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Assessing the Effect of MHS Genesis on Emergency Department and Follow-Up Routine Visits

March 2024

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Prepared for the Naval Postgraduate School, Monterey, CA 93943.

ACQUISITION RESEARCH PROGRAM
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ABSTRACT

In 2015 the Department of Defense (DOD) purchased MHS GENESIS, an electronic health record (EHR), to modernize and standardize medical and dental records across the Military Health System (MHS). This thesis evaluates MHS GENESIS's impact on appointment utilization patterns, focusing on emergency department (ED) revisits, routine follow-ups after ED visits, and telehealth visits. Using a difference-in-differences analysis I compare three military treatment facilities (MTF) that experienced MHS GENESIS implementation between 2016 and 2022 to a control MTF. Findings suggests that after the initial 6-month transition period, MHS GENESIS is associated with increases in ED revisits in San Diego and a decrease in 30-day ED revisits at Travis. Decreases in routine follow-up visits and telehealth visits rates are found across Madigan, Travis, and San Diego. Recommendations include continued evaluation of MHS GENESIS beyond the studied outcomes with consideration of other facility performance measures. Further studies should also account for variables such as manning and capability. Ongoing analysis is crucial to assess MHS GENESIS's continued impact on the MHS as standardization progresses and data integrity improves.

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LIST OF ACRONYMS AND ABBREVIATIONS

AHLTA	Armed Forces Health Longitudinal Technology Application
CHCS	Composite Health Care System
CMS	Centers for Medicare & Medicaid Services
CNO	Chief of Naval Operations
DC	Direct Care
DEERS	Defense Enrollment Eligibility Reporting System
DHA	Defense Health Agency
DMIS ID	Defense Medical Information System Identifiers
DOD	Department of Defense
ED	Emergency Department
EHR	Electronic Health Record
EMR	Electronic Medical Record
GAO	Government Accountability Office
LPM	Linear Probability Model
MHS	Military Health System
NCQA	National Committee for Quality Assurance
PC	Purchased Care
USCG	United States Coast Guard
VA	Veterans Affairs

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I. INTRODUCTION

A. PURPOSE

In today's rapidly evolving healthcare landscape, the effective utilization of electronic health records (EHRs) is pivotal to achieving optimal patient care, coordination, and cost-efficiency. The Department of Defense (DOD) recognized this imperative, leading to the acquisition of MHS GENESIS—a monumental step forward in modernizing the Military Health System (MHS) (Tong & Kapinos, 2023). MHS GENESIS is a commercial-off-the-shelf EHR that was acquired to replace the many disparate legacy systems used in the MHS (Mendez, 2019). This acquisition represents not only a technological upgrade but also a strategic endeavor to integrate medical and dental information across the entire spectrum of military healthcare facilities within the Navy, Air Force, and Army (Mendez, 2019). This transformation has the potential to usher in a new era of standardization, data-driven population health management, enhanced patient safety monitoring, and seamless health data exchange across military services, Veterans Affairs (VA), and civilian healthcare organizations (Tong & Kapinos, 2023).

In the 2022 Chief of Naval Operations (CNO) Navigation Plan, manpower, readiness, and total sailor fitness are listed as priorities in helping to maintain the Navy's superiority and advance America's advantage at sea (Chief of Naval Operations, 2022). Cost efficiency is also a priority within the Department of Defense (DOD), as it is understood that budget limitations exist, and we must utilize the current resources in the most efficient way possible. Evaluation of the implementation of MHS GENESIS and its impact on the health of the force aligns with overarching DOD and CNO priorities.

While MHS GENESIS holds great promise, it has yet to undergo a systematic evaluation of its tangible benefits and return on investment. By focusing on appointment utilization patterns, particularly emergency department (ED) visits, ED re-visits, routine follow up after ED visit and telehealth, this research will study whether MHS GENESIS has yielded improvements in patient care, care coordination, diagnostics, and overall healthcare system efficiencies. Furthermore, investigating the new EHR aligns with

overarching priorities of the DOD and the CNO, addressing both medical and deployment readiness while operating under budget constraints. This investigation serves not only as a critical internal assessment but also as a benchmark for quantifying the impact of this groundbreaking EHR acquisition on the health of the force.

B. RESEARCH QUESTIONS

This thesis aims to systematically evaluate MHS GENESIS's current benefits and return on investment by addressing the following questions:

- What impact does MHS GENESIS implementation have on appointment utilization patterns?
- How do ED visits and re-visits rates within 72 hours and 30 days change pre- and post- MHS GENESIS implementation?
- What are the routine follow-up visit rates within 7 and 30 days following an ED visit, pre- and post- MHS GENESIS implementation?
- How have telehealth visit rates changed pre- and post- MHS GENESIS implementation?

C. ORGANIZATION

This thesis comprises six chapters. Chapter II outlines the institutional background and highlights the ongoing MHS transformation and the history of the EHR modernization efforts. Chapter III presents a comprehensive literature review on measures of healthcare effectiveness, ED utilization, ED revisits, follow-up visits, and telehealth. Chapter IV details the research methodology, including data sources, sample population, and outcome variables. Chapter V examines analysis findings, describing outcomes at select hospitals before and after MHS GENESIS implementation. Chapter VI summarizes results, identifies limitations, and offers recommendations. Finally, the appendix contains additional data and supplementary tables that provide amplifying information to support this thesis.

II. INSTITUTIONAL BACKGROUND

Over the years, the DOD has established and maintained EHR systems to document healthcare services for military personnel and their families. Currently, DOD operates several disparate legacy EHR systems and is in the final stages of implementing MHS GENESIS. This new system aims to integrate all of the MHS, along with other EHR systems, used by Veterans' Affairs (VA), United States Coast Guard (USCG), and civilian healthcare providers (Mendez, 2019). Upgrading vital systems such as an EHR for 9.5 million beneficiaries is difficult, but merging three military healthcare operations, Army, Air Force and Navy, amplifies these challenges (Khan, 2018). In this section, I discuss the institutional background of the MHS's structure and ongoing transformation efforts after the establishment of the Defense Health Agency (DHA). I also provide the institutional background on the DOD's current EHR modernization efforts, including the implementation of MHS GENESIS. Finally, I review the background on measures of healthcare effectiveness to analyze the impact of the MHS GENESIS implementation, as it is crucial to balance technology advancement with its effect on healthcare quality and costs (Khan, 2018).

A. MILITARY HEALTH SYSTEM TRANSFORMATION

The MHS under DOD oversees healthcare entitlements for over 9.5 million beneficiaries worldwide, through military treatment facilities (MTFs) or TRICARE providers (Mendez, 2019). These facilities, numbering 723 globally, cater to various clinical needs based on size, mission, and capabilities (Mendez, 2019). Following three decades of demands for restructuring, Congress enforced a MHS overhaul under the FY 2017 National Defense Authorization Act (NDAA) (Tong & Kapinos, 2023). This reform transferred management of MTFs from individual military departments of the Army, Air Force and Navy to the DHA.

The DHA's responsibilities expanded to cover budgetary matters, information technology, healthcare administration, policy implementation, military medical construction, and other relevant aspects at the directive of the Secretary of Defense (Tong

& Kapinos, 2023). The NDAA also compelled the DOD to reorganize or realign MTFs to enhance support for medical readiness and military medical forces. The aim was to boost overall access to care, promote standardization and best practices across the MHS, and facilitate readiness training for military medical providers. As part of this reorganization, the DHA also established large health care markets, managing most patient encounters, and smaller markets focused on community hospitals (Tong & Kapinos, 2023).

Despite the congressional mandate in FY 2017, the DHA transformation continues. As of October 1, 2023, the DHA transitioned from 20 markets to nine Defense Health Networks backed by Defense Health Support Activities (Health.mil, 2023). This shift includes the removal of independent MTFs, aiming to align each one with a Defense Health Network (Health.mil, 2023). The goal is to streamline operations, stabilize the system, and consequently boost employee contentment, readiness, and the capacity to deliver healthcare consistently, regardless of location (Health.mil, 2023).

B. ELECTRONIC HEALTH RECORD MODERNIZATION

In 2015, the DOD awarded a $4.3 billion contract for a new MHS-wide EHR system that would replace all of the disparate legacy systems in place (Khan, 2018). The FY 2017 NDAA, which mandated the re-structuring of the MHS under DHA, simultaneously impacted the healthcare information technology structure, as it placed procurement, operations, and ownership under one organization (Khan, 2018). The author describes other provisions of the NDAA, such as Section 706, which mandates that the Secretary of Defense establish relationships between military and civilian healthcare facilities to improve care for beneficiaries, improve the training of military healthcare staff and increase resource sharing. Finally, the author discusses Sections 709 and 718 which focus on the standardization of the appointment making process, the number of appointments each provider should have and increasing the use of telehealth services in the MHS. Although the purchase of the EHR preceded the NDAA, the congressional mandate provided the structure, governance, and leadership to successfully implement this new technology (Khan, 2018).

Prior to the implementation of MHS GENESIS, healthcare services were documented in different components of the DOD health record, such as service treatment records, nonservice treatment records, and occupational health civilian employee treatment records (Mendez, 2019). The DOD maintains various legacy EHR systems to input, share, and archive healthcare data across these records (Mendez, 2019). However, the author caveats that access to these systems might be limited when beneficiaries relocate to areas without this infrastructure, necessitating the maintenance of paper health records. According to a Government Accountability Office (GAO) (2010) report, legacy system issues included non-user friendly interface, slow performance and unreliable around-the-clock availability. Despite allocating around $2 billion over a 13-year period to update the legacy EHR systems, the report shows ongoing problems, such as system downtime issues and time-consuming documentation, persisted.

According to Mendez (2019), the DOD's requirements for MHS GENESIS included: improved integration and accessible decision-making tools; provision of comprehensive medical records for all DOD beneficiaries and access to all MHS personnel globally; implementation of standardized workflows, improved data exchange, and secure transmission of medical data between the DOD, VA, and other federal/private healthcare providers; alignment with standards for interoperability and information sharing. The requirements for MHS GENESIS helped to ensure a more complete EHR system, when compared to legacy systems, spanning from entry to military service, as well as any civilian care rendered to finally the departure of military service and transition to the VA healthcare system. Moreover, MHS GENESIS is mandated to meet more than 95 capability requirements spanning health service delivery, health system support, health readiness, and force health protection concepts (see the appendix, Section A) (Mendez, 2019).

The new EHR system was slated for implementation across 25 distinct waves spanning MTFs throughout the United States and overseas. The implementation of MHS GENESIS began in the Pacific Northwest medical facilities in 2017 with the initial operating capability wave, which lasted through 2019 (Military Health System, 2023b). Madigan Army Medical Center, which will be analyzed in this thesis, was a part of this initial operating capability wave. This initial implementation wave experienced many

difficulties to include trouble ticket backlog, lengthy issue resolution process, inadequate staff training, and system capability gaps or limitations (Mendez, 2019). Another key feature in the implementation process was the reduction of services, such as appointments, laboratory or pharmacy, during the initial implementation (Frady, 2023). The purpose of the reduction in healthcare services was to maintain safety while allowing staff members to gain proficiency in using the new EHR system.

In a congressional report released in 2021, the GAO cited that despite improvements in performance, issues with the EHR deployment such as training, communication and unresolved incidents related to system defects persisted (Government Accountability Office, 2021). Following initial deployment, MHS GENESIS underwent numerous upgrades and adjustments, incorporating lessons learned from earlier phases to enhance the final deployment (Cornwell, 2023). The DHA actively sought feedback from users and stakeholders, integrating these insights into the deployment strategy, which facilitated smoother transitions and improved user experiences according to the program executive officer for the Defense Healthcare Management Systems (Cornwell, 2023). The final U.S. implementation wave occurred on June 3, 2023, and the current final wave of overseas implementation began on October 28, 2023 (Cornwell, 2023). Additionally, both the DOD and VA are slated to synchronously deploy MHS GENESIS at the James A. Lovell Federal Health Care Center in March 2024, aiming to establish a model for seamless collaboration across agencies and the broader healthcare industry, removing technological barriers for joint operations (Cornwell, 2023).

The overall scope and impact of the MHS GENESIS implementation are evident. The system represents a significant investment in modernizing the MHS' health record infrastructure and is expected to deliver substantial benefits in terms of improved care delivery and health information management (Tong & Kapinos, 2023). The impact of MHS GENESIS on patient care and costs is a key area for exploration. Tong and Kapinos (2023) recommend utilizing the variations in deployment across facilities to determine its causal effect on patient outcomes such as care coordination, medical errors, screenings, immunizations, and overtreatment.

