DEPLOYED ELECTRONIC MEDICAL RECORD POLICY COMPLIANCE: AN INTRA-DEPARTMENT PRINCIPAL-AGENT PERSPECTIVE

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ABSTRACT

To understand problems related to a policy of implementing a lifelong longitudinal electronic health record (EHR) more fully, this dissertation examines compliance with changes in policy over time. We analyze drivers of compliance with a required electronic medical record (EMR) by hospital clinicians completing the records for deployed service members. This study examines compliance as an outcome of principal-agent (PA) relationships, with the EMR modeled as the measure of success between one level of bureaucratic principal (i.e. medical command) with control over the necessary mechanisms in order to ensure compliance of agents (i.e., medical professionals).

Policy compliance is operationalized in three ways: 1) the total number of inpatient EMRs completed; 2) the date on which new records are started; 3) the average number of days to close an inpatient EMR. For each of these dimensions, "EMR" refers to what clinicians categorize as treatment for a disease non-battle injury or battle injury.

The first independent variable concept for this study is change in the level of information asymmetry between principal and agent, operationalized as the time a superordinate medical command (MEDCOM) is directly in control over hospitals. The second concept is the alignment of goals in order to reduce goal conflict. This is operationalized as a technology upgrade allowing hospital EMR to be used for both implementing the larger EHR as well as in providing real-time clinical notes necessary for the care of patients being evacuated to the next level of medical care. Finally, the concept of principal control mechanisms are operationalized in this study as the

introduction of increased monitoring policy and sanctions at the clinician level during hospital transition periods.

We use quantitative data in the form of completed electronic medical records and utilize a quasi-experimental research design. The specific design chosen for the study is the interrupted time-series. The population for this study is all United States military service members seen as inpatients in deployed military hospitals directly supporting Operation Iraqi Freedom. The study period is 105 weeks. Overall, this research meets the objectives outlined in Chapter 1 (Introduction). The study examined two important questions regarding clinician compliance with completing EMRs for deployed service members. First, this study addressed if there was a change in policy compliance over time. By conducting an analysis of policy interventions, we established changes in policy compliance. Compliance was defined as the fluctuation in inpatient records started, records completed, and changes in the average time to complete records. Secondly, this study examined what factors influenced the performance of hospital clinicians and how significant these drivers' impact was on record completion. The analysis consisted of graphing the changes over time and examining changes that were most likely due to policy interventions. We further analyzed the changes over time utilizing ANOVA and least squares regression.

The results supported many of the hypotheses. Technology upgrades not only led to greater completion rates but also reduced the amount of variation in records completed week to week. The introduction of the monitoring policy also increased both record completions and records started. Finally, sanctioning showed the greatest impact on completing records.

This research is important for four reasons. First, this study provides a method to analyze policy implementation at different levels within one federal department. Second, this research enhances the body of knowledge in the inter-disciplinary evaluation of policy implementation. Third, this dissertation examines the role of specific control mechanisms, namely monitoring and sanction, not previously reported in the EHR implementation literature. Finally, this study provides real-world implications for implementing EHR policies in deployed environments.

This study determines that the time a MEDCOM is in charge, technology upgrades, monitoring, and sanctions do have an effect on policy compliance but are reliant on the measurement of compliance. As an example, technology upgrades significantly increase the number of EMR completed at hospitals, but they are not statistically significant in increasing or decreasing the number of new encounters started at the hospital. In addition, patient categories influence the significance between the independent and dependent variables.

DEDICATION

This dissertation is dedicated to those in harm's way, serving our country overseas and to the medical personnel caring for them. The service these uniformed health care professionals provide, day in and day out, is nothing short of miraculous.

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Finally, to my wife, Ekaterina Mihailovna. You are my partner, friend, and harshest critic. Я люблю тебя, моя маленькая птичка.

TABLE OF CONTENTS

Table of Contents (Continued) Page

LIST OF TABLES

List of Tables (Continued)

Table Page

List of Tables (Continued)

Table Page

LIST OF FIGURES

List of Figures (Continued)

List of Figures (Continued)

Figure | Page

CHAPTER ONE

INTRODUCTION AND BACKGROUND

> *Mansfield recalls a night in Balad where he was treating a wounded soldier who was bleeding from a dressing over a complex hip/pelvis wound. "The only medical record I could access was a scribbled pencil note that I could not read," Mansfield said. "I basically had to start from scratch with the soldier. It would have been much less invasive to him if I accurately knew the extent of his wounds and surgeries with a good, thorough, legible medical record that I could access electronically."*[1]

Since the end of 2001, over 70,000 United States military casualties have been evacuated from Iraq and Afghanistan because of injuries or illness (Bilmes, 2008). In military terms, evacuation refers to "[t]he timely and efficient movement of the wounded, injured, or ill while providing en route medical care to and between medical treatment facilities" (FM 8-10-6). The first stage of a typical evacuation occurs when patients move from where they were injured to the nearest Combat Support Hospital (CSH). If it is deemed necessary for the patients to obtain further medical care after treatment at the CSH, the second stage of evacuation follows and the patients are flown by helicopter to an Air Force staging facility (another CSH) in central Iraq. The wounded are further stabilized and then transported for continued medical care in Germany before continuing to the United States. In addition to soldiers injured in battle, this process is similar for soldiers diagnosed with diseases and non-battle injuries.

Many patients are treated and continue service with the military. Others continue medical treatment in military hospitals and are eventually transitioned to the Veteran's

[1] Taken from http://www.health.mil/Press/Release.aspx?ID=169&a=1 (accessed 8 February 2010)

Affairs (VA) system for long-term care. Throughout the evacuation process, or this continuum of care, key patient treatment information is gathered at various stages in the form of patient encounters[2] and is recorded on paper, in an electronic format, or a combination of both. Much of the documentation from these encounters flows with the patient. After each new treatment, medical staffs add the individual patient encounter to a patient's complete medical record for that particular injury or illness. It is imperative for medical staff at each level to know what previous medical personnel believe to be the diagnosis and what treatments have been provided. Therefore, medical records play a central role in the treatment of patients.

How medical personnel manage patient encounters and complete medical records is therefore very important. During 1990-1991, the United States and a coalition of other countries embarked on what is now known as the Gulf War or Operation Desert Watch and Desert Storm. Many soldiers, sailors, airmen, and marines came home to a series of what seemed at the time to be non-related medical problems. Many were evaluated by medical professionals and thought to have psychological disorders more than medical problems. All of the medical records for soldiers deployed were paper, and many of these records, now only a couple of years later, were lost. Therefore, it was exceedingly difficult to see any trends surrounding the onset of any conditions. Equally frustrating is the fact that soldiers could not go produce or retrieve documents showing deteriorating conditions over time. The debate over causes and the true nature of this Gulf War Illness

[2] An encounter is defined as a contact between a patient and a healthcare provider who has primary responsibility for assessing and treating the patient at a given point in time, while exercising independent judgment. (ASD-HA, 1999).

(GWI) are still being debated (Haley, Kurt, & Hom, 1997; Ismail et al., 1999). A Presidential Oversight Board as well as numerous Congressional investigations ensued, resulting in a series of recommendations (DASD FHP&R, 2008)(DASD FHP&R, 2008). One recommendation was to create an electronic longitudinal health record for each service member.

The introduction of an electronic medical record (EMR) is one way to address deficiencies in deployed health records management. An electronic medical record would allow the documentation of individual patient encounters to follow a wounded service member from the beginning to the end of the evacuation and recovery process. Medical staff could add pertinent information in real time and securely transmit the data to a location where other medical staff could then access and add to the treatment record of the wounded. This EMR would be added to other records of treatments throughout the soldiers' career. This method creates an electronic longitudinal health record that covers information from initial entry into the military, any pre-deployment screening, through the deployment and to the end of their career. After the end of the service members' career, the Department of Veterans Affairs could access the EHR in order to ensure accuracy in data and best care for veterans (Medline, 2008).

The advent of EMR has been accompanied by improvements in healthcare. The Government Accountability Office reports regularly to the House of Representatives Subcommittee on Oversight and Investigations, Committee on Veterans' Affairs. There have been eleven separate reports since 2001. Although each shows that incremental changes have been made for the better, they continue to show concern about whether individuals are receiving a complete medical record after deployments at the time of leaving the service (GAO-08-1158T, 2008). Because of the continued focus on a longitudinal electronic health record, this study focuses only on the presence of the electronic record and not the paper record.

However, even with the many technological advances in this area, real-time patient data is still primarily moved in paper form with the wounded soldier. Although electronic data may be collected at the scene of the incident, practitioners continue to use paper records that are less accurate, secure, and complete than their electronic counterparts (Bates & Gawande, 2003; de Mul & Berg, 2007; Hillestad et al., 2005; Reid, 1972; Tzelepi, Pangalos, & Nikolacopoulou, 2002). For example, medics continue to carry a paper field medical card, which is a quick and simple way to document immediate medical care. There are many legitimate reasons for not starting an EMR at this point. For example, the point of injury may not be safe, making it an inopportune time to go through a computer start up process and multiple password-protected screens in order to access electronic records. As a result, despite the benefits of EMR, one is often not started until patients arrive at the first Combat Support Hospital (CSH).

Problem Statement

The use of EHRs is required by legislation passed by Congress in 1997 that prescribes the military to ensure complete health records for service members (United States Congress, 1997). This requirement is implemented by the DoD (Deputy Secretary of Defense, 1997), while the Defense Health Information Management System (DHIMS) program office is responsible for providing the software necessary for the implementation of this policy.

Despite clear legislation, the many different layers of bureaucracy responsible for implementing an EHR have yet to complete the transition to a paperless health record. The practice of paper-based medical records persists beyond a patient's initial care at the point of injury. This practice may seem puzzling, especially because federal law and Department of Defense (DoD) policy require the use of EHRs. As a matter of DoD policy, at a minimum, electronic documentation must begin at the first hospital (e.g., the U.S. Army Hospital, Ibn Sina, in Baghdad) and must continue throughout the remainder of the evacuation process (Multi-National Corps-Iraq, 2006; Multi-National Corps-Iraq, 2007). One reason for the persistence of paper-based records may be inconsistency in how information systems are implemented (Alavi & Joachimsthaler, 1992; Bardach, 1978; Cooper & Zmud, 1990; Hargrove, 1975; P. A. Sabatier, 1986).

Goals of the principals in charge of implementing the EHR may not match the goals of medical personnel responsible for direct patient care. Goal conflict is an inherent quality in principal-agent (PA) relationships. The PA relationship focuses on the contractual relationship between at least two parties in a hierarchical relationship. The first party (the principal) hires another (an agent) who possesses specific and specialized skills (Arrow, 1985; Clark, 1985; Dreher & Jensen, 2007; Olson, 2000). Agency theory has roots in modern policy analysis back to Weber (1978), but the basic premise of contracts and obligations precedes modern analysis by centuries (Ross, 1973). An examination of the contracts and obligations between bureaucratic levels within the military health system seems an appropriate way to identify what works and what does not. The military health system (MHS) has developed an EHR that can be maintained throughout deployments with the introduction of the EMR system specifically designed for deployed environments. For a myriad of reasons previously discussed, this implementation can be extremely difficult. However, it has been argued that by institutionalizing a well-constructed medical information system, organizations may overcome implementation difficulties.

Goal conflict is exemplified in how the EMR may not meet the requirements of clinicians as a way to pass medical data through the chain of evacuation in real time. The records completed in one location may not be readily available for clinicians at the gaining medical site. If this is the case, then the EMR does not meet the goals of the clinicians.

A deployed wartime environment with changing context and multiple principals may result in less than clear enforcement of policies. Implementing EHRs within a wartime-deployed environment implicitly requires the involvement of many agents at different hierarchical levels within the military bureaucracy. Even within a single bureaucratic department, there are differences between the principal organization (i.e., the higher headquarters for all medical care in a combat zone, known in this study as a MEDCOM, or Medical Command) at one level and agent organizations (i.e., the hospitals) at the next lower level. Compounding the difficulties are the rotation schedules of personnel within these organizations. In this environment, the principal organization changes on a rotational basis; thus, continual changes in operational rules and procedures are commonly made that are inherent in differing leadership styles. For instance, it is easy enough to envision each commander arriving with a desire to promote his or her agenda items.

Multiple objectives make the EMR just one of the many things medical personnel have to do. Rotation schedules may further compound the principal-agent problems identified above. There are also issues in implementing EHRs at the agent level due to individual hospital differences and personnel turnover. Although military hospital locations in Iraq may not change frequently, these hospitals undertake a number of primary missions. During the period of study, there were a total of eight U.S. military hospitals in Iraq and Kuwait. The United States Navy (USN) maintained the hospital in Kuwait; the United States Air Force (USAF) maintained the staging hospital in Iraq; there were two United States Army (USA) hospitals in Iraq specifically reserved for detainees; and the final four USA hospitals were located at different sites within Iraq and served specific geographical regions. The units responsible for providing leadership, administrative, and clinical personnel for each of these hospitals experienced a 100% turnover of military personnel every four to fifteen months, while individual clinicians rotated in and out of the combat zone with even greater frequency. In fact, based on their medical specialties and other related factors, clinicians may rotate in as few as ninety days. Dispersed locations, different hospital missions, constant turnovers in leadership, and uneven turnovers in clinicians all make it difficult to implement EHRs.

Against this backdrop of bureaucracy, inconsistent schedules, and multiple goals, it is not surprising that EMRs are not completed. The goal of this study is to explore issues tied to EMR implementation. The gap in electronic documentation may be a result of the varied and multiple actors engaged in implementation (O'Toole, 1986) or the operational control of principal over agent (Blom-Hansen, 2005). More specifically, theory suggests clinicians are more likely to engage in behaviors that non-medical principals may not easily comprehend (Sharma, 1997). For instance, policy implementers may not fully understand a physician's decision to stop utilizing EHRs during times when patient flow into the hospital is substantially increased. While the principal in this case may find it frustrating that the hospital abandoned the EHRs, electronic documentation may become significantly less important to the clinical staff when an emergency room is immediately flooded with wounded.

Purpose

To understand the problems related to EHR implementation more fully, this study applies agency theory to examine compliance with requirements to complete EMR over time. More specifically, this study analyzes drivers of compliance as factors in hospital clinicians' adherence to EMR use in a war zone. This study examines compliance as an outcome of principal-agent (PA) relationships, with the EHR encounter being modeled as the measure of success between one level of bureaucratic principal (i.e. MEDCOM) with control over the necessary mechanisms in order to ensure compliance of agents (i.e., medical professionals) (Sikora & Shaw, 1998).

Research Questions

The study examines two important questions regarding clinician compliance in completing electronic medical records (EMRs) for deployed service members. The questions are concerned with the application of the PA theory to examine if policy changes over time. Specifically, this study addresses the following questions:

1. Is there a change in policy compliance over time?
2. What factors influence the performance of hospital clinicians in implementing EMR, and how significant are these drivers' impact?

We are carrying out research to examine why some clinicians comply with the mandated use of the EMR and others do not, in order to be able to encourage and inform better targeted policies and strategies for creating a better overall EHR. Drivers of compliance include the introduction of new policies, threats of sanctioning, and upgrades to technology that allow for greater visibility of records and their timely completion.

Significance of the Study

This research is important for four reasons. First, this study provides a method to analyze policy implementation at different levels within one federal department. The framework surrounding policy implementation for this study is based on Mazmanian and Sabatier's (1981) work that provides guidance on how to analyze public sector policy implementation over time. This project furthers this scholarly work on policy implementation, by examining the non-statutory objectives of a principal and measuring the specific outputs of various agents in relation to these objectives.

Second, this research enhances the body of knowledge in the inter-disciplinary evaluation of policy implementation, which is also of importance to scholars (Angelstam et al., 2003; Blom-Hansen, 2005; Dreher & Jensen, 2007; Kiser, 1999; McLaughlin, 2005). Although a great deal of past research has focused on the implementation of various technologies related to EHR implementation, no specific research in the field specifically focuses on the relationship between principals and their agents. In addition, current research outside of the EHR domain does not consider principals and agents under circumstances of complete personnel change. In addition, the technological conditions specific to the health care industry may serve as an additional exogenous variable worthy of consideration (Mazmanian & Sabatier, 1981).

Third, this dissertation examines the role of specific control mechanisms, namely monitoring and sanctions, not previously reported in the EHR implementation literature. This will further the discourse related to the replication of a theoretical framework of expanding agency theory in order to modify existing knowledge relating to control mechanisms (Blom-Hansen, 2005). Current EHR implementation literature focuses on economic incentives as a means for promoting agent compliance. However, the Department of Defense (DoD) cannot currently provide any positive economic incentives to clinicians based on compliance, so the current literature is not as relevant in this context. Research suggests that by re-examining the implications of information asymmetry between the principal and the agent in addition to each party's separate goals, better policy outcomes may occur (Agranoff & McGuire, 2001; Box, 1999; Dreher & Jensen, 2007; Feldman & Khademian, 2002; Waterman & Meier, 1998). Therefore, this study focuses on the use of monitoring and sanctions in order to decrease information asymmetry and to provide clearly defined goals, which will be beneficial to public policy implementation and enforcement.

Finally, this study develops real-world implications for implementing EHR policies in deployed environments. Kawalek (2007) posits that information system (IS) theories and knowledge are generally not integrated with organizational problem-solving methods. The ultimate clients, in this case the taxpayers, paying for the change, are only one set of beneficiaries. The clinicians are also beneficiaries if the EHR works well. Leaders at the MEDCOM and hospitals are beneficiaries. Another, arguably most important beneficiary, is the individual or group that is most affected by the change, in this case, the wounded service members (Churchman, 1979; Kawalek, 2007; Simon, 1996). However, this party is often neglected in current research. Similar to Leege's (1974) statement that a policy researcher cannot be divorced from the policy itself, I am aware of the acute nature of this question because I, as a policy researcher, am not divorced from the policy-making arena.

Finally, it is important to note that this research itself and the accompanying findings do not implicitly or explicitly suggest a lack of quality patient care by military providers. As an example, during the Iraq war, survival rates of wounded combat soldiers have been higher than in any previous armed conflict and remain above 90% (Gawande, 2004). This study also does not suggest that information is not being gathered. Paper records with assessments and treatments at every stage of the evacuation process still accompany soldiers from the first notes at the point of injury through the evacuation chain. This research does suggest, however, that although there is a system that works, it is possible to make a system that works better. EHR documentation, as dictated by Congress in 1997, still requires a great deal of improvement.

Definition of Terms

Implementation: A process of interaction between the setting of goals and the actions geared to achieving them (Pressman & Wildavsky, 1984)

Policy Compliance: The adherence to broad statements of goals and objectives.

Electronic Health Record (EHR): The record containing information about an individual's longitudinal health status and health care.

Electronic Medical Record (EMR): which is the legal record created in hospitals and ambulatory environments that is the source of data for the electronic health record (Garet & Davis, 2006)

Outline of the Dissertation

This chapter provided the background and context of the EHR policy compliance construct. It also provided the problem and presented the purpose of the study and its significance. The chapter concluded with the definitions of key terms and an outline of the research. Chapter 2 is comprised of the literature review, which offers a discussion of implementation within the larger policy construct. The chapter draws on EHR and implementation literature in order to define the boundaries of compliance over time. It also provides a conceptual development of the principal-agent relationship, and the effect of technology implementation on clinician compliance. Chapter 3 explains the research methodology. This chapter provides the overall design strategy for the study and the process for collecting and analyzing the data. The chapter also includes a description of the data used, limitations, and threats to validity. Chapter 4 presents the findings of the results of the study, and Chapter 5 provides the summary, conclusion, and recommendations. The final chapter also includes potential practical uses of these findings and recommendations for future research.

CHAPTER TWO

REVIEW OF THE LITERATURE

This chapter reviews the literature relevant to the study of policy compliance during the implementation of electronic health records and includes the following:

- A discussion of implementation within the context of the larger policy process
- A review of the EMR and EHR
- EHR implementation and healthcare providers' compliance
- A review of the principal-agent relationship
- A discussion of control mechanisms focusing on the *ex post* mechanisms of monitoring and sanctions

The chapter begins with the over-arching perspective of policy implementation, i.e. how public sector entities achieve their goals. Next is a review of the electronic records used in medical care. The section begins with a review of pertinent research in the field and continues with a description of the specific terminology necessary for understanding EMR and EHR within the context of this particular study. The EMR and EHR section ends with an examination of the healthcare provider's role in ensuring compliance with EHR implementation. As shown in the review, we introduce a new way of examining compliance with public EHR implementation by introducing agency theory, specifically the principal-agent (PA) relationship. The focus of this study's analysis is on the certain control mechanisms in this relationship that the principal uses to control the subordinate's output. We conclude this chapter with a summary of the theoretical lens focusing on gaps in the literature on EMR compliance.

Concept of Implementation

In this study, we examine the implementation of EMRs in a deployed environment that was the result of legislation attempting to rectify past problems with health records in this specific context. In essence, we observe the relative success or failure of the policy implemented over time. This section begins with an overview of the concept of implementation. Next, we will examine the literature to determine why implementation either succeeds or fails and will reveal specific factors that lead to successful policy implementation.

The concept of implementation is rooted in the interaction process between goal setting and the actions geared to achieving goals. Within this definition, an interaction *process* is implicit, which Mazmanian and Sabatier (1981) describe as a cyclical pattern. First, a legislative body passes the basic statute. Implementing agencies decide how to implement the statute and then make adjustments based upon the compliance of target groups with agency decisions. After the initial implementation, the actual intended and unintended impacts of those outputs are measured. Legislatures then revise the policy and If any of the agency's decisions are perceived to be harmful, the legislative body will revise the policy until it is ready to be implemented again. Finally, a third agency evaluates the entire process and makes (or attempts to make) important revisions to the basic statute. The level of probable implementation success may be measured as early as the policy-formulation stage when the statute is being created (Pressman & Wildavsky, 1984). However, no matter when success is measured, creating legislation that is clear, targeted, and manageable will ensure a clearer path for successful implementation, especially as originating staff leave and new members of the organization arrive (Stone, 1977; West, 1982).

While the policy implementation process is generally accepted as being cyclical, researchers disagree over whether it can be divided into specific phases or not. Sabatier and Jenkins-Smith (1993) do not accept that there are discrete policy phases. For example, they believe that policy implementation cannot be separated from policy adoption as initially assumed by Lasswell[3], who believes that there are specific phases of the policy process (1956). It may be argued that the concept of discrete phases has led to the delegitimization of implementation research (Saetren, 2005). Sabatier (2007) instead provides a policy feedback loop in which policy formulation is informed by policy experience. In Sabatier's Advocacy Coalition Framework, he provides voice for the role of technical information as well as for the role of critical individuals and the relationships between the two. However, the Advocacy Coalition Framework ignores formal organizational structure, including micro-organizational structures. This study specifically examines the role of critical individuals and technical information. However, the examination of different sized organizational structures is also an integral part of this study.

[3] Lasswell's stages of the policy process stages include the following: 1. *Intelligence*, or the major components of an emerging policy problem; 2. *Promotion*, or the priority of the issue; 3. *Prescription*, or what is proposed to alleviate the problem; 4. *Invocation*, or coordination of the policy with existing norms; 5. *Application*, synonymous with implementation; 6. *Termination*, or how a policy ends, and 7. *Appraisal*, or the means of evaluating a policy's effectiveness.

Barrett and Fudge (1981) agree with Sabatier's policy feedback loop. However, they question if the purpose of studying implementation is concerned with achieving conformance or performance. The authors challenge the policy-centered view of the implementation process by disputing the *a priori* assumptions about the hierarchical relationship between policymaking and implementation. The authors' state that implementation is part of the political policy process, thereby making policy a statement of intent in order to change behavior as well as a negotiated output coming from the implementation process.

The authors' negotiative perspective shifts away from the formal effects that high-level organizational hierarchies have on policy outcomes. Barrett and Fudge (1981) also assert that the examination of control exerted at the highest levels of organizational hierarchies over the agents at the implementing (i.e., lower) levels of these hierarchies inhibits implementation research. Therefore, although there is a cyclical process involved, Barrett and Fudge (1981) argue that research should focus at the lower levels of the "policy-action continuum" (p. 15). Not only does the researcher need to focus on the nature of the policy, but he/she also needs to concentrate on whom the action depends, stating "Policy does not implement itself" (p. 9). It is in these lower levels of organizational structure where implementation actually occurs and where this study specifically focuses.

The question then becomes "how should the researcher examine the players involved in policy implementation?" During the early 1980s, much of the academic debate on policy implementation focused on the polarized perspectives of top-down and bottom-up analytical tools that could improve the successful implementation of a designed policy (Fesler & Kettl, 2009). Top-down tools focused on traditional organizational structures and emphasized the separation of politics and administration. Agent compliance at the bottom of the administrative structure was measured based upon policy guidance at the highest level of policy formulation. Due to the complexity in relationships and interactions in the implementation process, action in the form of output may not always be evaluated against policy goals (Elmore, 1982). Instead of examining policy outcomes in relation to top-driven policy initiatives, it is imperative to either examine only a portion of the entire top-down relationship or evaluate it from the bottom-up. This approach isolates only a portion of the implementation process and therefore provides a clearer examination of causal relationships (Hjern, 1982).

Hjern (1982) moved away from measuring success by the goals implicit in the statutes created by a legislative body and focuses instead on a bottom-up approach. He established that certain discretionary powers are a cause for inconsistency in implementation. He established a relationship between the assignments of non-statutory variables with increases in desirable policy outputs. Non-statutory variables are those items not specifically detailed in the legislative statute that can have an effect on policy output. One non-statutory variable may be in the selection of appropriate individuals, or actors, to carry out implementation. Empirical evidence suggests the choice of actors may be paramount for success. DiIulio and DiIulio (1994) suggest that the choice of actors at the beginning of the implementation process is the key to successful implementation later on. Alford (1975) suggests that the same is true not only in policy formulation but throughout implementation as well. Specifically within medicine, having the right clinicians support the implementation of an EHR can be an accurate measure of the relative success or failure of implementation policy. Because clinicians are responsible for completing the majority of EMRs, having credible clinicians' support a given policy points to its overall success.

Lipsky (1980) explores the existence and nature of discretionary power in organizational settings at the lowest levels of implementing agencies by examining lower-level employees as actors. He also explores the ways that front-line operatives either develop "coping mechanisms" in the absence of clear policy rules or negotiate policy modification through individual action when using such discretion. The actions of these street-level bureaucrats are his central focus in the determination of successful policy implementation.

Discretionary power exhibited by individuals is not the only reason for inconsistency. Implementation of EHR policy is generally not consistent through time; that is, there may be initial compliance, but this compliance does not remain constant. Policy implementation generally begins with increasing amounts of output with relative success, but success rates often manage to move downward over the initial terms of implementation. Additionally, Bache (1999) notes that policy output management frequently slopes back downward over a period of continued implementation. In such cases, policy reform and performance improvement becomes increasingly important.

It is important to note that within implementation literature, changes occur over time while the implementing actors remain relatively constant. In this study however, no one individual implementer is present for the entire period of study. This provides a unique opportunity to study the differential impact of complete changeovers of personnel from leadership in organizations, through to the front-line organizational operatives. This dissertation then fills a gap in policy implementation research.

Osbourne and Gaebler (1992) provide a different approach to the early 1990s' literature on New Public Management and implementation. During this time, focus turned away from traditional implementation methods and toward discovering implementation failures as a result of ambiguous policy objectives, lack of resource availability, and political control over implementing agencies. Osbourne and Gaebler's research focused on having the government embrace an entrepreneurial spirit in the development and implementation of policy.

Barrett (S. M. Barrett, 2004}) calls for more multi-disciplinary research in the field of public policy. Different disciplines explore ways to deal with addressing the central paradox of control and autonomy in achieving desired outcomes. Barrett argues that researchers need to search for balance between the requirements for public accountability with consumer responsiveness, respect for difference, and local autonomies. We examine the implementation of a larger EHR policy in a deployed environment that originated with Congress. It is imperative to discover what is happening at the lowest of levels of implementation and to examine the issues over time from a multi-disciplinary perspective.

The Electronic Medical Record and the Electronic Health Record

This section serves three purposes. The first purpose is to present background for defining the EMR and EHR. The second purpose of this section is to provide a description of the specific terminology and environment for understanding this particular EMR study. The third purpose is to establish where gaps exist in research related to electronic medical record-keeping.

Much of the literature uses different names for EHR based on the role a record plays in gathering data within a specific clinic or hospital. According to Garet and Davis (2006), there is a subtle, yet important difference between the EHR and the various kinds of EMRs. The EMR is the legal record created in hospitals and ambulatory environments that is the source of data for the EHR. The EHR is the record that allows different medical practitioners to share medical information easily among different medical stakeholders and to have a patient's information follow him/her through the various modalities of care. Most recently, in the Management Information Systems (MIS) literature, an electronic health record is defined as technology that captures digital patient information and then makes it available to those with proper access (Angst & Agarwal, 2009). The EMR is then a record of an individual incident of care. Each EMR becomes part of a larger individual EHR, which can then be shared in different environments.

The EMR is utilized in different settings, and there are various types of inpatient as well as outpatient records (Häyrinen, Saranto, & Nykänen, 2008). An outpatient record occurs when a patient visits a hospital or clinic for medical care but does not stay overnight. An inpatient record occurs when a patient is admitted to a hospital and stays for an indeterminate amount of time, usually for at least one night. Portions of the record may be filled in and used solely for administrative functions, such as billing, but other portions contain information about the care given by clinicians, also known as documentation of care.

Documentation of care has also been completed in different forms over the years. Initially, the EMR focused on electronically capturing only physician narratives for an encounter between patients and clinicians (Tange, Hasman, de Vries Robbé, & Schouten, 1997). Presently, most records address time-, source-, and problem-oriented facets of the EMR. Although most EMRs address multiple similar orientations, the structure of EMR is not standardized. There are two distinct structures common in the EMR. Sometimes data is entered in the form of unstructured free text. An example of such data is the use of manually generated nursing care plans. Other EMR use coded data, such as the International Classification of Diseases (ICD) for establishing diagnoses within the EMR. However, it is also common for EMRs to use a combination of both the free-text and coded data structures. In addition to nursing plans and coded data, additional components in many EMRs include information regarding procedures, medications given or prescribed, pathological findings, and other clinician notes.

As late as 1991, the Institute of Medicine (IOM) found that no current system was capable of capturing a complete patient record, or EHR. The IOM's definition of a complete patient record included time-oriented EMRs, source-oriented EMRs, and problem-oriented EMRs (Dick & Stein, 1991). Time-oriented records focus on building a chronological record of events. Physicians' narratives would be considered source-oriented EMRs, while problem-oriented EMRs focus only on one facet of care—for example, an EMR only for the department of surgery that excludes other departments not pertinent to the condition directly affecting surgery. According to the IOM study, the reasons for this lack of complete record systems were due to both technological and non-technological reasons. For example, the technology may not have been available to collect information directly from devices and placed into the records. A non-technological reason may be differences in departmental business practice. This study specifically examines one technological and a few of the non-technological reasons for lack of complete EHRs.

Developing an exact definition for an EMR and the larger EHR as well as pinpointing the reasons for lack their of completion have been confusing tasks in the medical records literature. The next section provides more specific terminology, as defined within the United States Military Health System (MHS), to help elucidate these terms more fully for use in the current study.

The Deployed EMR

The United States MHS incorporates all aspects of health services for the Department of Defense (DoD). The MHS maintains medical systems and ultimately produces a lifelong longitudinal EHR for patients similar Garet and Davis's (2006) definition. This DoD EHR assimilates both inpatient as well as outpatient EMRs in addition to ancillary service records, such as those for pharmacy, laboratory, and radiology care. Some medical records start in a traditional hospital environments, while others start in deployed environments. The technology used to capture every medical encounter in both deployed and non-deployed circumstances is similar, yet there are differences between them, which tend to compound the difficulties in completing the records.

It is important to limit the terminology used in this study to describe parts of the total EHR. Limiting terminology allows for a clearer understanding of the policy implementation process as it pertains to this particular context. First, we examine the types of records and how they fit together to create the longitudinal EHR. At the most basic level is the encounter, or an individual instance of care between a clinician and a patient. Multiple encounters describing the various elements of care within a particular hospital comprise a completed EMR, or the legal documentation of all care for a specific patient during a specific event. Multiple EMRs tell the story of all medical care give to a patient over their lifetime, which becomes the EHR.

We begin then with our definition of an encounter. An **encounter** is a specific instance of contact between a patient and a healthcare provider who has primary responsibility for assessing and treating the patient at a given time, while exercising independent judgment (ASD-HA, 1999). Examples of encounters include administrative data, medical history, care plans, diagnoses, procedures, medications, pathological findings, and other provider notes. Then there are open encounters, which are maintained on computer servers within each hospital. We consider an encounter to be an **open encounter** when the patient's information is initially entered, but the specified instance of care has yet to be completed and/or documented. After each instance of care and after the electronic documentation is completed, the inpatient information system produces a message saying that the encounter is ready to be transmitted to the EMR; this record is termed a **closed encounter**. For example, each time a clinician places an order for laboratory tests on a patient, this is a new encounter. The encounter remains open while the tests are being completed in the lab. When the tests are completed and the laboratory technician enters the results, this completes the encounter.

The aggregate of these completed encounters creates an **electronic medical record (EMR),** which is the legal record created in hospitals and ambulatory environments that is the source of data for the EHR (Garet & Davis, 2006). The EMR includes electronic versions of inpatient treatment records, outpatient treatment records, health records, dental records, civilian employee medical records, x-ray films, DD Forms 602 (i.e., "Patient Evacuation Tags"), DD Forms 1380 (i.e., "U.S. Field Medical Card"), alcohol/drug abuse prevention and control program records, and consultation service case files (ASD-HA, 1999). The EMR used by hospitals to document inpatient medical or dental care is initiated on admission and completed at the end of hospitalization prior to evacuation.

In order for an EMR to be considered a **completed electronic medical record**, it must be digitally signed by a clinician. In addition, the record must have a minimum number of fields complete in order to satisfy the requirements of a completed EMR. The fields that must be required to fulfill EMR completion standards for a patient encounter include patient registration, the patient's vital signs, clinical notes (provider progress, nurse progress, anesthesia progress, dietetics, doctors, pre- and post operative care, and admissions), patient assessment, treatment plan, patient disposition, discharge summary, and ancillary services (pharmacy, laboratory, and radiology) (Multi-National Corps-Iraq, 2007).

The MHS **electronic health record (EHR)** contains information about an individual's longitudinal health status and health care and is made up of the different EMRs a patient has had over his/her lifetime. Appropriate portions are easily accessible to authorized users when and where needed, including in different geographical areas. The EHR systems facilitate the worldwide delivery of healthcare, assist individuals and clinicians in making healthcare decisions, and support leaders in making operational and resource-allocation decisions. This then is how the entire record system is built: encounters→ EMR and EMR → EHR. Figure 2-1 provides a richer breakdown of this model.

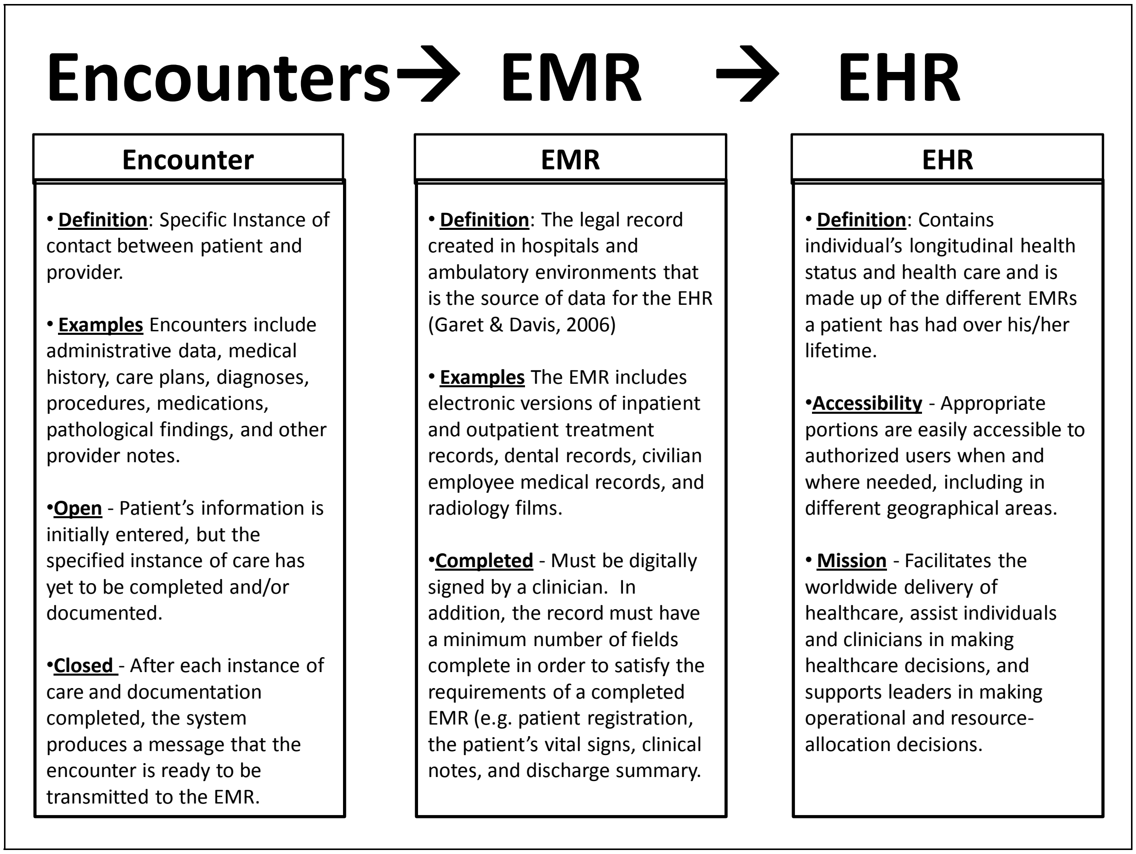

Figure 2-1. Components of Encounters to EMR to EHR

Next, we define the type of patients we will examine in this study.

