negative regression model. In the sample, FY10 – 65.3% of veterans had zero visits, FY11 – 64.3% of veterans had zero visits. I used the Stata command "countfit" to compare Poisson, negative binomial, zero-inflated Poisson and zero-inflated negative binomial models to help determine the best regression model to use for this data [93,99]. The graph in Figure 10 below shows the comparison of the fit of the Poisson, Negative Binomial, Zero-inflated Poisson, and Zero-inflated Negative Binomial regression models to the observed data.

Figure 9 – Fit comparison of Poisson and Negative Binomial to observed

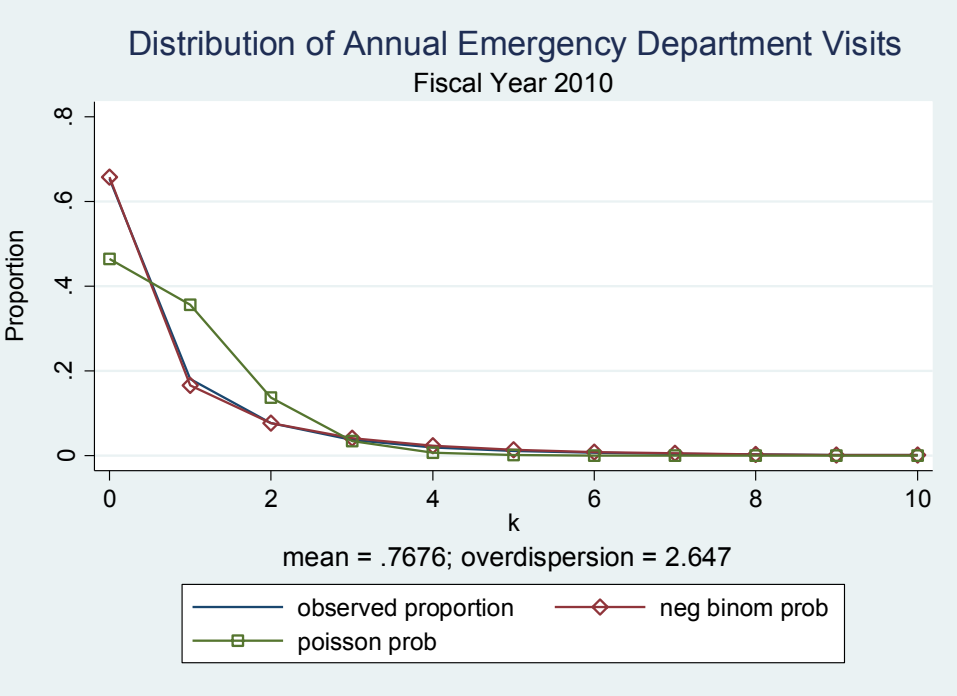
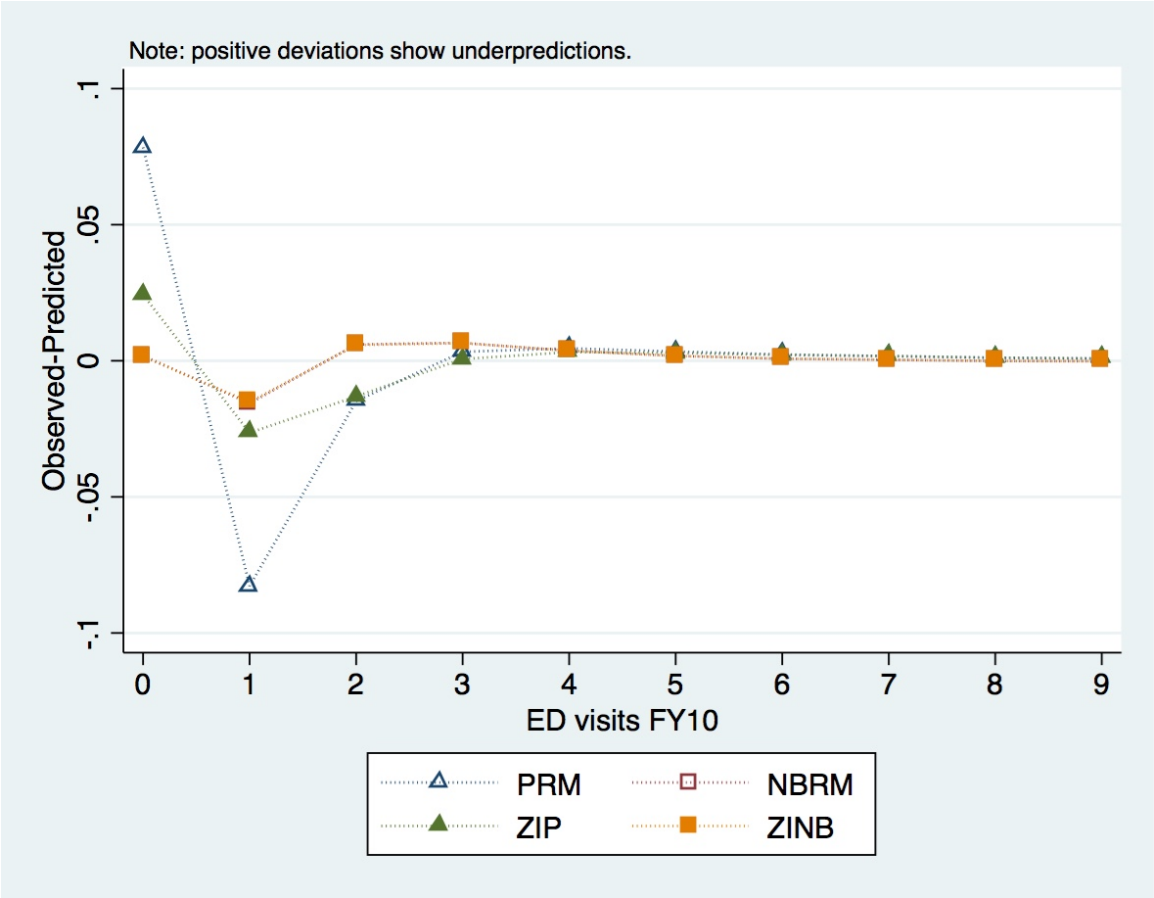


Figure 10 below graphically shows the results of all four possible regression models (Poisson, Negative Binomial, Zero-inflated Poisson, and Zero-inflated Negative Binomial). As in the graph in figure 1, the Poisson regression model under predicts zero ED visits. Visual inspection reveals that the poisson model under predicts the number of zero ED visits by approximately 8%. The Poisson model then over predicts the number of patients having only one ED visit by approximately 8% and then over predicts two ED visits by around 2%, makes a reasonably accurate prediction for three ED visits and then or more visits. The Zero-inflated Poisson (ZIP) regression model does a better job than the Poisson regression model but still under predicts the number of zero visits by about 2.5%.

The predicted number of patients that had only one visit is over predicted by approximately 2.5%. The ZIP model's prediction of two visits is slightly less than its prediction of one visit but over predicted two ED visits by about 2%. The ZIP model makes a reasonably accurate prediction for three ED visits and then slightly under predicts the number of patients that had four or five ED visits followed by accurately predicting six or more ED visits.

From visual inspection, the negative binomial regression and zero-inflated negative binomial regression models appear to be virtually identical in their predictions. Both models accurately predict the number of patients that do not have any ED visits (zero visits) and over predict numbers of patients who only have one ED visit by approximately 1-1.5%. There is slight over prediction of two to four ED visits with five or more visits being accurately predicted.

Figure 10 – Fit comparison of regression models



Regression model comparison results are summarized in table 27. Regression models were compared using Bayesian information criterion (BIC) and Akaike information criterion (AIC) as the criteria for model selection. Evidence was very strong that the negative binomial regression model (NBRM), zero-inflated poisson (ZIP), and zero-inflated negative binomial (ZINB) regression models were preferred over the poisson regression model (PRM), $p = 0.000$. The NBRM was found to be preferred over the ZIP model but evidence was very strong that the ZINB model was preferred over the NBRM,

p=0.000. The evidence also pointed to the ZINB model being preferred over the ZIP model, p=0.000.

The result was that a zero-inflated negative binomial regression model was fitted using the selected final variables. As mentioned previously, final variables were selected based on our theoretical framework, results of bivariate chi-squared and correlation analyses.