C. SUMMARY

The DOD has been upgrading its EHR system, after decades of using disparate legacy systems, and is finalizing the implementation of MHS GENESIS. This new system aims to integrate healthcare services for military personnel, their families, and other beneficiaries. In addition, the MHS enterprise underwent a major congressionally mandated transformation in 2017, transferring management to the DHA. The DHA's expanded responsibilities include budget, information technology, healthcare administration, and policy implementation. The EHR modernization, initiated in 2015, aimed to replace legacy systems and improve access, quality, and standardization. Despite challenges during the initial implementation, MHS GENESIS underwent upgrades for smoother deployment. Overall, MHS GENESIS represents a significant investment in modernizing the MHS' health record infrastructure with expected benefits in care delivery and health information management. The impact of MHS GENESIS on patient care and costs is a key focus, and in this thesis, I specifically explore variations in deployment across facilities for causal effects on patient utilization outcomes.

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III. LITERATURE REVIEW

Since its launch in 2017, the impact of MHS GENESIS on the DOD's healthcare system has not been assessed in published literature. In early 2023, the RAND Corporation published a research report on the topic of Military Health Care costs and potential future research areas. Although the MHS only accounts for 7% of the total DOD budget, funding continues to increase with each new fiscal year (Tong & Kapinos, 2023). The report made analysis recommendations to determine if the MHS reforms are serving to increase efficiency within the medical system and/or serving to contain costs. The report highlighted MHS GENESIS as a potential area of research to quantify the effects of the new EHR system on patient care and health care costs. Given the congressional mandates to increase the efficiency of the MHS, I instead review the literature available on select hospital measures providing comparable benchmarks that can be used for modelling within the MHS. First, I discuss the measures of healthcare effectiveness in the civilian sector, then I review the literature on ED utilization, which also includes revisits to the ED within a specified number of days. Furthermore, I review the literature on follow-up visits after an ED visit. Finally, I review the available literature on telehealth utilization in the MHS.

A. MEASURES OF HEALTHCARE EFFECTIVENESS

Here I discuss the potential impacts of MHS GENESIS based on existing studies of EHR adoption. Next, I discuss my primary outcome measures: ED revisit rates, follow-up visits, and telemedicine. To analyze the impact of MHS GENESIS, I will focus on specific healthcare outcomes as a proxy for improvements in the effectiveness of healthcare delivery. I will discuss ED revisit rates which can serve as a metric for healthcare system efficiency, highlighting factors which influence unplanned hospital returns, impact patient well-being and healthcare costs. I will also discuss follow-up visits that occur immediately following an initial ED visit as these efforts to improve care transitions, aim to reduce hospital revisits, prevent readmissions, and improve overall healthcare outcomes. Finally, I will review the MHS efforts to improve efficiency through the delivery of virtual health or telemedicine.

Using a variety of methods such as literature review, surveys and modelling, as well as various data sources such as the Healthcare Information and Management Systems Society (HIMSS)–Dorenfest survey, public records and medication error rates, Hillestad et al. (2005) investigate the potential health and financial benefits of adopting EHR systems in the healthcare industry. Their study suggests that the widespread adoption of EHR systems could lead to substantial annual savings, potentially exceeding $81 billion, primarily through improved healthcare efficiency and safety. The authors relate that savings come from reduced hospital days, administrative burden, drug prescriptions, and radiology orders. Furthermore, EHR systems have the potential to decrease adverse events related to drug prescriptions and improve the management of chronic diseases, leading to additional savings (Hillestad et al., 2005).

The Centers for Medicare & Medicaid Services (CMS) (2023) define three distinct metrics that track unplanned hospital visits: readmission rates, unplanned hospital visits post-outpatient procedure and hospital return days. Patients who face unplanned return visits to the hospital experience disruptions in their lives, heightening the likelihood of healthcare-associated infections and incurring greater financial costs (Centers for Medicare & Medicaid Services, 2023). CMS further defines hospital return days as a measure that reflects the average number of days patients, admitted for specific conditions, spend back in the hospital (in the ED, under observation, or in an inpatient hospital unit) shortly after discharge. These metrics focus on unplanned hospital visits, occurring within either a 30-day or 7-day window post-hospital visit or outpatient procedure. Returns to the hospital after a more extended period may be less influenced by the hospital's care quality and could instead be attributed to other factors such as increasing illness severity, patient behavior, or subsequent care received post-discharge (Centers for Medicare & Medicaid Services, 2023). Hospitals delivering exceptional care can effectively prevent these return visits and potentially reduce the duration of subsequent hospital stays (Centers for Medicare & Medicaid Services, 2023).

Improving ED care transitions is also vital for patient-centered healthcare, impacting outcomes and quality. Nationally, 8.2% return to the ED within three days of discharge, while a fifth of Medicare beneficiaries face readmission via the ED within 30

days, underscoring the importance of follow-up outpatient care (National Quality Forum, 2017). The National Quality Forum further discusses how inadequate information during transitions leads to anxiety, resource wastage, and patient harm. One specific measure proposed by the National Quality Forum was unscheduled ED return visits within 9 or 30 days.

In conclusion, the potential advantages of EHRs in healthcare emphasize the substantial cost savings and enhanced efficiency they offer. Addressing unplanned hospital returns through appropriate follow up is critical for reducing healthcare-associated infections, financial burdens, and enhancing overall healthcare quality. These metrics serve as vital indicators of healthcare system efficiency and patient well-being. Efforts by national bodies to prioritize measures and enhance care transitions through infrastructure development and revised care models underscore the importance of cohesive strategies in improving patient outcomes and mitigating fragmentation within healthcare systems. These published works inform how I select the outcomes for this thesis.

B. EMERGENCY DEPARTMENT UTILIZATION

There is an increasing interest in decreasing avoidable ED visits as well as hospitalizations since hospital-based care accounts for about one-third of health care expenses in the United States (Lin et al., 2018). The MHS has similar goals in decreasing avoidable ED traffic. From 2006 to 2014, there was an 18.4% increase in annual ED visits in the United States, reaching 106 million, while total ED hospitalizations rose by 6.8% to 18.6 million (Lin et al., 2018). Combing the National Emergency Department Survey, Lin et al. (2018) perform a retrospective observational study on adults 19 years and older to examine patient characteristics, co-morbidity scores, insurance, income levels and zip code as they relate to ED visits and admission rates. The authors found a decrease in admission rates that were attributed to clinical factors, policy factors as well as improved access to follow-up care (Lin et al., 2018).

Appropriate utilization of the EDs allows patients with true life-threatening conditions to access timely and needed medical resources. Tapia et al. (2022) discuss how EDs face overcrowding due to non-urgent cases, leading to delays in critical care.

Overcrowding causes longer waits, jeopardizing patient safety and quality of care, raising mortality rates, and causing financial losses (Tapia et al., 2022). Utilizing a retrospective chart review of patients seen at the Brooke Army Medical Center (BAMC), the authors sought to determine the proportion of ED patients that were non-emergent and met the criteria to be managed through a primary care appointment. In this study during the 12-month period of September 2019 to August 2020, 56.7% of patients were deemed eligible to be treated within a primary care setting. The authors further discuss that many non-urgent ED visits happen while about 10% of primary care slots remain open, highlighting the need to redirect resources to primary care for minor issues, easing ED strain, decreasing costs, improving readiness, and enhancing overall patient care.

A large literature suggests ED revisit rates are an effective measure of the efficiency of a healthcare system. For example, Han et al. (2015) review literature on early revisits to the ED and identify four main categories that explain early visits and revisit rates. The authors cite these main categories as patient-related, illness-related, healthcare system-related, and other factors. The study suggests that health care system related factors such as misdiagnosis, malpractice by the doctor, ineffective communication between the healthcare team and patients, as well as lack of referrals or continuity of care, are some precipitating factors that increase ED revisits. The study highlights varying rates of early ED revisits worldwide ranging from 0.39 to 27%, depending on factors like timeframes and patient groups. There was also no consistent definition of ED revisits which ranged from 48 hours to 90 days. The study emphasizes the importance of optimizing the discharge process in emergency care, which can be valuable in improving patient outcomes and reducing healthcare costs.

In another broader comparison of ED utilization, Duffy et al. (2023) uses regional data from three high income countries (New York (United States), Ontario (Canada), and New Zealand) to perform a retrospective cross-sectional analysis of ED visits for adults aged 18 and older between January 1, 2016, and September 30, 2017. The study found significant differences in ED utilization with Ontario having the highest annual per-capita ED utilization (443.2 visits per 1000 population/year), followed by New York (404.0) and New Zealand (248.4). ED utilization was highest among residents of the lowest income

neighborhoods in all countries. Ontario had the highest 30-day ED revisit rate (27.0%), followed by New York (21.4%) and New Zealand (18.6%) with the lowest rate. This study provides valuable insights into variations in ED utilization patterns across different high-income countries, highlighting the impact of factors such as income and healthcare system. Similarly, I will analyze ED utilization patterns in the MHS to assess differences between demographics such race and as officer versus enlisted.

Finally, Duseja et al. (2015) adopts an observational approach, utilizing data from the Healthcare Cost and Utilization Project databases to understand ED revisit rates within three days of the index ED visit, identifying variation in revisit rates based on diagnosis and state, and assessing the associated costs of such revisits. The research focuses on adults who had ED visits between 2006 and 2010 across six U.S. states. The study reveals that 8.2% of patients had a revisit within three days of an index ED visit, with a notable portion of these revisits occurring at different healthcare institutions. Notably, revisit rates varied depending on the diagnosis, with skin infections showing the highest revisit rate. Variability in revisit rates was also observed across different states, such as Florida and Nebraska. In Florida, total revisit costs for patients with revisits within 30 days exceeded the total index ED visit costs for all patients, indicating a substantial financial impact of these revisits. The study findings emphasize the need to address ED revisit rates to optimize healthcare resource allocation and enhance patient outcomes, which is particularly relevant for healthcare system management and decision-making.

Several studies discussed above explore different facets of ED utilization, shedding light on critical aspects impacting healthcare systems. Since the MHS often benchmarks its performance on civilian standards, I use the discussed outcomes and comparable methodology to analyze trends within the ED of the MHS system. Specifically, I analyze ED utilization and ED revisit rates pre and post MHS GENESIS to assess potential improvements in healthcare efficiency, such as increased access to follow up appointments. As stated by Tapia et al. (2022) it is important to understand ED utilization patterns in the MHS, as the misuse of the ED for routine care is costly and affects readiness. This thesis will provide the pulse on MHS performance on 72-hour and 30-day ED revisits and inform future decisions and recommendations needed based on this assessment. Comparisons of

revisit rates between different ranks and services for example, can highlight important patterns that could be used to drive targeted interventions for these groups. Together, the literature discusses different factors that can impact ED utilization thus substantiating the need for assessment of this area within the MHS, especially after the new EHR implementation.

C. FOLLOW UP CARE AFTER EMERGENCY DEPARTMENT

Another important factor in appropriate ED utilization is having adequate follow up care after an initial ED visit within either the primary care or specialty care outpatient arena, dependent on the patient's condition. The National Committee for Quality Assurance (NCQA) (2024) has established measures through the Healthcare Effectiveness Data and Information Set (HEDIS) that allow healthcare systems to track performance measures and utilize performance improvement tools to positively impact patient health outcomes. One such measure is the percentage of patients with high-risk multiple chronic conditions that receive a follow up visit within seven days of an ED visit. Although this measure does not specifically translate to the active-duty population in this thesis, it provides the methodology to inform the routine follow up outcome.

The literature also supports having adequate follow up as one of the determining factors in improving patient outcomes. Using data from over 9 million ED visits between 2011 and 2016, Lin et al. (2020) investigate how outpatient follow up affects post ED discharge mortality, a revisit to the ED or an inpatient hospitalization within 30 days of ED discharge. Having follow up care was linked to a higher risk of hospital return, but a lower risk of mortality within 30 days. This study suggests that access to outpatient care after an ED visit may significantly influence the health outcomes of Medicare beneficiaries (Lin et al., 2020).