This study examines only inpatient records. In an MHS healthcare facility, once a patient is admitted, providers supply inpatient care. This consists of the examination, diagnosis, treatment, and disposition of inpatients appropriate to the specialty and/or subspecialty under which the patient is being cared for as an inpatient in a hospital. Each one of these steps creates an individual encounter (ASD-HA, 1999). An **inpatient** is

> [a]n individual, other than a transient patient, who is admitted (placed under treatment or observation) to a bed in a [medical treatment facility] that has authorized or designated beds for inpatient medical or dental care.

> A person is considered an inpatient if formally admitted as an inpatient with the expectation that he or she will remain at least overnight and occupy a bed even though it later develops that the patient can be discharged or transferred to another hospital or does not actually use a hospital bed overnight. This definition does not include a patient administratively admitted to the hospital for the purposes of a same day surgery procedure. (ASD-HA, 1999)

It is also necessary to differentiate between the individuals within the hospital who take care of the inpatient. Specifically, there is a subtle, yet distinct difference between a clinician and a healthcare provider. A **healthcare provider**—a more general term—is a professional who provides health services to patients, such as a physician, dentist, nurse, or allied health professional. (ASD-HA, 1999). Therefore, clinicians also fit into the more general definition of the healthcare provider. Within the MHS, a **clinician** is defined as a physician or dentist practitioner normally having admitting privileges and primary responsibility for the care of inpatients. All healthcare providers can enter certain information into the deployed EMR based upon their duties and responsibilities. It is the clinician however, who is responsible for signing a completed EMR.

Healthcare providers in a tactical environment are not all placed in hospitals. According to military doctrine, there are three levels of tactical medical care, each having a different capability in both assessment and treatment of the patient: 1.emergency medical care, 2, initial resuscitative care, and 3. resuscitative care. Table 2-1 provides a description of each level.

Levels of Care	Description
Level 1 (Emergency Medical Care)	At this level of care, varieties of personnel provide emergency medical care. The initial treatment may be provided by self- or buddy-aid and is followed by a trained medical aid person. This aid person provides first aid and conveys or directs the casualty to an aid station that provides essential emergency care and prepares the casualty for evacuation to the rear. This care may include the beginning of intravenous fluid administration, hemorrhage control, and/or the establishment of an airway.
Level 2 (Initial Resuscitative Care)	This level provides resuscitative care as provided by company-sized medical units, such as clearing stations or medical companies. Depending on the capability of the medical unit, initial surgery to save a life or a limb may be available. The medical units prepare those patients requiring further care for evacuation to the next level facility.
Level 3 (Resuscitative Care)	This level provides medical care in facilities staffed and equipped for surgery and post-operative care. These facilities may provide additional surgical-specialty support and additional laboratory and radiology support.

Table 2-1. Levels of Tactical Medical Care

In order to concentrate solely on hospitals, we only examined inpatient medical records at level-three hospitals. Smaller clinics and aid stations do not have the ability to input inpatient encounters. Inpatient medical records are created after a patient is admitted into a hospital for care beyond the scope of smaller clinics, such as surgery or radiology. Focusing on hospitals within a single branch of the DoD allows us to examine a clear line of reporting made directly available to a single medical headquarters.

In addition, establishing the number, location, and mission of the hospital is important in examining the transitions times of healthcare providers, especially with when a hospital has a large number of clinical personnel transitioning out of theater at the same interval. Although Air Force electronic encounters are counted throughout the study, the Air Force hospital personnel transition every four months, thereby making it impossible to obtain exact dates as part of the study. In addition, there are two hospitals in Iraq that deal almost exclusively with detainees. Detainee is "a term used to refer to any person captured or otherwise detained by an armed force" (J-7, 2009). Detainee patient encounters are not included in this study, so the hospital transition dates for these hospitals are not incorporated.

Now that the specific terminology for this study has been established, let us shift focus to the specific medical information system utilized to capture patient information for the EHR. The **Composite Health Care System (CHCS)** is a software and hardware system that provides patient data management and communications capabilities. CHCS supports the following specific areas: reporting, patient registration, admission, disposition, transfer, inpatient activity documentation, laboratory orders (verifies and processes), drug and lab test interaction, radiology orders (verifies and processes), radiology test results identification, medication order processing, inpatient diet orders, patient nutritional status data, clinical dietetics administration, nursing, and order-entry (ASD-HA, 1999).

The MHS upgraded CHCS in Iraq during the period of study. The upgrade is named the **Theater Composite Health Care System (CHCS) Cache (TC2)**. Similar to CHCS, TC2 provides theater users inpatient documentation capabilities. Also like CHCS, TC2 has a user interface similar to the interface used by healthcare providers in fixed hospitals outside of the Iraqi theater. However, unlike CHCS and older interfaces, the TC2 system upgrade allows hospitals to become almost paperless within the facility and throughout a patient's evacuation. Although the two systems are similar for internal clinician use, there was one important change between the systems: after the EMR is completed, TC2 uploads inpatient documentation to the Theater Medical Data Store (TMDS) almost immediately. Then, TMDS may be accessed via the Internet by other healthcare providers with appropriate levels of access throughout the MHS. This assists in creating an EMR that may be studied during evacuation between hospitals, thereby alleviating the need for paper patient records accompanying patients. Healthcare providers at the Veterans Administration may also access information once it arrives in TMDS. Because EMR are now available from theater as well as from fixed MHS hospitals outside a deployment zone, this system enables the creation of a true longitudinal EHR that may be used beyond the patient's military career.

In order to specifically discuss deployed EMRs and how they tie in with the larger EHR, we need to consider what were considered to be deployment criteria for this study. The United States Central Command (USCENTCOM) sphere of control includes both the Iraq and Afghanistan areas of operation as well as a number of other locations. To limit the total number of medical units included in this study, we first limit the inquiry to one military operation with a large number of coalition forces deployed— Iraq[4]. We further

[4] Operation Iraqi Freedom includes casualties that occurred on or after March 19, 2003 in the Arabian Sea, Bahrain, Gulf of Aden, Gulf of Oman, Iraq, Kuwait, Oman, Persian Gulf, Qatar, Red Sea, Saudi Arabia, and United Arab Emirates. Prior to March 19, 2003, casualties in these countries were considered OEF. Taken from: http://www.defenselink.mil/news/casualty.pdf (accessed February 8, 2010).

limit the inquiry to include only one branch of DoD hospitals, Army hospitals. In addition, we do not account for the effect regional violence has on specific hospitals and, therefore, examine only aggregate data.

Even within the one branch of DoD hospitals, there are various medical information systems (IS) as part of the MHS that go beyond the EMR. There is an IS for gathering medical information in aggregate for theater medical surveillance, another for tracking patient movement in the combat zone, and a third for assisting in the ordering of large aircrafts to move patients out of Iraq and back to Germany and from Germany back to the United States. Many of these systems work with each other, while others do not.

In addition, some of the information systems work in real-time without much clinician intervention. Other medical IS, such as the EMR, are dependent upon clinicians' completion of encounters in order to be seen and utilized by other clinicians outside of the hospital initially entering the data. As such, it is paramount that clinicians comply with requirements to sign EMRs, especially if they need to be used in real-time. The next section addresses current research in EHR implementation and in gaining greater levels of clinician compliance.

EHR Implementation and Compliance

There has been a great deal of research in the field of EHR implementation, which has developed with numerous perspectives and methodologies. One focal area has been on the introduction of electronic records to reduce transcription errors. Studies of side-by-side comparisons of records indicate that paper records include a larger percentage of errors compared to their paperless counterparts, and increased levels of use actually decrease the number of errors even further (Bates et al., 1998; Bates & Gawande, 2003). Overall, the paper records are less accurate, secure, and complete (de Mul & Berg, 2007; Hillestad et al., 2005; Reid, 1972; Tzelepi et al., 2002).

Not only does the introduction of electronic records increase safety as a result of error reduction, they may also provide significant cost savings. A 2005 estimate predicted that changing the United States healthcare system to using only electronic records would create a savings of up to $81 billion (Taylor et al., 2005). Changing to electronic records could also provide benefits for physicians as well, such as the ability to review records for quality improvement and for more accurate billing. Anderson's (2006) study established the importance of physician incentives to break through barriers to any adoption of electronic health initiatives.

While there are some instances where EHRs are adopted voluntarily, there are also situations in which the government has mandated the use of a specific EHR. Many times in these circumstances, clinicians support the use of the information technology to improve quality but maintain a perception that the system is not reaching its full potential, thus limiting their compliance. Possible causes of such perceptions include the limited use of key functions within the EHR such as the ability to enter additional information into the record. In the Sequist (2005) study, the lack of an organizational EHR leader, or champion, also limited compliance in EHR use.

As one system reaches the end of its usefulness, another system will need to be brought online. However, a system within a healthcare facility will not successfully be replaced by a new one unless the new technology supports work practices better. Second, in the public sector, system designers usually face dilemmas based on contradictions between central interests and local-level perspective (Kyhlbäck & Sutter, 2007). For example, central interests may be interested in gathering data in order to assess best business practices for the entire organization, while at the local level it may be imperative to gather information for patient-by-patient care. Providers' willingness to accept an implementation also changes over time. Physicians, nurses, and administrators demonstrate the importance of the roles played by implementers and users in determining the outcomes of an EHR (Lapointe & Rivard, 2006). The presence of other stakeholders, such as the patients themselves, also plays a role in successfully implementing an EHR (Staroselsky et al., 2006). Having an organizational EHR leader during implementation increases output. Thus, only over time and with proper user training can an EHR be successfully implemented in a healthcare facility.

Research suggests a number of variables affecting EHR implementation. The literature included in Table 2-2 indicates that the hierarchical relationships between hospitals and headquarters have yet to scrutinized. Studies show that individual as well as organizational incentives, such as time savings, matter in healthcare providers' compliance with increased use of an EHR.

This study examines an environment in which monetary incentives to increase compliance simply cannot occur. However, as shown, compliance with mandatory implementations is also successful if certain criteria are met regardless of monetary incentives. Therefore, it is necessary to examine compliance as a result of other control mechanisms, namely the addition of monitoring and sanctions. This study provides an opportunity to examine the effects of clinician turnover not seen in other studies. EHR implementation involves a process in which clinicians, as well as those above them in the hierarchical arrangement of the MHS, come and go relatively frequently. Nevertheless, current literature fails to examine how the time that implementers in superordinate roles are in charge affects clinicians' compliance. There is also an opportunity to examine the introduction of a technological innovation that supports the work practice of evacuation.

Summary of EHR Implementation Research			
Author	Title	Research	Relevance
Kyhlbäck and Sutter (2007)	What does it take to replace an old functioning information system with a new one?: A case study	Described a case study related to the transformation of an older electronic medical system for a new one.	First, one system within healthcare work will not successfully be replaced by a new one unless the new technology supports work practices better. Second, in the public sector, system designers usually face dilemmas based on contradictions between central interests and local- level perspectives.
Anderson and Balas (2009)	Computerization of primary care in the United States	Surveyed physicians to establish the current level of information-technology use by physicians	Reveals the role of education in the benefits of medical information technology by medical specialty societies. Without the knowledge of benefits provided by these societies, less likely to adopt.
Bates et al. (1998)	Effect of Computerized Physician Order Entry and a Team Intervention on Prevention of Serious Medication Errors	Examined the use of EHR in reducing medical errors	Implementation of EHR reduces medical errors.
Anderson, J. (2006)	Social, ethical and legal barriers to E-health	Investigated the present status of information technology in health care and the perceived benefits	Identifies the requirements for physician needed to break through barriers to E-Health adoption

		and barriers by primary care physicians.	
Staroselsky et al. (2005)	Improving electronic health record (EHR) accuracy and increasing compliance with health maintenance clinical guidelines through patient access and input	Assessed the current state of EHR completeness for preventive services and the added value of patient-reported information.	Demonstrates the value of patient contributions in keeping records up-to-date. Records, when checked by patients, are often incomplete.
Sequist et al. (2007)	Implementation and Use of an Electronic Health Record within the Indian Health Service	Evaluated the implementation of a mandated EHR within the Indian Health Service (IHS), a federally funded health system for Native Americans. Evaluated both organizational champions as well as primary care physicians.	Clinicians support the use of information technology to improve quality in underserved settings, but many felt that it was not currently fulfilling its potential in the health service, potentially due to limited availability of key functions within the EHR.
Terry et al. (2009)	Adoption of Electronic Medical Records in Family Practice: The Providers' Perspective	Explored experiences, ideas, and perspectives regarding the adoption of EMR and examined perceived barriers and facilitators to EMR adoption	Computer literacy, time to deploy, training, and supporting problem-solvers is the key to successful implementation.
Lapointe and Rivard (2006)	Getting physicians to accept new information technology: insights from case studies	Analyzed the implementation of EHR systems in three hospitals to understand the dynamics of physicians' resistance to CIS implementation more fully	Providers change in their level of resistance to implementation over time. Physicians, nurses, and administrators demonstrated the important roles implementers and users play in determining the outcomes of IS implementations

Table 2-2. Summary of EHR Implementation Research

This section presented a background for defining the EHR and EMR in research and also provided a description of the specific terminology and environment needed for understanding this particular EMR study. Finally, it established that there are indeed gaps in EMR research. The following section seeks to address other gaps in the research related to this study by examining the hierarchical contractual relationship between implementers at the lowest level.

Agency Theory

If an information system is well structured, that alone does not necessarily lead to its successful implementation within an organization. Gortner et al. (2006) provide a very common formal definition, stating that that an organization is "a collection of people engaged in specialized and interdependent activity to accomplish a goal or mission" (2006). The structure of organizations and their ability to make correct and timely decisions also influence successful implementation. A larger organizational size often allows for specialization, and specialization of function or division of labor permits efficiency.

The problem with this common formal definition is that it does not necessarily answer questions about *control, motivation, and supervisory style*. Organization theory is not a single theory but truly a multidisciplinary approach. According to Dwight Waldo (1978), "Organization theory is characterized by vogues, heterogeneity, claims, and counterclaims."(p. 597) Waldo describes many of the different social sciences' approach to questions about organizations and how their respective theoretical lenses frame questions differently. The modern organization finds it difficult to achieve coordination with multiple goals and different members with differing incentives. The purpose of organization research, therefore, is to uncover that reality and to use the knowledge to predict and sometimes control that reality to improve the organization's functioning from the owners' standpoint.

Agency theory is then a useful analytic tool to understand information systems within an organizational hierarchy. The key tenet of the principal-agent relationship concerns ensuring that the agent completes his/her delegated functions as assigned by the principal (Kiser, 1999; Ross, 1973). There must be coordination between the two parties where knowledge regarding the focal task and attitudes regarding any risks involved may be at odds with one another. Medical information systems for the MHS function in this manner. This study will attempt to analyze EHR implementation for medical forces in Iraq from the principal-agent (PA) perspective.

Under the simplest settings of the PA relationship, there would be a single principal and a single agent; thus, much of the research in the field focuses on the relationship between a single principal and agent (Banfield, 1975; Weber, 1978; Weingast, 1984). In most circumstances, the principal wants to establish a contract with another individual, the agent, who will produce the principal's desired outcome. The principal could conceivably perform the function him/herself but has chosen not to for one reason or another. Sometimes the principal does not possess the required expertise or credentials, for example. Significantly fewer studies concern multiple principals with one agent (Weingast, 1984) or a single principal with multiple agents (O'Toole, 1986). The proposed course of study examines the agency relationship between a single principal the MEDCOM, and multiple agents, the hospitals.

No matter what the principal-agent ratio is, there are certain characteristics within the relationship that remain constant. Peterson (1993) presents five general characteristics of the principal-agent relationship. First, agents may differ in their types; that is, an agent may be careful in one setting, while in a different setting, he/she may be careless. Second, the agent's action influences the desired outcome of the relationship. For example, it is usually more costly in time for a physician to provide care and then accurately and completely fill out an electronic encounter, so they may be less likely to comply with having to do so. Third, there are usually random factors that influence the outcome in addition to the agent's actions and type. These random factors are normally beyond the control of either the principal or the agent. An example may be an unusually heavy flow of patients into an emergency room due to an attack on a convoy of U.S. military vehicles.

Fourth, there is the outcome, which depends on all of the previous characteristics: the type of agent, the actions taken, and the random factors outside of either party's control. This outcome is observable to both the principal and the agent. For example, an outcome could be the total number of completed encounters, or it could be comprised of many different facets, such as the quantity and quality of several relevant factors. Fifth is the concept of asymmetrical information. With asymmetrical information, normally only the agent observes the action and type. If the principal observes any action, it will come at a cost. For example, the hospital observes the number and nature of patients entering the emergency room. They assess and make decisions for patient care and enter information into the EMR. If the MEDCOM desires to see this process and better understand why EMR are missing certain data, then it costs them because they must have one of their own in the emergency room, assessing the situation along with hospital staff.

These five characteristics make up the basics of the principal-agent relationship, but there are also certain assumptions in this theory. Within agency theory, there are three basic assumptions:

- Both individuals as well as organizations act within the boundaries of their own self-interest.
- Information asymmetry exists between principals and agents.
- Goals between principals and agents can be in conflict.

The first assumption of agency theory is that actors are rational and make decisions that are in their own self-interest. Within both informal and formal institutional constraints, the same can be true of an organization as a whole (Mantzavinos, 2004). For example, it is within the rational self-interest of a principal organization to seek to lessen information asymmetry that exists with an agent organization over time (DiIulio & DiIulio, 1994; Kiser, 1999; Waterman & Meier, 1998). In discussing the principal-agent relationship in the context of the DoD and electronic health record (EHR) implementation, understanding the hierarchical relationships involved is imperative in understanding the limits of a principal's control.

In the context of this specific research topic, individual physicians in a deployed environment are the agent and their higher command structure is the principal. Within the constructs of neoinstitutional agency theory, if a political principal, such as the higher command, decides that it is not in its own rational self-interest to police or monitor its bureaucratic agents (e.g., clinicians), that principal is unlikely to directly bear any cost incurred by the agent's continued shirking (Waterman & Meier, 1998). The cost then passes onto the public—in this case the beneficiary of the principal, or the patient (Dye, 1986; Laine & Davidoff, 1996; Moody, Aaronson, Buising, & Barton, 2006; Zatzick et al., 2001). However, if the principal increases the amount of monitoring over the agents, in the form of monitoring completed encounters, desired policy outputs should increase.

Information asymmetry is an integral assumption within agency theory. Commonly, information asymmetry occurs as a result of the agent's greater understanding or technical expertise in relation to the principal. Proximity to the action of creating the output also assists in the agent gaining an information advantage (Waterman & Meier, 1998). The assumption holds that the greater amount of time the principal is present, the less overall information asymmetry exists between the principal and respective agent(s). However, within the confines of research, it is quite difficult to operationalize this concept (Mitnick, 1975). Within this study, the difficulty is aggravated by the movement of both principals and agents in and out of theater at varying times as well.

The final assumption within agency theory is that goal conflicts exist between principals and agents. In the simplest version of a principal-agent relationship, there is an outcome that can be easily measured and an agent that is more averse to risk than the principal. The principal wants the agent to perform a certain way, but verifying what the agent is doing is costly to both monitor and enforce. Therefore, there are two types of agency problems: adverse selection and moral hazard. Adverse selection refers to the agent's misrepresentation of his/her ability, and moral hazard refers to the opportunity to shirk without penalty if the principal fails to monitor adequately. In order for a principal to monitor and enforce the contract with an agent, they must rely on certain control mechanisms either before or after the contract begins. Research suggests that by re-examining the necessary assumptions of agent information asymmetry with the principal and separate goal setting, better policy outcomes may occur (Agranoff & McGuire, 2001; Box, 1999; Dreher & Jensen, 2007; Feldman & Khademian, 2002; Waterman & Meier, 1998).

Control Mechanisms

Blom-Hansen (2005) specifically focuses on control mechanisms as a measure of policy success. There are four control mechanisms, two of which require *ex ante* consideration, while the second two controls require *ex post* consideration. The first *ex ante* control mechanism is establishing the choice of agent(s) necessary for implementation. In this study, it would be best for a principal to choose only clinicians having a background in utilizing electronic patient documentation. For example, the principal may chose to only deploy clinical staffs that have previously worked with the DoD EHR. As another example, perhaps MEDCOMs could only choose hospital commanders that share a vision related to the importance of a deployed EMR as an integral portion of the total standard of care. In reality, this is not (nor should it be) a key decision point for establishing clinical competence, as there may be little control over the decision to include certain actors or allow for the presence of intermediaries prior to implementation (Bardach, 1978; Blom-Hansen, 2005; Hargrove, 1975). Specifically within this study, the MEDCOMs cannot choose which hospitals will work for them.

Without a choice of actors involved throughout the implementation process, it will be increasingly difficult to ascertain specific information relating to the second *ex ante* control, establishing incentives (Doolan & Bates, 2002). Current EHR implementation literature focuses on economic incentives as a means for agent compliance. Within the DoD, it is not currently possible to provide any positive economic incentives to agents based on compliance. This lack of incentives creates a moral hazard that can result in outcomes not beneficial to the principal, unless checked *ex post*. According to agency theory, each actor will act in his/her own self-interest (Alchian & Demsetz, 1972; Eisenhardt, 1989).

As agents are monitored, it remains necessary for sanctions to be available to correct any agency drift. Monitoring without consideration of reprisal is not sufficient in order to control implementation effectively (Blom-Hansen, 2005). The party imposing the sanction and the types of institutional constraints establish the success or failure of the relationship (North, 1990). Therefore, it is necessary to evaluate the effectiveness of the sanctions as well as the functioning of the hierarchical context.

Therefore, this study focuses on the use of monitoring and sanctions in order to decrease information asymmetry and provide clearly defined goals. According to Blom-Hansen, the first *ex post* mechanism is monitoring. Monitoring may be implemented in one of two forms: police patrol or fire alarm monitoring (McCubbins & Schwartz, 1984). Police patrol oversight is more formal and established and is, therefore, much more expensive in terms of both time and money. Fire alarm oversight is much less formal, and there is less direct involvement by the principal. In this type of oversight, monitoring of agents is conducted by a third party and is, therefore, less expensive. We observe in this study a form of police patrol monitoring, where the cost associated is diverted back to the agents. The sunk cost up front for the MEDCOM is in creating a monitoring policy. Cost is diverted to the hospitals as they create the reports and send them electronically to the MEDCOM.

Although less effective than *ex ante* mechanisms, *ex post* control mechanisms are necessary in order for principals to secure a degree of influence over agents. By focusing on the application of improved monitoring and sanctions, the question of *ex post* control effectiveness is important in public policy. In certain cases, such as the one in this study, measureable incentives can be provided to the agents if they conform to the policy, and principals also may not have the opportunity to choose agents. Therefore, this particular study's context allows for a unique opportunity not found in much of the economic literature surrounding agency theory (Waterman & Meier, 1998).

Summary

Policy implementation occurs at different levels. We have established that it is imperative to discover what is happening at the lowest of levels and to examine the issues over time and from a multi-disciplinary perspective. Research suggests a number of variables affecting implementation and has also indicated that there are a number of ways to study the implementation and usefulness of EHRs . However, policy compliance in the form of completing a mandatory record as described within the confines of a hierarchical relationship between two stakeholders has yet to be established in the MHS context. By examining ways in which a MEDCOM influences multiple hospitals, we further the research in the areas of EHR implementation, technology adoption, and *ex post* control mechanisms. This study provides further evidence suggesting that such relationships do affect output.

This study also examines an environment in which monetary incentives to increase compliance simply do not occur. Addressing this situation fills another gap in the literature. As shown, compliance with mandatory implementations is also successful if certain criteria are met. Therefore, it is necessary to examine compliance as a result of other control mechanisms, namely the addition of monitoring and sanctions.

Finally, this study provides an opportunity to examine the effects of personnel turnover not seen in other studies. This environment provides for a repetitive implementation where hospitals, as well as those above them in the hierarchical arrangement of MHS, come and go with relative frequency. There is also an opportunity to examine the introduction of a technological innovation that supports the work practice of evacuation.

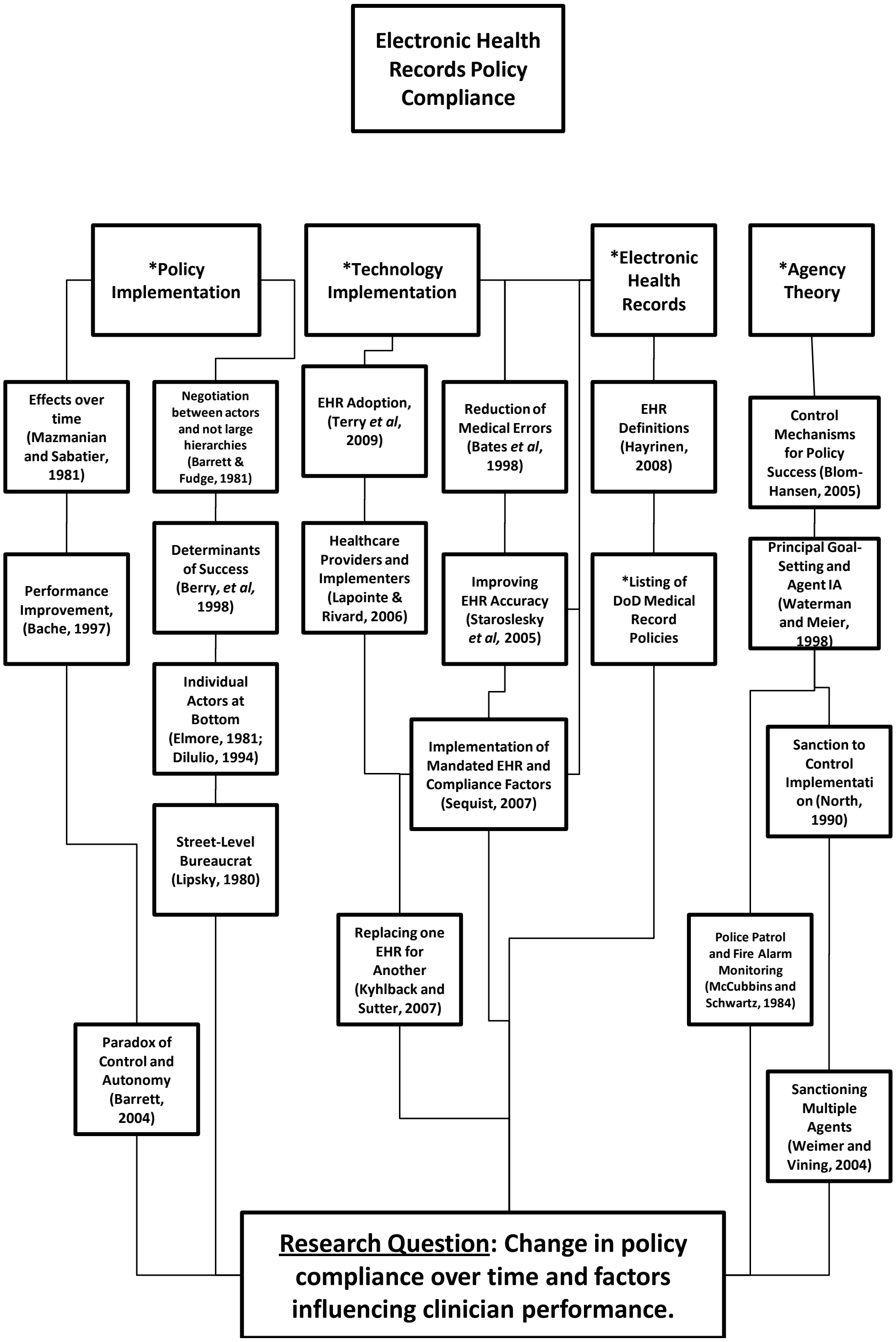

Figure 2-2. Summary of Relevant Research

CHAPTER THREE

RESEARCH METHODOLOGY

This chapter presents the methodology adopted for meeting this study's objective, which is to understand problems related to EHR implementation more fully by examining if there is compliance with a change in policy over time. We analyze the drivers of compliance with required electronic medical records (EMR) by hospital clinicians completing the records for deployed service members. This study examines compliance as an outcome of principal-agent (PA) relationships. The EMR is modeled as the measure of success between one level of bureaucratic principal (i.e., medical command) with control over the necessary mechanisms in order to ensure that bureaucratic agents (i.e., medical professionals) comply.

Out of the factors influencing the effectiveness of the EMR, the performance of hospital clinicians is considered an important determinant. Accordingly, much attention has been given to the ways by which clinicians' performance is achieved. From the perspective of agency theory analysis, it is costly and/or difficult for the principal to monitor or sanction an agent who maintains an information advantage. The PA model provides an analytic tool to examine how clinicians behave. Furthermore, solving agency problems contributes to increased clinician compliance and, ultimately, to the effectiveness of longitudinal EHR.

In describing the research methodology and procedures used for this study, a discussion of the following items is included:

- Conceptual framework
- Conceptual model
- Research questions
- Research design
- Operationalization of the dependent variables
- Operationalization of the independent variables
- Hypotheses
- Data-collection procedures
- Population selection
- Reliability and Validity
- Data-analysis procedures

The research consists of one major component: an examination of existing inpatient population data, which allows us to analyze the drivers of compliance with required EHR by hospital clinicians completing the EMR.

Conceptual Framework

This section concentrates on policy compliance over time, which is addressed through the use of interrupted time-series analysis.

Conceptual Model

Figure 3.1 is the proposed conceptual model for examining policy compliance. We begin with the conceptual input, the beneficiary population. The beneficiary population is the total operational environment in which a medical headquarters is responsible. This includes the sum of specific populations such as injured service members, Iraqi armed forces, and detainees. Rather than the total beneficiary population, we examine specific populations of patients and categories of injury relationship with completion of EMRs (e.g., policy compliance).

According to the model, there are three concepts affecting policy compliance in the form of output. Output is identified as the completion of EMR over time. The first two concepts, monitoring and sanctioning, are linked within the theory. Both monitoring and sanctions are part of the PA framework and are considered variables in this research, not constants (Waterman & Meier, 1998). Specifically, both are *ex post* control mechanisms, utilized by principals as part of a contract to ensure agent compliance. The third concept in the model is technology adoption. This concept accounts for the introduction of an information-system change that may have a direct effect on the output produced by agents (i.e., clinicians).

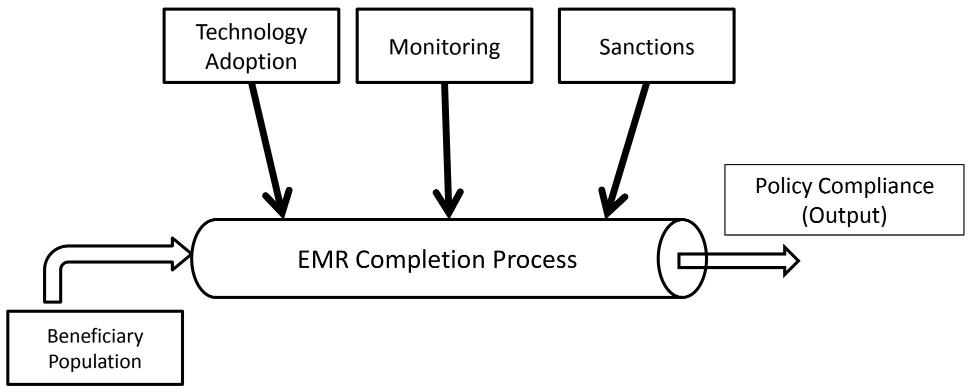

Figure3.1. Approach for Examining EHR Policy Compliance

Research Questions

The following research questions examine and explore the role of the policy compliance construct:

1. Is there a change in policy compliance over time?
2. What factors influence the performance of hospital clinicians and how great is their impact?

Research Design

This study is designed to examine policy compliance over time as well as to establish what factors influence hospital clinicians' performance and the extent of these factors' impact. We use quantitative data in the form of completed EMRs and utilize a quasi-experimental research design. Specifically, we chose to use an interrupted time series design for this study. In this type of design, a periodic measurement process occurs among a group performing a certain action, which is then followed by the introduction of an interval change into this time series. The results of this type of research are indicated by a discontinuity in the time series. In its simplest form, an interrupted time series is often diagrammed like Figure 3.2:

$$O_1\ O_2\ O_3\ I\ O_4\ O_5\ O_6$$ [5]

Figure 3.2. Basic Interrupted Time Series Design

The ultimate dependent variable in this study is compliance with policy in the form of increased output, which is defined as the number of completed EMRs. The complicated nature of the MHS-deployed EMR system does not allow researchers to evaluate its effectiveness in a single stage. Therefore, research on this system's effectiveness encompasses three separate criteria needed to examine a single level of analysis (i.e. the completed EMR). These criteria are the number of records started, the

[5] In this example, the O represents the observation, and the I represent separate interventions.

number of records completed, and the average number of days to complete. The individual record level is a proxy for policy compliance.

The first independent variable concept for this study is change in the level of information asymmetry between the principal and the agent, which is operationalized for this study as the time that a super-ordinate medical command (MEDCOM) directly in control over hospitals. The second independent variable concept is the alignment of both the principal's and the agents' goals in order to reduce goal conflict. This variable is operationalized as a technology upgrade allowing hospital EMR to be used for both implementing the larger EHR as well as for providing real-time clinical notes necessary for the care of patients being evacuated to the next level of medical care. Finally, the concept of principal control mechanisms are operationalized in this study as the introduction of increased monitoring policies and sanctions at the hospital level during the transition of new clinicians into/out of a hospital.

Justification for the Research Design

A quasi-experimental design was chosen for a number of reasons. First, we chose this particular research design due to the lack of full experimental control. Because data were collected over time in the past and not for the purpose of research, no experimental controls could be created. In addition, we were unable to evaluate two or more conditions with effects side by side, and we were unable to assign participants randomly. Another reason we chose this design is that it allowed us to explore relevant issues and discover appropriate weights associated with the variables. We were able to discover these associations because there are a number of data points recorded before and after each individual treatment. Thus, this design appropriately represents the elements of the research project and provides a structure both of which facilitate the purpose of this study (Glass, 1997).

Unit of Analysis

The unit of analysis is each completed inpatient EMR for every United States service member in support of Operation Iraqi Freedom (OIF), which was recorded weekly. There is no specific workweek in a deployed environment; however, the weeks are separated into seven-day blocks. The pool of completed EMRs for this study was diverse with respect to each patient's injury, gender, age, military rank, and branch of service. All EMR data were taken directly from the Theater Medical Data Store (TMDS) and accounts for a 105-week time period. Chapter 4 provides further details about the population as well as the descriptive statistics pertaining to the EMR.

Operationalizations of the Variables

We generated the dependent and independent variables in this study using a deductive method. The deductive method is appropriate when items are derived from literature and theory. In this case, the items are representative of the concept of compliance within the framework of the PA relationship. The following are the variables used to determine if there was a change in policy compliance over time and what factors influenced hospital clinicians' performance in a deployed environment.

Dependent Variables

There are three dependent variables in this study that examine dimensions of policy compliance. Policy compliance is operationalized in three ways: 1) the total number of inpatient EMRs completed; 2) the date on which new records are started; 3) the average number of days to close an inpatient EMR. For each of these dimensions, "EMR" refers to what clinicians categorize as treatment for a disease, non-battle injury, or battle injury. Therefore, each EMR falls into one of these three categories.

The first dependent variable measuring policy compliance is the total number of completed inpatient records in a one-week period. More specifically, this is the number of completed inpatient records per US service member in support of OIF. The changes in number become a measure of completion that will in turn become part of the larger EHR. Therefore, this is a measure of compliance with implementation with the overall EHR policy.