Table 28 - Evidence comparing regression model fit to observed data

PRM vs	BIC=684777.737	AIC=684255.947	Prefer	Over	Evidence
NBRM	BIC=625790.264	dif= 58987.473	NBRM	PRM	Very strong
	AIC=625257.826	dif= 58998.121	NBRM	PRM	
	LRX2=59000.121	prob= 0.000	NBRM	PRM	p=0.000
ZIP	BIC=667923.588	dif= 16854.148	ZIP	PRM	Very strong
	AIC=667316.609	dif= 16939.338	ZIP	PRM	
	Vuong= 41.982	prob= 0.000	ZIP	PRM	p=0.000
ZINB	BIC=625560.613	dif= 59217.124	ZINB	PRM	Very strong
	AIC=624942.985	dif= 59312.963	ZINB	PRM	
NBRM vs	BIC=625790.264	AIC=625257.826	Prefer	Over	Evidence
ZIP	BIC=667923.588	dif=-42133.325	NBRM	ZIP	Very strong
	AIC=667316.609	dif=-42058.783	NBRM	ZIP	
ZINB	BIC=625560.613	dif= 229.651	ZINB	NBRM	Very strong
	AIC=624942.985	dif= 314.841	ZINB	NBRM	
	Vuong= 9.226	prob= 0.000	ZINB	NBRM	p=0.000
ZIP vs	BIC=667923.588	AIC=667316.609	Prefer	Over	Evidence
ZINB	BIC=625560.613	dif= 42362.976	ZINB	ZIP	Very strong
	AIC=624942.985	dif= 42373.625	ZINB	ZIP	
	LRX2=42375.625	prob= 0.000	ZINB	ZIP	p=0.000

Results of the final ZINB regression model are found in tables 28 through 32. There were 47 total predictor (independent) variables in the regression model not including the outcome (dependent) variable, ED visits.

As a final model check, these final independent variables were checked for multicollinearity using a variance inflation factor (VIF). The selim_mh_cat_10 variable was shown to be collinear with a VIF value of 16.36 which is an indicator of multicollinearity since a VIF value greater than 10 indicates a probable problem with that variable. Since this is an important health status variable, I decided to run the regression model both with the selim_mh_cat_10 variable and without the variable in the final model.

Table 29 – Results of variance inflation factor test for multicollinearity

Variable	VIF	Sqrt VIF	Tolerance	R Squared
ed_visits_10	1.91	1.38	0.5246	0.4754
age_cat	1.5	1.23	0.6661	0.3339
male	1.06	1.03	0.9391	0.0609
married	1.3	1.14	0.7674	0.2326
race	1.02	1.01	0.9773	0.0227
vulnerable	2.37	1.54	0.422	0.578
scd	2.53	1.59	0.3959	0.6041
poor	1.47	1.21	0.6786	0.3214
homeless_10	1.09	1.04	0.9159	0.0841
any_hosp_y1	1.14	1.07	0.8789	0.1211
any_hosp_10	7.28	2.7	0.1374	0.8626
psyc_hosp_10	4.54	2.13	0.2201	0.7799
surg_hosp_10	1.72	1.31	0.5809	0.4191
med_hosp_noneuro_10	2.42	1.56	0.413	0.587
sa_hosp_10	1.04	1.02	0.9632	0.0368

Table 29 Continued

Variable	VIF	Sqrt VIF	Tolerance	R Squared
couns_ervisit	1.11	1.05	0.899	0.101
pain_ervisit	1.07	1.03	0.9357	0.0643
symptoms_ervisit	1.06	1.03	0.9422	0.0578
consult_ervisit	1.03	1.01	0.971	0.029
injpois_ervisit	1.04	1.02	0.9612	0.0388
rx_ervisit	1.03	1.02	0.9691	0.0309
rx_opioid_10	1.25	1.12	0.7968	0.2032
headache_ervisit	1.03	1.02	0.9699	0.0301
hstatus_ervisit	1.02	1.01	0.9848	0.0152
other_mh_ervisit	1.02	1.01	0.9769	0.0231
sa_ervisit	1.07	1.03	0.9381	0.0619
ptsd_ervisit	1.03	1.02	0.9663	0.0337
depress_ervisit	1.03	1.01	0.9726	0.0274
anxiety_ervisit	1.03	1.01	0.9753	0.0247
dx_resp_ervisit	1.05	1.02	0.9561	0.0439
dx_copd_10	1.22	1.1	0.8228	0.1772
dx_dm_10	1.21	1.1	0.8283	0.1717
dx_hbp_10	2.08	1.44	0.4806	0.5194
dx_lbp_10	3.29	1.81	0.3037	0.6963
dx_pain_10	3.29	1.81	0.3042	0.6958
dx_bipolar_10	1.11	1.05	0.9043	0.0957
dx_anxiety_10	1.14	1.07	0.8759	0.1241
dx_depression_10	1.41	1.19	0.7078	0.2922
dx_substance_10	1.58	1.26	0.6324	0.3676
dx_ptsd_10	1.61	1.27	0.6208	0.3792
dx_headache_10	1.11	1.05	0.9008	0.0992
dx_elix_33_10	1.06	1.03	0.9401	0.0599
edr_cat_10	1.94	1.39	0.516	0.484
selim_phys_cat_10	6.54	2.56	0.1529	0.8471
selim_mh_cat_10	16.36	4.04	0.0611	0.9389
selim_phys_ever_cat	3.19	1.79	0.3136	0.6864
ed_visits_cat_y1	1.2	1.09	0.8351	0.1649
mh_cat_10	1.86	1.36	0.5374	0.4626
sa_cat_10	1.46	1.21	0.6852	0.3148
pcc_visits_cat_10	1.85	1.36	0.541	0.459
Mean VIF	1.76			14.3406

Results were run as a complete ZINB regression model but results are shown in five separate tables below to match the various components of the theoretical framework. All results provided from the ZINB regression model are given "Ceteris Paribus", meaning "all other things remaining constant" and will not be expressly written after each result. In this case, it means that each of the following results discussed takes into account that all of the other 46 independent variables in the regression model were being held constant in relation to that variable's result. [1]

Of the four predisposing variables in our model, results were as follows. Significant predisposing factors were Ages 41+, Male, and Black veterans. Older veterans were predicted to have fewer ED visits compared to the younger veterans. , Veterans ages 31-40 had 3.3% fewer ED visits on average than the youngest group of veterans, ages 17-30 (z=-4.50, p=0.0000). The oldest veteran group in the sample (over age 40), were associated with 17.7% fewer ED visits than younger veterans age 17-30 (z= -21.44, p=0.0000).

Female veterans were found to use disproportionately more ED visits as male veterans were found to use 14.4% fewer ED visits in the VA system on average compared to female veterans (z=-18.02, p=0.0000). Married veterans were associated with 9% fewer

[1] Note: All results provided from the zero-inflated negative binomial regression model are given a blanket "Ceteris Paribus", which is a Latin term meaning "all other things remaining constant". Ceteris Paribus or "all other things remaining constant" will not be expressly written after each result but are assumed to be included with each result. In this case, it means that each of the following results discussed takes into account that all of the other 46 independent variables in the regression model were being held constant in relation to that variable's result.

ED visits than non-married veterans holding all other variables constant (z=-13.81, p=0.0000). Race was found to be a factor in increased use of the ED. On average, being a black veterans compared to a white veteran multiplied the expected number of ED visits by a factor of 1.24 or put another way, blacks have 24% more ED visits than whites (z=27.3, z=0.0000). Hispanics were found to have increased numbers of ED visits compared to whites. Hispanics had 2.2% more ED visits than whites on average (z=2.26, p=0.0240). Other races (Asian, Pacific Islander, American Indian, 2 or more races) had a very slight (-0.9%), but non-significant decrease in ED visits compared to whites (z=-0.55, p=0.5800).

Table 30 – ZINB regression model results – predisposing variables

ED Visits	IRR	Std. Err.	z	P>z	[95% Conf.	Interval]
Age						
Ages 31-40	0.9668	0.0072	-4.50	0.0000	0.9527	0.9811
Ages 41+	0.8228	0.0075	-21.44	0.0000	0.8082	0.8376
Male	0.8534	0.0075	-18.02	0.0000	0.8388	0.8682
Married	0.9102	0.0062	-13.81	0.0000	0.8981	0.9224
Race						
Black	1.2428	0.0099	27.30	0.0000	1.2236	1.2624
Hispanic	1.0221	0.0099	2.26	0.0240	1.0029	1.0417
Other	0.9905	0.0170	-0.55	0.5800	0.9577	1.0245

Vulnerable veterans compared to non-vulnerable veterans multiplies the expected number of ED visits by a factor of 0.9475, or vulnerable veterans experience 5.3% less ED visits than non-vulnerable veterans on average (z=-4.41, p=0.0000). Veterans with a service-connected disability (SCD) also have decreased ED visits compared to those veterans without a service-connected disability. Veterans with a SCD are associated with

4.7% fewer ED visits than non-SCD veterans (z=-4.70, p=0.0000). Those veterans defined as poor (VA medical care copay exempt) were found use an increased amount of ED visits. In other words, poor veterans were found to have almost 42% more ED visits than non-poor veterans (z=36.93, p=0.0000). Homeless veterans were similar to poor veterans in that they too were associated with 17.2 % increased ED visits compared to non-homeless veterans.