The rate of timely outpatient follow-up care after ED visits has also been reviewed for specific conditions, such as acute heart failure. Using a retrospective cohort study analyzing administrative claims for patients diagnosed with acute heart failure, Kilaru et al. (2022) assessed the frequency of outpatient follow up and discussed patient demographics that were associated with receiving follow-up care in a timely manner. In

this study the authors defined the primary outcome as obtaining an in-person outpatient clinic visit for heart failure within 30 days. The authors found that patients rarely obtained follow up visits after ED visits for heart failure in a timely manner, although almost 20% required hospitalization within 30 days. When the authors controlled for demographics, they found that younger patients, women, those of non-Hispanic Black race, and those with fewer historical clinic visits were less likely to secure a visit for outpatient follow-up care. The authors suggested that focusing efforts to assist in the transition after patients are discharged from the ED could improve health outcomes for patients with acute heart failure.

Follow-up care after an ED visit plays a pivotal role in patient outcomes, with studies emphasizing its impact as well as national quality agencies such as NCQA designating it as an important healthcare measure. I leverage literature-derived methodologies to compare metrics such as the proportion of patients with follow up visits at 7 or 30 days within the MHS, analyzing changes after MHS GENESIS implementation.

D. TELEHEALTH UTILIZATION

Given the congressional mandate to increase the use of telehealth within the MHS, I review the literature on the use of telehealth services within the military and civilian sectors. Madsen and Koehlmoos (2021) investigate the utilization of telehealth services within the MHS from 2006 to 2018 by analyzing health care claims from the MHS Data Repository. The research findings reveal a remarkable 19-fold increase in telehealth services during this period, reaching 48,667 occurrences by 2018. Physicians provided around 60% of these services, with mental health diagnoses being the most common reason for telehealth consultations. Notably, purchased care (PC) demonstrated differences from direct care (DC), showing higher expansion rates, involving more children and adolescents, and a lower use of telehealth for non-mental health services. The findings highlight the substantial growth and acceptance of telehealth services in both DC and PC settings within the MHS, emphasizing the need for further exploration into provider types, diagnoses, and patient demographics associated with telehealth utilization, particularly in the evolving clinical landscape influenced by COVID-19.

Additionally, in response to the COVID-19 pandemic, there was a significant change in how healthcare was provided in the MHS, increasing the prevalence of telehealth services. Using a cross-sectional design to analyze military and civilian healthcare system data, specifically telehealth services marked with codes like GT, GQ, and 95, from January 2019 to December 2021, Gilder et al. (2023) found that in 2020, there was a 20-fold increase in telehealth usage compared to 2019. Interestingly, the study highlights that the types of healthcare providers delivering telehealth shifted from mostly doctors to advanced practice nurses and physician assistants. While mental health care saw an increase in both DC and PC, 118% and 20% respectively, other telehealth visits for metabolic, endocrine, and musculoskeletal disorders decreased in the DC system, and were not fully compensated for in the PC system. In summary, the study found telehealth usage increased significantly, especially for behavioral health, while some care was postponed, delivered in other ways, or sought outside the MHS.

Similarly, telehealth utilization in the civilian healthcare sector is also widespread. Combing through administrative and EHR data from a large healthcare system with over 1300 primary care providers between April and December 2021, Reed et al. (2023) assess how primary care telemedicine compared to in-person office visits in terms of treatment and follow-up visits. The study findings revealed that out of 2,357,598 primary care visits, 50.8% used telemedicine, with video and telephone visits making up the majority. The study concluded that telemedicine can be an effective alternative to in-person care for treatment and follow-up visits. The findings support the overall goal of the MHS to expand telehealth to complement in-person healthcare delivery with the goal of increasing access to care.

Telehealth has been identified as a valuable tool in both deployed and non-deployed settings, enabling the provision of healthcare to remote populations and enhancing military readiness. The DHA is using MHS Video Connect to establish a patient-focused digital health care system, aiming to enhance connections between patients and providers (Hammer, 2023). The author highlights that this platform facilitates virtual health encounters, allowing providers to engage with patients remotely, aligning with the DHA's mission of modernization.

The available literature reviewing telemedicine trends in the MHS highlights a shift in the types of healthcare providers delivering telehealth, aligning with the MHS's goal of telehealth expansion. Additionally, the literature supports that combining telehealth with traditional in-person care is a viable and effective method to increase access to care. Zhang and Saltman (2022) discuss how telehealth delivery relies on device interoperability and data integration. The authors discuss how running separate EHR systems for different functions, such as the legacy systems within the MHS, can lead to technical and data compatibility issues and heightened cybersecurity threats. Furthermore, the authors highlight that suboptimal integration between telehealth platforms and EHRs adds clerical burdens on physicians, potentially contributing to professional burnout, with a disproportionate amount of time spent on EHR-related tasks. The integration of telehealth programs into a hospital's existing EHR system is emphasized to maximize telemedicine benefits, leveraging the familiarity of providers and staff with the baseline EHR system (Zhang & Saltman, 2022). I will further examine telehealth utilization before and after MHS GENESIS implementation to assess if the most recent trends continue to align with the MHS goal of expansion in this field.

E. SUMMARY

This literature review examines key outcomes to assess the impact of MHS GENESIS on the DOD's healthcare system, focusing on select hospital measures such as ED utilization, ED revisits, follow-up visits post-ED, and telehealth usage. Studies reveal the need to decrease avoidable ED visits and redirect resources to primary care, emphasizing the impact on readiness. Follow-up after ED discharge is explored, highlighting its effects on improved patient outcomes. Finally, Telehealth usage within the MHS has substantially increased, prompting shifts in provider types and care patterns, with findings comparing its effectiveness to in-person visits. Overall, these insights inform healthcare efficiency measures for resource allocation and patient care optimization.

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IV. DATA SOURCES AND METHODOLOGY

The main objective of this chapter is to outline the data and methodology I used to perform my analyses. I begin by explaining the source of the data set and the sample population that was used. Next, I expand on the creation of the key outcome variables used in the research and finish with an explanation of the methodology employed in the analyses.

A. DATA SOURCES

I use the Military Health System Data Mart (M2) as the data source to conduct my analyses. M2 is a secure database that contains various types of population, clinical and financial data. I specifically obtained population data from the Defense Enrollment Eligibility Reporting System (DEERS) and direct care clinical data from the Composite Health Care System (CHCS), the Armed Forces Health Longitudinal Technology Application (AHLTA) and MHS GENESIS. A more detailed description of these data sets is below:

- DEERS: Identifies one record per eligible beneficiary or person per month. This record contains personal identifying information such as age, gender, marital status as well as service information such as active-duty status, branch of service, rank, and occupation. The record also contains the beneficiary's enrollment site where they should receive primary medical care (Defense Manpower Data Center, n.d.)

- CHCS/AHLTA: Primarily manages outpatient medical data and includes features for ordering, recording, and storing information related to laboratory, radiology, pharmacy services, as well as administrative functions like scheduling appointments, medical record tracking, and quality assurance checks. Allows medical personnel to access beneficiary care visit records across the MHS while providing a means to document clinical notes with diagnostic codes and order entry (Mendez, 2019). Relevant information from this data source includes: enrollment site, enrollment site command, treatment Defense Medical Information System

(DMIS) Identifiers (ID), appointment status, appointment types, specialty, diagnosis, diagnosis group, disposition code, person identification, procedure codes and modifiers. Data from this source ends when each MTF transitions to MHS GENESIS described below.

- MHS GENESIS: New comprehensive inpatient and outpatient EHR, linking medical and dental data throughout the entire care process, spanning from initial injury to treatment at military facilities (Mendez, 2019). It takes the place of various outdated healthcare systems such as AHLTA and CHCS and contains the following variables: encounter (counts), enrollment site, enrollment site command, treatment DMIS ID, encounter date, calendar year, calendar month, product line, diagnosis (1-4), diagnosis group, disposition code, encounter type genesis, pseudo person identification, product line, procedure codes (1-10), procedure modifier codes (1-2).

B. SAMPLE POPULATION

My thesis will include analyses at the MTF or hospital level and the individual level. The hospital level analyses includes all routine outpatient and ED visits that occurred between October of 2016 through December of 2022 at the four selected hospitals which includes Madigan Army Medical Center, 60th Medical Group- Travis Air Force Base, Naval Medical Center San Diego, and Naval Medical Center Portsmouth. These hospital-level analyses focus on overall volume changes when the facility transitioned to GENESIS. The study population for individual-level analyses will include all active-duty U.S. service members who received treatment at any point between October of 2016 and December of 2022 at the four selected hospitals above. Individual-level analysis focuses on changes in patient visit patterns when the facility rendering their care transitions to MHS GENESIS. Table 1 lists the MHS GENESIS implementation dates for each selected hospital. Naval Medical Center Portsmouth is selected as the control MTF to account for macro changes in outcomes that are unrelated to MHS GENESIS implementation, since they did not experience this transition during the analysis date range.

Table 1. MHS Genesis Implementation Dates

Military Treatment Facility	MHS GENESIS Start Date
AMC Madigan	10/21/2017
60th MEDGRP–Travis	09/07/2019
NMC San Diego	02/27/2021
NMC Portsmouth **(control)**	**01/21/2023**

Each row within this data set represents a unique episode of care per patient, location of care, and diagnosis while also containing the representative patient demographics. As the military is a transient community, this analysis only follows patients who were treated at each selected hospital during the specific time. If these patients transitioned to other duty stations and subsequently changed their healthcare treatment facility to one outside of the scope of this analysis, their encounters will not be analyzed. The data may contain transient personnel who receive treatment at the selected facilities but are not enrolled there or assigned a primary care doctor for routine care. This may impact results related to follow-up care, for example, potentially underestimating the amount of routine care or overestimating ED visits.

C. VARIABLES

In this section I discuss the outcome, demographic, hospital, and post-GENESIS variables I used in this thesis.

1. Outcome Variables

The main outcome variables I analyze as a percentage are the following binary variables: (1) ED revisits within 72 hours, (2) ED revisit within 30 days, (3) routine follow-up visit within 7 days of ED visit, (4) routine follow-up visit within 30 days of ED visit, and (5) telehealth visit. These outcomes were selected based on comparable civilian metrics as well as the MHS's goal of expanding telehealth services.

I define a care episode as an ED visit if the encounter or appointment type for that record was classified as "Emergency" or "EROOM." Similarly, I define a care episode as a routine visit if the encounter or appointment type is classified as clinic, outpatient, or equivalent categories (see full list of categories in Table 10 in the appendix).

Next, I define two ED revisit outcomes: (1) 72-hour ED revisit takes on the value of one if a person returned to the ED within 72 hours from the initial ED visit, zero otherwise; (2) 30-day ED revisit takes on the value one if a person returns to the ED within 30 days from the initial ED visit, zero otherwise. These outcomes were created by first identifying the initial ED visit then comparing days elapsed until the next ED visit for the same patient. Similarly, I define two follow-up routine visit outcomes: whether a patient had a follow-up routine visit (i.e., non-ED visit) within 7 days and within 30 days from the initial ED visit.

Finally, I create the telemedicine utilization outcome variable using a combination of appointment status code, encounter types, appointment types, procedure codes and procedure modifier codes. First, a care episode is classified as telemedicine if it contains the appointment status code of "7" (from legacy EHR) or appointment types of "T-CON" or "VIRT" (legacy EHR and MHS GENESIS). In addition, a visit is classified as telemedicine if the procedure codes and their modifier codes matched the Defense Health Agency's Virtual 360 dashboard list (Carepoint, n.d.) (complete codes are listed in Table 11 in the appendix).

2. Demographic Variables

The following are the demographic variables I used in my linear probability model (LPM) regressions: gender, rank group and race, age and age squared. For gender I created an indicator for male equal to 1 if gender was equal to male and zero otherwise. The rank group contains enlisted and officer categories and are separated in the following manner Enlisted, Junior (E1-E4), Enlisted, Senior (E5-E9), Officer, Junior (O1-O3), Officer, Senior (O4-O11), Warrant, Officer (W1-W5), All Others (Military Health System, 2023a). I created a variable for Officers equal to 1 if the rank group was equal to Officer, Junior (O1-O3), Officer, Senior (O4-O11), Warrant, Officer (W1-W5), and zero for all others.

For the race category I merged two descriptors to incorporate both legacy system and MHS GENESIS coding according to the M2 Data Dictionary (Military Health System, 2023a). For simplification I created five variables equal to 1 if the race was White, Black, Asian (includes Native Hawaiian and Pacific Islander), American Indian (includes Alaskan Native), and Other (includes others, unknown and missing values).