The second dependent variable measuring policy compliance accounts for new patients entered into the inpatient EMR system. This is the total number of inpatient records for US service members started in a one-week period. As a new patient is admitted to a level-III hospital, a new electronic record for that individual should be started; however, this does not automatically occur. Because of time constraints or some other reason, clinicians may choose to start only a paper record. For example, a clinician may choose to complete only paper records if the emergency room is full of patients from a traumatic event. In such an event, specific patients may be injured severely enough that they will quickly be evacuated to another hospital, and in such cases, the clinician knows the EMR would not be able to follow the patient through the evacuation process. Therefore, this variable may act as a proxy for adverse selection. If a record is not started for every patient entering into a facility because of hospital staff's choices, this shows a misrepresentation of the agent's performance.

The third dependent variable measuring policy compliance accounts for patient records closed in the inpatient EMR system. This is the average number of days it takes to close an inpatient medical record within a one-week timeframe. For example, a record is started when a service member is admitted as a patient. The hospital treats the patient for a day and then evacuates him/her to Germany. Information in the record should follow the patient so that clinicians at the next location know what treatment occurred previously. By measuring the average amount of time it takes for clinicians to complete EMRs, the fluctuations in average time to complete become a measure of completion that will in turn become part of the larger EHR. Therefore, this is a measure of compliance with the implementation of the overall EHR policy. This time-to-completion dependent variable may be seen as a proxy for moral hazard. There may be a greater length of time for closing EMRs due to agents' lack of effort or shirking of their responsibilities.

In addition to these three dependent variables, clinicians further categorized the records as disease/non-battle injury, and battle injury. Some level of accidental injuries, such as car accidents, occur both in and out of the deployed environment; the same is also true in the case of diseases, such as heart disease. For the purpose of this study, we place these two into a single category named "routine." Nevertheless, some injuries are not routine, such as bombings and shootings. Analyses were conducted on each of the three dependent variables as well as the categories within each of the three variables.

Independent Variables

There are four independent variables in this study. The first independent variable for this study is change in the level of information asymmetry between principal and agent, which is operationalized as the time a super-ordinate medical command (MEDCOM) is directly in control over hospitals. The second variable is the alignment of goals in order to reduce goal conflict; this is operationalized as a technology upgrade. The upgrade allows hospital EMRs to be used for both implementing the larger EHR as well as for providing real-time clinical notes necessary for the care of patients being evacuated to the next level of medical care. Finally, the third and fourth variables—principal control mechanisms— are operationalized in this study as the introduction of increased monitoring policy and sanctions at the clinician level during hospital transition periods. A further discussion of the independent variables occurs in the hypothesis section.

Additional Variables

There are also a number of other variables used in this study. The first additional variable is the number of non-U.S. Military inpatient records *started* in a one-week period. This category includes all non-U.S. coalition forces, Iraqi military and police forces, contractors, U.S. and foreign civilians, and others unknown by healthcare providers when the records were started. This variable serves as a proxy for the competition for scarce resources utilized in order to start records. No matter where the patient comes from or for whom they work, once entering a military hospital, they must be treated. By military doctrine, the triage[6] and treatment of casualties is in order of severity, not by whom they are employed. As additional patients enter hospitals, they create a greater strain on personnel as well as systems (Beam, 2003).

The second variable is the number of non-U.S. Military inpatient records *completed* in a one-week period. This category includes all non-U.S. coalition forces, Iraqi military and police forces, contractors, U.S. and foreign civilians, and others unknown by healthcare providers when records were started. This variable serves as a proxy of the competition for scarce resources utilized in order to complete records.

The last variable is the number of U.S. service member casualties in Iraq per week. These numbers come from personnel databases that are separate from the MHS database, TMDS. In other words, one database does not feed into the other. This variable acts as a proxy for the U.S. military operational tempo in Iraq.

Hypotheses

This section has four main parts regarding policy compliance. The first is concerned with changes in the level of information asymmetry between the principal and agent over time. The second section centers on the alignment of goals through a technology upgrade in order to reduce goal conflict. The third part concerns the

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[6] The definition of triage is the "screening and classification of wounded, sick, or injured patients during war or another disaster to determine priority needs and thereby ensure the most efficient use of medical and surgical manpower, equipment, and facilities"(Merriam-Webster, 2007)

introduction of increased monitoring as a policy control mechanism. The last section deals with the principal control mechanism of sanctioning agents.

We begin by outlying the four global theoretical hypotheses that drive the sections sub-hypotheses. These are written as null hypotheses as a time–series analysis usually focuses on the null, examining if an intervention impacts the series (McDowall, 1980). For example, did a certain intervention have an impact on the time series? Therefore, for this study we submit four global theoretical null hypotheses regarding policy compliance:

- **Hypothesis 1:** The time that a principal supervises agents does not influence the amount of information asymmetry between the principal and their agents.
- **Hypothesis 2:** The introduction of technology that meets both the principal's and the agents' goals does not affect goal conflict or policy compliance.
- **Hypothesis 3:** There is a no relationship between a principal's increased monitoring and agent's policy compliance.
- **Hypothesis 4:** There is a no relationship between sanctions levied by a principal and agent's policy compliance.

The remainder of this section discusses each of the main parts regarding policy compliance and develops specific sub-hypotheses for each of the four main null hypotheses.

Cooperation between MEDCOM and Individual Clinicians

In this study, the time that MEDCOM (principal) is present in theater actively learning and gathering information from agents serves as a proxy for varying information asymmetry. The assumption in this context is that the more time the principal is present, the less overall asymmetry between the principal and the respective agents exists. However, it is quite difficult to operationalize this concept (Mitnick, 1975), which in turn is aggravated by the movement of agents in and out of theater at varying times.

A number of commanders, military information system professionals, and clinicians allege that if clinicians knew more about the documentation system and about importing the data captured for command decisions, then the clinicians would do a better job of completing the records in a timely fashion (Smith, 2008). Also, if those in charge at MEDCOM in a deployed environment and at higher levels in the planning and implementation process, knew more about the individual work processes at hospitals and about the limitations of the computers utilized to capture records, the policies they make and their expectations may match better and thus be more effective (Smith, 2008)[7]. These individuals' argument is highly important for understanding key problems in the PA relationships in this particular context. For example, it takes time for headquarters to develop effective policies to meet MEDCOM's expectations regarding hospitals, completion of more EMRs within a shorter timeframe (Smith, 2008). While it is not always the case, staff members and commanders serving as principals may lack adequate experience at the hospital level, thereby creating policy not easily followed. This problem is not expected to remain constant throughout deployment. In sum, the longer the command is in Iraq, the more effective it will become at managing agents' performance.

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[7] There is an interesting quote in the Smith article about systems use and delivery of care. The quote is from the 62nd Medical Brigade Chief of Clinical Operations, COL Susz Clark. She states "The way we document care is not the way we deliver care" (Smith, 2008).

- ***H1a****: The longer a MEDCOM supervises a hospital, the more output will be completed by the hospital.*

The fact that EMRs have the propensity to be more accurate, safer and more secure than paper records has already been established in the introduction chapter of this dissertation (Bates & Gawande, 2003; de Mul & Berg, 2007; Hillestad et al., 2005; Reid, 1972; Tzelepi et al., 2002). Therefore, it stands to reason that the principal would see the necessity for a greater percentage of records to be started, holding constant the operational tempo and the total number of U.S. service members at any time. By starting a greater percentage of records, a principal could assume greater visibility of what is truly happening at the hospital level that leads to poor agent compliance. The principal would also be ensuring a more accurate and secure record for clinicians throughout the evacuation chain to be utilized over the life of the patient.

- ***H1b****: The longer a MEDCOM supervises a hospital, the greater the increase in the number of inpatient EMRs started by the hospital.*

The only way for other medical facilities in the evacuation chain to see any electronic information is if the data is sent electronically. As records are completed, they are subject to review not only by other healthcare facilities but also by MEDCOM (Michaud, McClendon, & Salzman, 2006). Over time, the amount of information asymmetry should decrease as headquarters gather additional information on what is going on at the individual hospital level through inspections and assistance from the principal to the agents. In addition, the MEDCOM should gain a greater understanding of what information is important. Sharing this information with clinicians then allows an opportunity for agents to understand what is expected. This diminishing information asymmetry should allow for a greater understanding of what it will take to get all records completed in a timely fashion.

- ***H1c****: The longer a MEDCOM supervises a hospital, the less time it will take, on average, to complete inpatient EMRs.*

Technology Upgrades

Before the technology upgrade from CHCS to TC2, the prescribed inpatient EMRs could not be seen outside of the individual hospital once clinicians closed them (Clayson, 2007). Each hospital's total inpatient files were periodically sent via courier to records clerks in the U.S. and loaded into the appropriate medical systems (30th Medical Brigade, 2006). This system did not provide near real- or real-time access to inpatient information. However, the CHCS system did meet the requirement standards set for health care under of the Health Insurance Portability and Accountability Act (HIPAA). Therefore, although the CHCS EMRs did provide robust capability and was HIPAA compliant, it did not meet the "real-time" standards required by clinicians and only worked properly throughout the continuum of care if all healthcare facilities were able to input data (Clayson, 2007).

Prior to the TC2 upgrade, a competing software application—the Joint Patient Tracking Application (JPTA)—was implemented, which better served the clinicians' need to pass important information throughout the evacuation process (Deployment Link, 2008). This software was not initially developed as an EMR system but was a way for commanders to know where their soldiers were in the evacuation process. This web-based application quickly became a way for physicians to send important patient information on with their wounded patients throughout the evacuation project. However, the JPTA was not without drawbacks; in particular, it was not a query-able, longitudinal record; it does not meet the requirement standards set for healthcare under HIPAA; and patient data in JPTA is not as secure because non-healthcare providers, such as commanders, were able to access sensitive patient data. However, the JPTA was secure, fast, and reliable when there was internet connectivity available.

Patient administration staffs in hospitals initially entered demographic information into each of the two systems (CHCS and JPTA) when patients arrived and then again when they left a hospital in theater. Nurses and physicians entered clinical data into the CHCS system as part of internal business processes. However, clinicians using CHCS throughout the evacuation process were only able to enter information for their facility only. The EMR prior to the TC2 upgrade did not move in real-time in Iraq. In other words, the delay between the time physicians entered patient information well exceeded the time that other clinical staffs needed that information as they evacuated patients out of theater. Although this system was secure and was formatted like military hospitals outside of the combat zone, it was not adequately prepared to serve clinicians' needs in terms of sending information electronically. Because the former system could not meet these needs, clinical staff then relied more heavily on paper records and electronic systems not originally designed to carry patient data, to fill in the gaps. Finally, clinicians began using CHCS internally and JPTA externally in order to share patient information; however, this system required information to be entered twice, thereby increasing the staffs' workload (Russell, 2008).

After the upgrade to TC2, the inpatient EMRs could be seen outside of the Army hospital as soon as a clinician closed the record, as the information could be transmitted directly to the servers near Washington via the internet. During this upgrade, the Air Force hospitals also received TC2, making all hospitals with inpatient records now on the same system (Basu, 2007). This provided the near real-time visibility that clinicians required to make the EMRs available for treatment during evacuation.

This technology upgrade closes the gap between the principal's desire to implement EHRs and clinician's requirements for real-time EMRs that provide pertinent information for evacuation while limiting the amount of double entry. As such, this move aligned the principal's and the agents' goals more closely and should create increased system use. Thus,

- ***H2a***: *The introduction of technology upgrades at a hospital increases the medical records it completes.*

As a new patient is admitted to a hospital, a new record for the individual would be started; however, because of various constraints, clinicians may choose to start only a paper record. Assuming that the started records may now be seen throughout the evacuation, EMRs—which would most likely be seen as more useful—may be started more often. As such, the following hypothesis is proposed:

- ***H2b**: The introduction of technology upgrades at a hospital increases the number of inpatient EMRs it starts.*

Clinicians may also complete records faster if they can be utilized throughout evacuation by other clinicians in other hospitals. Therefore,

- ***H2c**: The introduction of technology upgrades at a hospital decreases the time it will take, on average, for clinicians to complete inpatient EMRs.*

Monitoring

Monitoring between clinicians' directly responsible for patient care during evacuation is one thing. However, how does increased monitoring by the MEDCOM affect compliance? It is hypothesized that this type of control mechanism also influences policy compliance. According to Blom-Hansen (2005), the first *ex post* mechanism is monitoring. Monitoring presents in different forms, either passive or active. McCubbins and Schwartz (1984) call these forms of monitoring of either fire alarm (less formal) or police patrol monitoring (more formal), as was discussed in the literature review section. This study examines the addition of a police patrol monitor by MEDCOM for the hospitals.

For this form of active reporting and monitoring, the costs are higher in terms of time. Staff members must create the monitor, collect data, analyze the data, and provide feedback to both the hospitals and to MEDCOM leadership. However, principals minimize much of the actual patrol costs by passing the data collection on to the hospitals, which collect all pertinent information for their own facilities.

In terms of monitoring in this study, we are concerned with the introduction of a police patrol monitor (McCubbins & Schwartz, 1984) in the form of a policy that is created by the principals and then passed on to the agents. In this study's context, a daily medical situation report (MEDSITREP) was introduced to capture all of the inpatient and outpatient information, which is then compiled and sent from each agent's hospital to the principal via secure email (Multi-National Corps-Iraq, 2006). Increased monitoring in the form of added reports should increase the output, decrease the number of records started due to agent shirking, and decrease the time to close encounters. Therefore, we propose the following hypotheses:

- ***H3a***: *Increased monitoring by MEDCOM through mandatory reporting by a hospital increases the output the hospital completes.*
- ***H3b***: *Increased monitoring by MEDCOM through mandatory reporting by a hospital will decrease the number of inpatient EMRs the hospital starts.*
- ***H3c***: *Increased monitoring by MEDCOM through mandatory reporting by a hospital will decrease the time it will take, on average, for clinicians to complete inpatient EMRs.*

Sanction

As principals monitor agents, it remains necessary for sanctions to be available to correct any agency drift (Blom-Hansen, 2005). Monitoring without consideration of reprisal is not sufficient in controlling implementation. The principal imposing the sanction and the types of institutional constraints establish the success or failure of the relationship with agents (North, 1990). Therefore, not only is it necessary to evaluate the effectiveness of the sanctions but also how principals levy sanctions on individual clinicians. Next, we discuss problems that led to the creation of this specific sanction.

Electronic records must be complete before they leave the servers at an individual hospital. Both before and after the TC2 upgrade, the records would stay on the servers as incomplete records until the clinicians digitally signed them. Before the upgrade, once the records were signed, they moved to another part of the server and no longer took up space in the system's active memory; they became stored messages awaiting download. Now, after the TC2 upgrade, the completed records are immediately sent (as internet connectivity allows) to the TMDS server.

A delay in completing the records causes a number of problems. As discussed previously, the MHS does not consider a record to be complete until a properly credentialed clinician digitally signs it. Ideally, the clinician closing the overall record is the same clinician who was in charge of the case when it was opened. However, this is not always the case. For example, another clinician may sign the record to close it for administrative purposes because the original clinician may have redeployed. However, although the record is now complete, it may not accurately provide information necessary for the lifelong longitudinal EHR. A second problem exists at the server level. As a greater number of incomplete records build up in the servers, it slows down the server's performance. If hundreds of opened records stay open, then new record processing takes much longer. For these reasons, MEDCOMs developed sanctions to deal with hospitals that do not close records in a timely fashion.

In the first quarter of 2006, the MEDCOM in charge of Army hospitals in Iraq sent an order to the hospitals. Within this order, it stated that the MEDCOM would now certify all hospitals as ready to redeploy (Kral, 2009). Although the physical facilities did not move, the hospital's personnel turn over every twelve to fifteen months. As part of this certification process, each hospital would be required to prove that all electronic outpatient and inpatient records were closed. Regulations state that all patient records must be "signed before the provider is allowed to redeploy back to [their home station]" (FICI-MCB-COP, 2006). Without the signed certification of the MEDCOM commander, all of the personnel would have to stay until the records were completed. This is referred to as a sanction threat (Boone, Sadrieh, & van Ours, 2009). No one would be allowed to redeploy until all records are completed and then verified by the MEDCOM. While clinicians may redeploy separate from the entire hospital, the largest single number of rotating clinical staff occurs at the end of the agent's deployment. As such, we suggest the following:

- ***H4a***: *Sanctions levied by MEDCOM specifying that a hospital with open encounters will not be allowed to depart theater increases the number of completed inpatient encounters near hospital transition times.*

Theory suggests clinicians are more likely to engage in behaviors misunderstood or counter to the desire of principals (Sharma, 1997). Clinicians are professional agents in a series of highly specialized sub-fields. Although the MEDCOM does have clinicians on staff, they do not have all of the specialties. As professionals, the agents then are not constrained as easily by principals. The power of principal over professional agent is therefore not as clear-cut. Sharma (1997) argues that in contrast to the normal power structure in the PA relationship where the principal is the main power holder, professionals have power over principals "by virtue of their subject matter expertise, functional indispensability, and intrinsic ambiguity associated with the services they provide" (p. 768). An example of this seemingly opportunistic behavior less understood by those implementing policy may be a decision made by a physician to stop utilizing the EMR during periods of greatly increased patient flow into the hospital. Electronic documentation may become significantly less important to the clinical staff when an emergency room is immediately flooded with wounded. However, agents may also underperform near the end of the deployment because doing so may not serve the perceived interest of the clinicians or patients to start the record, thereby creating an agency problem known as moral hazard. In other words, near the end of deployment, hospitals may misrepresent their patient numbers by not capturing all of the inpatient records in an electronic format. Therefore, we hypothesize the following:

- ***H4b**: Sanctions levied by MEDCOM specifying that a hospital with open encounters will not be allowed to depart theater decreases the number of inpatient EMRs started by a hospital near the end of its deployment.*

Although a clinician's signature is not required for a patient to be evacuated (because paper records travel with the patient), the signature is required before the encounter can be electronically transmitted outside of the facility to the theater medical data store (TMDS). As previously stated, any records that are open for a long amount of time must be closed prior to the unit's departure. Even if the individual clinician is no longer in theater, the hospital is responsible for closing the records. Therefore,

- ***H4c**: Sanctions levied by a MEDCOM specifying that a hospital with open encounters will not be allowed to depart theater increases the average time needed to complete the records near the transition.*

This section had four main parts addressing issues related to policy compliance. The first is concerned with information asymmetry. The second part addresses goal conflicts between the principal and its agents. The third part regarding policy compliance deals with the introduction of increased monitoring, and the final section discusses the principal control mechanism of sanctioning. We addressed the four global null hypotheses concerning policy compliance and then provided additional sub-hypotheses for each section. Figure 2-2 and 2-3 present graphical representations of the theoretical and operationalized research models for this dissertation. These figures also provide directional relationships for each of the sub-hypotheses.

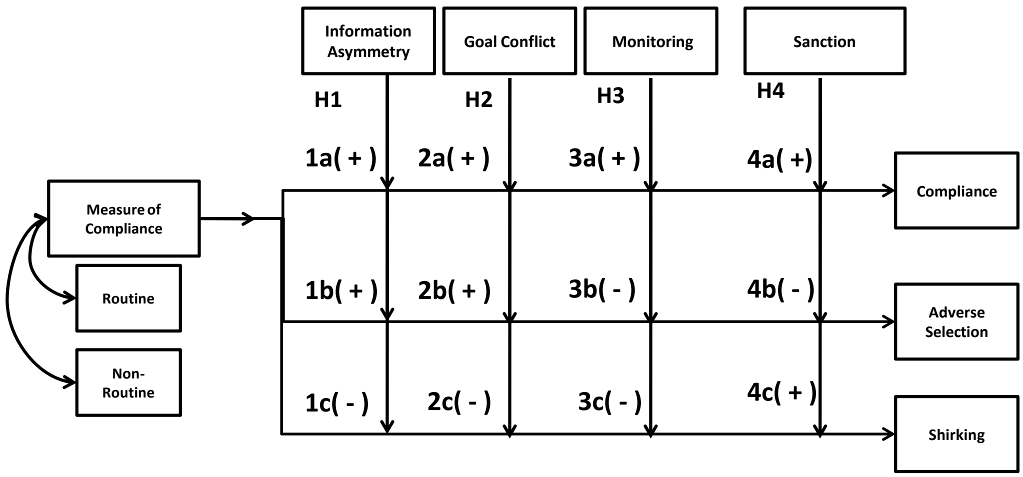

Figure 3-3. Theoretical Model Examining Deployed EMR Policy Compliance

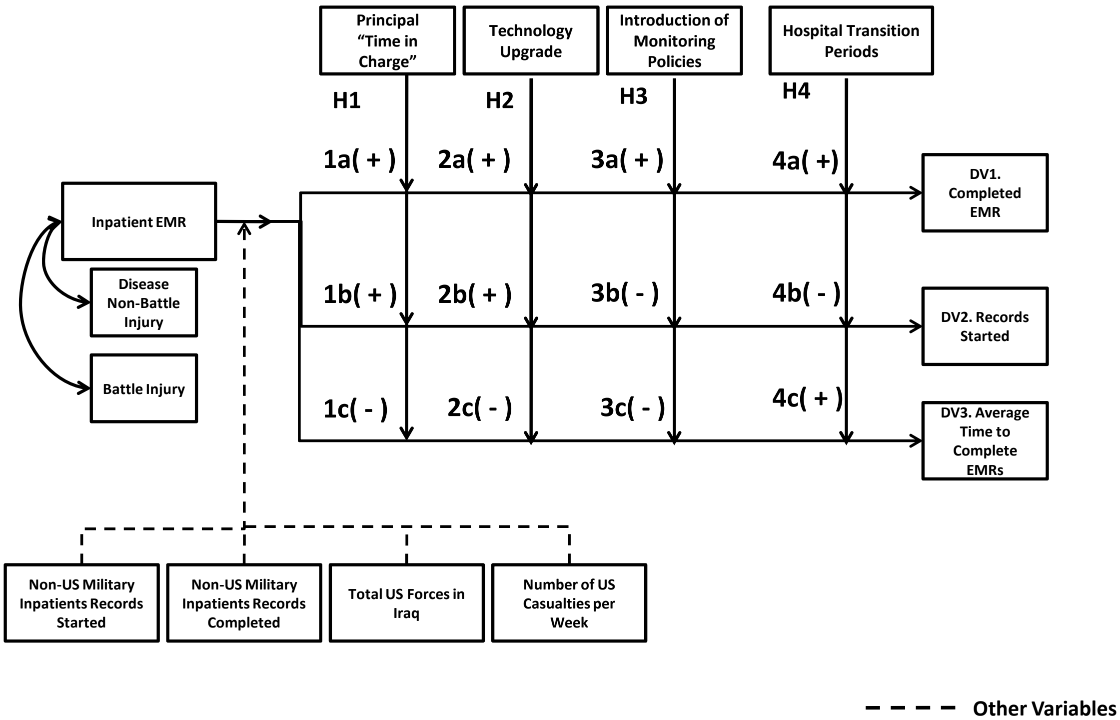

Figure 3-4. Operationalized Model Examining Deployed EMR Policy Compliance

Data Collection Procedures

The next section outlines the processes involved in data collection. For this study, thirteen separate variables have data associated. For these terms, we collected data from nine separate sources. Therefore, the outline of this section provides information for each of the variables. First, we provide sources for the data followed by definitions of the terms. We then provide examples of each term within the context of this study. We state if the terms are dependent, independent, mediating, or control variables and if we measure them as ratios, intervals, ordinals, or nominals. Finally, we explain how each term is coded within the study.

The first term is **Inpatient EMR**. The source for this data is the theater medical data store (TMDS). This term is defined as the legal record created in a hospital environment, which is the source of data for the electronic health record (Garet & Davis, 2006). For example, say a patient arrives at a hospital after being wounded; he/she is admitted and treated over a period of three days and is then evacuated back to the United States for rehabilitative care. The inpatient EMR covers the treatment during this time. This is an independent (treatment) variable and is measured as a ratio. The ratio is the number of records per week divided by the total number of U.S. service members deployed in support of OIF. For the purpose of this study, inpatient EMR is coded as the total number of U.S. service member records started and completed within a one-week period, or as the average time to complete records within a week.

The second term is **Routine or Non-Battle Injury EMR**. This is a sub-category of Inpatient EMR. The source for this data is the TMDS. This term is defined as “a person who is not a battle casualty, but who is lost to [their] organization by reason of disease or injury..." (ASD-HA, p. 99). Examples of individuals who would fall in this category are a service member with pneumonia or a patient who was injured while performing normal repairs on a vehicle. This is an independent variable and is measured as a ratio. The ratio is the number of routine records per week divided by the total number of U.S. service members deployed in support of OIF. Furthermore, within TMDS, clinicians have a choice between coding a patient as having a disease or a non-battle injury. For the purpose of this study, we consolidate the two and identify them as a routine EMR.

The next term is **Non-Routine or Battle Injury EMR**. This is a sub-category of Inpatient EMR, and the source for this data is the TMDS. This term is defined as the following:

> A casualty (death, wound, missing, capture, or internment) provided such loss is incurred in action. [The term] 'In action' characterizes the casualty status as having been the direct result of hostile action; sustained in combat and related thereto; or sustained going to or returning from a combat mission provided that the occurrence was directly related to hostile action. (ASD-HA, p.33)

An example of a patient who would fall under this category is a service member wounded by an improvised explosive device during a convoy. This is an independent variable and is measured as a ratio. The ratio is the number of non-routine records per week divided by the total number of U.S. service members deployed in support of OIF.

Principal Time in Charge is the next term, and the source for this data is various press releases discussing dates of MEDCOM Transfer of Authority (TOA). This term is defined by phases of time. The time begins when one Army medical brigade or medical command turns over command and control for all medical services in the Iraqi theater to another similar unit. The period ends when the next transition occurs. For example, a new term would begin when there is a change of command ceremony in Baghdad with one MEDCOM officially transferring authority to another. Although there is a transition period between the two commands, this ceremony marks the official turnover date. This MEDCOM serves for twelve months, and then command changes again. This is an independent nominal variable and is coded by the week a MEDCOM is in charge. (Example: Week 1, Week 2…Week 51, TOA, Week 1, Week 2, etc.).

The next term is **Technology Upgrade**. The source for this data is a report from the Medical Communications for Combat Casualty Care (MC4) program office. This term is defined as a technology upgrade allowing hospital EMR to be used for both implementing the larger EHR as well as for providing the real-time clinical notes necessary for the care of patients being evacuated to the next level of medical care. In this study, this refers to the upgrade from CHCS to TC2. This is an independent nominal variable and is coded in the following manner: 0= prior to upgrade, 1= after the upgrade.

The source for the term, **Introduction of Monitoring Policy,** comes from a memorandum from MEDCOM to units dated November 10, 2006. We define this term as the introduction of a daily medical situation report (MEDSITREP) for all inpatient and outpatient information, which is then compiled and sent from each agent hospital to the principal. In this study, this report lists the total number of inpatient beds for each hospital and how many are currently occupied. This independent nominal variable is coded in the following manner: 0=prior to introduction of monitoring policy and 1=after the monitoring policy.

The next term is **Hospital Transition Periods.** The source for this data is a report from the MC4 program office. This term is defined by phases of time, and the period begins when one Army hospital is within the four-week period prior to completing a 100% turnover of personnel to another incoming hospital. The period ends when the next transition occurs. One example of such a period is when there is a change of command ceremony in Baghdad as one hospital officially transfers authority to another. Although there is a transition period between the two hospitals, the ceremony marks the official turnover date. This turnover date is also used as a new hospital code is registered on hospital servers. Therefore, at midnight on the day of the change of command, a system administrator changes the code so all new records started from that point forward fall under the new hospital. This independent nominal variable is coded as follows: 0=period not transitioning and 1=transition period.

The next term is **Non-U.S. Military Records Started**, and the data for this term comes from TMDS. This term refers to the EMRs for all non-U.S. coalition forces, Iraqi military and police forces, contractors, U.S. and foreign civilians, and others unknown by healthcare providers at the time their records were started. For example, a record for a contractor who is admitted to the hospital due to a possible heart attack would fall in this category. For the purpose of this study, this term is coded as the total number of non-U.S. service member records started within a one-week period.

Non-U.S. Military Records Completed is the next term, and the source for this data is again the TMDS. This term refers to the EMRs for all non-U.S. coalition forces, Iraqi military and police forces, contractors, U.S. and foreign civilians, and others unknown by healthcare providers at the time their records were completed. One example in this category would be a record for a U.S. contractor brought to a hospital with chest pain. The record starts when the hospital admits the patient and the record then ends when test results are negative for a heart attack and the patient is released. For the purpose of this study, this term is coded as the total number of non-U.S. service member records completed within a one-week period.

The source for the term **Total United States Forces in Iraq** comes from the Defense Manpower Data Center (DMDC). This term is defined as the total number of service members deployed in support of OIF during any specific month. The DMDC separates the data by month; therefore, for the purpose of this study, if a week separated two one-month periods, the number for that week is based on the month with the greatest number of days falling in that specific week. For example, the week of January 1 through -January 7 uses the DMDC service member total for January. However, for the week of May 28 through June 3, we would use the May numbers, as there are four days in May and only three days in June for this week. For the purpose of this study, this term is coded as the total number of non-U.S. service members deployed (e.g., 130,000).

The next term is **Number of U.S. casualties per week**. Week-by-week numbers from iCasualties.org provides the source for this data[8]. The term itself is defined as the number of U.S. service member casualties in Iraq per week. These numbers come from personnel databases that are separate from the MHS database, TMDS. The number of casualties per week is separated into four sub-categories: hostile fire (from direct enemy action), accidents, friendly fire, and an "other" category. For example, the week of January 1 through January 7, 2005, saw a total of thirty-one casualties. Of these casualties, nineteen were from hostile fire, eleven were from accidents, and one was from

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[8] Weekly casualty information (by type) taken from http://icasualties.org/Iraq/CasualtyTrends.aspx (Accessed August 2009).

the “other” category. For the purpose of this study, the total number per week is coded as the total number of U.S. service member casualties within a one-week period.

This section outlined the processes involved in data collection. Thirteen separate variable terms have data associated. For each of these terms, we collected data from nine separate sources. Table 3-1 provides an overview of these terms and their relation to the dissertation.

Term	Source	Definition	Example	Variable	Measure (Ratio, Interval, Ordinal, Nominal)	Coded As
Inpatient EMR	Theater Medical Data Store	The legal record created in hospital environments that is the source of data for the electronic health record (Garet & Davis, 2006).	Patient arrives at a hospital after being wounded. They are admitted and treated over a period of three days. They are then evacuated back to the United States for rehabilitative care.	Independent (Treatment)	Ratio: Records per week	For the purpose of this study, coded as the total number of US Service member records within a one-week period started, completed, or the average time to complete records, within a week.
Routine or Non-Battle Injury EMR ——— **(Sub-category of Inpatient EMR)**	Theater Medical Data Store	Non-Battle Injury - "A person who is not a battle casualty, but who is lost to his organization by reason of disease or injury..." (ASD-HA, p.99).	Service member with pneumonia or injured while performing normal repairs on a vehicle.	Independent	Ratio: Routine records per week	Within TMDS, clinicians have a choice between coding as a disease or a non-battle injury. For the purpose of this study, we identify this a Routine EMR.
Non-Routine or Battle Injury EMR ——— **(Sub-category of Inpatient EMR)**	Theater Medical Data Store	"Any casualty (death, wound, missing, capture, or internment) provided such loss is incurred in action. "In action" characterizes the casualty status as having been the direct result of hostile action; sustained in combat and related thereto; or sustained going to or returning from a combat mission provided that the occurrence was directly related to hostile action." (ASD-HA, p.33)	Service member wounded by an improvised explosive device during a convoy.	Independent	Ratio: Non-routine records per week/total number of US forces	For the purpose of this study, we identify this a Non-Routine EMR.
Principal Time in Charge	Various press releases discussing dates of MEDCOM Transfer of Authority (TOA).	This time begins when one Army medical brigade or medical command turns over command and control for all medical services in the Iraqi theater to another, similar unit. The period ends when the next transition occurs.	There is a change of command ceremony in Baghdad when one MEDCOM officially transfers authority to another. Although there is a transition period between the two commands, this is the official turnover date. This MEDCOM serves for twelve months and then again changes command.	Independent	Interval	Coded by week that a MEDCOM is in charge. (Example: Week 1, Week 2,...Week 51, TOA, Week 1, Week 2, etc.)
Technology Upgrade	Report from the Medical Communications for Combat Casualty Care (MC4) program office.	Technology upgrade allowing hospital EMR to be used for both implementing the larger EHR as well as in providing real-time clinical notes necessary for the care of patients being evacuated to the next level of medical care.	Upgrading from CHCS to TC2.	Independent	Nominal	0=Prior to upgrade; 1=After the upgrade
Introduction of Monitoring Policies	Memorandum from MEDCOM to Units dated 10 November 2006	The introduction of a daily medical situation report (MEDSITREP) for total inpatient and outpatient information, compiled and then sent from each agent's hospital to the principal.	Report with total number of inpatient beds and how many are currently occupied.	Independent	Nominal	0=Prior to introduction of Monitoring Policy; 1=After the Monitoring Policy
Hospital Transition Periods	Report from the Medical Communications for Combat Casualty Care (MC4) program office.	This period begins when one Army hospital is within the four weeks prior to completing a 100% turnover of personnel to another, incoming hospital. The period ends when the next transition occurs.	There is a change of command ceremony when one hospital officially transfers authority to another. Although there is a transition period between the two hospitals, this is the official turnover date. This turnover date is also used as a new hospital code registered on hospital servers.	Independent	Nominal	0=Period not transitioning; 1=Transition Period
Non-US Military Records Started	Theater Medical Data Store	EMR for all non-US coalition forces, Iraqi military and police forces, contractors, US and foreign civilians, and others unknown by the healthcare providers at the time records were started.	A contractor is admitted to the hospital due to possible heart attack	Mediating	Ratio: Non-US service member records started per week	For the purpose of this study, coded as total number of non-US Service member records within a one-week period started within a week.
Non-US Military Records Completed	Theater Medical Data Store	Completed EMR for all non-US coalition forces, Iraqi military and police forces, contractors, US and foreign civilians, and others unknown by the healthcare providers.	A contractor is discharged from the hospital after testing to ensure patient diagnosed with angina due to stress.	Mediating	Ratio: Non-US service member records completed per week	For the purpose of this study, coded as total number of non-US Service member records within a one-week period started, completed, or the average time to complete records within a week.
Total of United States Forces in Iraq	Defense Manpower Data Center	Total number of service members deployed in support of Operation Iraqi Freedom during any specific month. Data separated by DMDC by-month. For the purpose of this study, if a week separated two one-month time periods, the number for that week is based on the month with the greatest number of days for that specific week.	For this study: The week of January 1st - January 7th we use the DMDC number for January. However, for the week of May 28th - June 3rd we use the May numbers as in this week there are four days in May and only three days in June.	Mediating	Ratio: ex. 130,000	The total number of service members deployed.

Table 3-1. Data Collection Procedures

Population Selection

The population used in this study provided a mixture of demographic characteristics including gender, age, branch of service, military rank, and varying levels and types of medical conditions. The population consisted of U.S. service members from both active and reserve units serving in OIF. This section describes the procedure for gaining access to the data and how the data was prepared for analysis.

We gained access to TMDS through a request to the Defense Health Information Management System (DHIMS) program office. This request considered the fact that the researcher is a medical information systems officer in the U.S. Army and maintains the requisite level of security clearance to view the data. A request was made to gain access to the secondary archival data that did not include any protected health information (PHI) as described under HIPAA. As mentioned previously, two hospitals within OIF operated almost exclusively with detainees as patients. Information for these records was not available for the researcher and, therefore, is not used in this study. Coded fields requested for the study include gender, military rank, age, branch of service, home unit, operation, category of injury, treatment (inpatient or outpatient), ending disposition (e.g., returned to duty or evacuated), arrival date, and final disposition date (completion date). The request for data also included specific parameters for the dates of the study from October 30, 2005, to November 03, 2007–a total of 105 weeks.

Once we received the data from TMDS, we further culled the dataset prior to conducting the analysis. Records not specifically coded in the operation field, OIF were removed. This step included the removal of records from operations including Operation

Enduring Freedom and other locations where the EMR systems were gathering data during the period of study. Next, we separated U.S. military from non-U.S. military. We then removed the records where the disposition (completion) date was earlier than the arrival date. This anomaly occurred nineteen times.

A search was then conducted in order to examine the age of U.S. military patients. No records for patients under eighteen were analyzed and were thus removed. In addition, following this line of reasoning, we omitted any record without an age associated with the patient. Therefore, we removed eleven additional records that were either from patients under eighteen or those with incomplete age fields.

Next, we examined the home units of service members in TMDS. First, we removed all records for which the home unit was obviously not an Army hospital in Iraq. This included entries from the hospital in Kuwait, which was not under the control of the Army MEDCOM. Then we eliminated all records from hospitals where patients were evacuated to and stationed only *after* evacuation from OIF (e.g., Walter Reed Army Medical Center). Next, we removed records for which the home unit was a naval vessel. Many naval ships are outfitted with systems having the ability to create EMRs and may have been involved directly in support of OIF. However, the medical components on these twenty-five ships are not responsible to the MEDCOM on ground and were hence removed.