Table 31 - ZINB regression model results - enabling variables

ED Visits	IRR	Std.Err.	z	P>z	[95% Conf.	Interval]
Vulnerable	0.9475	0.0116	-4.41	0.0000	0.9250	0.9705
SC Disabled	0.9531	0.0097	-4.70	0.0000	0.9342	0.9724
Poor	1.4119	0.0132	36.93	0.0000	1.3863	1.4380
Homeless	1.1724	0.0227	8.21	0.0000	1.1287	1.2178

Veterans who visited the ED with a perceived need were all were associated with increased ED visits as shown in table 28 below. Each of the reasons for an ED visit was found to be significant. Being a veteran who went to the ED for counseling were associated with a 117.7% increase in the number of ED visits compared to those that did not (z=121.21, p=0.0000).

I found that pain as the reason for going to the ED was positively associated with increased use of the ED. Veterans with pain, compared to those that did not, on average multiplied the expected number of ED visits by a factor 1.3848 (z=30.87, p=0.0000). Similarly, those veterans who went to the ED because of signs and symptoms

experienced were significantly associated with a 38.9% increase in the number of ED visits compared to those who went to the ED for other reasons (z=30.10, p=0.0000). Veterans looking for a consultation in the ED were significantly associated with a 46.5% increase in the number of ED visits compared to others who did not seek consultation in the ED (z=29.93, p=0.0000).

Going to the ED specifically for a prescription, particularly a prescription for opioids, was positively associated with large increases in the predicted number of ED visits. Veterans seeking any type of prescription from the ED multiplied the expected number of ED visits by a factor of 1.83 compared to those going to the ED for other reasons (z=30.27, p=0.0000), while those veterans who went for an ED visit specifically for an opioid prescription multiplied the expected number of ED visits by a factor of 2.1 or put another way, veterans going to the ED for opioid prescriptions had 207% more ED visits than veterans going to the ED for other reasons (z=104.38, p=0.0000).

On average, veterans going to the ED for headache had 29% more expected ED visits than veterans going to the ED for other reasons (z=11.37, p=0.0000). Checking health status as the reason a veteran went to the ED visit multiplied the expected number of ED visits by a factor of 1.2 on average (z=7.89, p=0.0000).

Veterans who went to the ED for mental health reasons, on average, saw a 29% increase in expected number of ED visits compared to veterans who went to the ED for other

reasons (z=10.29, p=0.0000). When veterans went to the ED for more specific mental health conditions such as substance abuse, PTSD, depression, or anxiety, all saw increased expected numbers of ED visits compared to veterans that went to the ED for other reasons. Specifically, veterans who went to the ED for Substance Abuse had 7.4% more ED visits (z=2.51, p=0.0120), veterans who went to the ED for PTSD had 17.8% more ED visits (z=6.27, p=0.0000), veterans who went to the ED for depression had 15% more ED visits (z=5.20, p=0.0000), and veterans who went to the ED for anxiety had 16.4% more ED visits (z=4.95, p=0.0000), all compared to veterans who went to the ED for other reasons respectively.

Table 32 - ZINB regression model results - need (perceived) variables

ED Visits	IRR	Std. Err.	z	P>z	[95% Conf.	Interval]
Reason for ED Visit						
Counseling	2.1765	0.0151	112.21	0.0000	2.1471	2.2063
Pain	1.3848	0.0146	30.87	0.0000	1.3564	1.4137
Signs & Symptoms	1.3892	0.0152	30.10	0.0000	1.3598	1.4193
Consultation	1.4654	0.0187	29.93	0.0000	1.4292	1.5026
Injury/Poisoning	1.3491	0.0166	24.35	0.0000	1.3170	1.3820
Prescription	1.8279	0.0364	30.27	0.0000	1.7579	1.9007
Opioid Prescription	2.0713	0.0144	104.38	0.0000	2.0432	2.0998
Headache	1.2916	0.0291	11.37	0.0000	1.2359	1.3499
Health Status	1.2002	0.0278	7.89	0.0000	1.1470	1.2558
Mental Health	1.2934	0.0323	10.29	0.0000	1.2316	1.3584
Substance Abuse	1.0736	0.0304	2.51	0.0120	1.0157	1.1349
PTSD	1.1782	0.0308	6.27	0.0000	1.1193	1.2401
Depression	1.1505	0.0310	5.20	0.0000	1.0913	1.2130
Anxiety	1.1684	0.0367	4.95	0.0000	1.0986	1.2426

Results from table 32 show that veterans who had evaluated needs (received a specific diagnosis from their ED visit) were not all associated with significant increases in the

expected number of ED visits. Table 32 revealed a mixed bag of results, with both significant and non-significant findings.

Results show that veterans with an ED visits resulting in a respiratory diagnosis showed a statistically significant 56% increase in the predicted number of ED visits on average compared to veterans without a respiratory diagnosis (z=36.74, p=0.0000). Conversely, veterans with a diagnosis of COPD, Diabetes, and Hypertension all showed non-significant decrease in the predicted number of ED visits. On average, a diagnosis of COPD showed a non-significant 1.4% decrease in expected ED visits (z=-0.84, p=0.3990), a diagnosis of Diabetes revealed a non-significant, negligible decrease of 0.07% in predicted ED visits (z=-0.37, p=0.7120), and a diagnosis of hypertension was also non-significant, and predicted an average decrease of 2.2% in expected ED visits (z=-1.01, p=0.3140). A low blood pressure diagnosis showed a significant decrease of 12.5% in expected ED visits on average (z=-10.60, p=0.0000). On average, veterans diagnosed with Headache or Pain saw significant increases in the number of predicted visits. Headache showed a 9.3% increase in ED visits on average (z=10.16, p=0.0000) and Pain showed a similar 11.3% increase in predicted ED visits (z=10.18, p=0.0000).

Continuing with diagnoses, compared to veterans without mental health diagnoses, veterans with mental health diagnoses were mostly positive increases in expected ED visits with the exception of depression and PTSD. Specifically, results showed that a diagnosis of Bipolar disorder was associated with a 9.6% increase in the predicted number of ED visits on average (z=5.37, p=0.0000) while an anxiety diagnosis

multiplied the expected number of ED visits by a factor of 1.087 on average (z=6.52, p=0.0000). A depression diagnosis had a non-significant and somewhat negligible decrease of .03% in the predicted number of ED visits. Rounding off the mental health diagnosis results, a substance abuse diagnosis brought a significant average increase of 5.8% in the expected number of ED visits (z=4.32, p=0.0000) and a diagnosis of PTSD showed an average decrease in the predicted number of ED visits of 4.5% (z=-3.51, p=0.0000).

Health Status indicators were significantly associated with positive increases in the number of predicted ED visits. The results of one such health status measure, a nominal variable, the number of Selim physical comorbidities (one comorbidity, two to three physical comorbidities, and four or more physical comorbidities) had the following results: One comorbidity, on average showed a 10.3% increase in the expected number of ED visits (z=7.94, p=0.0000). Those veterans in the sample with two-to-three Selim Physical comorbidities showed a significant average increase of 15.5% in the predicted number of ED visits (z=7.55, p=0.0000). Likewise, veterans with four or more comorbidities multiplied the predicted number of ED visits by a factor of 1.24 (z=5.99, p=0.0000).

Looking at a similar health status measure, the number of Selim Physical comorbidities ever (one comorbidity, two to three physical comorbidities, and four or more physical comorbidities) revealed the following: One comorbidity, on average showed a 7.7%

increase in the expected number of ED visits (z=7.25, p=0.0000). Those veterans in the sample with two-to-three Selim Physical comorbidities showed a significant average increase of 14.2% in the predicted number of ED visits (z=10.13, p=0.0000). Likewise, veterans with four or more comorbidities multiplied the predicted number of ED visits by a factor of 1.21, or a 21% increase in the average number of expected ED visits (z=8.73, p=0.0000).

Selim mental health comorbidities were shown to have similar positive increases in the predicted number of ED visits, increasing with each higher category. Veterans having just one mental health comorbidity, on average showed a 7.5% increase in the expected number of ED visits (z=5.22, p=0.0000). Those veterans in the sample with two-to-three Selim mental health comorbidities showed a significant average increase of 10.7% in the predicted number of ED visits (z=4.06, p=0.0000). Likewise, veterans with four or more mental health comorbidities were shown to multiply the predicted number of ED visits by a factor of 1.16, or a 15.8% increase in the average number of expected ED visits (z=3.35, p=0.0010).