Finally, age is defined as the age of the patient at the time of the visit and is calculated based on the patient's birthday and encounter date according to the M2 Data Dictionary (Military Health System, 2023a). Additionally, I square the age to capture the non-linear relationship between age and the outcomes of interest. This method can capture pattern changes in the data where the effect of age on the outcome changes as age increases.

3. MTF Variables

The MTFs I analyze are identified by their treatment DMIS ID which I list in Table 2. Additionally, I created interaction terms between Madigan and the long-term post-GENESIS period (which I define in the next section). I replicated this for Travis and San Diego to study the differential effects across the treatment facilities in comparison to the control facility (Portsmouth).

Table 2. Treatment DMIS ID

Military Treatment Facility	**Treatment DMIS ID**
AMC Madigan	0125
60th MEDGRP- Travis	0014
NMC San Diego	0029
NMC Portsmouth **(control)**	**0124**

4. Post-Genesis Variables

To separate the effect of MHS GENESIS implementation in the short-term (i.e., during the transition phase) and long-term, I created two variables. The short-term variable was equal to 1 if the encounter date was in between the implementation date and up to 6

months and zero otherwise. The long-term variable was equal to 1 if the encounter date was greater than 6 months after the implementation date and zero otherwise.

D. METHODOLOGY

In this analysis I use quantitative methods to compare appointment utilization patterns pre- and post-MHS GENESIS implementation. First, I used descriptive statistics to summarize appointment data for each hospital for the studied period. Since MHS GENESIS was implemented in waves I used a multi-period, multi-unit difference-in-differences framework to compare changes in patient visit volumes within facilities that transitioned to GENESIS (treatment) and changes in the same set of outcomes within facilities that stayed on the legacy system (control) between 2016 and 2022. With this approach I generated several LPM regressions, shown in Table 3, to estimate the effect of MHS GENESIS implementation on each of the outcome variables using unique independent variables to represent each hospital, while holding Portsmouth as the reference hospital.

The LPM regression models progress from simple to more complex. Model (1) controls for time and treatment facility fixed effects, with Portsmouth being the reference hospital; Model (2) adds controls for demographics to the initial regression; Model (3) adds diagnosis fixed effects; and finally, Model (4) includes interaction terms between facility and post GENESIS indicators, with Portsmouth serving as the reference hospital for post GENESIS comparison. Additionally, I multiply all outcomes by 100 to facilitate direct interpretation of regression coefficients as percentages.

Table 3. LPM Models

Model (1)	$Y_{it} = \beta0 + \alpha_i + \delta_t + \beta1 * postgenesis1_{it} + \beta2 * postgenesis2_{it} + \varepsilon_{it}$
Model (2)	$Y_{it} = \beta0 + \alpha_i + \delta_t + \beta1 * postgenesis1_{it} + \beta2 * postgenesis2_{it} + \beta3$*Male + $\beta4$*Officer + $\beta5$*Black + $\beta6$*American_Indian + $\beta7$*Asian + $\beta8$*Other + $\beta9$*Age + $\beta10$*Age^2 + ε_{it}
Model (3)	$Y_{it} = \beta0 + \alpha_i + \delta_t + \gamma_d + \beta1 * postgenesis1_{it} + \beta2 * postgenesis2_{it} + \beta3$*Male + $\beta4$*Officer + $\beta5$*Black + $\beta6$*AmericanIndian + $\beta7$*Asian + $\beta8$*Other + $\beta9$*Age + $\beta10$*Age^2 + ε_{it}
Model (4)	$Y_{it} = \beta0 + \alpha_i + \delta_t + \gamma_d + \beta1 * postgenesis1_{it} + \beta2 * postgenesis2_{it} + \beta3 * MadiganXpostgenesis2_{it} + \beta4 * TravisXpostgenesis2_{it} + \beta5 * SanDiegoXpostgenesis2_{it} + \beta6$*Male + $\beta7$*Officer + $\beta8$*Black + $\beta9$*American_Indian + $\beta10$*Asian + $\beta11$*Other + $\beta13$*Age + $\beta14$*Age^2 + ε_{it}

In this setup, α_i represents MTF fixed effects; δ_t represents time fixed effects for month and year; γ_d represents diagnosis fixed effects. Each β represents the impact of the listed independent variable on the selected outcome. The causal impact of the new EHR, or the impact of the short-term and long-term post- GENESIS variables, requires the strong assumption that, absent the EHR change and the selected controls, there would have been no change in the outcome. Although several controls were added to account for hospital specific factors, seasonality factors, and individual factors such as demographics and diagnoses, there still could be factors not accounted for that may influence the estimated effect of MHS GENESIS.

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V. RESULTS AND FINDINGS

This chapter will review the descriptive statistics and regression results for the four LPM models presented in the previous chapter. I will provide an analysis of the regression results for each of the following binary variables: (1) ED revisits within 72 hours, (2) ED revisit within 30 days, (3) routine follow-up visit within 7 days of ED visit, (4) routine follow-up visit within 30 days of ED visit, and (5) telehealth visit. Finally, I will provide a comparison of the outcome results by each hospital.

A. DESCRIPTIVE STATISTICS

The descriptive statistics for the key outcomes of the hospital-level analysis is displayed in Table 4. The column headings display the MTF or hospital (Madigan, Travis, etc.), with each row representing data for that location either before or after the implementation of MHS GENESIS. Portsmouth is the only hospital with one set of statistics prior to its MHS GENESIS implementation as this represents the control group for the analysis—it does not implement GENESIS during the sample period.

Table 4. Descriptive Statistics of Outcomes

MTF	Madigan		Travis		San Diego		Portsmouth
MHS GENESIS	Before	After	Before	After	Before	After	Before
Days Pre/Post-GENESIS	384	1,897	1,070	1,211	1,609	672	2,282
Total Visits	269,121	1,261,353	348,437	436,240	1,411,287	689,579	2,693,175
Average Visits/Day	701	665	326	361	877	1026	1180
ED Visits	9,073	70,625	16,957	15,491	130,512	62,967	182,532
Average ED Visits/Day	24	38	16	13	81	98	81
Routine Visits	224,994	971,782	260,202	277,066	992,527	416,551	2,015,764
Avg Routine Visits/Day	586	512	243	229	617	620	883
ED Revisit within 72hrs	4%	4%	5%	5%	5%	6%	4%
ED Revisit < 30 days	12%	13%	17%	16%	16%	17%	16%
ED Follow-up 7 days	41%	34%	49%	44%	38%	31%	39%
ED Follow-up 30 days	65%	59%	75%	74%	60%	63%	63%
Telemedicine	8%	4%	21%	9%	18%	9%	17%

The active-duty average visits per day, ED visits per day and routine visits per day are weighted based on the number of days before and after the EHR implementation and are also represented graphically in Figure 1. Travis and San Diego experienced an increase

in average total visits per day while Madigan experienced a decrease total visits per day post MHS GENESIS. Average ED visits increased at Madigan and San Diego while Travis experienced a decrease post MHS GENESIS. Average daily routine visits per day increased for San Diego and decreased for Madigan and Travis post MHS GENESIS. Overall, Figure 1 shows no major changes in volumes before and after MHS GENESIS implementation.

Figure 1. Comparison in Daily Visit Volumes before and after MHS GENESIS Implementation, by MTF

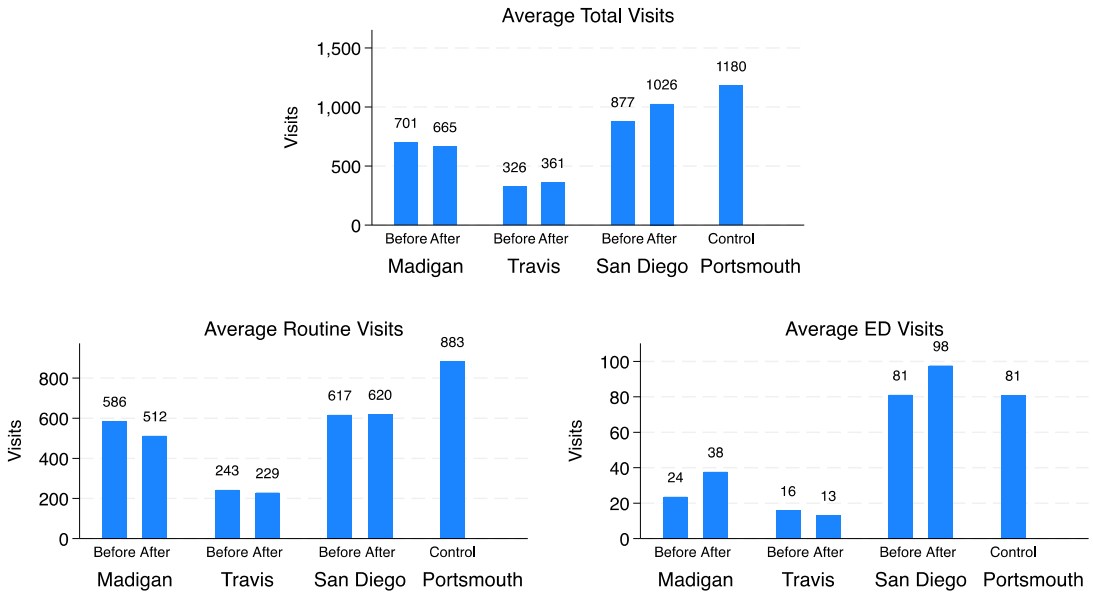
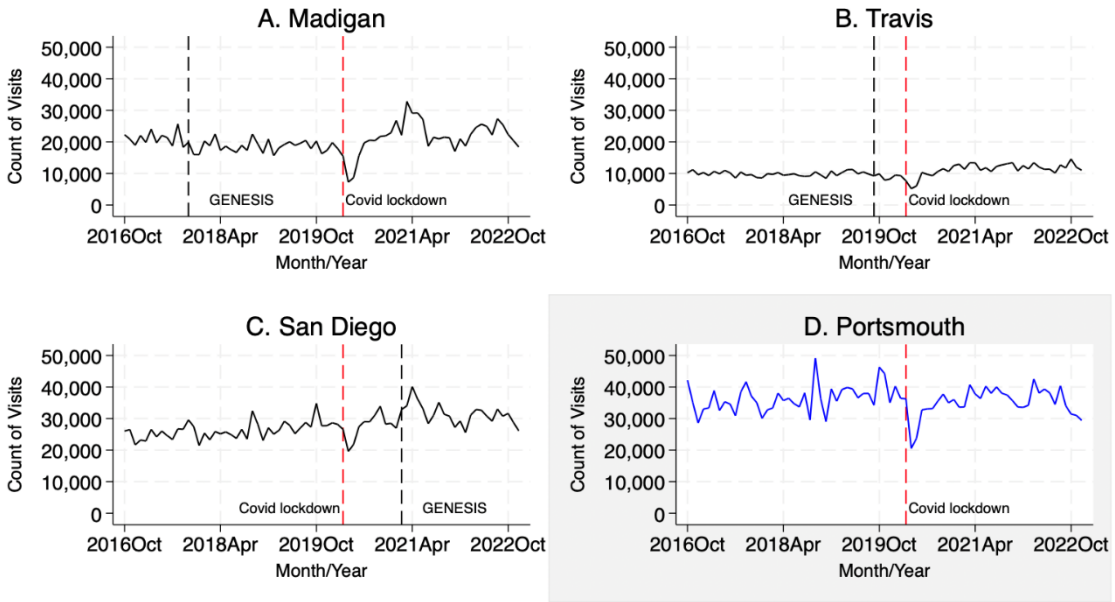


Table 4 also shows the fraction of revisits to the ED within 72 hours remained constant at Madigan and Travis at about 4% and 5%, respectively, while there was a slight increase in San Diego post MHS GENESIS. The selected military hospital rates fall within the range of 1.9% and 6.19% reported by Han et al. (2015) for ED revisits within 72 hours in civilian hospitals. The fraction of revisits to the ED within 30 days increased at Madigan and San Diego, while at Travis there was a decrease post MHS GENESIS. The fraction of routine follow-up after an ED visit within 7 days decreased at all hospitals and the fraction of follow up less than 30 days also decreased at Madigan and Travis with an increase in

San Diego post MHS GENESIS. Finally, the fraction of telemedicine visits also decreased at all hospitals after the implementation of the new EHR.