There were a number of additional considerations for the population in this study. These included gaining access to the records and ensuring that only records pertinent to this study were used. After limiting the period of study and cleaning the dataset, a large number of records were available for analysis. There are 10,013 U.S. service member inpatient records analyzed in this study. Further details about the population and descriptive statistics pertaining to the population are presented in Chapter 4.

Reliability

Reliability is a measure of whether or not one gets the same answer using an instrument to measure something more than one time (Bernard, 2000). This study utilizes a series of single-item measures in the interrupted time-series design, focusing on the construct of policy compliance. Utilizing a single-item measure in social science is presumed to have low reliability (Wanous, JP Hudy,,M.J., 2001). Although reliability is a significant issue when measuring constructs, in this study such measurement does not rely on individual or organizational understanding of compliance. The data under study are secondary archival records and cover patient information before, during, and after interventions. The individual clinicians are required to complete a record and need not understand the nature of policy compliance in order to complete their tasks. In addition, unlike simple pre-test or post-test designs, the time series adds a number of pre-intervention and post-intervention observations that separate real intervention effects from other trends in a study (Jaeger, Shulman, & American Educational Research Association, 1988). In addition, this larger number of observations increases the overall level of reliability within the study (Jaeger, 1990).

Validity

In this study, the researcher studied compliance with changes in policy over time, the factors influencing hospital clinicians' performance, and the impact these factors have on compliance. Internal validity specifies that there is a causal relationship between variables. External validity specifies that this same relationship is generalizeable across measures, times, settings, and persons. Neither of these is considered within this study. However, it is important to address internal and external factors that may influence the outcome and discuss how we mitigate risks to validity within the study.

The most definite weakness in any time-series study is researchers' failure to control history (Campbell, Stanley, & Gage, 1963). History is a threat to internal validity in that a rival hypothesis exists that some other near simultaneous event besides X produced a shift in the series. It is in the plausibility of ruling out such stimuli that credence in any given circumstance rests.

Maturation is the process through which the respondents—in this case the records themselves—change as a function of time passing but not because of a particular event (Campbell et al., 1963). An example of maturation would include growing older over time. This type of internal validity issue is not a major concern in the current study as changes between periods would require shifts in earlier time periods as well. In other words, one would expect to see a general upward trend prior to and after any specific event.

The next threat to validity is changes in instrumentation during the study period. The instrument used to measure policy output does not change between the pre-test and post-test. However, with the introduction of TC2, the tool utilized to capture the instrument did change. Although the end-users did not have to modify their behavior a great deal to operate the information system, the data collected does have a unique difference in how it may be used outside the hospital. With the introduction of the upgrade to TC2, other clinicians can see clinician input with access to TMDS in near real-time once the encounter is closed.

The next threat to validity is selection bias. The first possible selection bias is establishing hospital sites for the study. There are a number of smaller clinics and aid stations near deployed hospitals. However, each of these medical facilities has their own individual reporting chain, so establishing PA relationships would be quite problematic. Focusing on hospitals within a single branch of the DoD allows for a clear line of reporting directly to a single medical headquarters. In order to focus on hospitals, we examine only inpatient medical records, as smaller clinics and aid stations do not have the ability to input inpatient encounters.

Next, we consider which hospitals to include in the study. Establishing the number, location, and mission of the hospital is important in examining transition times with a large number of clinical personnel transitioning out of theater at the same interval. Although Air Force EMR are counted in the study, the Air Force hospital transitions every four months, but it was impossible to obtain exact dates as part of the study. In addition, there are two hospitals in Iraq that deal almost exclusively with detainees. However, detainee patient encounters are not included in this study, so the hospital transition dates for these hospitals are not incorporated.

Choosing only U.S. service members for this study also serves to alleviate possible selection bias. U.S. military are admitted to hospitals for both severe and less severe serious injuries and illnesses. The evacuation policy in Iraq during this study was to evacuate all U.S. soldiers not available to return to duty within a relatively short amount of time (i.e., two to four days) (*FM 8-10-6.*1991)FM 8-10-14). This creates a short inpatient time for U.S. service members as inpatients. In the study, the total of non-U.S. military inpatients (approximately 17% of the total inpatient encounters for the study)[9] were consolidated into one independent variable. Once admitted, local national patients and Iraqi security personnel may not be able to leave U.S. military hospitals within the same timeline set for inpatient U.S. military personnel. In addition, although the standard of care for these individuals is not in doubt, there may be significant selection bias if such records are measured similarly to U.S. military inpatients as far as complete documentation is concerned. Within the medical treatment facility, much of the administrative data pertaining to an EMR is a matter of standard operating procedure. For example, laboratory requests are ordered through the inpatient EMR system no matter what the patient's affiliation is. However, this medical data is not always utilized as part of a long-term EHR. These records may be used for the local national records outside of the facility in order to establish the overall workload of or the number of encounters in a hospital, but the completeness of the record itself is not an integral variable in examining standards of care for this demographic.

[9] During this study, there were 10,013 U.S. service member inpatient records. In addition, there were a total of 2,010 non-U.S. service members for a total of 12,023 total records.

Mortality, the next bias, refers to the fact that individuals may not complete their participation in a study (Bernard, 2000). Part of the design of this study is the change of medical headquarters and hospitals during the two-year timeframe. However, individual physicians working at hospitals may not have deployed for the entire twelve- to fifteen-month deployment (Petinaux, 2008). Individual physician deployments may last as few as ninety to one-hundred-and-eighty days depending on a number of variables, including rotating highly specialized sub-specialty physicians into and out of theater[10]. As individual physicians may not always deploy and redeploy in conjunction with the hospital, the operationalized measurement of sanctioning may be effected. However, the largest transition of physicians does occur during hospital transitions. By examining a large enough sample of inpatient records, we compare non-transition with transition periods in terms of outcome.

The time between the introduction of the monitoring policy and its diffusion to all hospitals within the deployed environment is virtually simultaneous, so there is little diffusion of treatment. During the period of study, all orders and policies are introduced to units electronically via email from the headquarters medical operation staff directly to hospital operations staff. The passing of orders are conducted in a highly formalized manner, allowing for the tracking of delivery and the receipt of documents (FM 5-0, 2005). The one diffusion of treatment that exists in the study is the technology upgrade. The upgrade process occurred over a period of eight weeks and is accounted for by coding in the study.

[10] ("Life and Death in a War Zone," PBS Airdate, 2 March 2004, NOVA transcript, http://www.pbs.org/wgbh/nova/transcripts/3106_combatdo.html (accessed 22 August 2009)

In discussing threats to external validity, it is important first to note that this study measures records that are normally kept. The interrupted time-series design is particularly appropriate in such institutional settings in which record keeping is part of the natural environment (Campbell et al., 1963). In addition, because there is no control for the experiment, the relationships between cause and effect must be stated prior to analysis. If post-hoc analysis is used, then a story can be crafted to fit the data, thereby becoming reactive to the effect of testing. Therefore, we establish our hypothetical relationships based on existing theory.

Data Analysis Procedures

The data required for the completion of this study was entered into a computer file for data analysis using JMP 8.0.2. Descriptive analyses were used to summarize the demographic information.

During the data analyses, the expected findings for each of the hypotheses are as follows:

Hypothesis 1: The longer a principal supervises agents, the smaller the amount of information asymmetry will exist between the principal and its agents. There is a significant positive correlation between the length of time a MEDCOM supervises hospitals and the output completed by the hospitals. The longer a MEDCOM supervises hospitals, the greater the increase of inpatient EMRs started by the hospitals. Finally, the longer a MEDCOM supervises hospitals, the less time it will take, on average, for clinicians to complete inpatient EMRs.

Hypothesis 2: The introduction of technology that meets both the principal's and agents' goals more fully reduces goal conflict and increases policy compliance. Therefore, the introduction of technology upgrades at hospitals increases the output completed by the hospitals and increases the number of inpatient EMRs started by the hospitals. Finally, the introduction of technology upgrades at hospitals decreases the time it will take, on average, for clinicians to complete inpatient EMRs.

Hypothesis 3: There is a relationship between increased monitoring by a principal and agents' policy compliance. Therefore, increased monitoring by MEDCOM through mandatory reporting by hospitals increases the output completed by the hospitals and will also decrease the number of inpatient EMRs started by the hospitals. Finally, increased monitoring by MEDCOM through mandatory reporting by hospitals will decrease the time it will take, on average, for clinicians to complete inpatient EMRs.

Hypothesis 4: There is a relationship between sanctions levied by a principal and the policy compliance of agents. Therefore, sanctions levied by MEDCOM specifying that a hospital with open encounters will not be allowed to depart theater increases the number of completed inpatient encounters near hospital transition times and decreases the number of inpatient EMRs started by the hospitals near the end of their deployment. Finally, the sanctions levied by a MEDCOM specifying that a hospital with open encounters will not be allowed to depart theater increases the average time needed to complete the records near the transition.

Test Statistics

Tests of significance for the time-series design can be difficult. First, we cannot measure changes in observations immediately before or after interventions, which does not provide any information about the baseline before the intervention. Without establishing a lasting effect, we also may not be able to establish any level of causal change (Campbell et al., 1963). Second, in this design, we cannot merely pool all of the data pre-intervention and post-intervention. If we were measuring a trend line that was constantly positively sloped both before and after the intervention, we would see an increase of course, but that increase would tell us nothing. In addition, if the trend line remained flat, shifted upward right before the intervention, and then stayed flat afterward, we would again see an increase that is not a true test of significance (Campbell et al., 1963).

Two suggestions emerge for the prevention of misinterpreting time-series studies. The first deals with exploring large datasets and classifying the collection of data in order for hidden effects to emerge. The second is to ensure that statistical analysis distinguishes ordinary fluctuations in a series from the genuine effects of the interventions (Jaeger et al., 1988). In order to heed the first suggestion, we begin by creating logical subsets of information based upon classifications of the data graphing the specific data points under examination. We hypothesize that interventions lead to either continuous improvement or a change in rate of gain. Campbell and Stanley (1963) submit that, in these circumstances, testing all points is most appropriate. Therefore, we will create a visual plot of the data for each of the separate hypotheses and sub-hypotheses (Gujarati, 2003).

It should be noted however, that in time series, there may be errors obscuring the intervention. The errors, or noise, may result from the fact that trends are common in time-series analyses. Another reason for this noise is the presence of random error (McDowall, 1980). The intervention may not be obvious through the visual plot alone, so a test for the intervention's genuine effects is necessary.

For the second suggestion, proper statistical analysis, we will utilize an interrupted time series analysis that rigorously examines the intervention's genuine effects. We will create a simultaneous regression model that includes all independent and possible mediating variables. Next, we will use Analysis of Variance (ANOVA) testing in order to summarize the results for the model as a whole. We will then test for the presence of multivariate outliers. A multivariate outlier exists if the combination of scores across predictors is substantially different from the remainder of the sample. We continue by examining for multicollinearity. Muliticollinearity exists if predictor variables co-vary too highly in terms of the proportion of the outcome variable they account for. Next, we will examine the models for first-order autocorrelation. The error for one case should not be systematically related to the error for other cases. Finally, we examine residual plots to ensure that the constant variance assumption has been satisfied.

After conducting full model proper statistical analysis, we examine the impact of each intervention on the reduced model. First, we graph and discuss each pre- and post-intervention. Then we examine the changes in slope both pre- and post.

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

The purpose of this chapter is to present the results of the data analysis proposed in Chapter 3 (Research Methodology). This chapter includes a discussion of the following:

- Review of the data collection process
- Discussion of the descriptive statistics associated with the variables in the study
- Hypotheses testing
- Summary of the results

The data collection process for this research consisted of gathering data from TMDS, various press releases, reports from the MC4 program office, memorandums from Iraq, DMDC, and iCasualties.org.

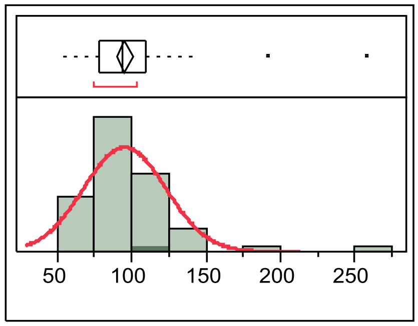
Descriptive Statistics

First, a review of the key study components is presented and then the descriptive statistics for each of the variables is provided. The unit of analysis is each completed inpatient EMR for every U.S. service member in support of OIF, which was recorded weekly. The period of study was 105 weeks. During this study period, there were 10,013 U.S. service member inpatient records. In addition, there were a total of 2,010 non-U.S. service member records for a total of 12,023 records.

Dependent Variables

Within the study, fifteen separate parameters are utilized. There are three dependent variables (with four total sub-categorical dependents), four independent variables, and four additional mediating variables. We begin with an analysis of the three dependent variables, which include the number of total completed records per week, the total number of records started per week, and the average amount of time per week to complete the records. Figures 4-1 through 4-3 provide the descriptive statistics for these three dependent variables.

Total Records Completed per Week - DV1



— Normal (95.3619, 27.7122)

Quantiles

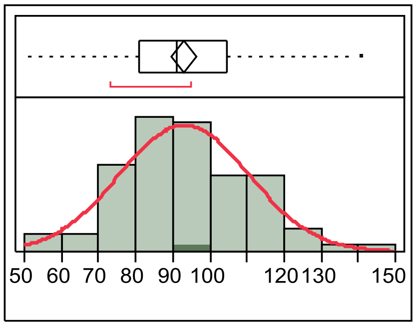
100.0%	Maximum	258
99.5%		258
97.5%		160.8
90.0%		124.4
75.0%	Quartile	109.5
50.0%	Median	94
25.0%	Quartile	78.5
10.0%		63.2
2.5%		53.65
0.5%		50
0.0%	Minimum	50

Moments

Mean	95.361905
Std Dev	27.712162
Std Err Mean	2.7044301
Upper 95% Mean	100.72489
Lower 95% Mean	89.998918
N	105

Figure4-1. Total Records Completed per Week - DV1

Total Records Started per Week - DV2



Normal (93.0667, 17.5216)

Quantiles

100.0%	Maximum	141
99.5%		141
97.5%		132.15
90.0%		114.4
75.0%	Quartile	104.5
50.0%	Median	91
25.0%	Quartile	81
10.0%		73
2.5%		52.3
0.5%		51
0.0%	Minimum	51

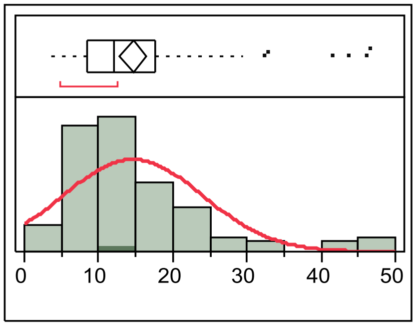
Moments

Mean	93.066667
Std Dev	17.521562
Std Err Mean	1.7099293
Upper 95% Mean	96.457521
Lower 95% Mean	89.675813
N	105

Figure 4-2. Total Records Started per Week - DV2

The assumption of normality for *Total Records Completed per Week* and *Total Records Started per Week* appears to be satisfied. However, *Average Time for Completion* deviated from normality. There were three outliers for the *Average Time for Completion* variable (weeks with average times of 166 days, 111.5 days, and 65.8 days). Omitting these outliers created a more normal distribution (Figure 4-3).

Average Time for Completion - DV3



Normal (14.6305,9.42084)

Quantiles

100.0%	Maximum	46.6218
99.5%		46.6218
97.5%		46.0881
90.0%		25.6484
75.0%	Quartile	17.5654
50.0%	Median	12.0956
25.0%	Quartile	8.48419
10.0%		5.61887
2.5%		3.58043
0.5%		3.52041
0.0%	Minimum	3.52041

Moments

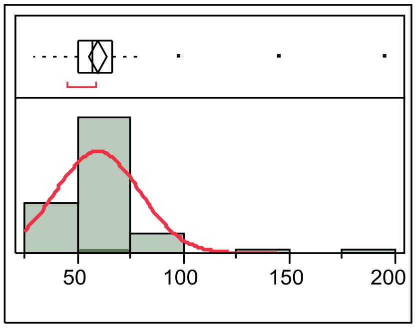
Mean	14.630519
Std Dev	9.420835
Std Err Mean	0.9328017
Upper 95% Mean	16.480947
Lower 95% Mean	12.780091
N	102

Figure 4-3. Average Time for Completion - DV3

Sub-Category of Dependent Variables

There are four total sub-category dependent variables in this study, including *DNBI Completions per Week, BI Completions per Week, DNBI Records Started per Week, and BI Records Started per Week*. There are a total of 6,261 DNBI completions and 3,752 BI completions in the study for a total of 10,013 completions. There are a total of 6,200 DNBI arrivals and 3,572 BI arrivals in the study for a total of 9,772 arrivals. The total of DNBI and BI completions equals the total number of completions, and the total of DNBI and BI arrivals equals the total number of arrivals. Figures 4-4 through 4-7 provide the descriptive statistics for these sub-categories.

DNBI Completions per Week - Sub1



Normal (59.6286,19.8597)

Quantiles

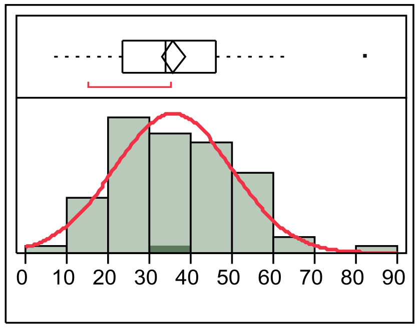
100.0%	Maximum	195
99.5%		195
97.5%		114.45
90.0%		75.4
75.0%	Quartile	66.5
50.0%	Median	57
25.0%	Quartile	50.5
10.0%		43.6
2.5%		33.3
0.5%		29
0.0%	Minimum	29

Moments

Mean	59.628571
Std Dev	19.859728
Std Err Mean	1.938111
Upper 95% Mean	63.471918
Lower 95% Mean	55.785225
N	105

Figure 4-4. DNBI Completions per Week - Sub1

BI Completions per Week - Sub2



Normal (35.7333, 14.2013)

Quantiles

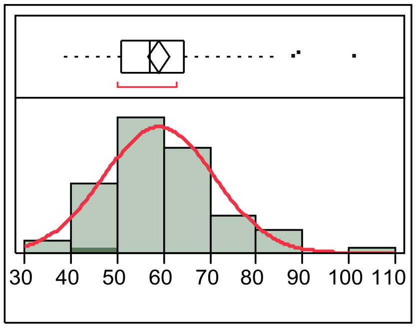
100.0%	Maximum	82
99.5%		82
97.5%		63
90.0%		54
75.0%	Quartile	46
50.0%	Median	34
25.0%	Quartile	23.5
10.0%		18.6
2.5%		14.3
0.5%		5
0.0%	Minimum	5

Moments

Mean	35.733333
Std Dev	14.201345
Std Err Mean	1.3859094
Upper 95% Mean	38.481644
Lower 95% Mean	32.985023
N	105

Figure 4-5. BI Completions per Week - Sub2

DNBI Started per Week - Sub3



Normal (59.0476, 11.9352)

Quantiles

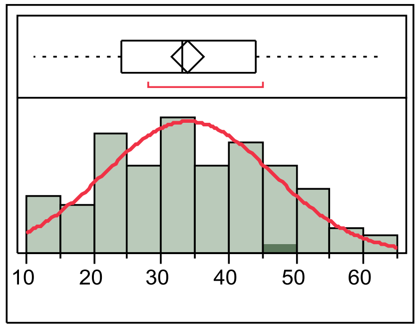
100.0%	Maximum	101
99.5%		101
97.5%		88.35
90.0%		74.2
75.0%	Quartile	64.5
50.0%	Median	57
25.0%	Quartile	51
10.0%		44
2.5%		39
0.5%		38
0.0%	Minimum	38

Moments

Mean	59.047619
Std Dev	11.935227
Std Err Mean	1.1647588
Upper 95% Mean	61.35738
Lower 95% Mean	56.737859
N	105

Figure 4-6. DNBI Started per Week - Sub3

BI Started per Week - Sub4



— Normal (34.019, 12.4375)

Quantiles

100.0%	Maximum	62
99.5%		62
97.5%		59.7
90.0%		51
75.0%	Quartile	44
50.0%	Median	33
25.0%	Quartile	24
10.0%		16
2.5%		13.3
0.5%		11
0.0%	Minimum	11

Moments

Mean	34.019048
Std Dev	12.437522
Std Err Mean	1.2137778
Upper 95% Mean	36.426015
Lower 95% Mean	31.612081
N	105

Figure 4-7. BI Started per Week - Sub4

The assumptions of normality for *DNBI Completions per Week, BI Completions per Week, DNBI Started per Week,* and *BI Started per Week* were satisfied, and there were no outliers present.

Independent Variables

There are four independent variables in this study, including *Principal Time in Charge*, *Technology Upgrade*, *Introduction of the Monitoring Policy*, and *Hospital Transition Periods*. In terms of the first variable—principle— there were three separate MEDCOMs in charge during this study period. The first principal was in charge for forty-five weeks; the second principal was in charge for forty-eight weeks; and the last principal was in charge for the final twelve weeks of the study. The technology upgrade occurred at week eighty-two, and the new monitoring policy was introduced in week fifty-five. Furthermore, there were two, five-week hospital transition times in which sanctioning may have occurred: 1) from weeks forty through forty-four and 2) from weeks forty-nine through fifty-three. Figure 4-9 provides the descriptive statistics for these four independent variables.

Principal Change - IV1
Frequencies

Level	Count	Prob
0	45	0.42857
1	48	0.45714
2	12	0.11429
Total	105	1.00000

N Missing 0
3 Levels

Technology Upgrade - IV2
Frequencies

Level	Count	Prob
0	81	0.77143
1	24	0.22857
Total	105	1.00000

N Missing 0
2 Levels

Introduction of the Monitoring Policy - IV3
Frequencies

Level	Count	Prob
0	54	0.51429
1	51	0.48571
Total	105	1.00000

N Missing 0
2 Levels

Hospital Transition Periods - IV4
Frequencies

Level	Count	Prob
0	95	0.90476
1	10	0.09524
Total	105	1.00000

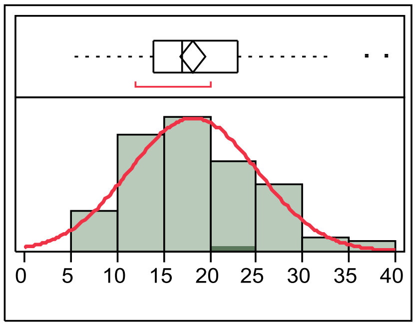
N Missing 0
2 Levels

Table 4-1. Frequencies for all IV (1-4)

Additional Variables

There are four additional mediating variables in this study, including *Non-U.S. Military Completions per Week*, *Non-U.S. Military Started per Week, U.S. Casualties Reported,* and *U.S. Service Members Deployed*. Figures 4-8 through 4-11 provide the descriptive statistics for these variables.

Non-U.S. Military Completions per Week - CV1



Normal (18.2095, 6.90554)

Quantiles

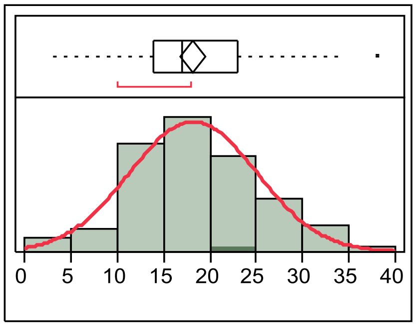
100.0%	Maximum	39
99.5%		39
97.5%		34.4
90.0%		27
75.0%	Quartile	23
50.0%	Median	17
25.0%	Quartile	14
10.0%		10
2.5%		6.65
0.5%		5
0.0%	Minimum	5

Moments

Mean	18.209524
Std Dev	6.9055374
Std Err Mean	0.6739114
Upper 95% Mean	19.545915
Lower 95% Mean	16.873132
N	105

Figure 4-8. Non-U.S. Military Completions per Week

Non-U.S. Military Started per Week - CV2



Normal (18.2095, 6.85943)

Quantiles

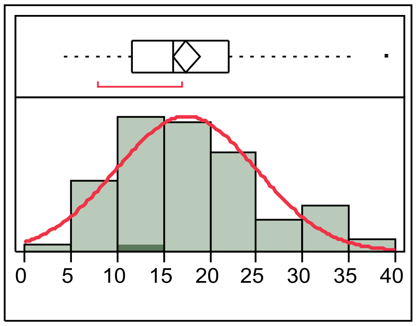
100.0%	Maximum	38
99.5%		38
97.5%		33.35
90.0%		27
75.0%	Quartile	23
50.0%	Median	17
25.0%	Quartile	14
10.0%		10
2.5%		4
0.5%		3
0.0%	Minimum	3

Moments

Mean	18.209524
Std Dev	6.8594338
Std Err Mean	0.6694122
Upper 95% Mean	19.536993
Lower 95% Mean	16.882054
N	105

Figure 4-9. Non-U.S. Military Started per Week

U.S. Casualties Reported - CV3



— Normal (17.4571, 7.58798)

Quantiles

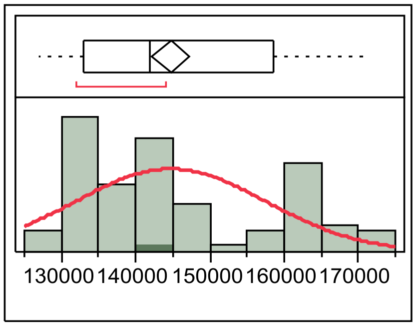
100.0%	Maximum	39
99.5%		39
97.5%		34.7
90.0%		30
75.0%	Quartile	22
50.0%	Median	16
25.0%	Quartile	11.5
10.0%		8.6
2.5%		5.65
0.5%		4
0.0%	Minimum	4

Moments

Mean	17.457143
Std Dev	7.5879821
Std Err Mean	0.7405112
Upper 95% Mean	18.925604
Lower 95% Mean	15.988681
N	105

Figure 4-10. U.S. Casualties Reported

U.S. Service Members Deployed - CV4



Normal (144714, 12861.7)

Quantiles

100.0%	Maximum	171000
99.5%		171000
97.5%		171000
90.0%		162000
75.0%	Quartile	158500
50.0%	Median	142000
25.0%	Quartile	133000
10.0%		132000
2.5%		126900
0.5%		126900
0.0%	Minimum	126900

Moments

Mean	144714.29
Std Dev	12861.686
Std Err Mean	1255.172
Upper 95% Mean	147203.34
Lower 95% Mean	142225.23
N	105

Figure 4-11. U.S. Service Members Deployed

The normality plots for *Non-U.S. Military Completions per Week*, *Non-U.S. Military Started per Week, U.S. Casualties Reported,* and *U.S. Service Members Deployed* do not appear to deviate from normality.

Hypotheses Testing

This section examines the results of the statistical analyses for the four hypotheses in this study. The analyses conducted included graphing each dependent variable over time with intervention analysis, analysis of variance (ANOVA), standard least squares regressions, and two-tailed *t*-tests.

Total Records Completed per Week

The time series for *Total Records Completed per Week* across the study's 105 weeks is illustrated in Figure 4-12. The graph shows the individual points and connecting lines between the observations for the average number of total records completed per week.

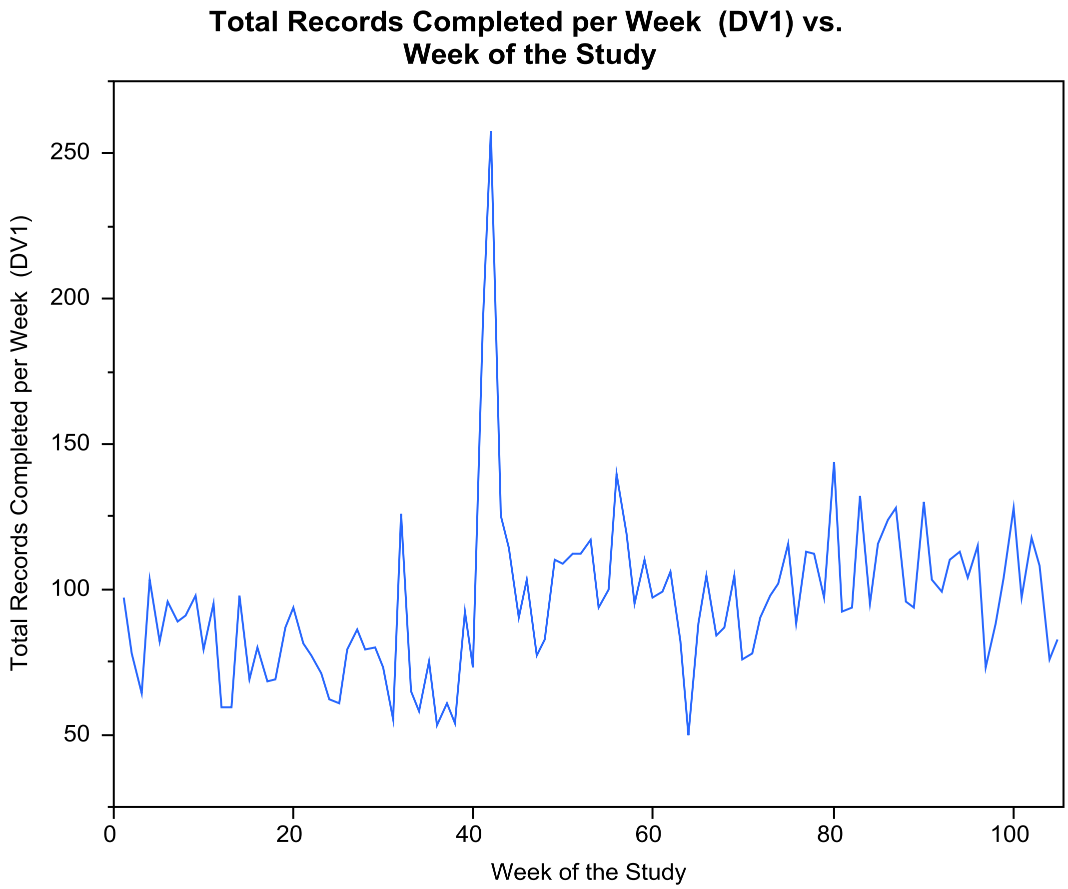


Figure 4-12. Graph of Total Records Completed Per Week

Then, a simultaneous regression model was created that included all independent and possible mediating variables. The summary of fit for the model is presented in Table 4-2.

RSquare	0.454863
RSquare Adj	0.403219
Root Mean Square Error	21.40809
Mean of Response	95.3619
Observations (or Sum Wgts)	105

Table 4-2. Overall Model Summary of Fit – DV1

The R-squared (R^2) estimates the proportion of the variation in the response around the mean that can be attributed to the model's terms and not to random error. R-squared adjusted makes the R^2 more comparable with other models of differing parameters by using the degrees of freedom (*df*) in its computation. The root mean square error is the standard deviation of the random error, and the mean of response is the overall mean of the response values. Furthermore, the observations record the number of observations used in the fit of the model (Sall, Lehman, & Creighton, 2001). ANOVA summarizes the results for the model as a whole; that is, ANOVA establishes if the simultaneous regression is a better predictor of change than simply using the mean of the outcome. For this model, $F(9,95) = 8.8076$, $p < .0001$, so there is at least one significant regression factor in the model.

Next, we examined if there are any multivariate outliers. A multivariate outlier exists if the combination of scores across predictors is substantially different from the remainder of the sample. A multivariate outlier would distort the regression line, thereby reducing the generalizability of the findings. To test for multivariate outliers, Cook's distance (D) was utilized. A score >1 indicates an outlier, which would thus need to be removed (Garson, 2008). In the 105 observations, Cook's D ranged from 1.6303e-5 to 0.8939, thereby showing no multivariate outliers.

We continued by examining DV1 for an absence of multicollinearity. Muliticollinearity exists if predictor variables co-vary too highly in terms of the proportion of the outcome variable they account for. In order to test for multicollinearity, we examined the variance inflation factor (VIF) for each of the independent and mediating variables. Any VIF >10 signifies an instance of multicollinearity (Garson, 2008). For the eight variables, the VIF ranged from 1.3706 to 5.4008, thereby establishing that multicollinearity is not present.

Next, we examined the model for first-order autocorrelation. The residual error for one case across time should not be systematically related the errors for other cases because if this occurs and is left unchecked, it can interfere with alpha level error rates. In order to establish the independence of errors between cases, the Durbin-Watson test was utilized. Durbin-Watson scores may range from 0 to 4, but scores remaining relatively close to 2 indicate no problem with independence (Garson, 2008). The Durbin-Watson test is only appropriate for time series data when it is suspected that the errors are correlated across time. The Durbin-Watson score for the total model of DV1 is 1.9533, thereby demonstrating that no autocorrelation is present.

Finally, the residual plot was examined to ensure that the constant variance assumption was satisfied. Residuals should reflect the absence of systematic distortions in the model. Figure 4-13 is the residual plot for DV1 and shows that the constant variance assumption was met.

Residual for Total Records Completed per Week (DV1)

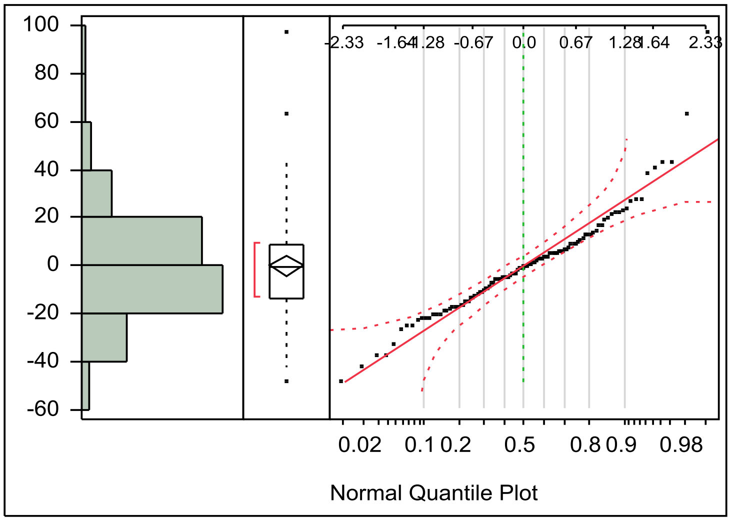


Figure 4-13. Residual Plot for
Total Records Completed per Week

Here, we considered a summary of fit for the full model regressing total records completed within a week with non-U.S. military records completed, non-U.S. military records started, U.S. casualties reported, and U.S. service members deployed across all weeks and including the interventions. Table 4-3 provides the parameter estimates, standard errors, and test statistics for each of the independent variables as well as for the mediating variables.

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		27.432022	45.13676	0.61	0.5448
Principal Change - IV1[0]		13.745335	7.285874	1.89	0.0623
Principal Change - IV1[1]		2.6611907	4.678248	0.57	0.5708
Technology Upgrade - IV2[0]		-1.208562	4.40198	-0.27	0.7843
Introduction of Monitoring Policy - IV3[0]		-14.18244	4.856757	-2.92	0.0044*
Hospital Transition Periods - IV4[0]		-26.52248	4.291773	-6.18	<.0001*
Non-U.S. Military Completions per Week - CV1		1.4487431	0.514555	2.82	0.0059*
Non-U.S. Military Started per Week - CV2		-1.223176	0.517492	-2.36	0.0201*
U.S. Casualties Reported - CV3		-0.367754	0.32388	-1.14	0.2590
U.S. Service Members Deployed - CV4		0.0006049	0.00028	2.16	0.0332*

Table 4-3. Parameter Estimates for All Variables with Total Records Completed per Week

Non-U.S. military completions had a significant positive impact on total records completed (p = 0.0059). Non-U.S. military starts had a significant negative impact on total records completed (p = 0.0201). Finally, U.S. service members deployed had a significant positive impact on records completed (p = 0.0332).

In the next section, we discuss the impact of each intervention on the total model. First, we present the graphs and discussions for each pre- and post-intervention, and then we examine the changes in slope for both the pre- and post interventions.

Intervention Component for Total Records Completed per Week

We use the regression model to assess the impact of exogenous intervention on the time series. The term *impact assessment* is used to refer to the statistical analysis of the time series quasi-experiment. The null hypothesis for an impact assessment is that the intervention caused a change in the process. If we make the regression model N_t, the impact assessment may be written as follows:

$$Y_t = f(I_t) + N_t.$$

The "function of I_t," $f(I_t)$, is the intervention component of the model (McDowall, 1980). and N_t is the total regression of the time series quasi-experiment. The Y_t time series is explained as the "noise" by the $N_t$component.