Lastly, hospitalization in different types of hospitals had a mixed effect in predicting ED visits. Overall, any hospitalization in the veteran's first year in the VA healthcare system were shown to multiply the expected number of ED visits by a factor of 0.767, or result in a 23% decrease in the predicted number of ED visits on average (z=-16.70, p=0.0000). Contrasting this result, a veteran having any hospitalization in FY10 showed

a significant increase of 58% in the expected number of ED visits on average (z=15.03, p=0.0000). Veterans hospitalized in psychiatric hospitals saw, on average, a 26.3% increase in the predicted number of ED visits (z=7.30, p=0.0000). Surgical hospitalizations on the other hand, showed a non-significant 5% decrease in the number of expected ED visits (z=-1.38, p=0.1670). Hospitalization in a medical facility revealed a significant 42.4% increase in the predicted number of ED visits (z=11.71, p=0.0000) while hospitalization in a substance abuse facility resulted in a 19.4% increase in the expected number of ED visits, which was close but was slightly beyond the significance threshold (z=1.86, p=0.0620).

Table 33 - ZINB regression model results - need (evaluated) variables

ED Visits	IRR	Std. Err.	z	P>z	[95% Conf.	Interval]
Diagnoses						
Respiratory	1.5564	0.0187	36.74	0.0000	1.5201	1.5936
COPD	0.9869	0.0154	-0.84	0.3990	0.9572	1.0176
Diabetes	0.9934	0.0178	-0.37	0.7120	0.9591	1.0289
Hypertension	0.9888	0.0110	-1.01	0.3140	0.9675	1.0107
Low Blood Pressure	0.8854	0.0102	-10.60	0.0000	0.8657	0.9056
Pain	1.1134	0.0118	10.18	0.0000	1.0906	1.1367
Headache	1.0927	0.0095	10.16	0.0000	1.0742	1.1116
Bipolar	1.0962	0.0187	5.37	0.0000	1.0601	1.1336
Anxiety	1.0870	0.0139	6.52	0.0000	1.0601	1.1146
Depression	0.9965	0.0127	-0.27	0.7850	0.9719	1.0218
Substance Abuse	1.0575	0.0137	4.32	0.0000	1.0310	1.0847
PTSD	0.9545	0.0127	-3.51	0.0000	0.9299	0.9797
Health Status						
Physical						
1 comorbidity	1.1033	0.0137	7.94	0.0000	1.0769	1.1305
2-3 comorbidities	1.1550	0.0220	7.55	0.0000	1.1126	1.1990
4+ comorbidities	1.2371	0.0440	5.99	0.0000	1.1539	1.3264
Physical - Ever						
1 comorbidity	1.0767	0.0110	7.25	0.0000	1.0554	1.0984

Table 33 Continued

ED Visits	IRR	Std. Err.	z	P>z	[95% Conf.	Interval]
2-3 comorbidities	1.1421	0.0150	10.13	0.0000	1.1131	1.1718
4+ comorbidities	1.2093	0.0263	8.73	0.0000	1.1588	1.2620
Mental Health						
1 comorbidity	1.0751	0.0149	5.22	0.0000	1.0463	1.1047
2-3 comorbidities	1.1074	0.0278	4.06	0.0000	1.0542	1.1632
4+ comorbidities	1.1576	0.0506	3.35	0.0010	1.0625	1.2612
Hospitalization						
Any Hospital – Y1	0.7665	0.0122	-16.70	0.0000	0.7430	0.7908
Any Hospital	1.5805	0.0481	15.03	0.0000	1.4889	1.6777
Psychiatric	1.2634	0.0405	7.30	0.0000	1.1865	1.3452
Surgical	0.9496	0.0355	-1.38	0.1670	0.8825	1.0219
Medical	1.4241	0.0430	11.71	0.0000	1.3423	1.5109
Substance Abuse	1.1937	0.1134	1.86	0.0620	0.9910	1.4380

The results of the multivariate regression for the utilization variables are shown in table 33 below. All of the results of these nominal utilization variables were significant with the exception of the Mental Health clinic visits 2-3 visits category. The number of ED visits a veteran had in their first year with the VA healthcare system increased the expected number of ED visits with each subsequent higher category of ED visits in that first year in the VA system.

A veteran having a single ED visit during that first year in the VA increased the expected number of ED visits by a factor of 1.82, or in other words, resulted in an 82% increase in the predicted number of ED visits on average (z=77.71, p=0.0000). Having 2-3 ED visits in that first year in the VA system showed a 133% increase in the expected number of ED visits (z=94.25, p=0.0000). Veterans having four or more ED visits in

their first year with the VA were predicted to have a 215% increase in the number of expected ED visits (z=86.24, p=0.0000).

Primary care, mental health, and substance abuse visits followed the same pattern as ED visits from the veteran's first year in the VA system. The number of primary care, mental health, and substance abuse visits a veteran had in their first year with the VA healthcare system increased the expected number of ED visits with each subsequent higher category of the aforementioned clinic visits in that first year in the VA system.

For example, a single visit to the primary care clinic showed a 15% decrease in the expected number of ED visits on average (z=-16.22, p=0.0000). The next category of primary care clinic visits (2-3 visits) revealed a significant and positive 8.7% increase in the predicted number of ED visits (z=8.37, p=0.0000) while having four or more primary care visits showed a 38.5% increase in the expected number of ED visits (z=29.92, p=0.0000).

A veteran having one Mental Health clinic visit was shown to multiply the expected number of ED visits by a factor of 0.9396, or put another way, resulted in a 6% decrease in the predicted number of ED visits on average (z=-6.12, p=0.0000). The next category of mental health clinic visits (2-3 visits) revealed a non-significant and positive 1.3% increase in the predicted number of ED visits (z=1.20, p=0.2290) while having four or

more primary care visits showed a significant 7.7% increase in the expected number of ED visits (z=7.36, p=0.0000).

A single visit to the substance abuse clinic revealed a 9.7% increase in the expected number of ED visits on average (z=4.00, p=0.0000). The next category of substance abuse clinic visits (2-3 visits) revealed a slightly less but significant and positive 9.5% increase in the predicted number of ED visits (z=3.12, p=0.0020) while having four or more substance abuse clinic visits showed a 10.7% increase in the expected number of ED visits (z=5.53, p=0.0000).

Table 34 - ZINB regression model results - utilization variables

ED Visits	IRR	Std. Err.	z Score	P>z	[95% Conf	Interval]
Utilization						
ED - Y1						
1 visit	1.8147	0.0139	77.71	0.0000	1.7876	1.8422
2-3 visits	2.3345	0.0210	94.25	0.0000	2.2937	2.3760
4+ visits	3.1480	0.0419	86.24	0.0000	3.0670	3.2311
Primary Care						
1 Visit	0.8455	0.0087	-16.22	0.0000	0.8285	0.8628
2-3 Visits	1.0868	0.0108	8.37	0.0000	1.0658	1.1082
4+ Visits	1.3851	0.0151	29.92	0.0000	1.3559	1.4150
Mental Health						
1 visit	0.9396	0.0096	-6.12	0.0000	0.9210	0.9585
2-3 visits	1.0129	0.0108	1.20	0.2290	0.9919	1.0343
4+ visits	1.0770	0.0109	7.36	0.0000	1.0559	1.0985
Substance Abuse						
1 visit	1.0972	0.0255	4.00	0.0000	1.0484	1.1482
2-3 visits	1.0945	0.0316	3.12	0.0020	1.0342	1.1582
4+ visits	1.1068	0.0203	5.53	0.0000	1.0677	1.1474

Research objective #2 results

Table 35 - Research objective #2 results

RO2 - Research Objective 2 *Evaluate the relationship between FY11 ED utilization and FY10 ED utilization using a regression model that accounts for predisposing, enabling and need variables*	
H2a	FY11 ED utilization can be predicted using FY10 ED utilization for OEF/OIF veterans
H2b	Vulnerable OEF/OIF veterans' use of EDs is the same as other, non-vulnerable OEF/OIF veterans

Research objective 2 evaluated the relationship between FY11 ED utilization and FY10 ED utilization using a regression model that accounts for predisposing, enabling and need variables. Research Objective 2 had two hypotheses that were tested during this study.

Hypothesis 2a stated that FY11 utilization could be predicted using FY10 utilization for OEF/OIF veterans. The results from the final zero-inflated negative binomial regression model did not accurately predict FY11 utilization when tested using a dependent t-test of means so our hypothesis was not supported. Results from the t-test below in table 34 showed that there was a statistically significant difference of mean differences ($t = 17.8984$, $df=311376$, $Pr(T>t) = 0.0000$) between the prediction using the zero-inflated negative binomial regression model and FY11 ED visits.