I visualize the monthly total of all outpatient visits for each respective hospital in Figure 2. MHS GENESIS implementation is marked with black dashed lines for Madigan, Travis, and San Diego. For example, in Figure 2A there were around 30,000 visits on the month of April 2021 for Madigan, while Figure 2B shows around 12,000 visits on the month of October 2022 for Travis. The figures provide a monthly display of the descriptive statistics discussed from Table 4, where Travis and San Diego have a slight increase in the average visits after MHS GENESIS while Madigan has a slight decrease. The COVID lockdown line is displayed in red since the pandemic had a big impact in the care provided in all healthcare facilities. Around the COVID lockdown, government-mandated shutdowns caused a decrease in the number of monthly encounters observed in all four hospitals. But the implementation of MHS GENESIS only shows a slight reduction in encounters for Madigan.

Figure 2. Total Monthly Visits from October 2016 – December 2022



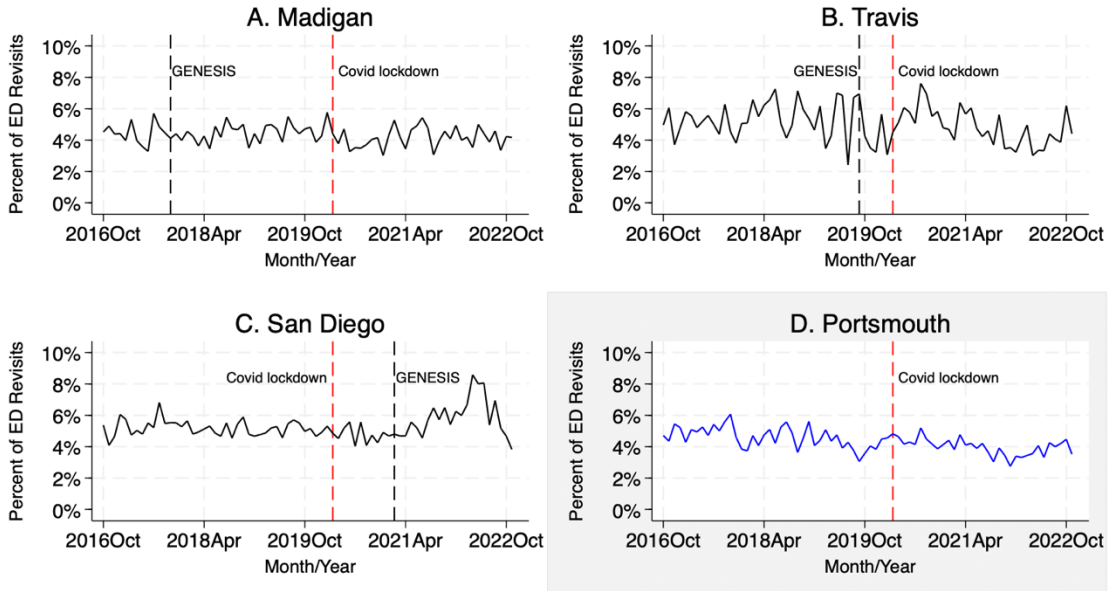
Note: Covid lockdown is defined as Mar 2020 for all; MHS GENESIS switch date is: Oct 2017 for Madigan, Sep 2019 for Travis and Feb 2021 for San Diego

B. EMERGENCY DEPARTMENT UTILIZATION

1. ED Revisits within 72 Hours

The understanding of utilization patterns in the MHS is crucial as using the ED inappropriately for routine care results in substantial costs and readiness implications (Tapia et al., 2022). Figure 3 illustrates the percentage of monthly ED revisits within 72 hours for each respective hospital. MHS GENESIS implementation is marked with black dashed lines for Madigan, Travis, and San Diego. The COVID lockdown line is displayed in red. The percentage of monthly ED revisits within 72 hours remains stable for all MTFs except San Diego who experiences a slight increase post MHS GENESIS. As an example, in Figure 3C between April 2021 and October 2022 ED revisits within 72 hours spike as high as 8%, while Figure 3A shows variations that remain between 4% and 6% during the entire observation period. The figures provide a monthly display of the descriptive statistics discussed from Table 4, where San Diego had a slight increase in the percentage of ED revisits within 72 hours after MHS GENESIS while all other hospitals remain stable.

Figure 3. Percent of Monthly ED Revisits within 72 Hours from October 2016 – December 2022



Note: Covid lockdown is defined as Mar 2020 for all; MHS GENESIS switch date is: Oct 2017 for Madigan, Sep 2019 for Travis and Feb 2021 for San Diego

The LPM regression results for the effect of MHS GENESIS implementation on the ED revisit within 72 hours outcome is presented in Table 5. Model (1) starts with controls for time and treatment facility fixed effects, with Portsmouth being the reference MTF; Model (2) adds controls for demographics to the initial regression; Model (3) adds diagnosis fixed effects; and finally, Model (4) includes interaction terms between facility and post GENESIS indicators, with Portsmouth also serving as the reference MTF for post GENESIS comparison.

When I analyze the immediate (within 6 months) post-GENESIS period, only Model (1) shows statistically significant results. With added controls in Models 2–4, the changes in the immediate post-GENESIS period are not statistically significant. In the long-term (after 6 months) post GENESIS period, the results show a statistically significant increase in ED revisits within 72 hours ranging from 0.88 – 1.33 percentage points across Models 1–3. This suggests that, following the implementation of MHS GENESIS, patients were 0.88 – 1.33 percentage points more likely to have an ED revisit within 72 hours of their initial ED visit. The 1.33 percentage point change is equivalent to 28% increase given the base rate of ED revisit is 4.8%.

The increase in the ED revisit rate post GENESIS > 6 months in Model (3) is mainly driven by San Diego, as shown in Model (4) which adds interactions to study differential effects across the treatment facilities. Model (4) shows that for the interaction term between San Diego and the long-term post GENESIS period, 72-hour ED revisit rates went up by 1.49 percentage (equivalent to 31% increase from the baseline of 4.8%). The interaction term between Madigan and the 6-month post-GENESIS period shows that changes in ED revisit rate at Madigan is 0.15 percentage points higher than the change observed in Portsmouth and this is not statistically significant. On the other hand, Travis experienced a decrease in 72-hour ED revisits by 0.2 percentage points in the long-term post-GENESIS period, but this was also not statistically significant.

Table 5. Effects of MHS GENESIS on ED Revisits within 72 Hours

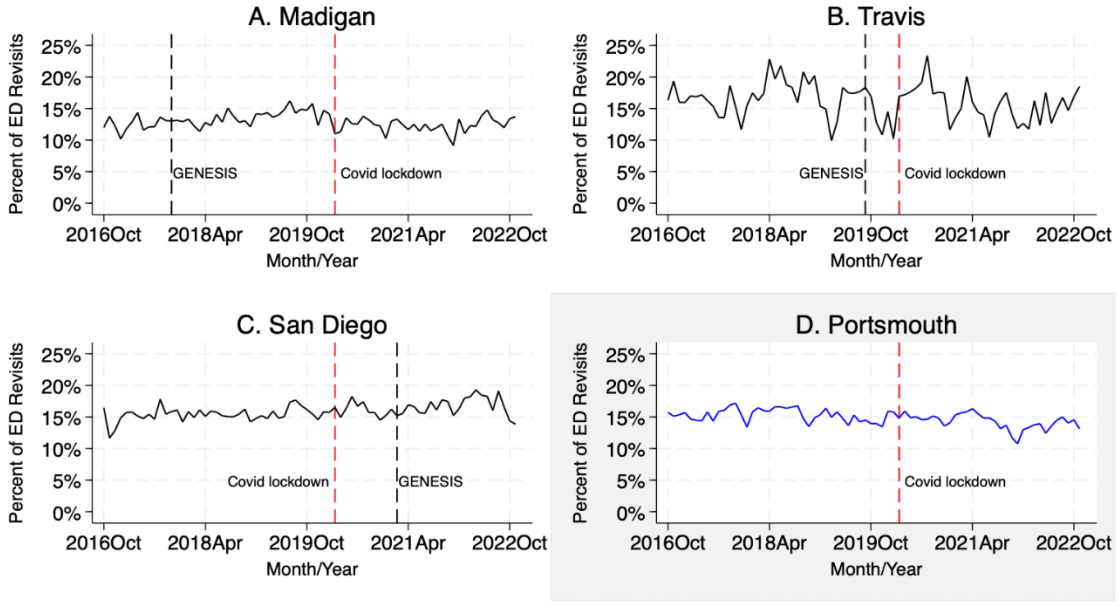
	(1) Post-GENESIS	(2) Demographics	(3) Diagnosis FE	(4) Interaction
Post-GENESIS <= 6 months	0.457***	0.241	-0.037	-0.266
	(0.171)	(0.173)	(0.174)	(0.180)
Post-GENESIS > 6 months	1.332***	1.108***	0.883***	
	(0.127)	(0.130)	(0.131)	
Travis post-GENESIS > 6 months				-0.210
				(0.255)
San Diego post-GENESIS > 6 months				1.494***
				(0.156)
Madigan post-GENESIS > 6 months				0.148
				(0.226)
Portsmouth (reference MTF)				
Travis	0.156	0.168	0.128	0.604***
	(0.142)	(0.142)	(0.142)	(0.169)
San Diego	0.714***	0.744***	0.725***	0.601***
	(0.079)	(0.079)	(0.079)	(0.081)
Madigan	-1.064***	-1.052***	-1.072***	-0.465**
	(0.141)	(0.141)	(0.142)	(0.206)
Month/Year Fixed Effects	X	X	X	X
Demographics		X	X	X
Diagnosis Fixed Effects			X	X
Constant	4.302***	9.233***	9.190***	9.162***
	(0.050)	(0.432)	(0.431)	(0.431)
Outcome Mean	4.8	4.8	4.8	4.8
R-Squared	0.001	0.002	0.008	0.008
Observations	488,157	488,157	488,157	488,157

Standard errors in parentheses * p<.10, ** p<.05, *** p<.01
Note: Demographics include male, officer, age, age squared and race (White (reference), Black, American Indian, Asian, and other)

2. ED Revisits within 30 Days

It is worth examining ED revisits within 30 days because patients tend to utilize the ED for non-urgent or primary care services as discussed by Han et al. (2015), whereas 72-hour ED revisits are more likely associated with increasing illness severity. The percentage of monthly ED revisits that occur within 30 days for each respective MTF can be seen in Figure 4. The percentage of monthly ED revisits within 30 days had a slight increase after MHS GENESIS for Madigan and San Diego while Travis experienced a slight decrease. As an example, in Figure 4B shows that around MHS GENESIS implementation the 30-day revisit rate was around 18%, while Figure 4A shows cyclical variations that remain between 10% and 15% during the entire observation period.

Figure 4. Percent of Monthly ED Revisits within 30 Days From October 2016 – December 2022



Note: Covid lockdown is defined as Mar 2020 for all; MHS GENESIS switch date is: Oct 2017 for Madigan, Sep 2019 for Travis and Feb 2021 for San Diego

The LPM regression results for the effect of MHS GENESIS implementation on the ED revisit within 30 days outcome is presented in Table 6. When I analyze the immediate (within 6 months) post-GENESIS period, results are only statistically

significant in Model (1) and Model (4). However, in Model (1) the immediate post-Genesis period shows an increase in ED revisits within 30 days while Model (4) shows a decrease in the outcome after adding controls for demographics, diagnosis and MTF specific effects. In the long-term (after 6 months) post GENESIS period, the results show a statistically significant increase in ED revisits within 30 days ranging from 0.78 – 1.97 percentage points across Models 1–3. This suggests that, in the 6 months or greater period following the implementation of MHS GENESIS, patients were 0.78 – 1.97 percentage points more likely to have an ED revisit within 30 days of their initial ED visit.

The increase in the ED revisit rate post GENESIS > 6 months in Model (3) is mainly driven by San Diego, as shown in Model (4) which adds interactions to study differential effects across the treatment facilities. Model (4) shows that for the interaction term between Travis and the long-term post GENESIS period, 30-day ED revisit rates decreased by 1.2 percentage points (equivalent to 8% decrease) in comparison to Portsmouth. The interaction term between Madigan and the 6-month post-GENESIS period is not statistically significant. On the other hand, San Diego experienced a statistically significant increase in 30-day ED revisits by 1.54 percentage points in the long-term post-GENESIS period in comparison to Portsmouth (equivalent to 10% increase).