Impacts themselves may be considered in terms of two specific characteristics: *onset* and *duration*. An impact may be *abrupt* or *gradual* in its onset and either *permanent* or *temporary* in duration (McDowall, 1980). The analysis in this study, then, not only examined the form of the graph but also the statistical significance of changes in slope after the interventions. Each of the independent variables in the model was considered for the analysis, including principal time in charge, technology upgrade, introduction of the monitoring policy, and hospital transition periods.

Principal Time in Charge

We began by examining the intervention of the principal time in charge on total records completed per week. Figure 4-14 is a graph of the entire times series with the intervention shown with a dotted line.

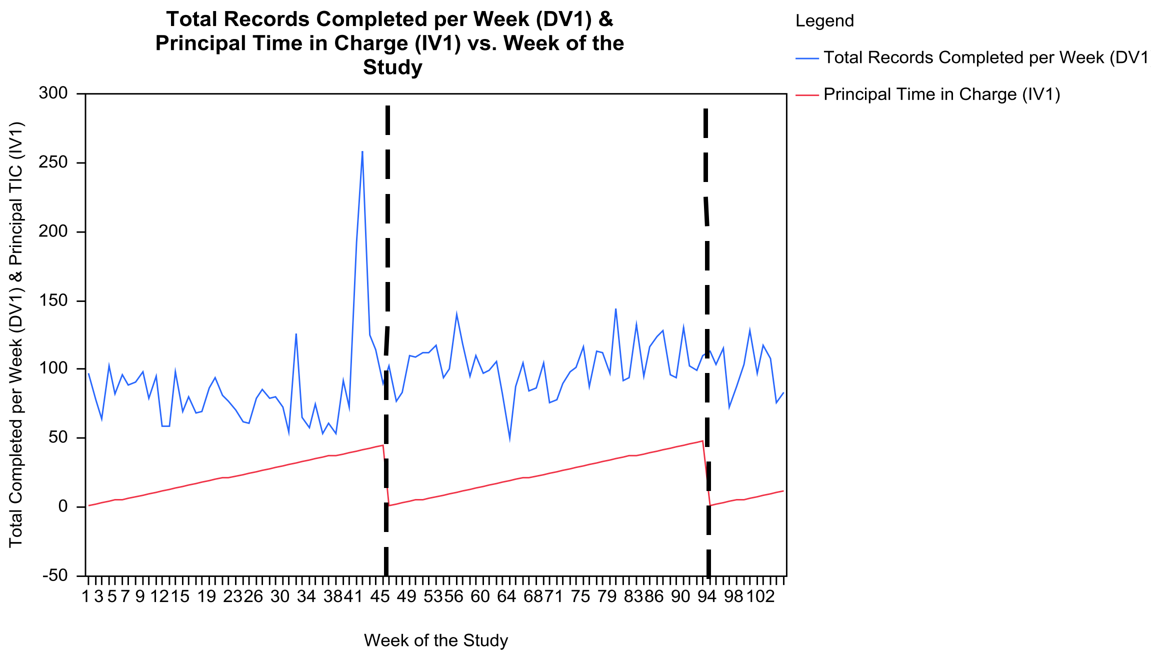


Figure 4-14. Intervention of Principal Time in Charge with Total Records Completed per Week

The onset of the principal time in charge intervention was abrupt and negative immediately following the intervention. The duration of change was temporary with only the first of the three sections displaying a gradually rising trendline. The second section appears to remain stationary, while the third section generally trends downward even though it only includes twelve weeks of observations. We used the *F*–test for each period in order to examine significant changes in the slope over time for each principal during the period (Neter, Wasserman, & Kutner, 1990). The null hypothesis is that the slope of one period equals the slope of another other period. In this model, we rejected the null if $F^* > F_{1,101} = 3.94$. For the test of slope for period one and two, $F^* = 2.438$. For the test of slope for period one and three, F* = 1.7546. For the test of slope for period two and three, F* = 0.2895. In each of the three cases, we failed to reject the null hypothesis.

Technology Upgrade

Next, we analyzed the intervention of the technology upgrade on total records completed per week. Figure 4-15 is a graph of the entire times series with the intervention shown with a dotted line.

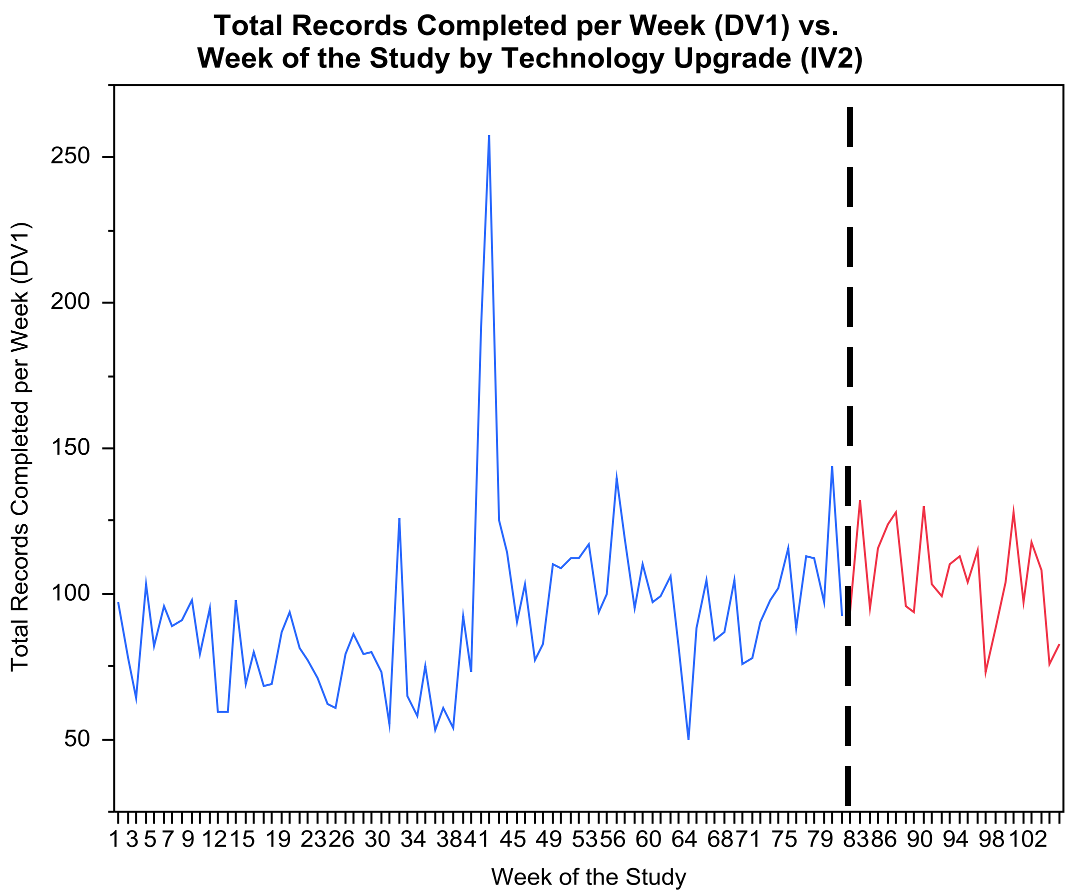


Figure 4-15. Intervention of Technology Upgrade with Total Records Completed per Week

The onset of this intervention was gradual as there were no immediate spikes in records completed after the technology upgrade. The duration was permanent, although not in the visual changes in slope. The *t*–test was used for each coefficient to test the significance of *unique effects* for each predictor.   As viewed in the parameter estimates table (Table 4-4), it is evident that the technology upgrade did significantly change the number of total records completed (p = 0.0442).

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		98.87037	3.172543	31.16	<.0001*
Technology Upgrade (IV2)[0]		-6.462963	3.172543	-2.04	0.0442*

Table 4-4. Parameter Estimates for Technology Upgrade With Total Records Completed per Week

There was also a significant impact on the standard deviation (σ^) after the intervention. Prior to the upgrade, the σ^ = 29.47, and after the upgrade the variance estimate was σ^ = 16.36. The number of records does not significantly increase, but the change in the estimate of the variability decreased by almost half.

Introduction of the Monitoring Policy

Next, we analyze the intervention of the introduction of monitoring on total records completed per week. Figure 4-16 is a graph of the entire times series.

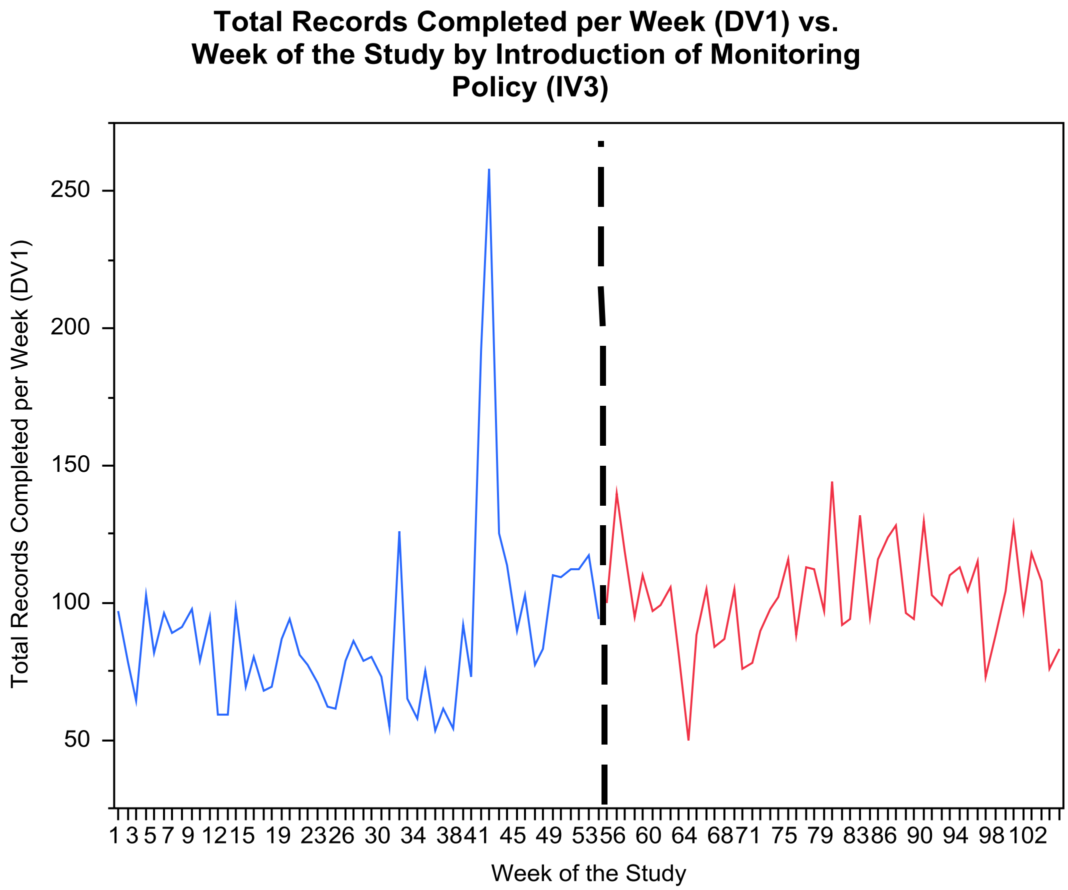


Figure 4-16. Intervention of Monitoring Policy with Total Records Completed per Week

The onset of this intervention was abrupt, as there was an immediate spike in records completed after the introduction of the monitoring policy. The duration was temporary and began with an upward spike, then trended back downward. From the parameter estimates table (Table 4-5), it is clear that the introduction of the monitoring policy did affect the number of total records completed ($p = 0.0167$).

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		95.545752	2.643671	36.14	<.0001*
Introduction of Monitoring Policy (IV3)[0]		-6.434641	2.643671	-2.43	0.0167*

Table 4-5. Parameter Estimates for Monitoring Policy With Total Records Completed per Week

Hospital Transition Periods

Next, we analyzed the intervention of the hospital transition periods on total records completed per week. Figure 4-17 is a graph of the entire times series.

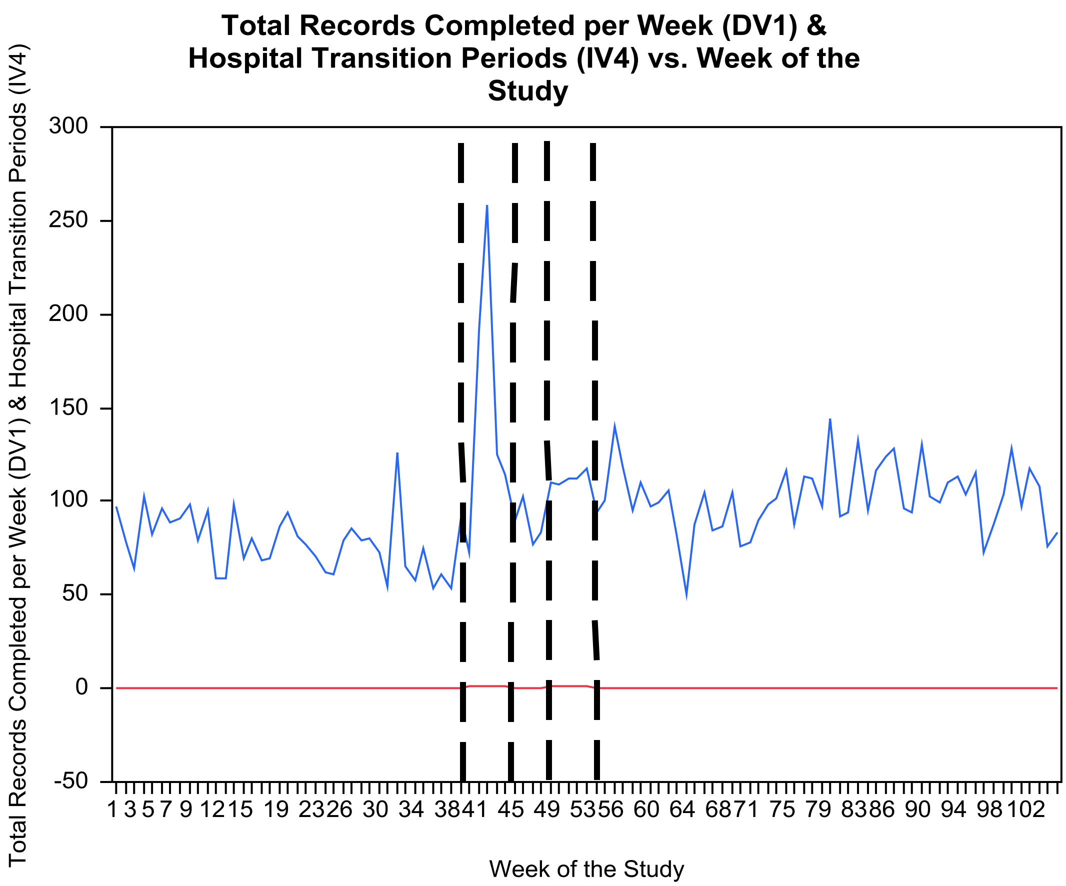


Figure 4-17. Intervention of Hospital Transitions With Total Records Completed per Week

The onset of this intervention was abrupt, as there was an immediate spike in records during the hospital transition periods. The duration was temporary and included a visually significant spike in both cases where hospitals were in transition periods (the first much larger than the second). We can, therefore, state that the intervention of hospital transition periods did significantly change the number of total records completed ($p = < 0.001$) (Table 4-6).

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		111.84211	4.171612	26.81	<.0001*
Hospital Transition Periods (IV4)[0]		-20.35789	4.171612	-4.88	<.0001*

Table 4-6. Parameter Estimates for Hospital Transitions With Total Records Completed per Week

There was also a significant impact on the mean and standard deviation during the intervention periods. During non-transition periods, the $\mu^{\wedge} = 91.48$ and $\sigma^{\wedge} = 20.39$. During the transition periods, the $\mu^{\wedge} = 132.2$ and $\sigma^{\wedge} = 50.37$. The number of records did significantly increase as well as the mean and standard deviations.

Total Records Started per Week

The time series for *Total Records Started per Week* across the 105 weeks in the study is illustrated in Figure 4-18. The graph shows the individual points and connecting lines between the observations for the average number of total records started per week.

The regression model included all independent and possible mediating variables and is represented in Table 4-7. For this model, F(9,95) = 3.3605, p < 0.0013, so there was at least one significant regression factor in the model. In the 105 observations, Cook's D ranged from 1.3086e-5 to 0.0763, thereby showing no multivariate outliers. The VIF for all eight variables was the same, therefore establishing that multicollinearity was not present. The Durbin-Watson score for the entire model of total records started was 1.5076, thereby showing no autocorrelation.

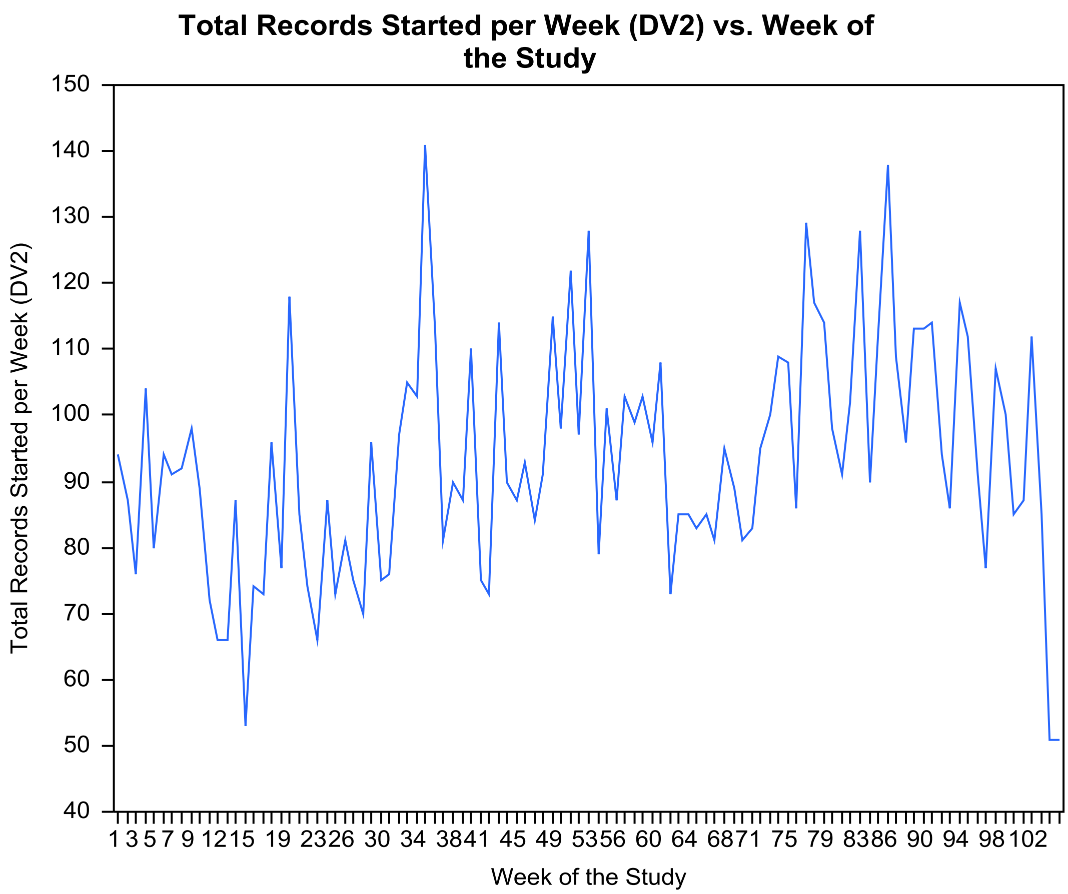


Figure 4-18. Graph of Total Records Started Per Week

RSquare	0.241482
RSquare Adj	0.169622
Root Mean Square Error	15.96653
Mean of Response	93.06667
Observations (or Sum Wgts)	105

Table 4-7. Overall Model Summary of Fit (DV2)

Figure 4-19 is the residual plot for DV2 and shows that the constant variance assumption was met.

Residual Total Records Started per Week (DV2)

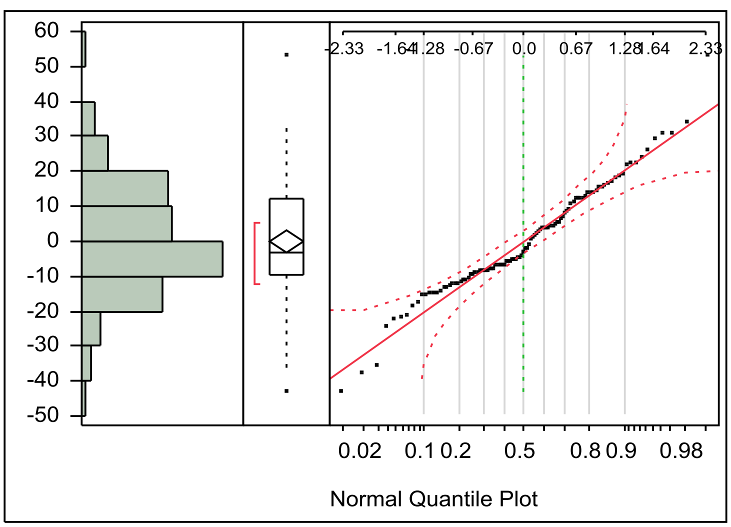


Figure 4-19. Residual Plot for Total Records Started per Week

Here, we considered a summary of fit for the model regressing total records started per week with non-U.S. military records completed, non-U.S. military records started, U.S. casualties reported, and U.S. service members deployed across all weeks and including the interventions. Table 4-8 provides the parameter estimates, standard errors, and test statistics for each of the independent variables as well as the mediating variables. None of the mediating variables influenced the number of records started.

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		76.289306	33.6638	2.27	0.0257*
Principal Change - IV1[0]		2.6376319	5.433934	0.49	0.6285
Principal Change - IV1[1]		6.6651295	3.48912	1.91	0.0591
Technology Upgrade - IV2[0]		-4.916213	3.283075	-1.50	0.1376
Introduction of Monitoring Policy - IV3[0]		-1.742347	3.622255	-0.48	0.6316
Hospital Transition Periods - IV4[0]		-7.056162	3.20088	-2.20	0.0299*
Non-U.S. Military Completions per Week - CV1		-0.556427	0.383764	-1.45	0.1504
Non-U.S. Military Started per Week - CV2		0.6690951	0.385955	1.73	0.0862
U.S. Casualties Reported - CV3		0.3050461	0.241556	1.26	0.2097
U.S. Service Members Deployed - CV4		0.0001017	0.000209	0.49	0.6273

Table 4-8. Parameter Estimates for All Variables with Total Records Started per Week

Intervention Component for Total Records Started per Week

Principal Time in Charge

We began by examining the intervention of the principal time in charge on total records started per week. Figure 4-20 is a graph of the entire times series with the intervention shown as a dotted line. We also included a line connecting the weekly numbers. The onset of this intervention was abrupt and negative immediately following the intervention. The duration of change was temporary with the first and second sections displaying a gradually rising trendline. The third section generally trended downward, but it only included twelve observation weeks.

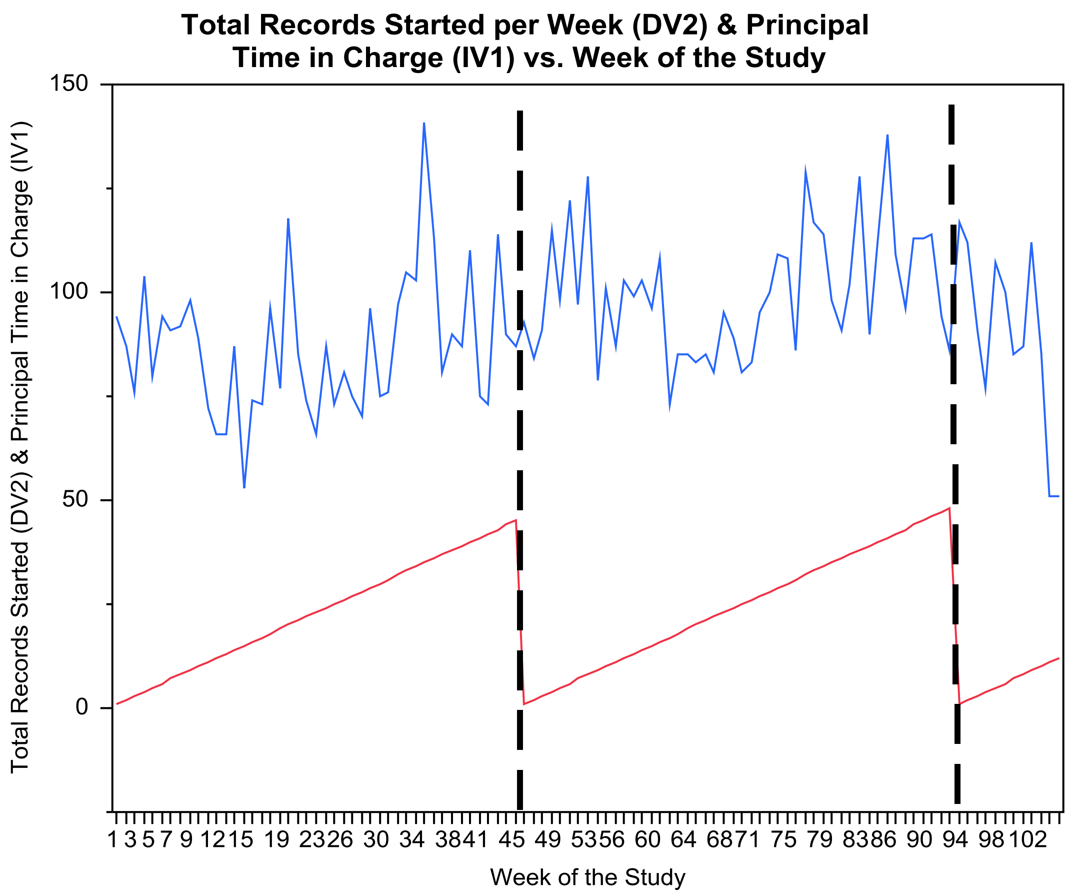


Figure 4-20. Intervention of Principal Time in Charge with Total Records Started Per Week

In this model, we rejected the null if $F^* > F_{1,101} = 3.94$. For the test of slope for periods one and two, $F^* = 0.2708$. As such, we failed to reject the null hypothesis. For the test of slope for periods one and three, $F^* = 21.0082$; therefore, the null hypothesis was rejected. For the test of slope for periods two and three, $F^* = 13.5646$, therefore rejecting the null hypothesis.

Technology Upgrade

Next, we analyzed the intervention of the technology upgrade on the total records started per week. Figure 4-21 is a graph of the entire times series with the intervention shown as a dotted line.

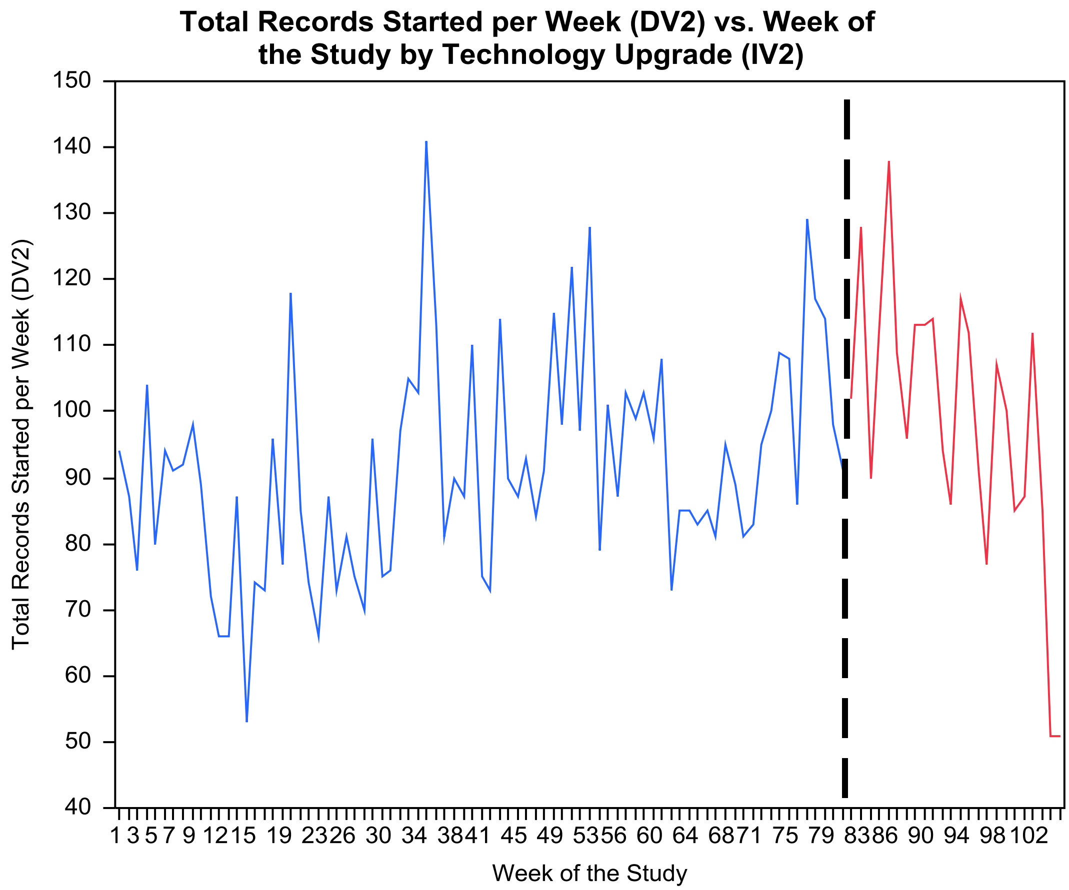


Figure 4-21. Intervention of the Technology Upgrade with Total Records Started Per Week

The onset of this intervention was immediate as there were immediate spikes in the records started after the technology upgrade. The duration was temporary with a more permanent decline for the remainder of the time series. Based on the parameter estimate table, it is clear that the technology upgrade did not have an effect ($p = 0.0702$) on the number of total records started (Table 4-9).

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		95.066358	2.013461	47.22	<.0001*
Technology Upgrade (IV2)[0]		-3.683642	2.013461	-1.83	0.0702

Table 4-9. Parameter Estimates for the Technology Upgrade with Total Records Started Per Week

Introduction of the Monitoring Policy

Next, we analyzed the intervention of the introduction of monitoring on total records started per week. Figure 4-22 is a graph of the entire times series with this intervention.

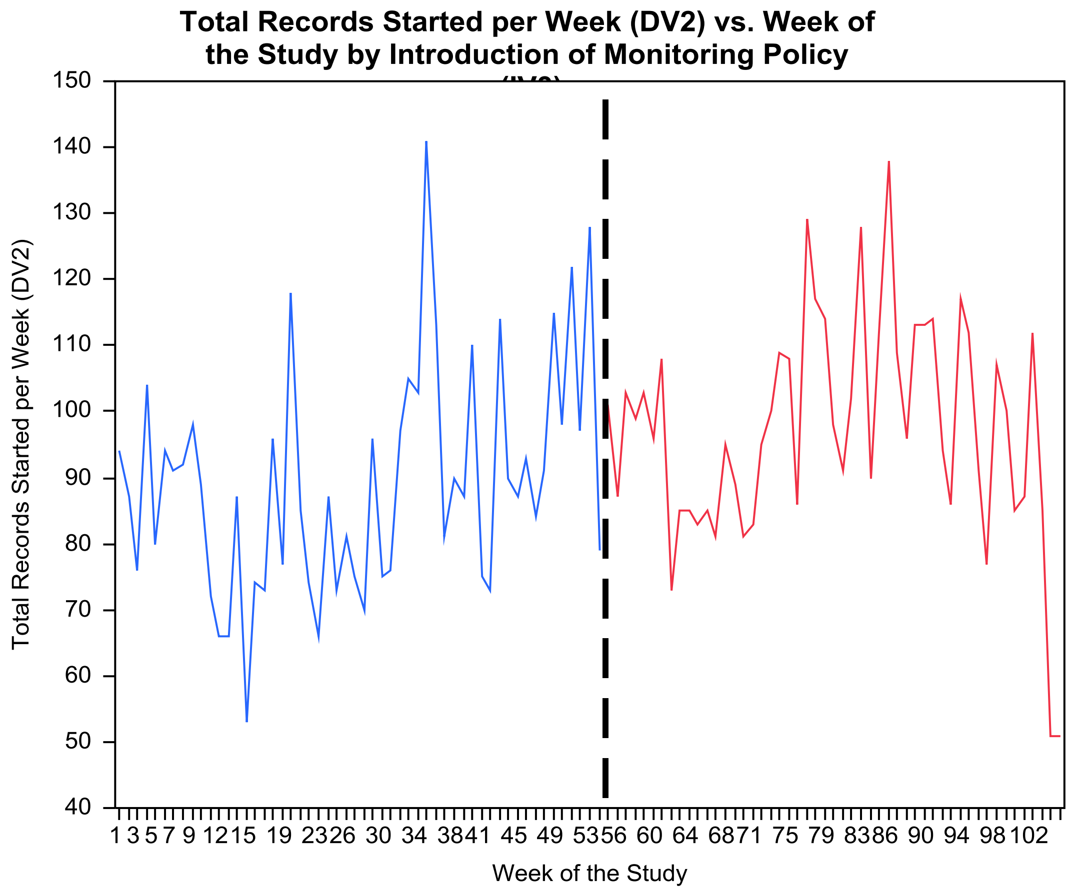


Figure 4-22. Intervention of the Monitoring Policy with Total Records Started Per Week

The onset of this intervention was abrupt, as there was an immediate upward spike in records started after the introduction of the monitoring policy. The duration was temporary and began with an upward trend, which then moved downward. Based on the parameter estimates table (Table 4-10), it is clear that the introduction of the monitoring policy influenced the number of total records started (p = 0.0200).

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		93.179739	1.674097	55.66	<.0001*
Introduction of Monitoring Policy (IV3)[0]		-3.957516	1.674097	-2.36	0.0200*

Table 4-10. Parameter Estimates for the Monitoring Policy with Total Records Started Per Week

Hospital Transition Periods

Next, we analyzed the intervention of the introduction of monitoring on total records started per week. Figure 4-23 is a graph of the entire times series.

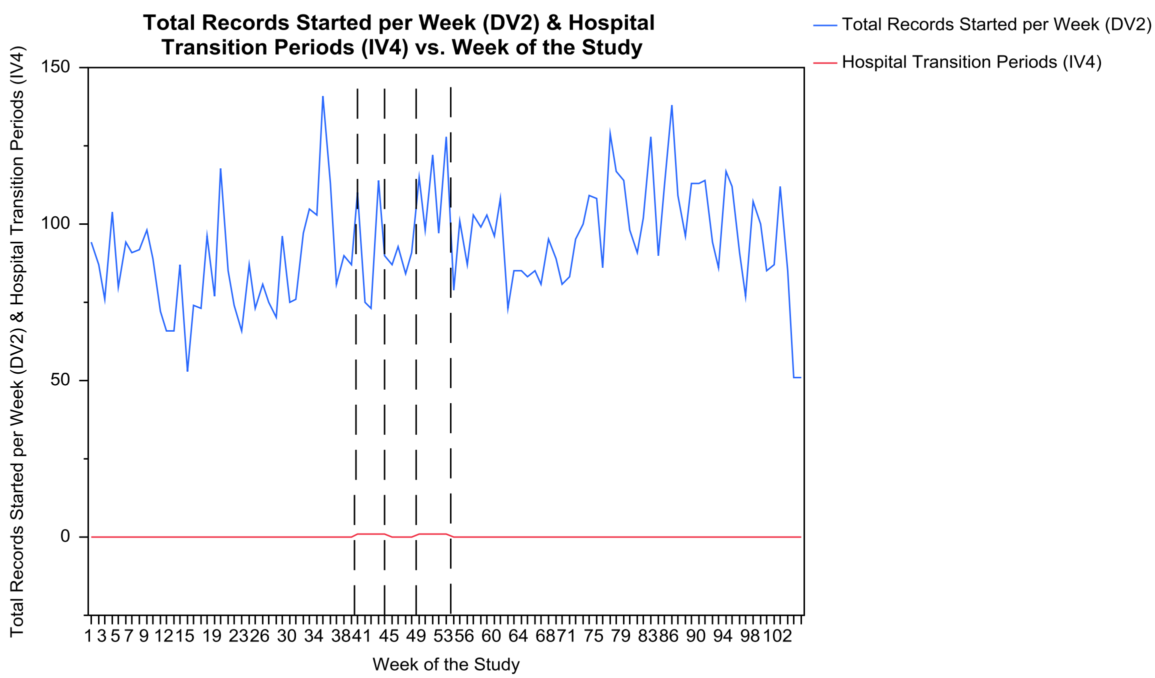


Figure 4-23. Intervention of Hospital Transitions with Total Records Started Per Week

The onset of this intervention was abrupt, as there was an immediate spike in records during the hospital transition periods. The duration was temporary and included a visually significant spike at the beginning and end of both cases with a trough for each in the middle weeks. Based on the parameter estimates table (Table 4-11), it is clear hospital transition periods did not influence the number of total records started ($p = 0.0831$).