Table 36 - Dependent (paired) t-test of means

Paired t-Test

Variable	Obs	Mean	StdErr	StdDev	[95% Conf.	Interval]
FY11 prediction	311,377	.8560644	.0037401	2.086992	.848734	.8633948
FY11 ED visits	311,377	.7957171	.0030581	1.706479	.7897232	.801711
Difference	311,377	.0603473	.0033716	1.881419	.0537389	.0669556

mean(diff) = mean(FY11 prediction – FY11 ED visits) t = 17.8984
Ho: mean(diff) = 0 degrees of freedom = 311376

Ha: mean(diff) < 0 Ha: mean(diff) != 0 Ha: mean(diff) > 0
Pr(T < t) = 1.0000 Pr(T > t) = 0.0000 Pr(T > t) = 0.0000

Hypothesis 2b stated that vulnerable OEF/OIF veterans' use of EDs is the same as other non-vulnerable veterans. We tested this hypothesis through a paired T-test between vulnerable and non-vulnerable veterans' ED use. Results of the paired T-test of means are reported below:

Table 37 – t-test of differences (vulnerable vs. non-vulnerable veteran) ED use

Paired t test

Variable	Obs	Mean	Std. Err.	Std. Dev.
FY10 Vulnerable	311,377	0.8354516	0.0035604	1.986741
FY10 Non-vulnerable	311,377	1.115266	0.0065987	3.682135
Difference	311,377	-0.2798143	0.0034437	1.921641

Mean(diff) = mean(FY10 vul - FY10 non-vul) t = -81.2533
Ho: mean(diff) = 0 degrees of freedom = 311376
Ha: mean(diff) < 0 Ha: mean(diff) != 0 Ha: mean(diff) > 0
Pr(T < t) = 0.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 1.0000

Results of the t-test revealed that there was a significant difference between vulnerable and non-vulnerable veterans' use of the ED in terms of the number of visits and the

ZINB regression model did not do a good job of predicting future ED use for these two groups of veterans.

The table below summarizes whether the various hypotheses in RO#1 and RO#2 were supported or not supported by the data.

Table 38 - Summary of study findings

RO1 - Research Objective 1 *Describe and classify OEF/OIF veterans according to ED use, Primary Care Use, and the ratio of ED to Primary Care visits (EDR) for FY10/FY11*		
H1a	Utilization of VA services by OEF/OIF veterans will be associated with predisposing, enabling, and need variables	Hypothesis 1a Supported
H1b	More than 50% of OEF/OIF veterans in the sample will fall in the low ED use/low EDR subgroup	Hypothesis 1b Supported
H1c	A higher proportion of vulnerable OEF/OIF veterans will fall into the high ED use/high EDR subgroup than other veterans in the sample	Hypothesis 1c Not Supported
RO2 - Research Objective 2 *Evaluate the relationship between FY11 ED utilization and FY10 ED utilization using a regression model that accounts for predisposing, enabling and need variables*		
H2a	FY11 ED utilization can be predicted using FY10 ED utilization for OEF/OIF veterans	Hypothesis 2a Not Supported
H2b	Vulnerable OEF/OIF veterans' use of EDs is the same as other, non-vulnerable OEF/OIF veterans	Hypothesis 2b Not Supported

8. DISCUSSION

My adapted model of Andersen's Behavioral Model of Health Services Use was able to select predisposing, enabling, and need variables for our predictive models with good results but the final ZINB regression model was ultimately unable to accurately predict future year utilization. Interestingly, the factors selected based on the adapted theoretical model created a predictive regression model with good fit (LR chi2(62) = 94877.05, Prob > chi2 = 0.0000) and the majority of the independent variables (39 of 46) showed significant associations with the dependent variable (number of ED visits) but the models were unable to predict future utilization. Some of the reasons for why the zero inflated negative binomial regression model may not have been able to accurately predict future year utilization could be that there were significant variables missing from the model. Notably absent from our data were predisposing health belief variables, and both community and family enabling variables. In addition, I may have selected incorrect variables to inflate the zeros in the ZINB regression model. In my final regression model, only 5 of the 7 variables selected to inflate the zeros were found to be significant. Also, since there were only two fiscal years of ED visit data available, this was not enough years of data for the model to predict a trend because a minimum of three years of data is required. In this study, having a quasi-repeated measures sample of patients with only two fiscal years of sample data may have caused a "regression artifact" or "regression to the mean" (RTM) phenomenon. OIF/OEF veteran patients were not randomly selected from the study population but were asymmetrically selected

based on their prior use of VA health services. If the selected sample had a preponderance of veterans with abnormally low ED use or very high ED use, you won't be able to tell if tell if such an anomaly was with the current year or with the prior year or even if there is an associated pattern. In such a case, this would be a threat to the validity of the results of the study.

This study added to the body of literature on frequent ED use in that it agreed with the findings of many previous studies concerning the factors that are associated with frequent ED use [1,4,46,52,54-56,76,84,100-104]. The results of my analysis showed that 4 or more visits to the ED within a fiscal year as the number of ED visits that constitutes a high frequent ED user agreed with the results of others and fell right in the middle of the 2-12 visit range for frequent visits found and in line with the 3 or 4 visits used as the frequent visit threshold in the majority of studies. Although this number is not definitive, it does seem to be the consensus reached for larger studies on frequent ED use.

My results showed that 5.2% of all ED OEF/OIF veteran users could be considered frequent ED users which is right in alignment with the existing literature. However, this percentage is slightly lower than the VA experience of around 8% of all veterans being frequent ED users which has previously reported to have been similar to the percentage of frequent ED users in the general U.S. population [29-31]. This lower percentage may be due to several reasons. One reason is that these veterans have only recently returned and therefore have much less experience with the VHA system in general. This lack of

experience may contribute to significant differences in utilization from the veterans of previous wars strictly due to a lack of knowledge about what VA services are available to them and how to access them.

Another possible reason is that OEF/OIF veterans are an older population than their predecessors from previous wars with a larger percentage of veterans being married than in previous wars. Findings indicated that the majority of OEF/OIF veteran frequent ED users were over 30 years of age (57%), male (82%), White (61%), unmarried (58%), had a VA service-connected disability (80%), and met the study criteria to be considered exempt from VA copays (ie., poor) (90%). Agreeing with other previous studies, findings indicated that among the 53,250 or 17.1% of Black OEF/OIF veterans in the sample, a disproportionately higher percentage of Blacks (23.2%) were found among frequent ED users. Looking at homeless veterans, a sub-analysis of homeless OEF/OIF veterans revealed that of the 5,269 or 1.7% homeless veterans in the sample, a disproportionately higher percentage (6.4%) were seen within frequent ED users.

As reported in previous studies, veterans that are frequent ED users are sicker than non-frequent ED users [29,46]. My findings agreed with this and indicated that frequent ED users had a disproportionally higher number of physical and mental comorbidities than the rest of their veteran cohort.

A special subpopulation of particular concern to the VA are women veterans. The VA reports that the overall numbers of women veterans continue to rise and that the percentage of women in cohort OEF/OIF was higher than in previous wars [24,105-107]. A disproportionately higher percentage of women veterans in this study were found to have high rates of ED utilization than men; a finding that only partially agrees with results from previous research [31,108].

An important aspect of this study was that it attempted to classify high frequent ED users using EDR as a measure of the proportion of ED visits over the proportion of primary care visits to better understand the high frequent ED use/high ED reliance population. Findings indicated that using the adapted theoretical model of utilization adapted from Andersen's for variable selection was good at finding the factors that explained variation in ED utilization. Results of the final ZINB regression model revealed that all factors were significantly associated with high frequent ED use with the exception of hospitalization in surgical and substance abuse hospitals, and diagnoses of COPD, High Blood Pressure, Diabetes Mellitus, and PTSD. Interestingly, in my sub-analysis of homeless veterans in the sample, findings showed that a diagnosis of COPD was significantly associated with frequent ED visits ($p<0.0001$). As expected, age was a confounder but it was the veterans over 30 years of age within the OEF/OIF cohort that experienced a significant decrease in the odds of having another ED visits compared to the younger group age 17-30. This may explain why enabling factors such as married were significant in reducing the odds of having an ED visit compared to the younger

cohort which were found less likely to be married. Also, when compared to whites, Blacks were the only race group found to be significantly more likely to have increased numbers of ED visits.

I was able to classify four distinct subgroups of ED users in this study: Low ED use and Low EDR (Low-Low); Low ED use and High EDR (Low-High); High ED use and Low EDR (High-Low) and High ED use and High EDR (High-High). After analyzing the data for the High-Low subgroup, I determined that this subgroup was not a valid subgroup because each cell in the High-Low subgroup was found non-significant and the number of observations in the High-Low category was low with only 377 observations or 0.1% of the entire sample represented. Post-analysis, I found that the three subgroups could be characterized as follows: The Low-Low group consisted of the majority of veterans who have a primary care physician but never use the ED except in rare circumstances when they find themselves in the ED due to a traumatic event such as a broken bone, car accident or other type of true emergency. The Low-High group consisted of veterans who also have a primary care physician who helps them manage a chronic illness such as Asthma or Diabetes but had an incident where their chronic illness gets out of control after business hours and requires a trip to the ED for care. The High-High group consisted of those veterans who may or may not have a primary care physician yet often use the ED as a source of usual care or as a method to "game" the system in order to obtain pain medications, care for their physical needs, or counseling

for mental health needs since all of these services are in high demand within the VA system and often difficult to gain access to these services in a timely manner.