Overall, I find similar results for the 72-hour and 30-day ED revisit outcome, where the increase in ED revisit rates is driven by San Diego in long term post-GENESIS period. Travis experienced a decrease in both outcomes, with only 30-day ED revisits being statistically significant, while the changes at Madigan were not statistically significant for either outcome. Additionally, the analysis of the demographics in Models (2), (3) and (4) for both outcomes show statistically significant results for males, officers, race, and age. Males are less likely to have an ED revisit than females while officers are less likely to have an ED revisit than enlisted personnel. While Asians are also less likely than Whites to have an ED revisit within 72 hours and American Indians and other race category are less likely than Whites to have an ED revisit within 30 days. Finally, age shows a U-shaped relationship where both outcomes initially decrease as age increases, reaches a minimum point, and then increases thereafter (see Table 12 and Table 13 in the appendix).

Table 6. Effects of MHS GENESIS on ED Revisits within 30 Days

	(1) Post-GENESIS	(2) Demographics	(3) Diagnosis FE	(4) Interaction
Post-GENESIS <= 6 months	0.784***	-0.291	-0.383	-0.569*
	(0.288)	(0.289)	(0.291)	(0.301)
Post-GENESIS > 6 months	1.968***	0.827***	0.783***	
	(0.213)	(0.217)	(0.218)	
Travis post-GENESIS > 6 months				-1.193***
				(0.427)
San Diego post-GENESIS > 6 months				1.535***
				(0.262)
Madigan post-GENESIS > 6 months				0.333
				(0.378)
Portsmouth (reference MTF)				
Travis	0.580**	0.868***	0.899***	1.736***
	(0.238)	(0.237)	(0.238)	(0.282)
San Diego	0.681***	1.029***	0.997***	0.836***
	(0.132)	(0.132)	(0.133)	(0.136)
Madigan	-3.492***	-2.991***	-3.074***	-2.693***
	(0.237)	(0.236)	(0.237)	(0.345)
Month/Year Fixed Effects	X	X	X	X
Demographics		X	X	X
Diagnosis Fixed Effects			X	X
Constant	14.843***	33.741***	33.211***	33.182***
	(0.084)	(0.722)	(0.722)	(0.722)
Outcome Mean	15.1	15.1	15.1	15.1
R-Squared	0.002	0.011	0.014	0.014
Observations	488,157	488,157	488,157	488,157

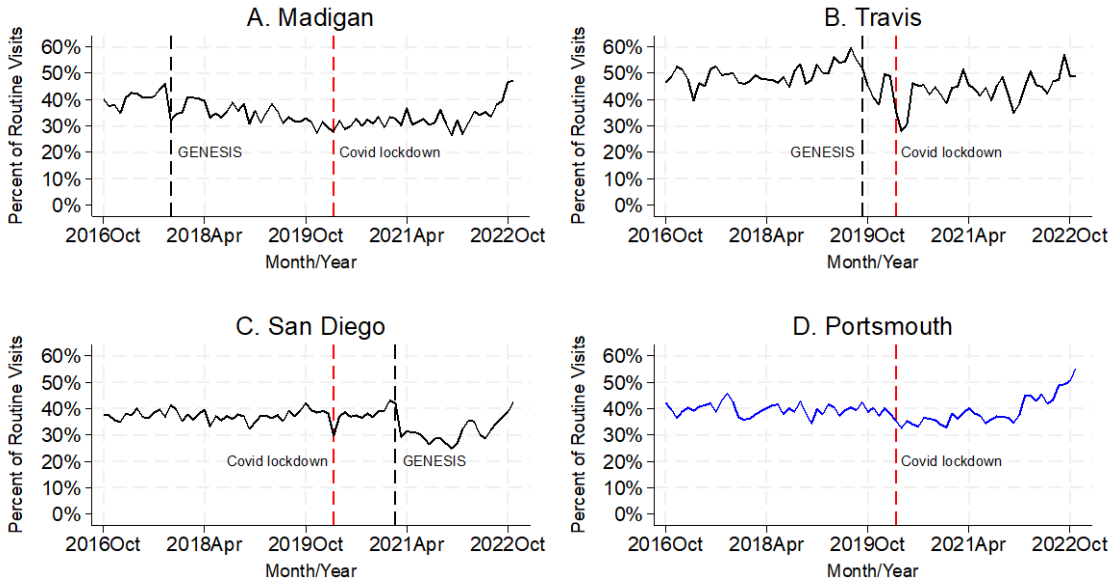
Standard errors in parentheses * p<.10, ** p<.05, *** p<.01
Note: Demographics include male, officer, age, age squared and race (White (reference), Black, American Indian, Asian, and other)

C. ROUTINE FOLLOW-UP VISIT

1. Routine Follow-Up within 7 Days

It is important to analyze follow-up care after ED visits because this measure is associated with improved patient outcomes (Lin et al., 2020). Figure 5 suggests the percentage of monthly routine follow-ups within 7 days had a slight decrease after MHS GENESIS for Madigan, Travis, and San Diego.

Figure 5. Percent of Monthly Routine Follow-Up Visit within 7 Days From October 2016 – December 2022



Note: Covid lockdown is defined as Mar 2020 for all; MHS GENESIS switch date is: Oct 2017 for Madigan, Sep 2019 for Travis and Feb 2021 for San Diego

The LPM regression results for the effect of MHS GENESIS implementation on the routine follow-up within 7 days outcome presented in Table 7 confirm the decrease visualized in Figure 5. When I analyze the immediate (within 6 months) post-GENESIS period, results are statistically significant across all models, showing a decrease in routine follow-up visits within 7 days in the first 6 months of MHS GENESIS implementation. Results for the long-term post GENESIS period also show statistically significant decreases across Models 1–3 ranging from 8.24 – 10.76 percentage points. This suggests that 6

months after the implementation of MHS GENESIS, patients were 8.24 – 10.76 percentage points less likely to have a routine follow-up visit within 7 days.

The decrease in the rate of routine follow-up visit within 7 days post GENESIS > 6 months in Model (3) is driven by all three MTFs, as shown in Model (4) which adds interactions to study differential effects across the treatment facilities. Model (4) shows that for the interaction term between Travis and the long-term post GENESIS period, the rate of routine follow-up visits within 7 days decreased by 8 percentage points (equivalent to 53% decrease) in comparison to Portsmouth. San Diego also experienced a statistically significant decrease in the follow-up rate of 10.8 percentage points in the long-term post-GENESIS period in comparison to Portsmouth (equivalent to 71.5% decrease). The interaction term between Madigan and the 6-month post-GENESIS period shows that changes in the follow-up rate at Madigan is 9.35 percentage points less than the change in Portsmouth. Overall, this suggests that MHS GENESIS implementation had a negative impact on a patient's ability to schedule a routine follow-up within 7 days of their initial ED visit compared to the control facility.

Table 7. Effects of MHS GENESIS on Routine Follow-Ups within 7 Days

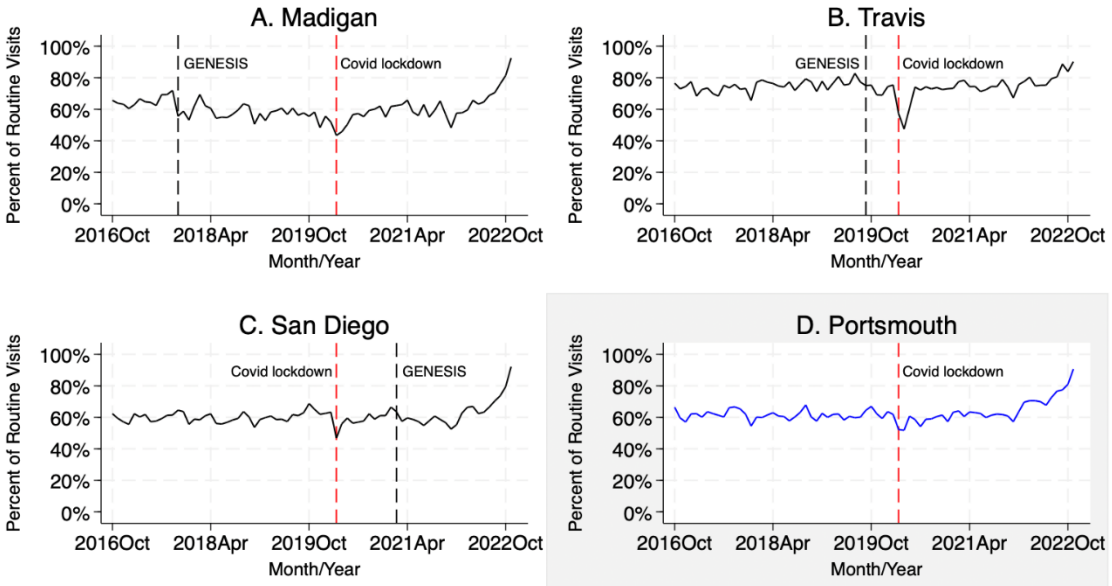
	(1) Post-GENESIS	(2) Demographics	(3) Diagnosis FE	(4) Interaction
Post-GENESIS <= 6 months	-5.409***	-7.817***	-7.115***	-6.917***
	(0.489)	(0.493)	(0.488)	(0.504)
Post-GENESIS > 6 months	-8.244***	-10.763***	-9.768***	
	(0.367)	(0.374)	(0.370)	
Travis post-GENESIS > 6 months				-7.996***
				(0.650)
San Diego post-GENESIS > 6 months				-10.797***
				(0.476)
Madigan post-GENESIS > 6 months				-9.347***
				(0.598)
Portsmouth (reference MTF)				
Travis	10.963***	11.182***	13.891***	13.125***
	(0.374)	(0.373)	(0.368)	(0.431)
San Diego	-1.645***	-1.142***	-0.300	-0.114
	(0.224)	(0.224)	(0.221)	(0.227)
Madigan	1.965***	2.047***	3.379***	3.033***
	(0.395)	(0.395)	(0.390)	(0.542)
Month/Year Fixed Effects	X	X	X	X
Demographics		X	X	X
Diagnosis Fixed Effects			X	X
Constant	39.415***	59.614***	53.192***	53.192***
	(0.139)	(1.227)	(1.209)	(1.209)
Outcome Mean	37.9	37.9	37.9	37.9
R-Squared	0.010	0.016	0.051	0.051
Observations	306,449	306,449	306,449	306,449

Standard errors in parentheses * p<.10, ** p<.05, *** p<.01
Note: Demographics include male, officer, age, age squared and race (White (reference), Black, American Indian, Asian, and other)

2. Routine Follow-Up within 30 Days

Modeling the study completed by Lin et al. (2020), who compared outcomes between 7- and 30-day follow-up, I also study the follow-up rate at 30 days following an initial ED visit. Figure 6 highlights a slight decrease in the percentage of monthly routine follow-up visits that occur less than 30 days following an ED visit for Madigan and Travis and a slight increase for San Diego after MHS GENESIS implementation.

Figure 6. Percent of Monthly Routine Follow-Up within 30 Days from October 2016 – December 2022



Note: Covid lockdown is defined as Mar 2020 for all; MHS GENESIS switch date is: Oct 2017 for Madigan, Sep 2019 for Travis and Feb 2021 for San Diego

The LPM regression results in Table 8 illustrate the impact of MHS GENESIS implementation on the routine follow-up within 30 days, however unlike Figure 6, the results show that all MTFs displayed a decrease. The immediate (within 6 months) post-GENESIS period shows statistically significant decrease in the outcome across all models. Results for the long-term post GENESIS period also show statistically significant decreases across Models 1–3 ranging from 4.58 – 7.51 percentage points. This suggests that 6 months

after the implementation of MHS GENESIS, patients were 4.58 – 7.51 percentage points less likely to have a routine follow-up visit within 30 days of their initial ED visit.

The decrease in the rate of routine follow-up visit within 30 days post GENESIS > 6 months in Model (3) is driven by all MTFs, as shown in Model (4) which adds interactions to study differential effects across the treatment facilities. Model (4) shows that for the interaction term between Travis and the long-term post GENESIS period, the rate of routine follow-up visits within 30 days decreased by 6.45 percentage points (equivalent to 10.3% decrease) in comparison to Portsmouth. San Diego experienced a statistically significant decrease in the follow-up rate of 5.38 percentage points in the long-term post-GENESIS period in comparison to Portsmouth (equivalent to 8.6% decrease). The interaction term between Madigan and the 6-month post-GENESIS period shows that changes in the follow-up rate at Madigan are 8.68 percentage points less than the change observed in Portsmouth.