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		97.152632	2.884104	33.69	<.0001*
Hospital Transition Periods (IV4)[0]		-5.047368	2.884104	-1.75	0.0831

Table 4-11. Parameter Estimates for Hospital Transitions with Total Records Started Per Week

Average Time to Completion

The time series for average time to completion across the 105 weeks in the study is illustrated in Figure 4-24. The graph shows the individual points and connecting lines between the observations for the average number of total records started per week. The regression model included all independent and possible mediating variables and is represented in Table 4-12. For this model, $F(9,92) = 1.6678$, $p < 0.1081$. In the observations, Cook's D ranged from 1.378e-8 to 0.1884, thereby showing no multivariate outliers. For the eight variables, the VIF ranged from 1.4067 to 5.3574, thereby establishing that multicollinearity was not present. The Durbin-Watson score for the total model of average time to completion was 1.9408, thereby showing no autocorrelation.

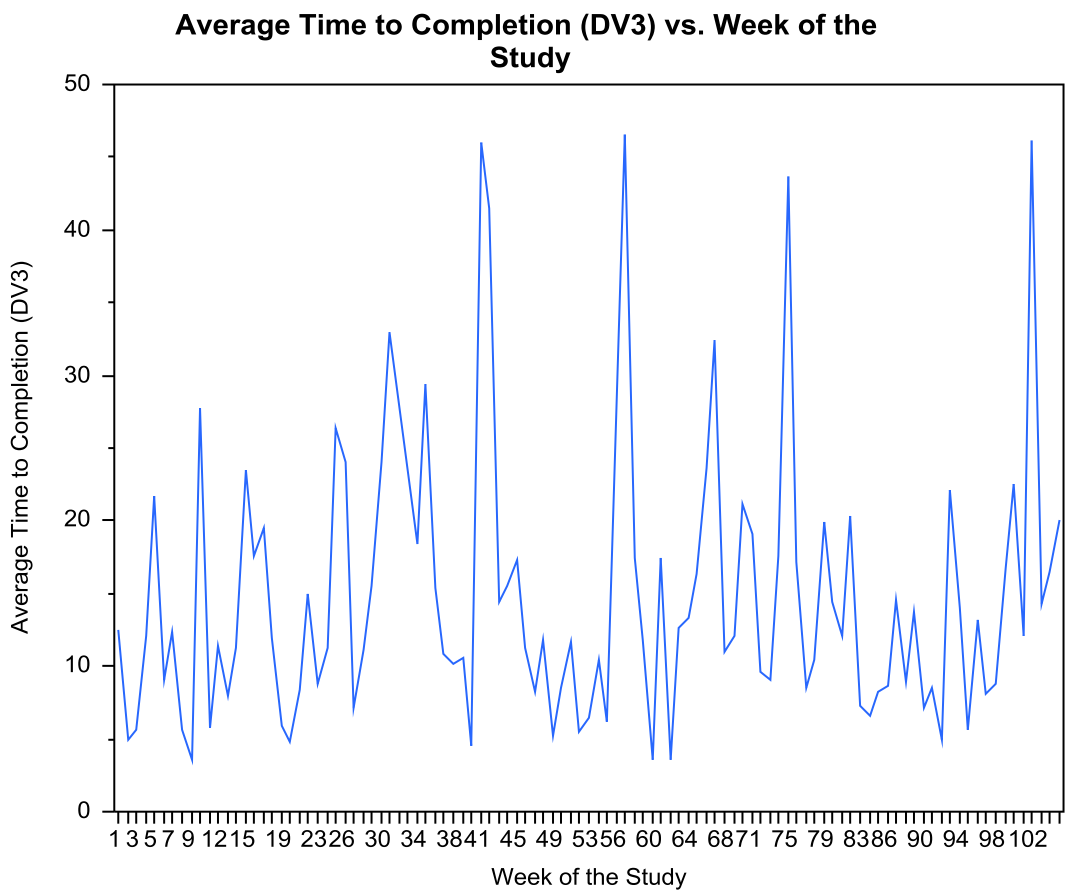


Figure 4-24. Graph of Average Time to Completion

RSquare	0.140267
RSquare Adj	0.056163
Root Mean Square Error	9.152461
Mean of Response	14.63052
Observations (or Sum Wgts)	102

Table 4-12. Overall Model Summary of Fit – DV3

Figure 4-25 is the residual plot for average time to completion and shows that the constant variance assumptions were met.

Residual Average Time to Completion (DV3)

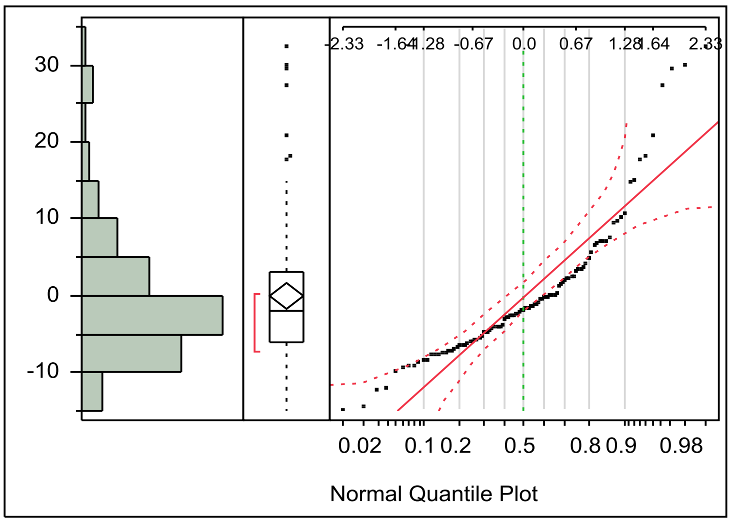


Figure 4-25. Residual Plot for Average Time to Completion

Here, we considered a summary of fit for the model regressing average time to completion with non-U.S. military records completed, non-U.S. military records started, U.S. casualties reported, and U.S. service members deployed across all weeks and including the interventions. Table 4-13 provides the parameter estimates, standard errors, and test statistics for each of the independent variables as well as for the mediating variables. None of the mediating variables influenced the average time to completion.

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		35.239453	19.78069	1.78	0.0781
Principal Change (IV1)[0]		3.2741268	3.122781	1.05	0.2972
Principal Change (IV1)[1]		-5.450208	2.001644	-2.72	0.0077*
Technology Upgrade (IV2)[0]		1.3365549	1.907091	0.70	0.4852
Introduction of Monitoring Policy (IV3)[0]		-4.707228	2.097967	-2.24	0.0273*
Hospital Transition Periods (IV4)[0]		-2.072388	1.844214	-1.12	0.2641
Non-U.S. Military Completions per Week (CV1)		0.4030394	0.226143	1.78	0.0780
Non-U.S. Military Started per Week (CV2)		-0.290303	0.229787	-1.26	0.2097
U.S. Casualties Reported (CV3)		0.053008	0.141673	0.37	0.7091
U.S. Service Members Deployed (CV4)		-0.000149	0.000123	-1.22	0.2271

Table 4-13. Parameter Estimates for All Variables with Average Time to Completion

Intervention Component for Average Time to Completion

Principal Time in Charge

We began by examining the intervention of the principal time in charge on average time to completion. Figure 4-26 is a graph of the entire times series with the intervention shown as a dotted line. We include both a line as well as a smoother of the mean.

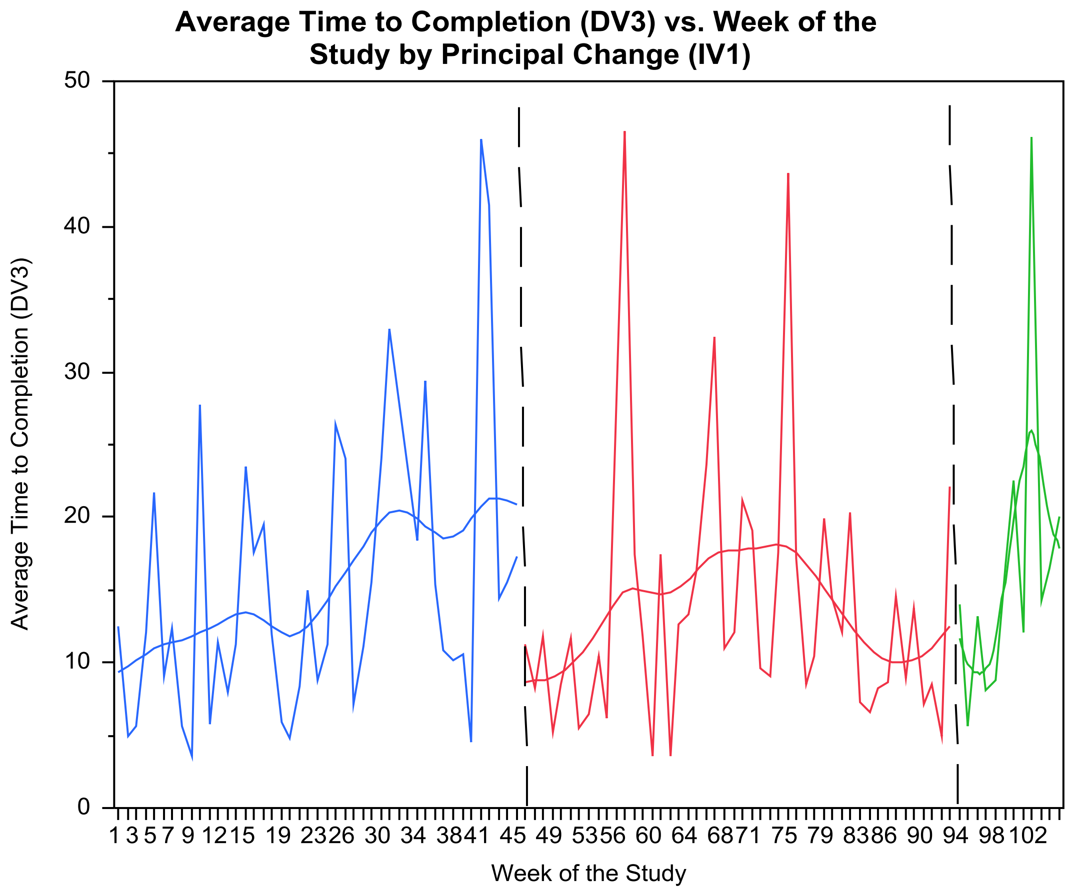


Figure 4-26. Intervention of Principal Time in Charge with Average Time to Completion

The onset of this intervention was abrupt and negative immediately following the change of commands. The duration of the change was permanent with only the second section not displaying a gradually rising trendline.

In this model, we rejected the null if $F^* > F_{1,101} = 3.94$. For the test of slope for periods one and two, $F^* = 3.337$. We, therefore, failed to reject the null hypothesis. For the test of slope for periods one and three, $F^* = 3.1933$, again failing to reject the null hypothesis. For the test of slope for periods two and three, F* = 4.8636, again rejecting the null hypothesis.

Technology Upgrade

Next, we analyzed the intervention of the technology upgrade on average time to completion. Figure 4-27 is a graph of the entire times series with the intervention shown as a dotted line.

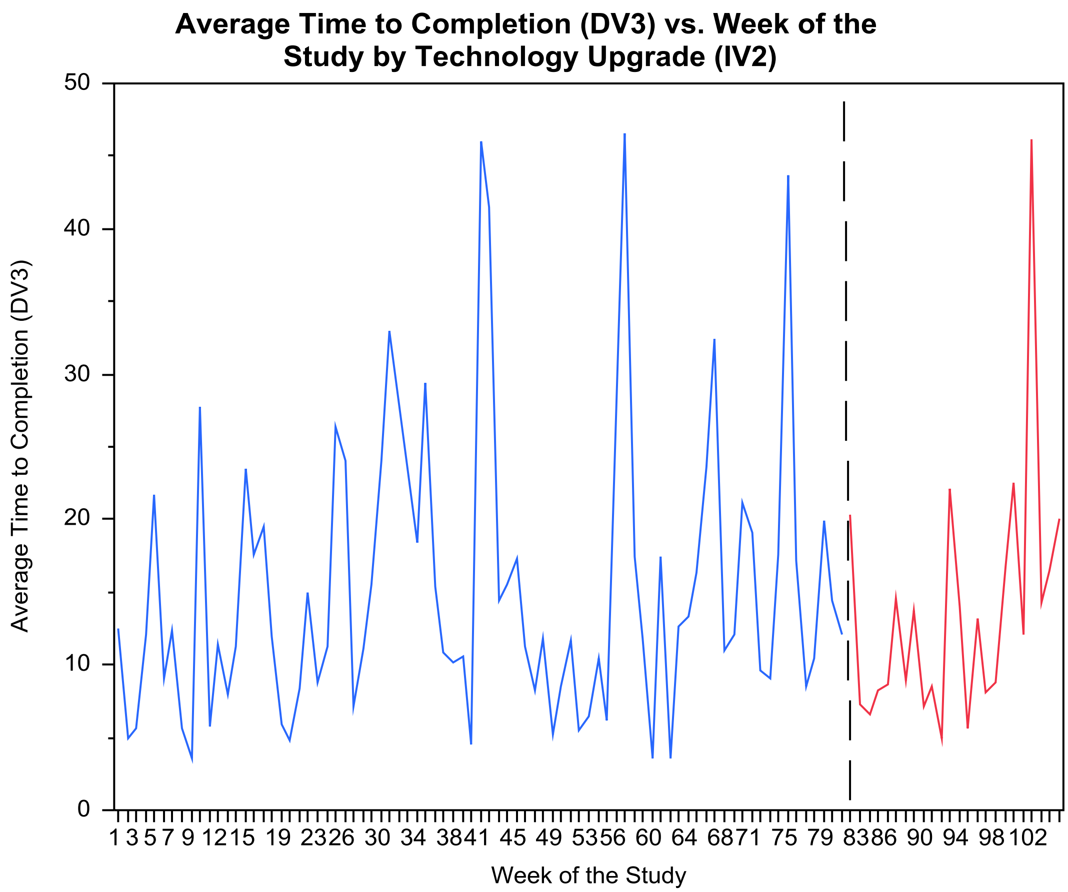


Figure 4-27. Intervention of the Technology Upgrade with Average Time to Completion

The onset of this intervention was abrupt, as there is an immediate spike in average time to completion after the technology upgrade. The duration was temporary, and there was a dip in the average. Finally, there was a steady incline for the remainder of the time series. Based on the parameter estimates table (Table 4-14), we can conclude that the technology upgrade did not have an effect on the slope for average time to completion ($p = 0.5786$).

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		14.304994	1.103301	12.97	<.0001*
Technology Upgrade (IV2)[0]		0.6148812	1.103301	0.56	0.5786

Table 4-14. Parameter Estimates for Technology Upgrade with Average Time to Completion

Introduction of the Monitoring Policy

Next, we analyzed the intervention of the introduction of the monitoring policy on average time to completion. Figure 4-28 is a graph of the entire times series with regard to this intervention.

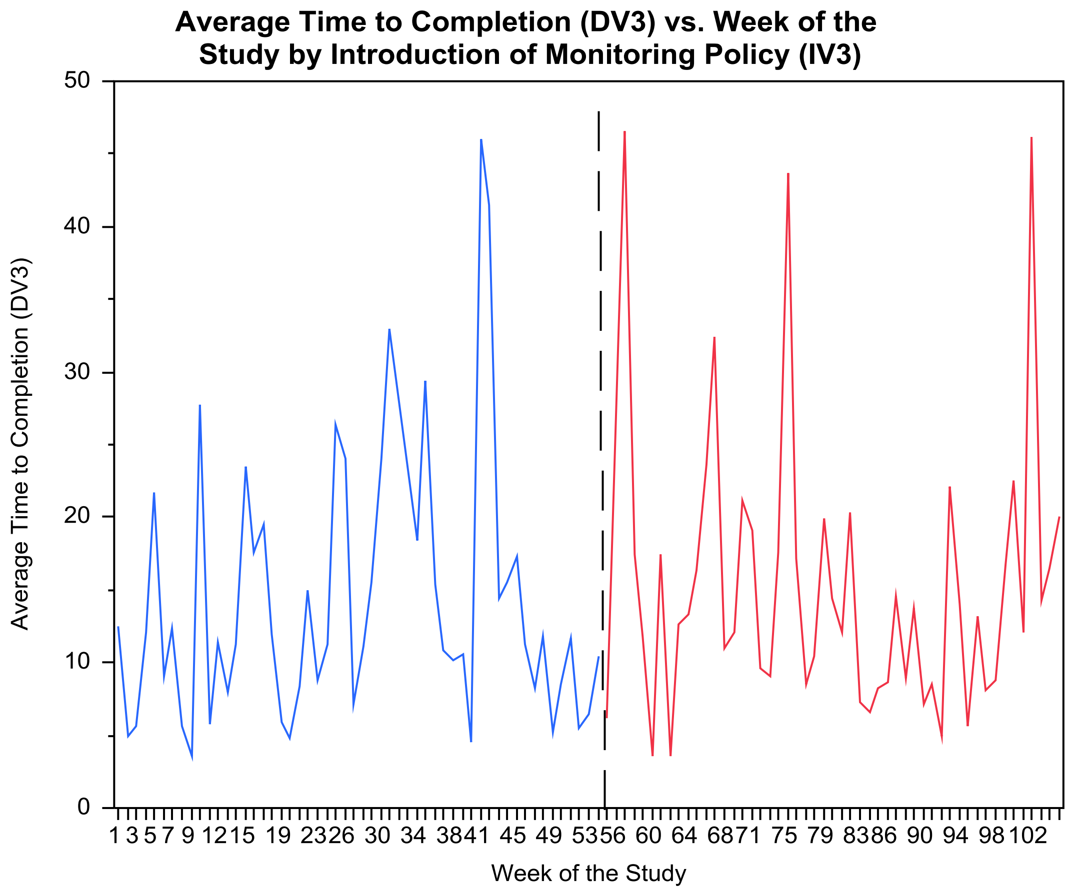


Figure 4-28. Intervention of the Monitoring with Average Time to Completion

The onset of this intervention was abrupt, as there was an immediate spike in average time to completion after the introduction of the monitoring policy. The duration was temporary. From the parameter estimates table (Table 4-15), it is clear that the introduction of the monitoring policy negatively influenced the number of total records started ($p = 0.5614$).

<table>
<tr><th>Term</th><th></th><th>Estimate</th><th>Std Error</th><th>t Ratio</th><th>Prob>|t|</th></tr>
<tr><td>Intercept</td><td></td><td>14.641213</td><td>0.936047</td><td>15.64</td><td><.0001*</td></tr>
<tr><td>Introduction of Monitoring Policy (IV3)[0]</td><td></td><td>-0.545383</td><td>0.936047</td><td>-0.58</td><td>0.5614</td></tr>
</table>

Table 4-15. Parameter Estimates for Monitoring Policy with Average Time to Completion

Hospital Transition Periods

Next, we analyzed the intervention of the introduction of monitoring on total records started per week. Figure 4-29 is a graph of the entire times series with this intervention.

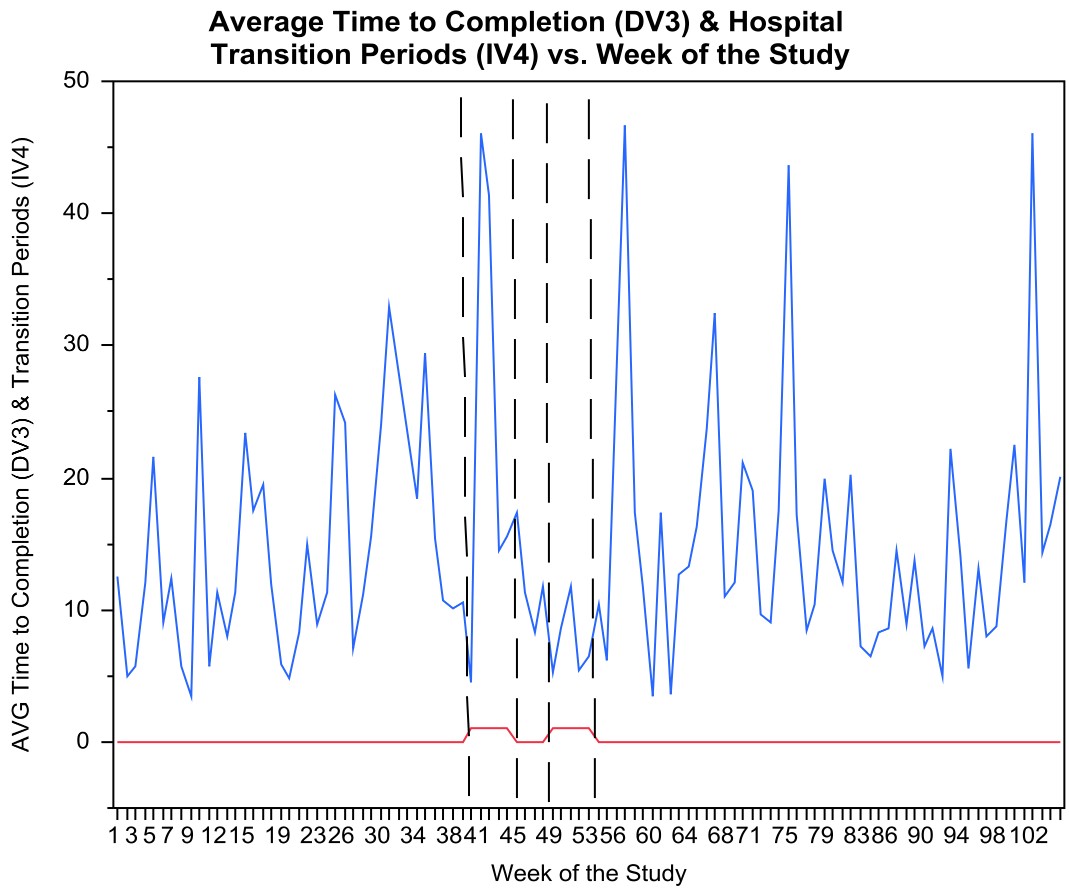


Figure 4-29. Intervention of Hospital Transition Times with Average Time to Completion

The onset of this intervention was abrupt, as there is an immediate spike in time to completion during the hospital transition periods. The duration was temporary and included a visually significant spike at the beginning and end of the first case. Based on the parameter estimates table (Table 4-16), we can conclude that hospital transition periods did not significantly influence the number of total records started ($p = 0.6434$).

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		15.218395	1.574557	9.67	<.0001*
Hospital Transition Periods (IV4)[0]		-0.73126	1.574557	-0.46	0.6434

Table 4-16. Parameter Estimates for Hospital Transition with Average Time to Completion

DNBI Completed per Week

The time series for *DNBI Completed per Week* across the 105 weeks in the study is illustrated in Figure 4-30. The graph shows the individual points and connecting lines between the observations for the average number of DNBI records completed per week. The regression model includes all independent and possible mediating variables and is represented in Table 4-17. For this model, $F(9,95) = 9.3294$, $p < 0.0001$, so there is at least one significant regression factor in the model. In the 105 observations, Cook's D showed no multivariate outliers. The VIF for all eight variables displayed no signs of multicollinearity present. The Durbin-Watson score for the total model of DNBI completions is 1.9831, thereby showing no autocorrelation.

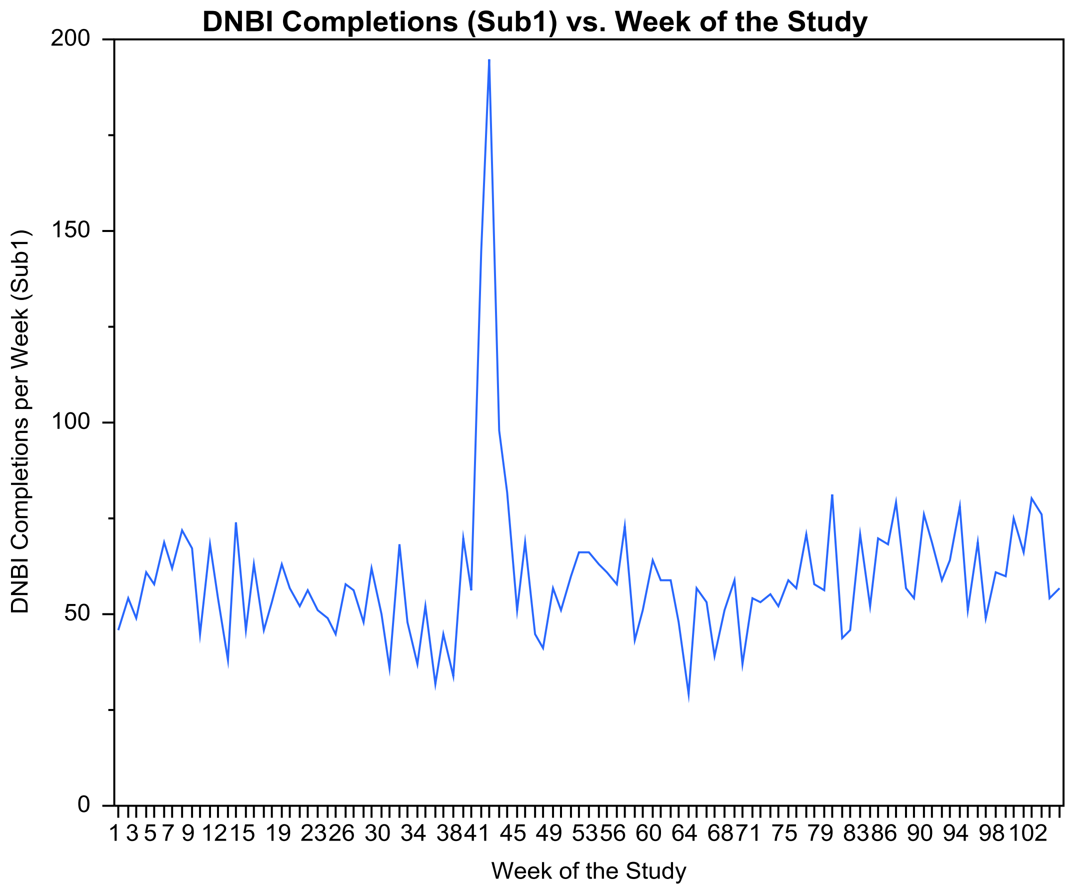


Figure 4-30. Graph of DNBI Records Completed Per Week

RSquare	0.469168
RSquare Adj	0.418878
Root Mean Square Error	15.13934
Mean of Response	59.62857
Observations (or Sum Wgts)	105

Table 4-17. Overall Model Summary of Fit – Sub 1.

Figure 4-31 is the residual plot for DNBI completions and shows that the constant variance assumptions were met.

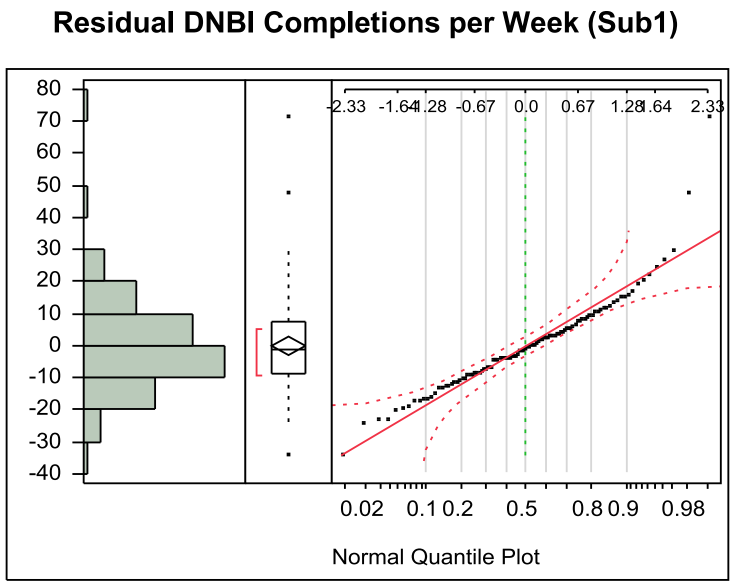


Figure 4-31. Residual Plot for DNBI Records Completed per Week

Summary of DNBI Parameter Estimates

Here, we considered a summary of fit for the model regressing DNBI records completed with non-U.S. military records completed, non-U.S. military records started, U.S. casualties reported, and U.S. service members deployed across all weeks and including the interventions. Table 4-18 provides the parameter estimates, standard errors, and test statistics for each of the independent variables as well as for the mediating variables. All four of the mediating variables influenced the DNBI completions.

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		13.869679	31.91974	0.43	0.6649
Principal Change - IV1[0]		17.406391	5.152412	3.38	0.0011*
Principal Change - IV1[1]		-4.168397	3.308355	-1.26	0.2108
Technology Upgrade - IV2[0]		-1.365103	3.112985	-0.44	0.6620
Introduction of Monitoring Policy - IV3[0]		-10.82989	3.434593	-3.15	0.0022*
Hospital Transition Periods - IV4[0]		-20.33864	3.035049	-6.70	<.0001*
Non-U.S. Military Completions per Week - CV1		1.1082247	0.363882	3.05	0.0030*
Non-U.S. Military Started per Week - CV2		-0.908691	0.365959	-2.48	0.0148*
U.S. Casualties Reported - CV3		-0.602415	0.229041	-2.63	0.0100*
U.S. Service Members Deployed - CV4		0.0004569	0.000198	2.31	0.0232*

Table 4-18. Parameter Estimates for All Variables with DNBI Records Completed

Next, we examined each of the IVs separately in relation to DNBI records completed. We began with principal time in charge. In this model, we rejected the null if $F^*>F_{1,101} = 3.94$. For the test of slope for periods one and two, $F^* = 0.9505$. We therefore failed to reject the null hypothesis. For the test of slope for periods one and three, $F^* = 0.3531$, again failing to reject the null hypothesis. For the test of slope for periods two and three, $F^* = 0.7601$, therefore failing to reject the null hypothesis once more. Next, we examined the technology upgrade, monitoring, and sanctioning on DNBI records completed. Table 4-19 provides the parameter estimates, standard errors, and test statistics for each of the individual independent variables.

Technology Upgrade					
Term		**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Intercept		61.239969	2.300412	26.62	<.0001*
Technology Upgrade (IV2)[0]		-2.968364	2.300412	-1.29	0.1998
Monitoring					
Term		**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Intercept		59.618192	1.947963	30.61	<.0001*
Introduction of Monitoring Policy (IV3)[0]		0.3632898	1.947963	0.19	0.8524
Sanctioning					
Term		**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Intercept		72.142105	2.946876	24.48	<.0001*
Hospital Transition Periods (IV4)[0]		-15.45789	2.946876	-5.25	<.0001*

Table 4-19. Parameter Estimates for IVs II-IV and DNBI Completed

BI Completed per Week

The time series for BI completed per week across the 105 weeks in the study is illustrated in Figure 4-32. The graph shows the individual points and connecting lines between the observations for the average number of BI records completed per week. The regression model included all independent and possible mediating variables and is represented in Table 4-20. For this model, $F(9,95) = 9.7389$, $p < 0.0001$, so there is at least one significant regression factor in the model. In the 105 observations, Cook's D showed no multivariate outliers. The VIF for all eight variables displayed no signs of multicollinearity present. Finally, the Durbin-Watson score for the total model of BI completions was 1.9067, thereby showing no autocorrelation.

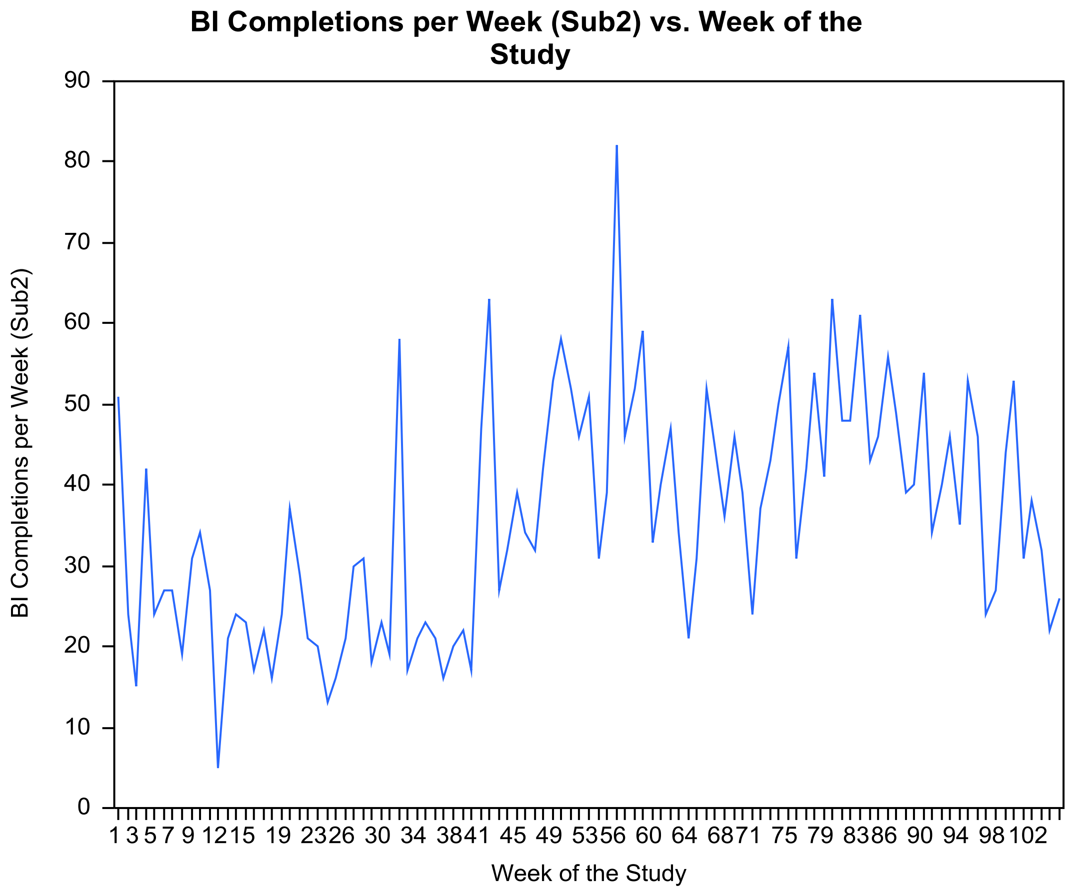


Figure 4-32. Graph of BI Completions Per Week

RSquare	0.479881
RSquare Adj	0.430606
Root Mean Square Error	10.71608
Mean of Response	35.73333
Observations (or Sum Wgts)	105

Table 4-20. Overall Model Summary of Fit – Sub 2

Figure 4-33 is the residual plot for BI completions and shows that the constant variance assumptions were met.

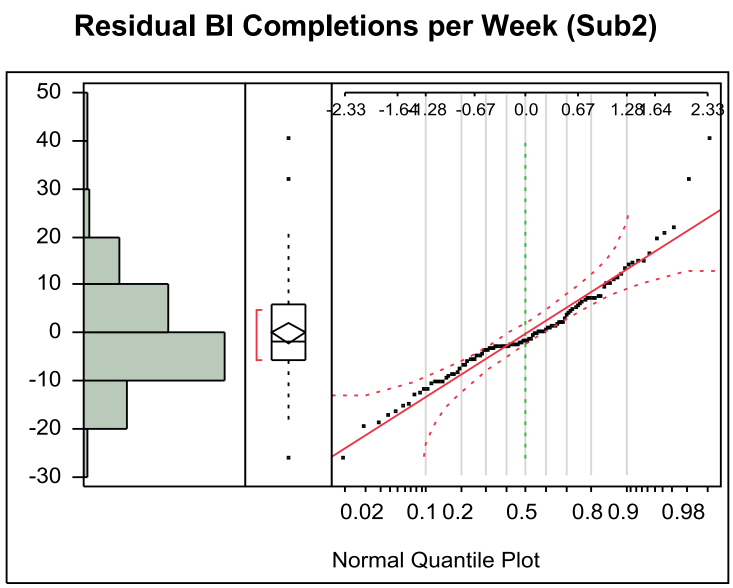


Figure 4-33. Residual Plot for BI Records Completed per Week

Summary of BI Parameter Estimates

Here, we considered a summary of fit for the model regressing BI records completed with non-U.S. military records completed, non-U.S. military records started, U.S. casualties reported, and U.S. service members deployed across all weeks and including the interventions. Table 4-21 provides the parameter estimates, standard errors, and test statistics for each of the independent variables as well as for the mediating variables. None of the four mediating variables influenced the BI completions.