9. CONCLUSIONS

The VHA system is currently stressed by the return of this OEF/OIF cohort of veterans and access to needed services can be difficult, particularly for those veterans that are just entering into the VA system. Because the VA system is very large and complex, particularly to the combat wounded and for those with mental health illness, navigating this monolithic healthcare system can be extremely challenging. Adding to this stress are the recent headlines of veterans dying while stuck on waiting lists for needed medical appointments along with news of the VA secretary resigning under pressure from Congress and VA employees being terminated [109,110]. All these factors add to reasons why veterans use the ED as their path (access) to needed medical and mental health services.

Based on the results of my analysis, EDR, when used in conjunction with high ED use adds a novel methods to identify and classify subgroups within the frequent ED user population. From a case management perspective, the ability to proactively identify veterans with physical and mental health needs who are at risk for using the ED as their usual source of care is an important tool. Also, being able to those veterans with healthcare needs that are not being currently met by the VA system in a timely manner may inform the VA administration of a way to quantify and better understand the demand for medical and mental health care needed by VA-enrolled OEF/OIF veterans.

Study limitations

There were several limitations in this study. First, the study was a cross-sectional study and as such, we are unable to make causal inferences based on the results. Second, the sample population for this study contained data only for OIF/OEF veteran VHA patients. Because of this, the results from this study could not be generalizable to any population other than the study sample. In addition, the results of this study were not generalizable to: 1) all VHA-enrolled veterans or veterans in general; 2) Other types of health systems or; 3) the U.S. general population. Third, the study sample was limited to a 2-year timeframe, which meant that we were unable to analyze trends over time. Fourth, the study sample had missing data on veteran ED use outside the VHA, which meant that the ED use numbers may be underestimated. A fifth limitation concerned homeless veterans. The sample homeless veteran numbers may have been overestimated due to VHA's non-removal of the homeless flag. This is a known problem within the VHA. Sixth, the sample data did not contain a rural variable. One of the limitations of this was that rural veterans might be more likely to use EDs outside of VHA system, which would cause the ED use numbers to be underestimated. Another limitation of rural areas is that there may be a potential for bias among patients in rural areas with more limited access to EDs. One final limitation was that the study sample did not contain any community-level variables. Previous research by Lowe et al., found that community characteristics affected ED use in Medicaid patients [111].

Study implications / next steps

Predicting health services use for veterans with universal care may help to guide future research in a post-Patient Protection and Affordable Care Act (ACA) environment. Currently, vulnerable veterans have their healthcare needs taken care of by the VA's integrated healthcare system, yet many Americans still do not have ready access to healthcare. As the provisions of the ACA continue to be implemented with the goal of making healthcare available and affordable to all Americans, continued research on predicting utilization of healthcare services will be required as budget pressures to reduce costs continue to grow. In addition, using predictive models in conjunction with various classification methods may help identify possible future frequent ED users.

Future research might include an expanded timeframe (3-5 years) in order to look at trends. Expanding the scope of this study by adding ED-utilization in populations outside of the VHA along with the addition of community-level variables, and rural/non-rural indicators to the data would be very helpful to better understand VA and non-VA ED utilization differences between veteran and non-veteran populations. Another avenue of research that would add to extant literature would be a study to compare veterans (both VHA enrolled veterans and non-VHA enrolled veterans) and non-veteran ED-use consistency across multiple years. Moreover, additional research comparing specific high-risk conditions to each other (eg., TBI vs. COPD. vs. chronic pain, etc.)

may be helpful in understanding how these multiple conditions interact and affect ED utilization.

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APPENDIX

Table 39 – Available independent variables - frequency distribution

Variables	Freq (N=311,377)	%
Age Categories		
Ages 17-30	127,740	41.0%
Ages 31-40	86,789	27.9%
Ages 41+	96,848	31.1%
Race/Ethnicity		
White	197,421	63.4%
Black	53,250	17.1%
Hispanic	36,621	11.8%
Other	24,085	7.7%
Military Service		
Army	198,995	63.9%
Air Force	32,056	10.3%
Navy	38,888	12.5%
Marines	41,198	13.2%
Military Rank		
Enlisted	290,906	93.4%
Warrant/Officer	20,471	6.6%
Military Component		
Active Duty	180,957	58.1%
Guard/Reserve	130,420	41.9%
Education Level		
Up to High School	244,755	78.6%
Some College	31,259	10.0%
College Grad or Higher	31,375	10.1%
Unknown	3,988	1.3%
Poor		
No	82,950	26.6%
Yes	228,427	73.4%
ED Visits - FY10		
0 Visits	203,413	65.3%
1 Visit	56,417	18.1%
2-3 Visits	35,350	11.4%
4+ Visits	16,197	5.2%
ED use - FY10		
Low ED use	295,180	94.8%
High ED use	16,197	5.2%
ED Visits - FY11		
0 Visits	200,359	64.3%

Table 39 Continued

Variables	Freq	%
1 Visit	57,404	18.4%
2-3 Visits	36,602	11.8%
4+ Visits	17,012	5.5%
ED use - FY11		
Low ED use	294,365	94.5%
High ED use	17,012	5.5%
ED Visits First Year in VA		
0 visits	226,514	72.7%
1 visit	48,598	15.6%
2-3 visits	27,347	8.8%
4+ visits	8,918	2.9%
Mental Health Clinic Visits FY10		
0 visits	174,714	56.1%
1 visit	39,649	12.7%
2-3 visits	36,624	11.8%
4+ visits	60,390	19.4%
Substance Abuse Clinic Visits FY10		
0 visits	296,870	95.3%
1 visit	4,127	1.3%
2-3 visits	2,550	0.8%
4+ visits	7,830	2.5%
PCC Visits - FY10		
0 Visits	50,649	16.3%
1 Visit	91,039	29.2%
2-3 Visits	107,058	34.4%
4+ Visits	62,631	20.1%
PCC Visits - FY11		
0 Visits	61,568	19.8%
1 Visit	93,126	29.9%
2-3 Visits	100,055	32.1%
4+ Visits	56,628	18.2%
Emergency Department Reliance (EDR) - FY10		
Low EDR	194,143	62.3%
High EDR	117,234	37.7%
Emergency Department Reliance (EDR) - FY11		
Low EDR	183,049	58.8%
High EDR	128,328	41.2%
TBI Categories		

Table 39 Continued

Variables	Freq	%
No History	261,107	83.9%
Mild	27,959	9.0%
Moderate	14,124	4.5%
Severe/Other	8,187	2.6%
# of Physical Comorbidities FY10		
Zero	175,355	56.3%
1	91,550	29.4%
2-3	41,148	13.2%
4+	3,324	1.1%
# of Mental Health Comorbidities FY10		
Zero	174,067	55.9%
1	66,692	21.4%
2-3	65,832	21.1%
4+	4,786	1.5%
Total # of Selim Physical Comorbidities Ever		
zero	134,036	43.0%
1	104,434	33.5%
2-3	62,738	20.1%
4+	10,169	3.3%
Gender		
Female	40,944	13.1%
Male	270,433	86.9%
Married		
No	170,522	54.8%
Yes	140,855	45.2%
Ever Homeless?		
No	298,762	95.9%
Yes	12,615	4.1%
Homeless FY10		
No	306,108	98.3%
Yes	5,269	1.7%
Homeless FY11		
No	305,059	98.0%
Yes	6,318	2.0%
Hospital Post ER Care in 2011		
No	303,150	97.4%
Yes	8,227	2.6%

Table 39 Continued		
Variables	Freq	%
Vulnerable Veteran		
No	64,135	20.6%
Yes	247,242	79.4%
Service Connected Disability		
No	104,223	33.5%
Yes	207,154	66.5%
Service-Connected Disability - Depression		
No	295,446	94.9%
Yes	15,931	5.1%
Service-Connected Disability - Anxiety		
No	290,235	93.2%
Yes	21,142	6.8%
Service-Connected Disability - PTSD		
No	208,122	66.8%
Yes	103,255	33.2%
Service-Connected Disability - Alcohol/Drugs		
No	310,570	99.7%
Yes	807	0.3%
Service-Connected Disability - TBI		
No	286,532	92.0%
Yes	24,845	8.0%
Service-Connected Disability - Arthritis		
No	299,860	96.3%
Yes	11,517	3.7%
Service-Connected Disability - TR-arthritis		
No	294,347	94.5%
Yes	17,030	5.5%
Any Hospitalization in First VA Year		
No	302,600	97.2%
Yes	8,777	2.8%