Overall, I find similar results for the routine follow-up within 7 days and 30 days outcome. The decrease in routine follow-up rates is driven by all three MTFs in long term post-GENESIS period. Additionally, the analysis of the demographics in Models (2), (3) and (4) for both outcomes show statistically significant results for males, officers, race, and age. Males are less likely to have a routine follow-up than females while officers are also less likely to have a routine follow-up than enlisted personnel. While American Indians are also less likely than Whites to have a routine follow-up within 30 days, the other race category are less likely than Whites to have a routine follow-up within both 7 and 30 days. Finally, age shows a U-shaped relationship where both 7-day and 30-day routine follow-up outcomes initially decrease as age increases, reaches a minimum point, and then increases thereafter (see Table 14 and Table 15 in the appendix).

Table 8. Effects of MHS GENESIS on Routine Follow-Ups within 30 Days

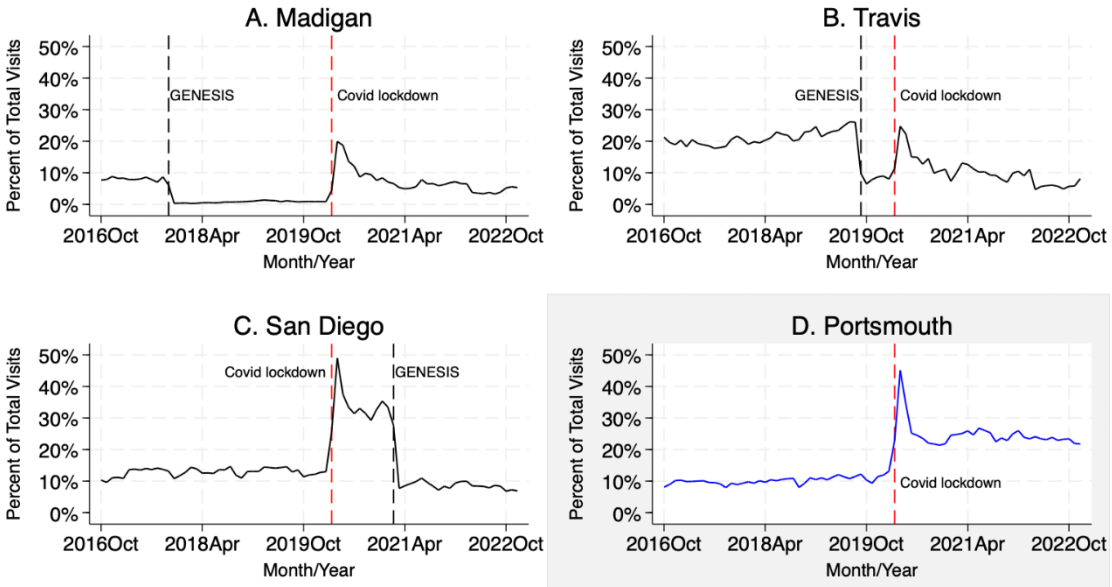
	(1) Post-GENESIS	(2) Demographics	(3) Diagnosis FE	(4) Interaction
Post-GENESIS <= 6 months	-3.312***	-6.132***	-5.456***	-6.048***
	(0.486)	(0.488)	(0.485)	(0.501)
Post-GENESIS > 6 months	-4.582***	-7.513***	-6.553***	
	(0.365)	(0.371)	(0.368)	
Travis post-GENESIS > 6 months				-6.445***
				(0.646)
San Diego post-GENESIS > 6 months				-5.379***
				(0.474)
Madigan post-GENESIS > 6 months				-8.677***
				(0.595)
Portsmouth (reference MTF)				
Travis	13.928***	14.545***	16.675***	16.692***
	(0.372)	(0.370)	(0.366)	(0.429)
San Diego	-0.791***	-0.107	0.437**	0.257
	(0.223)	(0.222)	(0.220)	(0.226)
Madigan	1.037***	1.743***	2.502***	4.199***
	(0.393)	(0.392)	(0.389)	(0.539)
Month/Year Fixed Effects	X	X	X	X
Demographics		X	X	X
Diagnosis Fixed Effects			X	X
Constant	62.607***	78.121***	72.856***	72.817***
	(0.138)	(1.217)	(1.203)	(1.203)
Outcome Mean	62.4	62.4	62.4	62.4
R-Squared	0.018	0.030	0.058	0.058
Observations	306,449	306,449	306,449	306,449

Standard errors in parentheses * p<.10, ** p<.05, *** p<.01
Note: Demographics include male, officer, age, age squared and race (White (reference), Black, American Indian, Asian, and other)

D. TELEHEALTH UTILIZATION

Given the MHS goal of expanding telehealth use, I display the percent of telemedicine visits for each respective hospital in Figure 7. All hospitals display an increase in telemedicine in the period immediately following the COVID lockdown. Madigan has a decrease in the percent of telemedicine visits after MHS GENESIS implementation and this percentage remains lower than the pre MHS GENESIS period. Travis also shows a decrease post MHS GENESIS implementation and after the COVID lockdown the percentage remains at half of pre MHS GENESIS levels. Finally, after the surge in telemedicine immediately post COVID lockdown, the percentage of telemedicine also decreases in San Diego. In contrast, the fraction of telemedicine visits remains high and above pre pandemic levels at Portsmouth.

Figure 7. Percent of Monthly Telemedicine Visits October 2016 – December 2022



Note: Covid lockdown is defined as Mar 2020 for all; MHS GENESIS switch date is: Oct 2017 for Madigan, Sep 2019 for Travis and Feb 2021 for San Diego

The LPM regression results for the effect of MHS GENESIS implementation on the telemedicine visits outcome presented in Table 9 confirm the decreases represented

visually in Figure 7. When I analyze the immediate (within 6 months) post-GENESIS period, results are statistically significant across all models, showing a decrease in telemedicine visits in the first 6 months of MHS GENESIS implementation. Results for the long-term post GENESIS period also show statistically significant decreases across Models 1–3 ranging from 13.38 – 17.93 percentage points. This suggests that 6 months after the implementation of MHS GENESIS, patients were 13.38 – 17.93 percentage points less likely to have a telemedicine visit.

The decrease in telemedicine visits post GENESIS > 6 months in Model (3) is driven by all 3 MTFs, as shown in Model (4) which adds interactions to study differential effects across the treatment facilities. Model (4) shows that for the interaction term between Travis and the long-term post GENESIS period, the rate of telemedicine visits decreased by 19.72 percentage points (equivalent to 149.4% decrease) in comparison to Portsmouth. San Diego also experienced a statistically significant decrease in the rate of telemedicine visits of 11.89 percentage points in the long-term post-GENESIS period in comparison to Portsmouth (equivalent to 90% decrease). The interaction term between Madigan and the 6-month post-GENESIS period shows that changes in the telemedicine visit rate at Madigan are 10.5 percentage points less than the change observed in Portsmouth.

Additionally, the analysis of the demographics in Models (2), (3) and (4) show statistically significant results for males, officers, race, and age. Males are less likely to have a telemedicine visit than females while officers are more likely to have a telemedicine visit within than enlisted personnel. For race, there is also statistically significant results showing that Asian and the other race category are less likely than Whites to have a telemedicine visit while Blacks are more likely than Whites to have a telemedicine visit. Finally, age shows a U-shaped relationship where the outcome initially decreases as age increases, reaches a minimum point, and then increases thereafter (see Table 16 in the appendix).

Table 9. Effects of MHS GENESIS on Telemedicine Visits

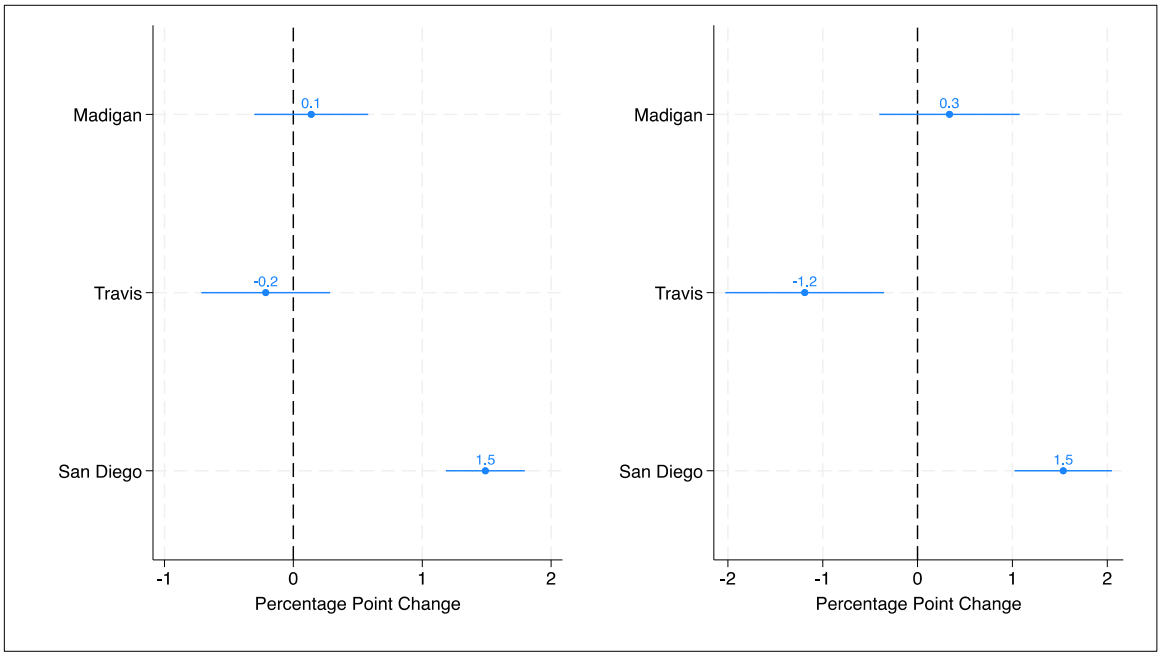
	(1) Post-GENESIS	(2) Demographics	(3) Diagnosis FE	(4) Interaction
Post-GENESIS <= 6 months	-14.801***	-14.694***	-9.914***	-9.623***
	(0.069)	(0.070)	(0.069)	(0.071)
Post-GENESIS > 6 months	-17.926***	-17.818***	-13.376***	
	(0.050)	(0.051)	(0.052)	
Travis post-GENESIS > 6 months				-19.723***
				(0.082)
San Diego post-GENESIS > 6 months				-11.887***
				(0.067)
Madigan post-GENESIS > 6 months				-10.495***
				(0.076)
Portsmouth (reference MTF)				
Travis	7.412***	7.559***	7.695***	10.723***
	(0.049)	(0.049)	(0.048)	(0.057)
San Diego	3.116***	3.334***	3.533***	3.140***
	(0.034)	(0.034)	(0.033)	(0.034)
Madigan	2.587***	2.867***	2.226***	0.011
	(0.051)	(0.051)	(0.050)	(0.066)
Month/Year Fixed Effects	X	X	X	X
Demographics		X	X	X
Diagnosis Fixed Effects			X	X
Constant	16.776***	8.819***	4.064***	4.070***
	(0.020)	(0.163)	(0.159)	(0.159)
Outcome Mean	13.2	13.2	13.2	13.2
R-Squared	0.056	0.059	0.114	0.115
Observations	7,061,796	7,061,795	7,061,795	7,061,795

Standard errors in parentheses * p<.10, ** p<.05, *** p<.01
Note: Demographics include male, officer, age, age squared and race (White (reference), Black, American Indian, Asian, and other)