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		13.562344	22.59375	0.60	0.5498
Principal Change - IV1[0]		-3.661056	3.647032	-1.00	0.3180
Principal Change - IV1[1]		6.8295875	2.341753	2.92	0.0044*
Technology Upgrade - IV2[0]		0.1565412	2.203464	0.07	0.9435
Introduction of Monitoring Policy - IV3[0]		-3.352558	2.431108	-1.38	0.1711
Hospital Transition Periods - IV4[0]		-6.183836	2.148299	-2.88	0.0049*
Non-U.S. Military Completions per Week - CV1		0.3405185	0.257567	1.32	0.1893
Non-U.S. Military Started per Week - CV2		-0.314485	0.259037	-1.21	0.2277
U.S. Casualties Reported - CV3		0.2346606	0.162122	1.45	0.1511
U.S. Service Members Deployed - CV4		0.0001481	0.00014	1.06	0.2934

Table 4-21. Parameter Estimates for All Variables with BI Records Completed

Next, we examined each of the IVs separately in relation to BI records completed. We began with principal time in charge. In this model, we rejected the null if $F^*>F_{1,101} = 3.94$. For the test of slope for periods one and two, $F^* = 3.212$. We therefore failed to reject the null hypothesis. For the test of slope for periods one and three, $F^* = 15.6774$, again rejecting the null hypothesis. For the test of slope for periods two and three, $F^* = 7.1536$, again rejecting the null hypothesis. Next, we examined the technology upgrade, monitoring, and sanctioning on BI records completed. Table 4-22 provides the parameter estimates, standard errors, and test statistics for each of the individual independent variables.

<table>
<tr><th>Technology Upgrade</th><th></th><th></th><th></th><th></th><th></th></tr>
<tr><td>Term</td><td></td><td>Estimate</td><td>Std Error</td><td>t Ratio</td><td>Prob>|t|</td></tr>
<tr><td>Intercept</td><td></td><td>37.630401</td><td>1.622083</td><td>23.20</td><td><.0001*</td></tr>
<tr><td>Technology Upgrade (IV2)[0]</td><td></td><td>-3.494599</td><td>1.622083</td><td>-2.15</td><td>0.0335*</td></tr>
<tr><td>Monitoring</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Term</td><td></td><td>Estimate</td><td>Std Error</td><td>t Ratio</td><td>Prob>|t|</td></tr>
<tr><td>Intercept</td><td></td><td>35.92756</td><td>1.221605</td><td>29.41</td><td><.0001*</td></tr>
<tr><td>Introduction of Monitoring Policy (IV3)[0]</td><td></td><td>-6.79793</td><td>1.221605</td><td>-5.56</td><td><.0001*</td></tr>
<tr><td>Sanctioning</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Term</td><td></td><td>Estimate</td><td>Std Error</td><td>t Ratio</td><td>Prob>|t|</td></tr>
<tr><td>Intercept</td><td></td><td>39.7</td><td>2.322431</td><td>17.09</td><td><.0001*</td></tr>
<tr><td>Hospital Transition Periods (IV4)[0]</td><td></td><td>-4.9</td><td>2.322431</td><td>-2.11</td><td>0.0373*</td></tr>
</table>

Table 4-22. Parameter Estimates for IVs II-IV and BI Completed

DNBI Records Started per Week

The time series for DNBI started per week across the 105 weeks in the study is illustrated in Figure 4-34. The graph shows the individual points and connecting lines between the observations for the average number of DNBI records started. The regression model includes all independent and possible mediating variables and is represented in Table 4-23. For this model, $F(9,95) = 1.9874$, $p = 0.0491$, so there is at least one significant regression factor in the model. In the 105 observations, Cook's D showed no multivariate outliers, and the VIF for all eight variables displayed no signs of multicollinearity present. The Durbin-Watson score for the total model of DNBI completions was 1.5567, thereby showing no autocorrelation.

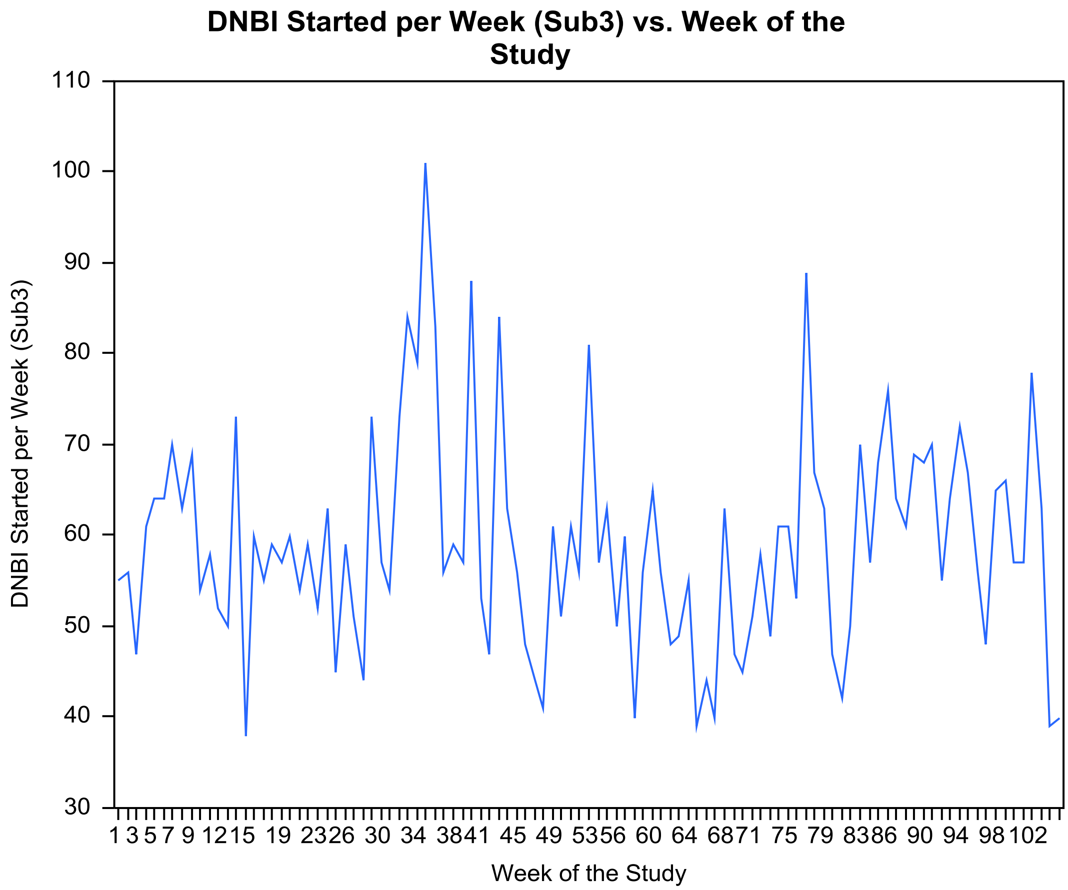


Figure 4-34. Graph of DNBI Records Started Per Week

RSquare	0.158447
RSquare Adj	0.078721
Root Mean Square Error	11.45582
Mean of Response	59.04762
Observations (or Sum Wgts)	105

Table 4-23. Overall Model Summary of Fit – Sub 3

Figure 4-35 is the residual plot for DNBI started and shows that all assumptions are met.

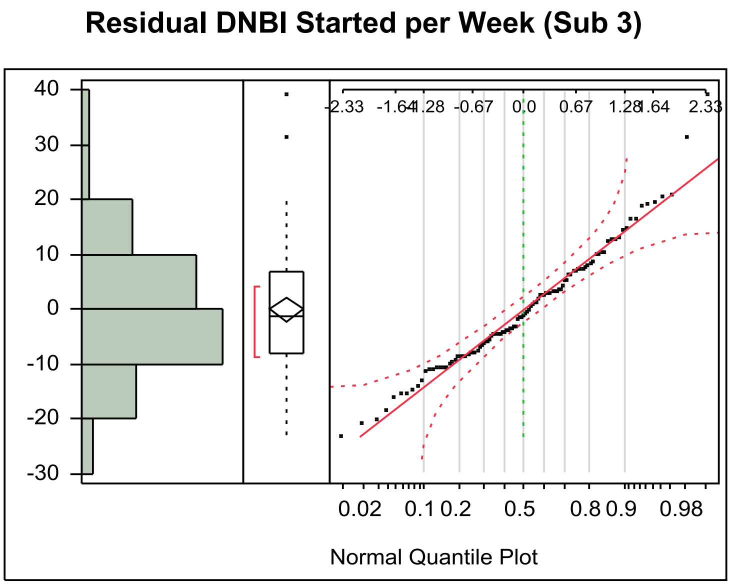


Figure 4-35. Residual Plot for DNBI Records Started per Week

Summary of DNBI Started Parameter Estimates

Here, we considered a summary of fit for the model regressing DNBI records started with non-U.S. military records completed, non-U.S. military records started, U.S. casualties reported, and U.S. service members deployed across all weeks and including the interventions. Table 4-24 provides the parameter estimates, standard errors, and test statistics for each of the independent variables as well as for the mediating variables. None of the four mediating variables influenced the DNBI starts.

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		68.339696	24.15342	2.83	0.0057*
Principal Change - IV1[0]		8.4786527	3.89879	2.17	0.0321*
Principal Change - IV1[1]		-1.088929	2.503407	-0.43	0.6646
Technology Upgrade - IV2[0]		-5.0117	2.355571	-2.13	0.0360*
Introduction of Monitoring Policy - IV3[0]		-2.587424	2.59893	-1.00	0.3220
Hospital Transition Periods - IV4[0]		-5.611041	2.296598	-2.44	0.0164*
Non-U.S. Military Completions per Week - CV1		-0.47836	0.275347	-1.74	0.0856
Non-U.S. Military Started per Week - CV2		0.421176	0.276919	1.52	0.1316
U.S. Casualties Reported - CV3		-0.133769	0.173314	-0.77	0.4421
U.S. Service Members Deployed - CV4		-6.013e-6	0.00015	-0.04	0.9681

Table 4-24. Parameter Estimates for All Variables with DNBI Records Started

Next, we examined each of the IVs separately in relation to DNBI records started. We begin with principal time in charge. In this model, we rejected the null if $F^* > F_{1,101} = 3.94$. For the test of slope for periods one and two, F* = 0.2898. We, therefore, failed to reject the null hypothesis. For the test of slope for periods one and three, F* = 0.9031, again failing to reject the null hypothesis. For the test of slope for periods two and three, F* = 1.0165, again failing to reject the null hypothesis. Next, we examined the technology upgrade, monitoring, and sanctioning on DNBI records started. Table 4-25 provides the parameter estimates, standard errors, and test statistics for each of the individual independent variables.

Technology Upgrade					
Term		**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Intercept		59.969136	1.383549	43.34	<.0001*
Technology Upgrade (IV2)[0]		-1.697531	1.383549	-1.23	0.2226
Monitoring					
Term		**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Intercept		59.009259	1.16338	50.72	<.0001*
Introduction of Monitoring Policy (IV3)[0]		1.3425926	1.16338	1.15	0.2512
Sanctioning					
Term		**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Intercept		61.486842	1.971339	31.19	<.0001*
Hospital Transition Periods (IV4)[0]		-3.013158	1.971339	-1.53	0.1295

Table 4-25. Parameter Estimates for IVs II-IV and DNBI Started

BI Records Started per Week

The time series for BI records started per week across the 105 weeks in the study is illustrated in Figure 4-36. The graph shows the individual points and connecting lines between the observations for the average number of BI records started. The regression model included all independent and possible mediating variables and is represented in Table 4-26. For this model, F(9,95) = 11.2223, p = < 0.0001, so there is at least one significant regression factor in the model. In the 105 observations, Cook's D showed no multivariate outliers. Furthermore, the VIF for all eight variables displayed no signs of multicollinearity present, and the Durbin-Watson score for the total model of BI completions was 1.7161, thereby showing no autocorrelation.

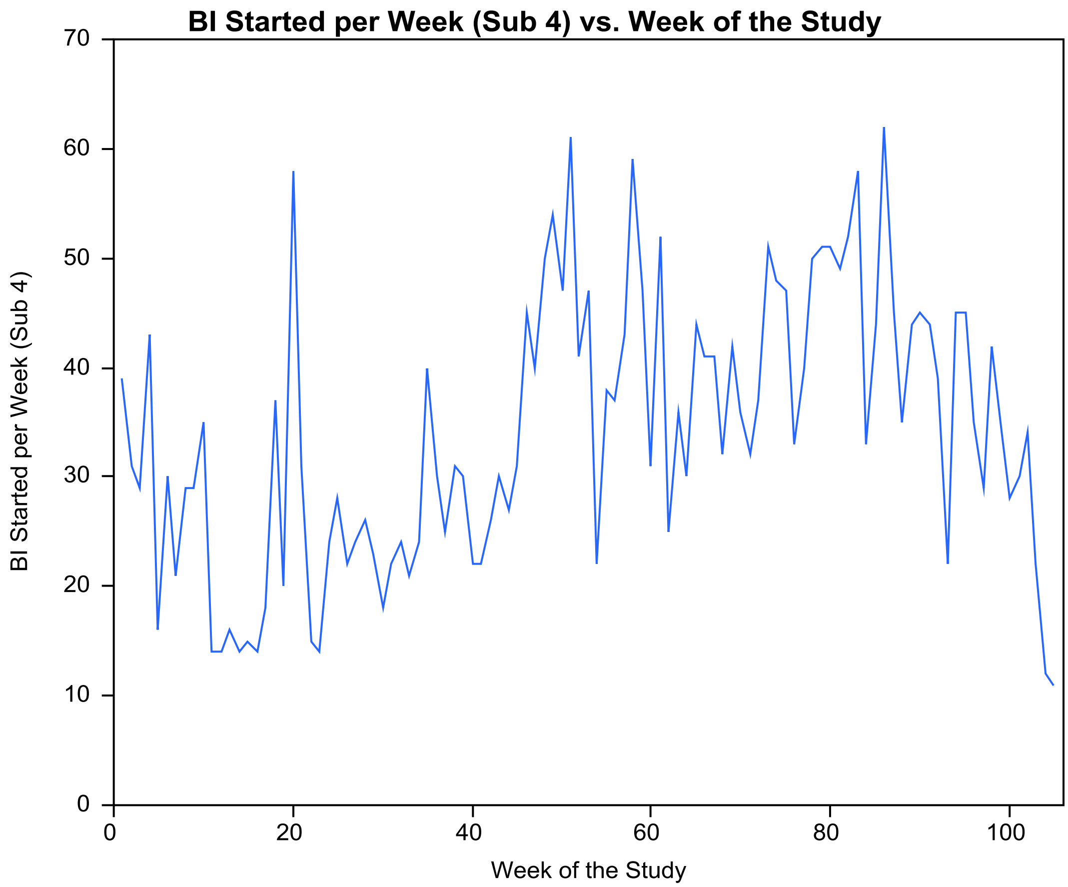


Figure 4-36. Graph of BI Started Per Week

RSquare	0.515308
RSquare Adj	0.46939
Root Mean Square Error	9.059863
Mean of Response	34.01905
Observations (or Sum Wgts)	105

Table 4-26. Overall Model Summary of Fit – (Sub 4)

Figure 4-37 is the residual plot for DNBI started and shows that all assumptions were met.

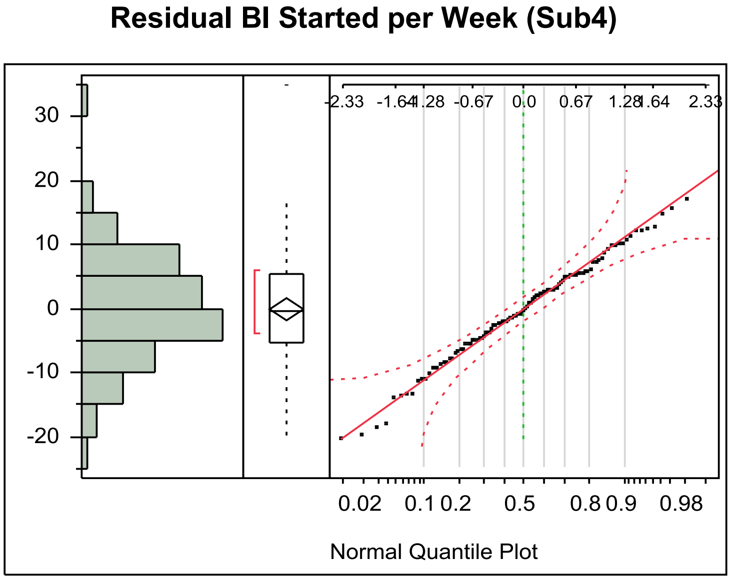


Figure 4-37. Residual Plot for BI Records Started per Week

Summary of BI Started Parameter Estimates

Here, we considered a summary of fit for the model regressing BI records started with non-U.S. military records completed, non-U.S. military records started, U.S. casualties reported, and U.S. service members deployed across all weeks and including the interventions. Table 4-27 provides the parameter estimates, standard errors, and test statistics for each of the independent variables as well as for the mediating variables. The last principal in charge is significant (p = 0.0002). The only significant mediating variable influencing BI completions was the number of U.S. casualties reported (p = 0.0019). .

Term		Estimate	Std Error	t Ratio	Prob>|t|
Intercept		7.9496106	19.10179	0.42	0.6782
Principal Change - IV1[0]		-5.841021	3.083368	-1.89	0.0612
Principal Change - IV1[1]		7.7540584	1.979825	3.92	0.0002*
Technology Upgrade - IV2[0]		0.095487	1.862909	0.05	0.9592
Introduction of Monitoring Policy - IV3[0]		0.8450768	2.05537	0.41	0.6819
Hospital Transition Periods - IV4[0]		-1.445121	1.81627	-0.80	0.4282
Non-U.S. Military Completions per Week - CV1		-0.078067	0.217759	-0.36	0.7208
Non-U.S. Military Started per Week - CV2		0.2479192	0.219002	1.13	0.2605
U.S. Casualties Reported - CV3		0.438815	0.137066	3.20	0.0019*
U.S. Service Members Deployed - CV4		0.0001077	0.000118	0.91	0.3656

Table 4-27. Parameter Estimates for All Variables with BI Records Started

Finally, we examined each of the IVs separately in relation to BI records started. We began with principal time in charge. In this model, we rejected the null if $F^*>F_{1,101} = 3.94$. For the test of slope for periods one and two, F* = 2.2051. We, therefore, failed to reject the null hypothesis. For the test of slope for periods one and three, F* = 36.9824, therefore rejecting the null hypothesis. For the test of slope for periods two and three, F* = 21.0436, again rejecting the null hypothesis. Next, we examined the technology upgrade, monitoring, and sanctioning on BI records started. Table 4-28 provides the parameter estimates, standard errors, and test statistics for each of the individual independent variables.

Technology Upgrade					
Term		**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Intercept		35.097222	1.439028	24.39	<.0001*
Technology Upgrade (IV2)[0]		-1.986111	1.439028	-1.38	0.1705
Monitoring					
Term		**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Intercept		34.170479	1.102745	30.99	<.0001*
Introduction of Monitoring Policy (IV3)[0]		-5.300109	1.102745	-4.81	<.0001*
Sanctioning					
Term		**Estimate**	**Std Error**	**t Ratio**	**Prob>|t|**
Intercept		35.665789	2.067778	17.25	<.0001*
Hospital Transition Periods (IV4)[0]		-2.034211	2.067778	-0.98	0.3275

Table 4-28. Parameter Estimates for IVs II-IV and BI Started

Summary

This chapter presented the results of the of the data analyses proposed in Chapter 3 (Research Methodology). The period of study was 105 weeks, and during this study, there were 10,013 U.S. service member inpatient records. In addition, there were a total of 2,010 non-U.S. service member records for a total of 12,023 records. There were fifteen separate parameters utilized. There were three dependent variables (with four total sub-categorical dependents), four independent variables, and four additional mediating variables. The analyses included utilizing descriptive statistics, graphing each dependent variable over time with intervention analysis, analysis of variance (ANOVA), and standard least squares regressions. Table 4-29 through 4-31 provides a summary of the test results.

The discussion, interpretation, and conclusions of these results are presented in Chapter 5.

Statistical Tests Matrix (Records Completions)				
	Tests	**DV1 - Completions**	**DNBI Completions**	**BI Completions**
Overall	Mean	95.361905	59.628571	35.733333
	Std Dev	27.712162	19.859728	14.201345
	Std Err Mean	2.7044301	1.938111	1.3859094
	N	105	105	105
	Rsquare	0.454863	0.469168	0.479881
	Rsquare Adjusted	0.403219	0.418878	0.430606
	ANOVA	$F(9,95) = 8.8076$, $p<.0001$	$F(9,95) = 9.3294$, $p<0.0001$	$F(9,95) = 9.7389$, $p<0.0001$
IV1 - Principal Time in Charge	Hypothesized Relationship	**(+)**	(+)	(+)
	$\beta1=\beta2$	No	No	No
	$\beta1=\beta3$	No	No	Yes
	$\beta2=\beta3$	No	No	Yes
IV2 - Technology Upgrade		**(+)**	(+)	(+)
	Significant / Relationship	Yes (+)	No	Yes (+)
	Graph Change / Notes	Gradual-Permanent. Significant / Relationship change in σ^.	none	none
IV3 - Monitoring		**(+)**	(+)	(+)
	Significant / Relationship	Yes (+)	No	Yes (+)
	Graph Change / Notes	Abrupt-Temporary	none	none
IV4 - Sanctioning		**(+)**	(+)	(+)
	Significant / Relationship	Yes (+)	Yes (+)	Yes (+)
	Graph Change / Notes	Abrupt-Temporary. Significant / Relationshipchange in µ^ and σ^.	none	none

Additional Variables				
Non-U.S. Military Completions per Week - CV1	Significant / Relationship	Yes (+)	Yes (+)	No
Non-U.S. Military Started per Week - CV2	Significant / Relationship	Yes (-)	Yes (-)	No
U.S. Casualties Reported - CV3	Significant / Relationship	No	Yes (-)	No
U.S. Service Members Deployed - CV4	Significant / Relationship	Yes (+)	Yes (+)	No
(+) or (-)	*Hypothesized Relationship in the study			

Table 4-29. Statistical Tests Matrix for Completions

Statistical Tests Matrix (Records Started)				
	Tests	**DV2 - Started**	**DNBI Started**	**BI Started**
Overall	Mean	93.066667	59.047619	34.019048
	Std Dev	17.521562	11.935227	12.437522
	Std Err Mean	1.7099293	1.1647588	1.2137778
	N	105	105	105
	Rsquare	0.241482	0.158447	0.515308
	Rsquare Adjusted	0.169622	0.078721	0.46939
	ANOVA	F(9,95) = 3.3605, p<0.0013	F(9,95) = 1.9874, p=0.0491	F(9,95) = 11.2223, p=<0.0001
IV1 - Principal Time in Charge	Hypothesized Relationship	**(+)**	(+)	(+)
	β1=β2	No	No	No
	β1=β3	Yes	No	Yes
	β2=β3	Yes	No	Yes

IV2 - Technology Upgrade		**(+)**	(+)	(+)
	Significant / Relationship	No	No	No
	Graph Change / Notes	Abrupt-Temporary	none	none
IV3 - Monitoring		(-)	(-)	(-)
	Significant / Relationship	Yes (+)	No	Yes
	Graph Change / Notes	Abrupt-Temporary	none	none
IV4 - Sanctioning		(-)	(-)	(-)
	Significant / Relationship	No	No	No
	Graph Change / Notes	Abrupt-Temporary	none	none
Additional Variables				
Non-U.S. Military Completions per Week - CV1	Significant / Relationship	No	No	No
Non-U.S. Military Started per Week - CV2	Significant / Relationship	No	No	No
U.S. Casualties Reported - CV3	Significant / Relationship	No	No	Yes (-)
U.S. Service Members Deployed - CV4	Significant / Relationship	No	No	No
(+) or (-)	*Hypothesized Relationship in the study			

Table 4-30. Statistical Tests Matrix for Starts

Statistical Tests Matrix (Average Time to Completion)		
	Tests	**DV3 - Average Time to Complete**
Overall	Mean	14.630519
	Std Dev	9.420835
	Std Err Mean	0.9328017
	N	102
	Rsquare	0.140267
	Rsquare Adjusted	0.056163
	ANOVA	$F(9,92) = 1.6678$, $p<0.1081$
IV1 - Principal Time in Charge	Hypothesized Relationship	**(-)**
	β1=β2	No
	β1=β3	No
	β2=β3	Yes
IV2 - Technology Upgrade		**(-)**
	Significant / Relationship	No
	Graph Change / Notes	Abrupt-Temporary
IV3 - Monitoring		**(-)**
	Significant / Relationship	No
	Graph Change / Notes	Abrupt-Temporary
IV4 - Sanctioning		**(+)**
	Significant / Relationship	No

	Graph Change / Notes	Abrupt-Temporary
Additional Variables		
Non-U.S. Military Completions per Week - CV1	Significant / Relationship	No
Non-U.S. Military Started per Week - CV2	Significant / Relationship	No
U.S. Casualties Reported - CV3	Significant / Relationship	No
U.S. Service Members Deployed - CV4	Significant / Relationship	No
(+) or (-)	*Hypothesized Relationship in the study	

Table 4-31. Statistical Tests Matrix for Time in Charge

CHAPTER FIVE

SUMMARY, DISCUSSION, CONCLUSION, AND POLICY IMPLICATIONS

The purpose of this chapter is to provide the final outcomes, implications, and recommendations for the research done in this study. The chapter includes the following topics:

- Summary of the dissertation
- Discussion of the results and implications
- Outcome of the study
- Limitations
- Future Research
- Policy implications

Summary of the Dissertation

Despite clear legislation, many different layers of bureaucracy that are responsible for implementing EHRs have yet to complete the transition to paperless records. As a matter of DoD policy, at a minimum, electronic documentation must begin at the first hospital and then continue throughout the remainder of the evacuation process (Multi-National Corps-Iraq, 2006; Multi-National Corps-Iraq, 2007). The use of EHRs is required by legislation passed by Congress in 1997 that requires the military to ensure that complete health records are maintained for service members (United States Congress, 1997).

The goals of the principals in charge of implementing EHRs may not match those of the medical personnel responsible for direct patient care. Furthermore, EMRs may not meet requirements of clinicians in terms of passing on medical data through the chain of evacuation in real-time. Theory suggests that clinicians are more likely to engage in behaviors that lay principals may not easily comprehend (Sharma, 1997). As such, the gap in electronic documentation may be a result of the varied and multiple actors engaged in the implementation process (O'Toole, 1986) or the operational control of principal over agent (Blom-Hansen, 2005). Compounding these difficulties are the rotation schedules of personnel within these organizations.

Goal conflict is an inherent quality in principal-agent (PA) relationships. The PA relationship focuses on the contractual relationship between at least two parties in a hierarchical system: the first party (the principal) hires another (an agent) who possesses specific and specialized skills (Arrow, 1985; Clark, 1985; Dreher & Jensen, 2007; Olson, 2000). Based on this relationship, an examination of the PA relationships as well as the contracts and obligations between bureaucratic levels within the military health system seems an appropriate tool in order to identify what works and what does not in terms of policy implementation.

Therefore, in order to understand the problems related to EHR implementation more fully, this study applied agency theory to examine compliance with requirements to complete EMR over time. More specifically, this study analyzed drivers of compliance as factors in hospital clinicians' adherence to EMR use in a war zone. This study examined compliance as an outcome of PA relationships with the completed EMR encounter being modeled as the measure of success of between one level of bureaucratic principal with control over the necessary mechanisms in order to ensure the compliance of agents (Sikora & Shaw, 1998).

The study examined two important questions regarding clinician compliance in completing EMRs for deployed service members. The questions were related to the application of the PA theory to examine if policy changed over time. Specifically, this study addressed whether there was a change in policy compliance over time, what factors influenced hospital clinicians' performance, and how significant these drivers' impact was. Drivers of compliance included the introduction of new policies, threats of sanctioning, and technology upgrades that provided greater record visibility and facilitated more timely completion.

This study was designed to examine policy compliance over time as well as to establish what factors influenced clinicians' performance as well as the extent of these factors' impact. We used quantitative data in the form of completed EMRs and utilized a quasi-experimental research design. Specifically, we chose to use an interrupted time series design for this study.

The ultimate dependent variable in this study was compliance with policy in the form of increased output, which was defined as the number of completed EMRs. The complicated nature of the MHS-deployed EMR system did not allow us to evaluate its effectiveness in a single stage. Therefore, research on this system's effectiveness encompassed three separate criteria to examine a single level of analysis (i.e., the completed EMR). These criteria were the number of records started, the number of records completed, and the average number of days to complete a record. As such, the individual record level was a proxy for policy compliance.

The first independent variable for this study was change in the level of information asymmetry between the principal and the agent, which was operationalized as the time that a super-ordinate medical command (MEDCOM) was directly in control over hospitals. The second independent variable was the alignment of both the principal's and the agents' goals in order to reduce goal conflict. This variable was operationalized as a technology upgrade allowing hospital EMR to be used for both implementing the larger EHR as well as for providing real-time clinical notes necessary for the care of patients being evacuated to the next level of medical care. Finally, the final variable, principal control mechanisms, was operationalized as the introduction of increased monitoring policies and sanctions at the hospital level during the transition of hospitals in and out of theater.

The process of data collection for this research consisted of gathering data from TMDS, various press releases, reports from the MC4 program office, memorandum from Iraq, DMDC, and iCasualties.org. The unit of analysis was each completed inpatient EMR for every U.S. service member in support of OIF, which was recorded weekly. The period of study was 105 weeks. During this study, there were 10,013 U.S. service member inpatient records. In addition, there were 2,010 non-U.S. service member records, for a total of 12,023 records.

Discussion of the Results

As previously stated, this research examined changes in policy compliance over time and the impact of factors influencing clinician performance in relation to EMR completion, the number of EMR started, and the average time to complete the records. There were four independent variables in the study: *Principal Time in Charge*, *Technology Upgrade*, *Introduction of the Monitoring Policy*, and *Hospital Transition Periods*. For each of the four main hypotheses, we will discuss the overall findings in addition to the findings for each of the three sub-hypotheses. Within each of these sections, we will also discuss specific results for both the routine (DNBI) as well as the non-routine (BI) record categories.

Principal Time in Charge

The first null hypothesis stated that the length of time a principal supervises agents does not influence the amount of information asymmetry between the two parties. The results of hypothesis 1 were derived from graphing and ANOVA. First, we hypothesized that the longer a MEDCOM supervises a hospital, the more output will be completed by the hospital. We examined this by comparing the slopes of MEDCOM 1 with the slopes of MEDCOMs 2 and 3. We then compared MEDCOM 2 with MEDCOM 3. There were no statistically significant changes in overall record completions based on the length of time a principal was in charge. When we examined the results of routine records completed between MEDCOMs, again there was no statistically significant change. However, there was a statistically significant change in non-routine records completed when examining the slope changes between MEDCOM 1 and 3 as well as between MEDCOMs 2 and 3. These findings do not support the hypothesis that the longer a principal is in charge, the less information asymmetry in the form of more completed records will occur. The significance in non-routine completions over time when compared MEDCOM 3 may be due to the fact that this final MEDCOM was only in charge for a period of twelve weeks, as there was no significant change in slope for the periods when a MEDCOM was in charge for over forty weeks.

Next, we examined the impact of the principal time in charge on the number of records started. We hypothesized that the longer a MEDCOM supervised a hospital, the greater the increase in the number of inpatient EMRs would be started by the hospital. Again, there were no statistically significant changes in overall records started based on the time a principal was in charge. However, we saw a similar trend in records started as we saw in records completed when further examining routine and non-routine records started. These findings do not support the hypothesis that the time a principal is in charge, the less information asymmetry will occur in the form of more records started. Again, the significance in non-routine completions over time when compared MEDCOM 3 may be due to the fact that this final MEDCOM was only in charge for a period of twelve weeks because, again, there was no significant change in slope for the periods when a MEDCOM was in charge for over forty weeks.

Finally, we examined the impact of the principal time in charge on the average time to complete records. We hypothesized that the longer a MEDCOM supervised a hospital, the less time it would take, on average, to complete inpatient EMRs. There was no statistically significant change between the first and second MEDCOMs' time in charge. This result is similar to the first and third MEDCOM. However, there was a statistically significant change in average time to completion between the second and third MEDCOM. These findings do not support the hypothesis that the time a principal is in charge, the less information asymmetry will occur in the form of a decrease in the average time to complete records. The significance in the average time to complete records when compared MEDCOM 3 may again be the result of this final MEDCOM only being in charge for a period of twelve weeks.

In summary, although the time a principal is in charge does not influence the amount of information asymmetry between the principal and agent for the entire model, there is statistical significance when the model is broken down by category. Dependent upon the actual principal in charge and the category (routine or non-routine) of record, there is occasionally a correlation between a principal staying in charge longer and the number of records started and completed and the average time to complete the records.

Technology Upgrade

Next, we examined the influence of technology upgrades on goal conflict. The second null hypothesis stated that the introduction of technology that meets both the principal's and the agents' goals does not affect goal conflict or policy compliance. The results of hypothesis 2 were derived from graphing, ANOVA, and least squares regression. We began with the impact of the technology upgrade as a reducer of conflict vis-a-vis the number of records completed. We hypothesized that the introduction of technology upgrades at a hospital would increase the overall number of medical records it completed. There were statistically significant changes in overall record completions based on the technology upgrade, and the overall average number of records completed increased by about 6.5 after the upgrade. This also held true for the non-routine sub-category as well. Within the non-routine category, the number of records completed increased by approximately 3.5 records. Furthermore, the change in the estimate of the variability decreased by almost half. These findings support the overall hypothesis that the technology upgrade reduced the amount of goal conflict by both increasing the number of records completed as well as reducing the amount of variability among records.

Next, we examined the influence of the technology upgrade on the number of inpatient EMRs started by the hospital. We hypothesized that the technology upgrades at a hospital would increase the number of inpatient EMRs it started. We found that there was an abrupt change in the records started, but this change was temporary and was not statistically significant overall. Broken down by category, the change in the number of routine and non-routine records started was also not significant. These findings do not support the sub-hypothesis that technology upgrades increase the number of records started.

Finally, we examined the influence of the technology upgrade on the average time to complete records. We hypothesized that the introduction of technology upgrades at a hospital would decrease the time it would take, on average, for clinicians to complete inpatient EMRs. We found that there was no statistically significant change in the average time to complete records after the technology upgrade. However, upon examination of the graph, there is an abrupt, yet temporary, increase in the average number of days to complete records followed by an even more abrupt drop in the average days to complete records. This finding may be explained by the initial completion of records left open longer that initially increased the average time to complete. The drop in the average time to complete records would follow as more records are completed in a lower average amount of time.

In summary, although the technology upgrade only significantly impacted the number of records completed (positively), the graphs show a significant decrease in the estimated variability occurring in the overall and non-routine number of records completed. Therefore, we can reject the overall null hypothesis that technology upgrades do not affect goal conflict because there is a substantive change in completions between the pre- and post-interventions as well as decreased variability. However, we must reject the two related sub-hypotheses that examined the relationship between upgrades and the number of records started and average time to completion.

Monitoring

Next, we examined the influence of monitoring on policy compliance. The third hypothesis stated that there was no relationship between a principal's increased monitoring and agents' policy compliance. The results of hypothesis three were derived from graphing, ANOVA, and least squares regression. We began with the impact of increased monitoring on the total number of records completed. We hypothesized that increased monitoring by MEDCOM through mandatory reporting by a hospital would increase the output of records by the hospital. There was a statistically significant positive relationship between increased monitoring and records completed in the overall model. Overall, the increase in records was abrupt and temporary but in such a manner as to increase the average number of completions by about 6.5 records after the policy introduction. The non-routine category of increased records averaged about 6.8 additional records after the policy introduction. However, the routine category of increased records after monitoring was not statistically significant. These results support the sub-hypothesis that there was an increase in records completed after increased monitoring was implemented.

Next, we examined the influence of monitoring policy on the number of inpatient EMRs started by the hospitals. We hypothesized that increased monitoring by MEDCOM through mandatory reporting by a hospital would decrease the number of inpatient EMRs started by the hospital. There was an abrupt and temporary change in the number of records started after the intervention, and there was a statistically significant change in records started by an average of approximately four records. There also was a change in over five non-routine records started after monitoring began, but there was no statistically significant change in the routine category. These findings do not support the hypothesis that monitoring will decrease the number of records started, as there was actually an increase in records started.

Finally, we examined the influence of increased monitoring on the average time to complete records. We hypothesized that increased monitoring by MEDCOM through mandatory reporting by a hospital would decrease the time it would take, on average, for clinicians to complete inpatient EMRs. Again, there was an abrupt, yet temporary, increased change in records completed. However, the change was not statistically significant. These findings do not support the hypothesis than monitoring will decrease the average time to complete records. However, the largest average time to completion spike occurred immediately after the introduction of the monitoring policy. This would account for the abrupt and temporary success of the policy. In other words, if an increased number of older records were closed when the policy took effect, then the policy did have the desired effect, at least initially.