Table 39 Continued

Variables	Freq	%
FY10 to FY11 ED Continuity (Sensitivity = Exact or higher # of ED visits)		
No	69,964	22.5%
Yes	241,413	77.5%
FY10 to FY11 ED Continuity (Sensitivity = +/- one ED visit)		
No	56,779	18.2%
Yes	254,598	81.8%
FY10 to FY11 ED Continuity (Sensitivity = +/- two ED visits)		
No	27,042	8.7%
Yes	284,335	91.3%
TBI - Mild		
No	277,235	89.0%
Yes	34,142	11.0%
TBI - Moderate		
No	297,006	95.4%
Yes	14,371	4.6%
TBI - Severe		
No	310,981	99.9%
Yes	396	0.1%
TBI - Penetrating		
No	311,255	100.0%
Yes	122	0.0%
TBI - Unclassified		
No	300,966	96.7%
Yes	10,411	3.3%
TBI - Any		
No	261,107	83.9%
Yes	50,270	16.1%
TBI - VA		
No	259,714	83.4%
Yes	51,663	16.6%
Amputation Lower-loss		
No	311,000	99.9%
Yes	377	0.1%

Table 39 Continued

Variables	Freq	%
Amputation Upper-loss		
No	311,352	100.0%
Yes	25	0.0%
Amputation Both-loss		
No	311,364	100.0%
Yes	13	0.0%
Amputation Uplobolp		
No	311,377	100.0%
Amputation Hearing-loss		
No	243,204	78.1%
Yes	68,173	21.9%
Amputation Otosclerosis		
No	311,329	100.0%
Yes	48	0.0%
Amputation Labyrinthitismeniere		
No	307,798	98.9%
Yes	3,579	1.1%
Amputation Perferated Eardrum		
No	310,109	99.6%
Yes	1,268	0.4%
Amputation Tinnitus		
No	209,617	67.3%
Yes	101,760	32.7%
Rx-Opioid Analgesics FY10		
No	253,491	81.4%
Yes	57,886	18.6%
Rx-Opioid Analgesics FY11		
No	251,009	80.6%
Yes	60,368	19.4%
Non-Psychiatric Hospital FY10		
No	305,908	98.2%
Yes	5,469	1.8%
Non-Psychiatric Hospital FY11		
No	305,625	98.2%
Yes	5,752	1.8%

Table 39 Continued

Variables	Freq	%
Any Hospitalization FY10		
No	299,161	96.1%
Yes	12,216	3.9%
Surgical Hospitalization FY10		
No	309,628	99.4%
Yes	1,749	0.6%
Medical Hospitalization(No Neuro) FY10		
No	307,585	98.8%
Yes	3,792	1.2%
Psychiatric Hospital FY10		
No	304,630	97.8%
Yes	6,747	2.2%
Substance Abuse Hospitalization FY10		
No	311,221	99.9%
Yes	156	0.1%
Counseling ED Visit		
No	262,318	84.2%
Yes	49,059	15.8%
Pain ED Visit		
No	293,041	94.1%
Yes	18,336	5.9%
Symptoms & Signs ED Visit		
No	294,748	94.7%
Yes	16,629	5.3%
Consultation ED Visit		
No	299,619	96.2%
Yes	11,758	3.8%
Injury/Poison ED Visit		
No	297,854	95.7%
Yes	13,523	4.3%
Prescription ED Visit		
No	307,462	98.7%
Yes	3,915	1.3%
Headache ED Visit		
No	308,016	98.9%
Yes	3,361	1.1%

Table 39 Continued

Variables	Freq	%
Health Status ED Visit		
No	307,897	98.9%
Yes	3,480	1.1%
Other Mental Illness ED Visit		
No	308,538	99.1%
Yes	2,839	0.9%
Substance Abuse ED Visit		
No	309,134	99.3%
Yes	2,243	0.7%
PTSD ED Visit		
No	308,649	99.1%
Yes	2,728	0.9%
Depression ED Visit		
No	308,832	99.2%
Yes	2,545	0.8%
Anxiety ED Visit		
No	309,607	99.4%
Yes	1,770	0.6%
Physical Illness ED Visit		
No	310,056	99.6%
Yes	1,321	0.4%
Suicide ED Visit		
No	310,381	99.7%
Yes	996	0.3%
Any TBI ED Visit		
No	310,912	99.9%
Yes	465	0.1%
Neoplasms ED Visit		
No	311,164	99.9%
Yes	213	0.1%
Pregnancy ED Visit		
No	311,308	100.0%
Yes	69	0.0%
Dx Respiratory System - ED visit		
No	298,211	95.8%
Yes	13,166	4.2%
Dx Skin Cancer - ED visit		
No	305,803	98.2%
Yes	5,574	1.8%

Table 39 Continued

Variables	Freq	%
ED visit Dx - Digestive System		
No	306,708	98.5%
Yes	4,669	1.5%
ED visit Dx - Genitourinary		
No	307,593	98.8%
Yes	3,784	1.2%
ED visit Dx - Nervous System		
No	307,402	98.7%
Yes	3,975	1.3%
ED visit Dx - Muscular/Connective		
No	308,245	99.0%
Yes	3,132	1.0%
ED visit Dx - Circulatory System		
No	308,985	99.2%
Yes	2,392	0.8%
ED visit Dx - Infectious Disease		
No	309,408	99.4%
Yes	1,969	0.6%
ED visit Dx - Endocrine System		
No	309,851	99.5%
Yes	1,526	0.5%
ED visit Dx - Blood		
No	311,220	99.9%
Yes	157	0.1%
Dx-Anemia FY10		
No	307,473	98.7%
Yes	3,904	1.3%
Dx-Cancer FY10		
No	307,970	98.9%
Yes	3,407	1.1%
Dx-OA FY10		
No	295,251	94.8%
Yes	16,126	5.2%

Table 39 Continued

Variables	Freq	%
Dx-Cataract FY10		
No	309,428	99.4%
Yes	1,949	0.6%
Dx-Hepatitis FY10		
No	309,322	99.3%
Yes	2,055	0.7%
Dx-Chronic Obstructive Pulmonary Disease FY10		
No	300,665	96.6%
Yes	10,712	3.4%
Dx-Congestive Heart Failure FY10		
No	311,157	99.9%
Yes	220	0.1%
Dx-Diabetes FY10		
No	302,506	97.2%
Yes	8,871	2.8%
Dx-Diverticulitis FY10		
No	310,617	99.8%
Yes	760	0.2%
Dx-Prostate FY10		
No	309,043	99.3%
Yes	2,334	0.7%
Dx-Gallbladder FY10		
No	310,696	99.8%
Yes	681	0.2%
Dx-Gout FY10		
No	309,373	99.4%
Yes	2,004	0.6%
Dx-Heart Attack FY10		
No	311,124	99.9%
Yes	253	0.1%
Dx-Hip FY10		
No	307,362	98.7%
Yes	4,015	1.3%
Dx-HBP FY10		
No	267,114	85.8%
Yes	44,263	14.2%
Dx-Angina FY10		
No	311,203	99.9%
Yes	174	0.1%

Table 39 Continued

Variables	Freq	%
Dx-Bowel DS FY10		
No	310,310	99.7%
Yes	1,067	0.3%
Dx-Irregular Heartbeat FY10		
No	309,619	99.4%
Yes	1,758	0.6%
Dx-Low Blood Pressure FY10		
No	233,773	75.1%
Yes	77,604	24.9%
Dx-Other Arterial FY10		
No	307,463	98.7%
Yes	3,914	1.3%
Dx-Ulcer FY10		
No	310,855	99.8%
Yes	522	0.2%
Dx-PVD FY10		
No	311,132	99.9%
Yes	245	0.1%
Dx-Rheumatoid Arthritis FY10		
No	310,937	99.9%
Yes	440	0.1%
Dx-Seizures FY10		
No	310,776	99.8%
Yes	601	0.2%
Dx-Skin Cancer FY10		
No	310,997	99.9%
Yes	380	0.1%
Dx-TIA FY10		
No	311,255	100.0%
Yes	122	0.0%
Dx-Thyroid FY10		
No	304,987	97.9%
Yes	6,390	2.1%
Dx-UTI FY10		
No	309,812	99.5%
Yes	1,565	0.5%
Dx-Prostate FY10		
No	310,836	99.8%
Yes	541	0.2%

Table 39 Continued

Variables	Freq	%
Dx-Stroke FY10		
No	310,589	99.7%
Yes	788	0.3%
Dx-Alcohol Selim FY10		
No	285,717	91.8%
Yes	25,660	8.2%
Dx Pain FY10		
No	203,253	65.3%
Yes	108,124	34.7%
Dx Schizophrenia FY10		
No	309,850	99.5%
Yes	1,527	0.5%
Dx Bipolar FY10		
No	300,671	96.6%
Yes	10,706	3.4%
Dx Depression FY10		
No	245,090	78.7%
Yes	66,287	21.3%
Dx Substance Abuse FY10		
No	279,732	89.8%
Yes	31,645	10.2%
Dx Anxiety FY10		
No	277,687	89.2%
Yes	33,690	10.8%
Dx PTSD FY10		
No	214,347	68.8%
Yes	97,030	31.2%
Dx Headache FY10		
No	275,819	88.6%
Yes	35,558	11.4%
Dx Elix 33 FY10		
No	281,115	90.3%
Yes	30,262	9.7%
Dx-Anxiety Selim FY10		
No	277,687	89.2%
Yes	33,690	10.8%
Dx-Depression Selim FY10)		
No	242,838	78.0%
Yes	68,539	22.0%

Table 39 Continued

Variables	Freq	%
Dx-Bipolar Selim FY10		
No	300,671	96.6%
Yes	10,706	3.4%
Dx-Schizophrenia Selim FY10		
No	309,846	99.5%
Yes	1,531	0.5%
Dx-PTSD Selim FY10		
No	214,347	68.8%
Yes	97,030	31.2%

Table 40 - Nominal predisposing variables frequency distribution

Variables	Frequency	%	Variables	Frequency	%
Age			**Military Service**		
Ages 17-30	127,740	41.0%	Army	198,995	64.0%
Ages 31-40	86,789	27.9%	Air Force	32,056	10.3%
Ages 41-50	66,522	21.4%	Marines	41,198	13.2%
Ages 51+	30,326	9.7%	Navy	38,888	12.5%
Gender			**Military Component**		
Female	40,944	13.1%	Active	180,957	58.1%
Male	270,433	86.9%	Guard	84,107	27.0%
Race/Ethnicity			Reserve	46,313	14.9%
White	197,421	63.4%	**VA Poverty Determination**		
Black	53,250	17.1%	Non-Exempt from Copay	228,427	73.4%
Hispanic	36,621	11.8%	Exempt from Copay	65,767	21.1%
Asian	7,884	2.5%	Unclassified	17,183	5.5%
Native American/Pacific Islander	4,630	1.5%	**Homeless in FY10**		
Unknown	11,571	3.7%	No	306,108	98.3%
Married			Yes	5,269	1.7%
No	170,522	54.8%	**Homeless in FY11**		
Yes	140,855	45.2%	No	305,059	98.0%
			Yes	6,318	2.0%

Table 41 - Discrete predisposing variables

variable	*N*	*mean*	*variance*	*skewness*	*kurtosis*	*min*	*max*	*p25*	*p50*	*p75*	*p99*
years_since_last_deployment	311,377	4.61	5.49	0.00	1.96	0	10	3	5	7	9

Table 42 - Enabling categorical variables frequency distribution

Variables	Frequency	%	Variables	Frequency	%
Married			**Service-Connected Disability - Depression**		
No	170,522	54.8%	No	295,446	94.9%
Yes	140,855	45.2%	Yes	15,931	5.1%
Military Rank			**Service-Connected Disability - Anxiety**		
Enlisted	290,906	93.4%	No	290,235	93.2%
Officer	17,594	5.7%	Yes	21,142	6.8%
Warrant Officer	2,877	0.9%	**Service-Connected Disability - PTSD**		
Education Level			No	208,122	66.8%
Less than High School	4,038	1.3%	Yes	103,255	33.2%
High School Graduate/GED	240,717	77.3%	**Service-Connected Disability - Alcohol/Drug**		
Some College	31,259	10.0%	No	310,570	99.7%
College Graduate	23,592	7.6%	Yes	807	0.3%
Post-College/Professional Degree	7,783	2.5%	**Service-Connected Disability - TBI**		
Unknown	3,988	1.3%	No	286,532	92.0%
VA Poverty Determination			Yes	24,845	8.0%
Non-Exempt from Copay	228,427	73.4%	**Service-Connected Disability - Arthritis**		
Exempt from Copay	65,767	21.1%	No	299,860	96.3%
Unclassified	17,183	5.5%	Yes	11,517	3.7%
Homeless in FY10			**Service-Connected Disability - TR-arthritis**		
No	306,108	98.3%	No	294,347	94.5%
Yes	5,269	1.7%	Yes	17,030	5.5%
Homeless in FY11					
No	305,059	98.0%			
Yes	6,318	2.0%			

Table 43 - Discrete and count enabling variables

Variables	*N*	*Mean*	*Variance*	*Skewness*	*Kurtosis*	*Min*	*Max*	*p25*	*p50*	*p75*	*p99*
Number of Years in VA System	311377	4.22	3.76	0.73	2.81	2	10	3	4	5	9
Service Connected Disability Rating - 2002	12601	3.87	98.60	3.70	21.27	0	100	0	0	0	50
Service Connected Disability Rating - 2003	16809	4.03	116.86	3.87	22.40	0	100	0	0	0	50
Service Connected Disability Rating - 2004	33373	5.20	180.27	3.46	16.94	0	100	0	0	0	60
Service Connected Disability Rating - 2005	56373	9.13	341.38	2.44	8.97	0	100	0	0	10	80
Service Connected Disability Rating - 2006	85607	12.59	478.33	1.94	6.21	0	100	0	0	20	90
Service Connected Disability Rating - 2007	116869	17.49	633.88	1.44	4.19	0	100	0	0	30	100
Service Connected Disability Rating - 2008	158930	22.05	770.23	1.12	3.16	0	100	0	10	40	100
Service Connected Disability Rating - 2009	211647	25.19	866.09	0.92	2.66	0	100	0	10	50	100
Service Connected Disability Rating - 2010	311377	25.37	908.46	0.91	2.58	0	100	0	10	50	100

Table 44 - Discrete count need variables

variable	N	M	SD	min	max	p25	p50	p75	p99
Physical Comorbidities	311,377	0.63	0.88	0	10	0	0	1	4
Physical Comorbidities - Ever	311,377	0.94	1.11	0	12	0	1	1	5
Mental Health Comorbidities	311,377	0.76	1.02	0	6	0	0	1	4

Table 45 - Primary categorical utilization variables

Variables	Frequency	%	Variables	Frequency	%
ER Visit in FY10			**Substance Abuse Clinic Visit in FY11**		
No	203,413	65.3%	No	296,580	95.2%
Yes	107,964	34.7%	Yes	14,797	4.8%
ER Visit in FY11			**PTSD Clinic Visit in FY10**		
No	200,359	64.3%	No	272,381	87.5%
Yes	111,018	35.7%	Yes	38,996	12.5%
Primary Care Visit in FY10			**PTSD Clinic Visit in FY11**		
No	50,649	16.3%	No	273,067	87.7%
Yes	260,728	83.7%	Yes	38,310	12.3%
Primary Care Visit in FY11			**Hospitalization in 2010**		
No	61,568	19.8%	No	299,161	96.1%
Yes	249,809	80.2%	Yes	12,216	3.9%
Multiple ER Visits Within 30 Days			**Surgical Hospitalization in 2010**		
No	279,937	89.9%	No	309,628	99.4%
Yes	31,440	10.1%	Yes	1,749	0.6%
Mental Health Outpatient Care in FY10			**Psychiatric Hospital in 2010**		
No	163,614	52.5%	No	304,630	97.8%
Yes	147,763	47.5%	Yes	6,747	2.2%
Mental Health Clinic Visit in FY10			**SA Hospital in 2010**		
No	174,714	56.1%	No	311,221	99.9%
Yes	136,663	43.9%	Yes	156	0.1%
Mental Health Clinic Visit in FY11			**Non-Psychiatric Hospital - 2010**		
No	182,010	58.5%	No	305,908	98.2%
Yes	129,367	41.5%	Yes	5,469	1.8%
Substance Abuse Clinic Visit in FY10			**Non-Psychiatric Hospital - 2011**		
No	296,870	95.3%	No	305,625	98.2%
Yes	14,507	4.7%	Yes	5,752	1.8%

Table 46 - Primary discrete utilization variables

Variables	*N*	*Mean*	*Variance*	*Skewness*	*Kurtosis*	*Min*	*Max*	*p25*	*p50*	*p75*	*p99*
Counts of ED visits in FY10	311377	0.767555	2.842699	5.59417	69.40037	0	67	0	0	1	8
Counts of ED visits in FY11	311377	0.795717	2.91207	5.155373	53.25688	0	45	0	0	1	8
Counts of Primary Care Visits in FY10	311377	2.292279	5.925193	4.142075	57.34945	0	115	1	2	3	11
Counts of Primary Care Visits in FY11	311377	2.134522	5.845166	5.354389	166.2511	0	194	1	2	3	11
Counts of Mental Health Visits in FY10	311377	2.605453	68.78574	21.95036	1489.289	0	1098	0	0	2	30
Counts of Mental Health Visits in FY11	311377	2.607151	64.55556	14.25486	470.2105	0	648	0	0	2	31
Counts of Substance Abuse Clinic Visits in FY10	311377	0.789879	59.09577	21.65006	796.5919	0	547	0	0	0	23
Counts of Substance Abuse Clinic Visits in FY11	311377	0.861017	65.90839	19.27035	588.8775	0	538	0	0	0	26