In summary, there was a positive and significant increase in records completed, both overall and for non-routine inpatient records, after the introduction of the policy monitoring. This finding follows the hypothesized relationship put forth in this study. There was an abrupt, yet temporary, spike in records started after the intervention. However, there was a statistically significant increase in the number of records started after monitoring was initiated, which is counter to the hypothesis. Finally, the monitoring intervention did not significantly influence the average time for records to be completed, although there was a temporary jump in average time to completion immediately following the introduction of the policy. Therefore, we can reject the overall null hypothesis that increased monitoring does not influence adverse selection because there is a substantive change between the pre- and post-monitoring interventions for both completions and records started.

Sanctioning

Next, we examined the influence of sanctions and policy compliance. The fourth null hypothesis stated that there was no relationship between sanctions levied by a principal and agents' policy compliance. The results of hypothesis four were derived from graphing, ANOVA, and least squares regression. We began with the impact of sanctions on the total number of records completed. We hypothesized that sanctions levied by MEDCOM specifying that a hospital with open encounters would not be allowed to depart theater would increase the number of completed inpatient encounters near hospital transition times. We found that there was an abrupt change in records completed during the transition times. The number of records completed increased by over twenty records during the transition periods. There was also a positive increase in completion for the routine category by approximately fifteen records. Furthermore, the positive increase in non-routine completions increased by almost five records during transition periods. These results support the sub-hypothesis that sanctioning increases completions.

Next, we examined the influence of sanctions on the total number of records started. We hypothesized that sanctions levied by MEDCOM specifying that a hospital with open encounters would not be allowed to depart theater would decrease the number of inpatient EMRs started by a hospital near the end of its deployment. We found that there was not a statistically significant increase in records started during the transition period. Furthermore, there was no statistically significant relationship between routine or non-routine records started and increased sanctioning. These findings do not support the hypothesis that sanctioning decreases the number of records started.

Finally, we examined the influence of sanctioning on the average time to complete records. We hypothesized that sanctions levied by a MEDCOM specifying that a hospital with open encounters would not be allowed to depart theater would increase the average time to complete records near the transition. Although there was an abrupt change in time to completion during transition periods, these were temporary and were not statistically significant. However, there were two distinct periods of transition, the second of which occurred soon after the introduction of the monitoring policy. During the first, there was quite a large spike in the average time to completion. The second spike, however, was not nearly as large, therefore causing the lack of statistical significance. This possible interaction between monitoring and the second sanction period may be the reason for the lack of statistical significance.

In summary, there was a positive and significant increase in records completed for overall, routine, and non-routine inpatient records during the hospital transition periods. These findings follow the hypothesized relationship put forth in this study. There was no significant relationship between hospital transition periods and records started. Therefore, we can reject the overall null hypothesis that there is no relationship between sanctions levied by a principal and agent policy compliance. Furthermore, the lack of influence of records started during transition periods yields even greater strength to the relationship between completions and threat of sanction. There was not any significant change in the number of records started, yet the completions were greater during transition periods than at any other time during the study. Finally, although the hospital transitions' intervening influence on average time to completion was not statistically significant, there may still be a relationship between these two variables that is masked by the monitoring policy. Next, we discuss the influence of additional variables on the number of records completed, records started, and the average time to complete records.

Additional Variables

Within this study, we utilized four additional variables that may have had an influence on agents' compliance: *Non-U.S. Military Record Completions per Week*, *Non-U.S. Military Record Starts per Week, U.S. Casualties Reported,* and *U.S. Service Members Deployed*. This section examines these variables' influences on the study.

The variable for non-U.S. military record completions per week was only significant when examining overall U.S. military completions and routine completions. For both types of completions, the relationship was positive. As the number of U.S. completions rose, so did the number of non-U.S. completions. The most likely explanation for this finding would be the introduction of sanctions, which was also significant for both overall and routine U.S. military completions. Sanctioning for unfinished records was not dependent on the association of the patient.

The next variable, non-U.S. military records started per week, was only significant when examining overall U.S. military completions and routine completions. For both types of completions, the relationship was negative. As the number of non-U.S. records starts rose, the number of U.S. completions went down. The most likely explanation for this finding is related to the competition for scarce resources within hospitals. More specifically, as more non-U.S. patients enter a hospital, clinicians are less likely to complete EMR due to increased workload.

The next variable, U.S. casualties reported, was only significant when examining overall U.S. military routine completions. This was the only additional variable showing a statistically significant relationship with non-routine (BI) inpatient records. The relationship between these two variables makes sense, as the variable was introduced to provide a validation that battle injury starts coincided with combat action on the ground. The lack of significance between all U.S. military completions and average time to complete can be accounted for in the variability in completions and time to complete within the study. If there was a direct significant relationship between U.S. military casualties reported outside of the record and the number of completions and average time to complete, there would not be a need for this study examining policy interventions. We would simply examine U.S. military casualty numbers in order to understand and predict variations in the number of records started, completed, and time to complete.

The final additional variable is the number of U.S. service members deployed. This variable was only significant when examining overall U.S. military completions and routine completions. For both types of completions, the relationship was positive. As the number of U.S. service members rose, so did the number of overall and routine U.S. record completions. It is interesting to note that the increase deployed soldiers had no statistically significant impact on the number of records started or average time to complete the records.

Outcome of the Study

Overall, this research meets the objectives outlined in Chapter 1 (Introduction). The study examined two important questions regarding clinician compliance with completing EMRs for deployed service members. First, this study addressed if there was a change in policy compliance over time. By conducting an analysis of policy interventions, we established changes in policy compliance. Compliance was defined as the fluctuation in inpatient records started, records completed, and changes in the average time to complete records. Secondly, this study examined what factors influenced the performance of hospital clinicians and how significant these drivers' impact was on record completion. The analysis consisted of graphing the changes over time and examining changes that were most likely due to policy interventions. We further analyzed the changes over time utilizing ANOVA and least squares regression.

The results supported many of the hypotheses. Technology upgrades not only led to greater completion rates but also reduced the amount of variation in records completed week to week. The introduction of the monitoring policy also increased both record completions and records started (although the increase in starts was hypothesized incorrectly). Furthermore, the abrupt and temporary spike in average time to completion after introducing the monitoring policy was great enough to impact what would have been a statistically significant average time to completion change during hospital transition times. This could be explained as a correction of agent moral hazard. Any incomplete opened records remaining during the rotation would have to be completed in order for the hospitals to re-deploy. Finally, sanctioning showed the greatest impact on completing records.

Overall, the first model examining the number of inpatient U.S. service member record completions seemed to be a good fit. The number of record completions served as a proxy for policy compliance, and the overall percent of variance described by the model was over 45%. All hypothesized variables except principal time in charge had a statistically significant influence on agent compliance.

The second model examining the number of inpatient records started over time was also a good fit but not quite as good as the first model. Inpatient records started served as a proxy for adverse selection. The overall percent of variance described by the model was approximately 25%. This stands to reason, as there should be less explained in the formal model by records started than by records completed. Records started may are more likely influenced by forces outside of the hospital (such as the presence of roadside bombs) than by clinician input. Furthermore, the number of records started was only statistically significant in the routine category; the non-routine category of records started was not influenced by policy interventions.

The third model was the least well suited in this study. The dependent variable, average time in charge, served as a proxy for moral hazard and did not seem to be explained well by the interventions. The overall percent of variance described by the model was only 14%. There are a number of reasons for this. First, the interaction of monitoring seemed to influence the second sanctioning period. In addition, records not started in OIF may have influenced the average time to completion and, therefore, were not closed until much later in hospitals back in the United States. Certain inpatient records were coded as beginning in OIF but were actually started in hospitals back in the United States as part of the patient's long-term recovery. Those specifically coded as originating in a U.S. hospital were removed. In the end, coding by locations was not standardized, thus creating greater variance.

Limitations

The quantitative analysis in this research focused on examining policy compliance over time and establishing what variables influenced hospital clinicians' performance and how much impact those variables had. However, this type of design did not allow the researcher to have control over the variables. Nevertheless, the strengths of this type of study were rooted in the fact that it is exploratory and descriptive. In an effort to establish interactions between variables, this type of study offered information rich in detail and provided a direction for future research. In fact, four additional variables were established in order to increase how well future outcomes were likely to be predicted by this model. This research generated knowledge, clarified issues, and uncovered determinants associated with policy compliance.

Future Research

Future studies should be conducted in order to evaluate the nature of compliance further. Such studies should analyze the relationship between the introduction of a high-level completeness standard for individual patient encounters and the compliance by clinicians in deployed inpatient medical facilities. We hypothesize that under these policy conditions, compliance would be incomplete. Furthermore, a sample of the actual product of interest, the EMR, could be examined for significant variation in completeness during certain phases of a hospital's deployment. Specifically, an examination of EMR should occur at different points before, during, and immediately following hospital transition periods. We predict increased levels of physician shirking just prior to a hospital's redeployment. The monitoring policy does not include a check for completeness of record, so by implementing this type of monitoring and sanction system, would we observe an increase in the quantity but reduction in the completeness of the EMR? Would this sanction actually provide an inferior product?

Additional studies should be conducted to ascertain why clinicians either comply or do not comply with policy. A study may follow the principal-professional relationship (variant of PA theory) further to analyze the relationship between policy and the professionals responsible for implementation as part of total patient care. Does the monitoring system put in place influence clinicians' decisions to comply or not? The research design for this type of study should be qualitative. Data could be collected through focus groups of physicians deployed after the policy came into effect. Interviews would involve unstructured and generally open-ended questions that are few in number yet designed to elicit views and opinions from the participants.

In addition to the two studies listed above, additions to the current study's methodology also have a place in future research. First, the study may be extended to include additional principals. In this study, we only examined approximately two and one-quarter MEDCOM rotations. In addition, future studies could be conducted focusing only on the inpatient records of a single location over numerous personnel rotations. Finally, replication of this research in Operation Enduring Freedom in Afghanistan would provide an opportunity to test all hypotheses over a longer period.

Policy Implications

The purpose of this section is to provide additional pertinent policy implications associated with the findings of this study. First, we discuss goal congruity in planning considerations. Next, we examine *ex post* control mechanism use in future MHS implementations. Finally, we consider future deployed hospital staffing.

Goal Congruity in Planning Considerations

The technology upgrade introduced in the study had a positive influence on completions as well as on reduced variability in numbers of records completed per week. Although this upgrade assisted in what we termed goal conflict, there may be broader policy considerations for dealing with goals that are at odds. We begin with the goals themselves. The first goal is the creation of a lifelong longitudinal EHR, which was mandated by Congress in 1997. Another goal is the immediate care of the patient through accurate recording of assessments and treatments that help throughout the chain of evacuation, which is concerned with the immediate standard of patient care: saving the life.

Because the pre-upgraded EMR could not provide pertinent information on time, clinicians adopted workaround systems such as JPTA, which were not designed to be

EMRs, but provided real-time patient information. Although not designed as such, the system was utilized to capture the EMR in theater and feed the larger EHR; however, this system simply could not provide the necessary information to all of the parties who needed it during the evacuation process. Initially, the inpatient records were not available for viewing outside the facility until well after the normal period for U.S. military evacuation. After the upgrade, the records were available as soon as they were signed, which was normally part of the discharge process. Even after the upgrade, the process remained too slow (as seen in the average time to complete each record after the technology upgrade) to replace JPTA and paper records.

It should be clarified that the system was still being developed as implementation occurred. The entire deployed EMR was in development by MC4 when system deployment began in 2003. Changes such as the software upgrade fundamentally changed business processes as well. As the theater has matured, lessons have been learned about requirements for clinicians. These lessons need to be continually incorporated into updated mandatory processes for hospitals. Simply stating that a lifelong EHR has been mandated by Congress is not enough impetus to drive decisions to adopt technology at the lowest level, especially when the mandate does not match the needs of those providing care on the ground and saving lives.

***Ex Post* Control Mechanism Use**

One of the facets of the study was the use and impact of monitoring and sanctions on compliance. As stated previously, specifically within EHR adoption outside the MHS, one can offer economic incentives for implementation. Implementation leaders may also only hire those with a desire to participate in the utilization of EHR as part of their requirements for positions within the company. Although the military does offer limited bonuses for certain medical specialties, no incentives are offered for the use of EHR. We are not advocating changing the hiring practices of military clinicians or providing compensation rates based upon clinician compliance to utilize EHR; however, we are advocating the parsimonious use of monitoring and sanctions, specifically within this type of environment. *Ex post* control mechanisms have been shown to be effective in garnering additional policy compliance. However, we must re-iterate the necessity for parsimony and ensuring the measurement of proper output. First, policy makers should only use parsimony in sanctioning items that are most important. Completion is probably worth sanctioning as it affects records that make it to TMDS and because too many open records slow down inpatient record servers and make day-to-day operations more difficult. Secondly, ensuring proper output in measuring makes it possible to evaluate the specific issues as hand. In other words, policy makers must require and monitor only those data items most important for evacuation as well as long-term information for the VA. For example, in this study, we examined the number of records completed. Perhaps more than merely ensuring that records are completed, we should ensure that records have the most pertinent data.

Considerations for Future Hospital Staffing

One finding in this study that was not hypothesized came from an examination of additional variables. It was found that the increase in non-U.S. military records started had a negative influence on the number of U.S. service member records completed.

Currently, the number of deployed hospitals in theater is based upon the number of service members deployed as well as the number of anticipated casualties based on operational tempo. However, the number of civilians being trained to replace police and military personnel in these situations (as part of the rebuilding process) are not a part of the equation and neither are the increased numbers of civilians and contractors that may require inpatient medical care.

First, although there have always been civilians on the battlefield, it was not until recently that the numbers of contractors either rivaled or surpassed the number of U.S. service members deployed. This number of contractors, without providing their own inpatient capabilities, adds stress to the deployed military healthcare systems. Secondly, non-U.S. military personnel may not be evacuated as quickly (in the case of contractors) or at all (in the case of local police and military personnel). If inpatient stays are longer for these categories of patients, this would influence the workload of hospital staff.

APPENDICES

Appendix A

Acronym List

ANOVA .... Analysis of Variance

BI...Battle Injury

CDR .... Central Data Repository

CHCS .... Composite Health Care System

CSH... Combat Support Hospital

DD Form .... Department of Defense Form

DHIMS.. Defense Health Information Management System

DMDC.. Defense Manpower Data Center

DNBI.. Disease and Non-Battle Injury

DoD...Department of Defense

DV...Dependent Variable

EHR... Electronic Health Record

EMR..Electronic Medical Record

FM... Field Manual

GWI.. Gulf War Illness

HIPAA .... Health Insurance Portability and Accountability Act

HQDA .... Headquarters Department of the Army

ICD.. International Classification of Diseases

IOM .... Institute of Medicine

IS .... Information System

IV .... Independent Variable

JPTA .... Joint Patient Tracking Application

MC4 .... Medical Communications for Combat Casualty Care

MEDCOM .... Medical Command

MEDEVAC .... Medical Evacuation

MEDSITREP .... Medical Situation Report

MHS .... Military Health System

MIS .... Management Information Systems

MNC-I .... Multi-National Corps – Iraq

OEF .... Operation Enduring Freedom

OIF .... Operation Iraqi Freedom

PA .... Principal-Agent

PHI .... Protected Health Information

PHR .... Personal Health Record

TC2 .... Composite Health Care System (CHCS) Cache

TMDS .... Theater Medical Data Store

TMIP .... Theater Medical Information Program

TOA .... Transfer of Authority

USAF .... United States Air Force

USCENTCOM .... United States Central Command

USN..United States Navy

VA...Veteran’s Affairs

VIF .... Variance Inflation Factor

References

30th Medical Brigade. (2006). *Operation iraqi freedom 05-07 after action review* (No. 05-07). Retrieved from Army Knowledge Online

Agranoff, & McGuire. (2001). Big questions in public network management research. *Journal of Public Administration Research and Theory, 11 (3): 295*

Alavi, M., & Joachimsthaler, E. A. (1992). Revisiting DSS implementation research: A meta-analysis of the literature and suggestions for researchers. *MIS Quarterly, 16*(1), 95-116. Retrieved from http://www.jstor.org/stable/249703

Alchian, A. A., & Demsetz, H. (1972). Production, information costs, and economic organization. *The American Economic Review, 62*(5), 777-795. Retrieved from http://www.jstor.org/stable/1815199

Alford, R. R. (1975). *Health care politics.* Chicago, IL: University of Chicago Press.

Anderson, G. F., Frogner, B. K., Johns, R. A., & Reinhardt, U. E. (2006). Health care spending and use of information technology in OECD countries. *Health Affairs, 25*(3), 819-831.

Angelstam, P., Mikusiński, G., Rönnbäck, B., Östman, A., Lazdinis, M., Roberge, J., et al. (2003). Two-dimensional gap analysis: A tool for efficient conservation planning and biodiversity policy implementation. *Ambio, 32*(8, Remote Sensing for the Environment), 527-534. Retrieved from http://www.jstor.org/stable/4315436

Angst, C. M., & Agarwal, R. (2009). Adoption of electronic health records in the presence of privacy concerns: The elaboration likelihood model and individual persuasion. *MIS Quarterly, 33*(2), 339-370. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=38224406&site=ehost-live

Arrow, K. J. (1985). The economics of agency. In J. W. Pratt, & R. J. Zeckhauser (Eds.), *Principals and agents: The structure of business* (pp. 37-51). Boston, Mass.: Harvard Business School Press.

ASD-HA. (1999). In Assistant Secretary of Defense for Health Affairs (Ed.), *DoD 6015.1-M*. Falls Church, VA: Office of the Assistant Secretary of Defense (Health Affairs).

Bache, I. (1999). The extended gatekeeper: Central government and the implementation of EC regional policy in the UK. *Journal of European Public Policy, 6*(1), 28-45. doi:10.1080/135017699343784

Banfield, E. C. (1975). Corruption as a feature of governmental organization. *Journal of Law and Economics, 18*(3, Economic Analysis of Political Behavior: Universities-National Bureau Conference Series Number 29), 587-605. Retrieved from http://www.jstor.org/stable/725047

Bardach, E. (1978). *Implementation game.* Cambridge, MA: MIT Press.

Barrett, S. M. (2004). Implementation studies: Time for a revival? personal reflections on 20 years of implementation studies. *PUBLIC ADMINISTRATION, 82*(2), 249-262.

Barrett, S., & Fudge, C. (1981). *Policy and action : Essays on the implementation of public policy*. London ; New York: Methuen.

Basu, S. (2007, Army equips air force with digital medical recorders in iraq., 9. Retrieved from http://www.usmedicine.com/article.cfm?articleID=1679&issueID=106

Bates, D. W., & Gawande, A. A. (2003). Improving safety with information technology. *The New England Journal of Medicine, 348*(25), 2526-2534. doi:10.1056/NEJMsa020847

Bates, D. W., Leape, L. L., Cullen, D. J., Laird, N., Petersen, L. A., Teich, J. M., et al. (1998). Effect of computerized physician order entry and a team intervention on prevention of serious medication errors. *JAMA: The Journal of the American Medical Association, 280*(15), 1311-1316. doi:10.1001/jama.280.15.1311

Beam, T. E. (Ed.). (2003). *Military medical ethics volume 2, section 4: Medical ethics in the military* (http://www.bordeninstitute.army.mil/published _volumes/ethics Vol2/Ethics-ch-13.pdf)

Bernard, H. R. (2000). *Social research methods : Qualitative and quantitative approaches*. Thousand Oaks, Calif.: Sage Publications.

Bilmes, L. J. (2008). *Iraq's 100-year mortgage: The price tag for caring for the americans who fight this war could exceed what it costs to wage it.(ARGUMENT)(war casualties and wounded military personnels)* Retrieved from http://find.galegroup.com/itx/infomark.do?&contentSet=IAC-Documents&type=retrieve&tabID=T002&prodId=EAIM&docId=A176479613&source=gale&srcprod=EAIM&userGroupName=clemson_itweb&version=1.0

Blom-Hansen, J. (2005). Principals, agents, and the implementation of EU cohesion policy. *Journal of European Public Policy, 12*(4), 624. doi:10.1080/13501760500160136

Boone, J., Sadrieh, A., & van Ours, J. C. (2009). Experiments on unemployment benefit sanctions and job search behavior. *European Economic Review, 53*(8), 937-951. doi:10.1016/j.euroecorev.2009.04.005

Box, R. C. (1999). Running government like a business: Implications for public administration theory and practice. *The American Review of Public Administration, 29*(1), 19-43. doi:10.1177/02750749922064256

Campbell, D. T., Stanley, J. C., & Gage, N. L. (1963). *Experimental and quasi-experimental designs for research*. Chicago: Rand McNally.

Churchman, C. W. (1979). *The systems approach and its enemies* New York : Basic Books, c1979.

Clark, R. C. (1985). The economics of agency. In J. W. Pratt, & R. J. Zeckhauser (Eds.), *Principals and agents: The structure of business* (pp. 55-79). Boston, Mass.: Harvard Business School Press.

Clayson, E. (2007). *The gateway: TC2 fielding update.* Retrieved April 08, 2010, from https://www.mc4.army.mil/mc4newsletter/2007_7/pmcorner.asp

Cooper, R. B., & Zmud, R. W. (1990). Information technology implementation research: A technological diffusion approach. *Management Science, 36*(2), 123-139. Retrieved from http://www.jstor.org/stable/2661451

DASD FHP&R. (2008). *GulfLINK home.* Retrieved 3/6/2008, 2008, from http://www.gulflink.osd.mil/library/info_paper.jsp de Mul, M., & Berg, M. (2007). Completeness of medical records in emergency trauma care and an IT-based strategy for improvement. *Medical Informatics & the Internet in Medicine, 32*(2), 157-167.

Deployment Link. (2008). *About deployment technologies & support programs.* Retrieved 3/6/2008, 2008, from http://deploymentlink.osd.mil/about.jsp?topic=2

Deputy Secretary of Defense. (1997). *DoD directive 6490.2: Joint medical surveillance*.

Dick, R. S., & Stein, E. B. (1991). *The computer-based patient Record—An essential technology for health care*. Washington DC: National Academy Press.

DiIulio, J. D.,Jr., & DiIulio, J. J.,Jr. (1994). Principled agents: The cultural bases of behavior in a federal government bureaucracy. *Journal of Public Administration Research and Theory: J-PART, 4*(3), 277-318. Retrieved from http://www.jstor.org/stable/1181886

Doolan, D. F., & Bates, D. W. (2002). Computerized physician order entry systems in hospitals: Mandates and incentives. *Health Aff, 21*(4), 180-188. doi:10.1377/hlthaff.21.4.180

Dreher, A., & Jensen, N. M. (2007). Independent actor or agent? an empirical analysis of the impact of U.S. interests on international monetary fund conditions. *The Journal of Law and Economics, 50*(1), 105-124. Retrieved from http://www.journals.uchicago.edu/doi/abs/10.1086/508311

Dye, R. A. (1986). Optimal monitoring policies in agencies. *The Rand Journal of Economics, 17*(3), 339-350. Retrieved from http://www.jstor.org/stable/2555715

Eisenhardt, K. M. (1989). Agency theory: An assessment and review. *The Academy of Management Review, 14*(1), 57-74. Retrieved from http://www.jstor.org/stable/258191

Elmore, R. F. (1982). Backward mapping: Implementation research and policy decisions. In W. Williams (Ed.), *Studying implementation: Methodological and administrative issues* (pp. 18-19-35, 261). Chatham, NJ: Chatham House.

Feldman, M. S., & Khademian, A. M. (2002). To manage is to govern. *Public Administration Review, 62*(5), 541-554. Retrieved from http://www.jstor.org/stable/3110015

Fesler, J. W., & Kettl, D. F. (2009). *The politics of the administrative process* (Fourth Edition ed.). Washington D.C.: Congressional Quarterly Press.

FM 8-10-6. (1991). Retrieved 5/1/2008, 2008, from http://www.enlisted.info/field-manuals/fm-8-10-6-medical-evacuation-in-a-theater-of-operations.shtml

GAO-08-1158T. (2008). *GAO-08-1158T, information technology: DOD and VA have increased their sharing of health information, but further actions are needed.* Retrieved 12/7/2008, 2008, from http://www.gao.gov/htext/d081158t.html

Garet, D., & Davis, M. (2006). Electronic medical records vs. electronic health records: Yes, there is a difference. *A HIMSS AnalyticsTM White Paper,*

Garson, G. D. (2008). *"Time series analysis", from statnotes: Topics in multivariate analysis.* Retrieved 3/6/2010, 2010, from http://faculty.chass.ncsu.edu/garson/pa765/statnote.htm

Gawande, A. (2004). Casualties of war -- military care for the wounded from iraq and afghanistan. *The New England Journal of Medicine, 351*(24), 2471-2475. doi:10.1056/NEJMp048317

Glass, G. V. (1997). Interrupted time series quasi-experiments. In R. M. Jaeger, & L. S. Shulman (Eds.), *Complementary methods for research in education* (2nd ed., pp. 589-608). Washington, DC: American Educational Research Association.

Gortner, H. F., Ball, C. M., & Nichols, K. G. (2006). *Organization theory: A public and non-profit perspective* Wadsworth Publishing.

Gujarati, D. N. (2003). *Basic econometrics* (4th ed.). Boston: McGraw Hill.

Haley, R. W., Kurt, T. L., & Hom, J. (1997). Is there a gulf war syndrome? searching for syndromes by factor analysis of symptoms. *JAMA : The Journal of the American Medical Association, 277*(3), 215-222.

Hargrove, E. C. (1975). *The missing link: The study of the implementation of social policy (an urban institute paper ; 797-1)* Urban Inst Pr.

Häyrinen, K., Saranto, K., & Nykänen, P. (2008). Definition, structure, content, use and impacts of electronic health records: A review of the research literature. *International Journal of Medical Informatics, 77*(5), 291-304. doi:DOI: 10.1016/j.ijmedinf.2007.09.001

Hillestad, R., Bigelow, J., Bower, A., Girosi, F., Meili, R., Scoville, R., et al. (2005). Can electronic medical record systems transform health care? potential health benefits, savings, and costs. *Health Affairs, 24*(5), 1103-1117.

Hjern, B. (1982). Review: Implementation research: The link gone missing. *Journal of Public Policy, 2*(3), 301-308. Retrieved from http://www.jstor.org/stable/3998186

Ismail, K., Everitt, B., Blatchley, N., Hull, L., Unwin, C., David, A., et al. (1999). Is there a gulf war syndrome? *Lancet, 353*(9148), 179-182.

J-7, J. S. (2009). *JP 1-02, DOD dictionary of military and associated terms.* Retrieved 03/16, 2010, from http://www.dtic.mil/doctrine/dod_dictionary/

Jaeger, R. M. (1990). *Statistics : A spectator sport* (2nd ed.). Newbury Park, Calif.: Sage Publications.

Jaeger, R. M., Shulman, L. S., & American Educational Research Association. (1988). *Complementary methods for research in education*. Washington, DC: American Educational Research Association.

Kawalek, J. (2007). *Rethinking information systems: Organizational processes and how to change them* (1st ed.) Routledge.

Kiser, E. (1999). Comparing varieties of agency theory in economics, political science, and sociology: An illustration from state policy implementation. *Sociological Theory, 17*(2), 146-170. Retrieved from http://www.jstor.org/stable/202095

Kral, D. (2009). *The timing of medical brigade's implementation of sanctions against hospitals*. [Personal Communication]

Kyhlbäck, H., & Sutter, B. (2007). What does it take to replace an old functioning information system with a new one?: A case study. *International Journal of Medical Informatics, 76*(Supplement 1), S149-S158. doi:DOI: 10.1016/j.ijmedinf.2006.05.047

Laine, C., & Davidoff, F. (1996). Patient-centered medicine. A professional evolution. *JAMA the Journal of the American Medical Association, 275*(2), 152. doi:10.1001/jama.275.2.152

Lapointe, L., & Rivard, S. (2006). Getting physicians to accept new information technology: Insights from case studies. *Canadian Medical Association Journal, 174*(11), 1573-1578. doi:10.1503/cmaj.050281

Lasswell, H. D. (1956). *The decision process: Seven categories of functional analysis*. College Park, MD: University of Maryland.

Leege, D. C., & Francis, W. L. (1974). *Political research: Design, measurement, and analysis*. New York: Basic Books.

Lipsky, M. (1980). *Street-level bureaucracy : Dilemmas of the individual in public services*. New York: Russell Sage Foundation.

Mantzavinos, C. (2004). *Individuals, institutions, and markets (political economy of institutions and decisions)* Cambridge University Press.

Mazmanian, D. A., & Sabatier, P. A. (1981). *Effective policy implementation* Lexington, Mass. : Lexington Books, c1981.

McCubbins, M. D., & Schwartz, T. (1984). Congressional oversight overlooked: Police patrols versus fire alarms. *American Journal of Political Science, 28*(1), 165-179. Retrieved from http://www.jstor.org/stable/2110792

McDowall, D. (1980). *Interrupted time series analysis*. Beverly Hills: Sage.

McLaughlin, M. (2005). Listening and learning from the field: Tales of policy implementation and situated practice. *The roots of educational change* (pp. 58) Springer Netherlands.

Medline. (2008). *MedlinePlus: Veterans and military health.* Retrieved 3/6/2008, 2008, from http://www.nlm.nih.gov/medlineplus/veteransandmilitaryhealth.html

Merriam-Webster, I. (2007). *Merriam-webster's dictionary and thesaurus*. Springfield, Mass.: Merriam-Webster.

Michaud, E., McClendon, M., & Salzman, K. (2006). The tactical electronic medical record: The key to medical transformation. *The United States Army Medical Department Journal, October - December 2006*, 56-64.

Mitnick, B. M. (1975). The theory of agency: The policing "paradox" and regulatory behavior. *Public Choice, 24*, 27-42. Retrieved from http://www.jstor.org/stable/30022842

Moody, R., Aaronson, J., Buising, C., & Barton, D. (2006). *Army Medical Department Journal,* , 46-50.

Multi-National Corps-Iraq. (2006). *Standard operating procedure (SOP) for medical communication for combat casualty care (MC4) outpatient applications.* MNC-I: 3rd Medical Command.

Multi-National Corps-Iraq. (2007). *Tab D to appendix 15 health information systems annex Q to MNC-I OPORD 08-01*. MNC-I: 3rd Medical Command.

Neter, J., Wasserman, W., & Kutner, M. H. (1990). *Applied linear statistical models : Regression, analysis of variance, and experimental designs* (4th ed.). Homewood, IL: Irwin.

North, D. C. (1990). *Institutions, institutional change and economic performance (political economy of institutions and decisions)* Cambridge University Press.

Olson, D. E. (2000). Agency theory in the not-for-profit sector: Its role at independent colleges. *Nonprofit and Voluntary Sector Quarterly, 29*(2), 280-296. doi:10.1177/0899764000292004

Osborne, D., & Gaebler, T. (1992). *Reinventing government : How the entrepreneurial spirit is transforming the public sector*. Reading, Mass.: Addison-Wesley Pub. Co.

O'Toole, L. J.,Jr. (1986). Policy recommendations for multi-actor implementation: An assessment of the field. *Journal of Public Policy, 6*(2), 181-210. Retrieved from http://www.jstor.org/stable/3998344

Petersen, T. (1993). Recent developments in: The economics of organization: The principal-agent relationship. *Acta Sociologica, 36*(3, Rational Choice Theory), 277-293. Retrieved from http://www.jstor.org/stable/4200860

Pressman, J. L., & Wildavsky, A. B. (1984). *Implementation: How great expectations in washington are dashed in oakland : Or, why it's amazing that federal programs work at all, this being a saga of the economic development administration as told by two sympathetic observers who seek to build morals on a foundation of* (3rd ed.). Berkeley, Calif: University of California.

Reid, M. H. (1972). Fishing through patient records. *Medical Care, 10*(6), 488-496. Retrieved from http://www.jstor.org/stable/3762958

Ross, S. A. (1973). The economic theory of agency: The principal's problem. *The American Economic Review, 63*(2, Papers and Proceedings of the Eighty-fifth Annual Meeting of the American Economic Association), 134-139. Retrieved from http://www.jstor.org/stable/1817064

Russell, G. (2008,). Medical communications for combat casualty care (MC4) - blog.

Sabatier, P. A., & Jenkins-Smith, H. C. (1993). *Policy change and learning: An advocacy coalition approach (theoretical lenses on public policy)* Westview Press.

Sabatier, P. A. (1986). Top-down and bottom-up approaches to implementation research: A critical analysis and suggested synthesis. *Journal of Public Policy, 6*(1), 21-48. Retrieved from http://www.jstor.org/stable/3998354

Sabatier, P. A. (2007). *Theories of policy process*. Boulder, Colo: Westview Press.

Saetren, H. (2005). Facts and myths about research on public policy implementation: Out-of-fashion, allegedly dead, but still very much alive and relevant. *POLICY STUDIES JOURNAL, 33*(4), 559-582.

Sall, J., Lehman, A., & Creighton, L. (2001). *JMP start statistics : A guide to statistics and data analysis using JMP and JMP IN software* (2nd ed.). Pacific Grove, CA: Duxbury.

Sequist, T. D., Ayanian, J. Z., & Cullen, T. (2005). Information technology as a tool to improve the quality of american indian health care. *American Journal of Public Health, 95*(12), 2173-2179.

Sharma, A. (1997). Professional as agent: Knowledge asymmetry in agency exchange. *The Academy of Management Review, 22*(3), 758-798. Retrieved from http://www.jstor.org/stable/259412

Sikora, R., & Shaw, M. J. (1998). A multi-agent framework for the coordination and integration of information systems. *Management Science, 44*(11, Part 2 of 2), S65-S78. Retrieved from http://www.jstor.org/stable/779712

Simon, H. A. (1996). *The sciences of the artificial* Cambridge, Mass. : MIT Press, c1996.

Smith, L. (2008). The deployed electronic medical record. *The United States Army Medical Department Journal,* (October-December 2008), 63-67.

Staroselsky, M., Volk, L. A., Tsurikova, R., Pizziferri, L., Lippincott, M., Wald, J., et al. (2006). Improving electronic health record (EHR) accuracy and increasing compliance with health maintenance clinical guidelines through patient access and input. *International Journal of Medical Informatics, 75*(10-11), 693-700. doi:DOI: 10.1016/j.ijmedinf.2005.10.004

Stone, A. (1977). *Economic regulation and the public interest: The federal trade commission in theory and practice* Cornell Univ

Tange, H. J., Hasman, A., de Vries Robbé, P. F., & Schouten, H. C. (1997). Medical narratives in electronic medical records. *International Journal of Medical Informatics, 46*(1), 7-29. doi:DOI: 10.1016/S1386-5056(97)00048-8

Taylor, R., Bower, A., Girosi, F., Bigelow, J., Fonkych, K., & Hillestad, R. (2005). Promoting health information technology: Is there A case for more-aggressive government action? *Health Affairs, 24*(5), 1234-1245.

Tzelepi, S., Pangalos, G., & Nikolacopoulou, G. (2002). Security of medical multimedia. *Medical Informatics & the Internet in Medicine, 27*(3), 169-184.

US CODE: Title 10,1074. Medical and Dental Care for Members and Certain Former Members, http://www.law.cornell.edu/uscode/search/display.html?terms=TITLE 10; Subtitle A; PART II; CHAPTER 55; Sec. 1074f. Medical tracking system for members deployed overseas:&url=/uscode/html/uscode10/usc_sec_10_00001074----000-notes.htmlU.S.C. (1997).

Waldo, D. (1978). *Public Administration Review, 38*(6), 589-597. Retrieved from http://www.jstor.org/stable/976043

Wanous, JP Hudy,,M.J. (2001). Single-item reliability: A replication and extension. *Organizational Research Methods, 4*(4), 361-375.

Waterman, R. W., & Meier, K. J. (1998). Principal-agent models: An expansion? *Journal of Public Administration Research and Theory: J-PART, 8*(2), 173-202. Retrieved from http://www.jstor.org/stable/1181555

Weber, M. (1978). *Economy and society: An outline of interpretive sociology (2 volume set)* University of California Press.

Weingast, B. R. (1984). The congressional-bureaucratic system: A principal agent perspective (with applications to the SEC). *Public Choice, 44*(1, Carnegie Papers on Political Economy, Volume 4: Proceedings of the Carnegie Conference on Political Economy), 147-191. Retrieved from http://www.jstor.org/stable/30023940

West, W. F. (1982). The politics of administrative rulemaking. *Public Administration Review, 42*(5), 420-426. Retrieved from http://www.jstor.org/stable/975644

Zatzick, D. F., Kang, S., W. Ladson Hinton, Kelly, R. H., Hilty, D. M., Franz, C. E., et al. (2001). Posttraumatic concerns: A patient-centered approach to outcome assessment after traumatic physical injury. *Medical Care, 39*(4), 327-339. Retrieved from http://www.jstor.org/stable/3768048