E. SUMMARY

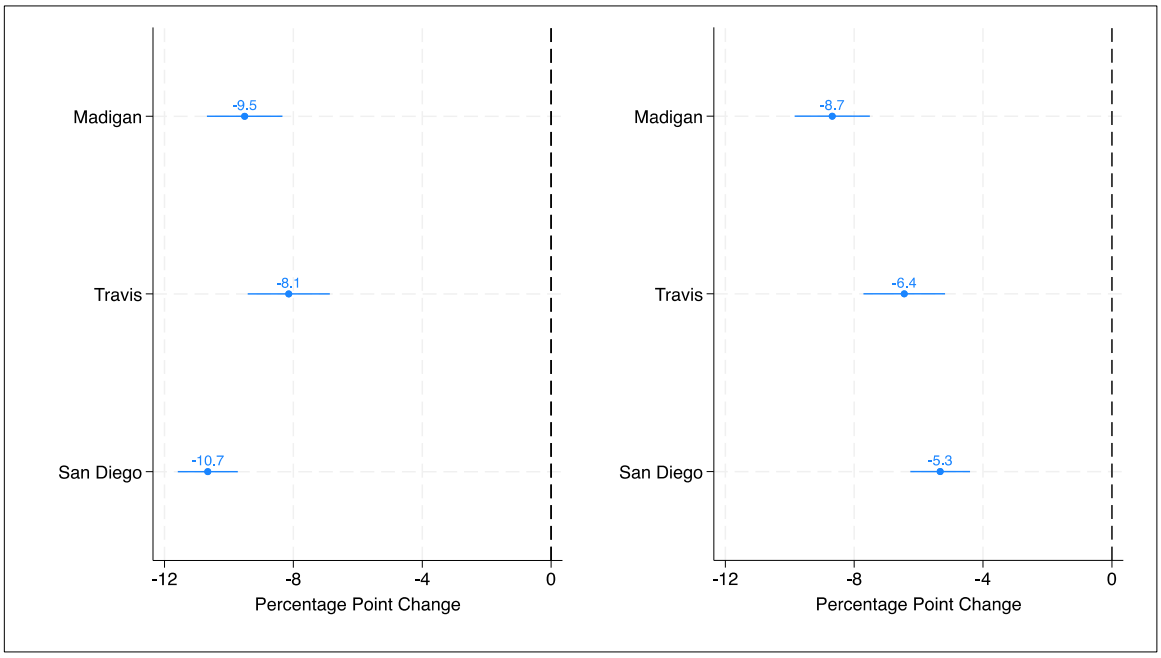
The key findings of this analysis show that, after accounting for the initial 6-month transition stage, MHS GENESIS is associated with mostly neutral or negative patient visit outcomes. In Figure 8 I show the results of the difference-in-differences analysis of the effect of MHS GENESIS implementation on each hospital for both 72-hour and 30-day ED revisit. San Diego experienced increases in ED revisits, while Madigan showed no significant change and Travis showed a small positive change with a reduction in the 30-day ED revisit outcome. On the other hand, decreases in routine follow-up visits were observed in all sites after the initial transition period and is shown in in Figure 9.

Figure 8. Effect of MHS GENESIS on Probability of ED Revisit within 72 Hours and 30 Days, by MTF



ED Revisits within 72 hours is shown on the left and within 30 days is shown on the right.

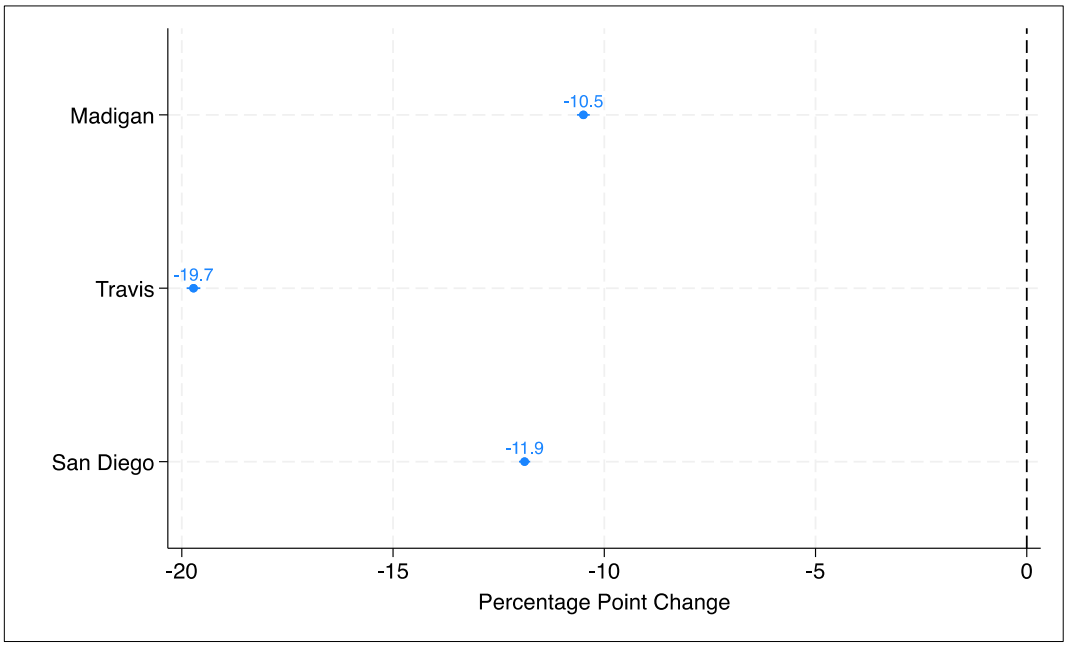
Figure 9. Effect of MHS GENESIS on Probability of Routine Follow-Up within 7 and 30 Days of Initial ED Visit, by MTF



Routine follow-up within 7 days is shown on the left and within 30 days is shown on the right.

The results for telehealth indicate a significant decrease across all three MTFs following EHR implementation. This widespread decrease is shown in Figure 10. The decrease in this outcome may be impacted by the coding practices used to define a telehealth visit in the legacy system versus the standards used after the implementation of MHS GENESIS.

Figure 10. Effect of MHS GENESIS on Probability of Telehealth Visit, by MTF



Additionally, the analysis of the demographics indicates that males are less likely than females to have ED revisits, routine follow-ups, and telemedicine visits. This analysis supports the notion that active-duty females interact with the healthcare system more frequently than males. Officers are also less likely to have ED revisits and routine follow-ups; however, they are more likely to have a telemedicine visit compared to enlisted personnel. These results suggest that enlisted personnel have more in-person interaction with the healthcare system than officers.

Regarding race, Asians are less likely than Whites to have ED revisits within 72 hours and telemedicine visits when compared to Whites. American Indians are also less likely to have ED revisits within 30 days and routine follow-ups within 30 days compared to Whites. Blacks are more likely to have telemedicine visits when compared to Whites. Finally, for all ED revisit, routine follow-up, and telehealth outcomes, as age increases the outcome initially decreases, reaches a minimum point, and then increases thereafter.

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VI. CONCLUSION AND RECOMMENDATIONS

A. CONCLUSION

The implementation of a new consolidated EHR system has the potential to significantly improve the healthcare system through enhanced efficiency and safety, including reduced hospital days, administrative burden, drug prescriptions, imaging orders, adverse events, and improved management of chronic diseases (Hillestad et al., 2005). The DOD's acquisition of MHS GENESIS and subsequent phased implementation of the new EHR provided the opportunity to evaluate outcomes and assess the benefits of this new technology within the MHS.

In this thesis my aim was to answer the following narrowly scoped research questions:

- What impact does MHS GENESIS implementation have on appointment utilization patterns?
- How do ED visits and re-visits rates within 72 hours and 30 days change pre- and post- MHS GENESIS implementation?
- What are the routine follow-up visit rates within 7 and 30 days following an ED visit, pre- and post- MHS GENESIS implementation?
- How have telehealth visit rates changed pre- and post- MHS GENESIS implementation?

My initial hypothesis was that MHS GENESIS would have a positive impact on appointment utilization patterns. For example, I expected a decrease in ED revisit rates due to improved care coordination and patient management from the new EHR, leading to appropriate follow-up appointments and quality care with adequate discharge instructions to prevent ED returns. Similarly, I anticipated an increase in routine follow-up rates due to increased efficiencies and patient coordination from the new EHR. Finally, I would expect

an increase in the rate of telehealth visits due to both the new integrated EHR and increased MHS efforts to expand telehealth services.

However, my findings suggest that MHS GENESIS had either no impact or mostly negative impacts on the appointment utilization patterns I reviewed. After implementing appropriate controls, which included the initial 6-month transition stage, San Diego experienced a 31.25% increase in the rate of the 72-hour ED revisit outcome and a 10% increase in the rate of the 30-day ED revisit outcome when compared to the mean. The increase in the ED revisit outcomes for San Diego was an unexpected finding. Travis and Madigan showed no significant change in the rate of the 72-hour ED revisit outcome. Travis was the only outlier showing an 8% decrease in the 30-day ED revisit outcome when compared to the mean. This finding supports my hypothesis of increased efficiency in the healthcare system resulting in a decrease in returns to the ED for Travis. Although I expected decreases in ED revisits across all hospitals post-MHS GENESIS implementation, MTF ED revisit rates (see Table 4) still fall within the range of 0.39% to 16% (for 72 hours through 30 days) shown in the integrative literature review performed by Han et al. (2015).

Additionally, all sites experienced a decrease in the rate of both routine follow-up visit outcomes after the initial transition period. This finding was unexpected, as I hypothesized that the new EHR would increase the follow-up rate after an initial ED visit. Although comparable standardized recommendations for routine follow-up rates was not found in the literature review, Lin et al. (2020) discusses a rate of 40.4% for 7 days and 70.8% within 30 days in a study of Medicare patients. The follow-up rates shown in Table 4 for the 7-day and 30-day routine follow-up outcome for all hospitals studied show a similar range for the 7-day follow-up (31% through 49%) and comparable rates of follow-up within 30 days (59% through 75%).

Furthermore, results for telehealth also demonstrate a significant decrease across all three hospitals following EHR implementation. This finding is unexpected as it conflicts with the MHS goal of expanding telehealth services. Although, Gilder et al. (2023) discuss a substantial increase in telehealth across the MHS, the author's study period only examines January 2019 through December 2021, focusing on the peak pandemic period.

The authors highlights the prevalence rate of telehealth in the direct care system for 2019 through 2021 where the rate of telehealth starts at 3.76% in 2019, increases to 11.56% in 2020, but falls to 8.09% in 2021. Telehealth rates across the three hospitals I studied fall between the range of 4% to 9% after MHS GENESIS, following similar trends discussed by Gilder et al. (2023).

B. LIMITATIONS

There are several important limitations to consider when interpreting the results of this study. First, the MHS comprises 723 MTFs globally, each varying in size, mission, and capabilities (Mendez, 2019). This analysis focused solely on comparing three hospitals that underwent MHS GENESIS implementation against a control facility that did not implement the new EHR within the study period. The results from this analysis cannot be generalized to the entire MHS; however, they indicate that further analysis is needed to explore MHS-wide effects of MHS GENESIS.

Another significant limitation includes the cross-mapping of appointments from the legacy system to MHS GENESIS. The mapping documents used to create the routine outcome shown in Table 10 (in the appendix) did not provide a 100% match from all legacy appointment types to MHS GENESIS appointments. This may impact the routine follow-up rates, either underestimating or overestimating the outcome if our definition of routine is too narrowly or too broadly defined. Furthermore, coding practices for telehealth visits have changed significantly from the legacy system to MHS GENESIS. The procedure and modifier codes listed in Table 11 (in the appendix) were not widely used in the legacy system, where appointment types were more widespread.

Another factor that limits this study is the lack of delineation between enrolled and non-enrolled personnel. Enrolled personnel should have an assigned primary care doctor within the hospital, while non-enrolled or transient personnel may have a primary care provider attached to their operational unit or a different location. The behavior of non-enrolled and transient personnel can be different if they visit the hospital for emergency services but seek a follow-up with their embedded medical team. This delineation is

important for future analysis as combining all populations may skew results and overestimate ED utilization and underestimate routine follow-up care.

Other limitations of this analysis include the potential impact of changes in health-seeking behavior patterns during the pandemic or alterations in policies at any of the hospitals studied within the analysis period. As an example, variations in force health protection conditions across different military bases, determined by community prevalence rates during the pandemic, could have resulted in reduced access to certain facilities at different times. Such limitations may have influenced appointment availability and possibly led to an increase in emergency department visits if patients faced constraints in scheduling routine appointments. It is assumed that, conditional on all controls, the trends observed at Portsmouth offer a reliable counterfactual to represent the trajectory of other hospitals had they not implemented MHS GENESIS. However, this assumption may be erroneous in cases where unforeseen events impacted the hospitals, thus affecting the outcomes under study.

Finally, there are also other improvements and efficiencies that may be more challenging to measure widely such as patient, doctor, healthcare staff satisfaction, reduced documentation time, improved decision support or reduced patient harm (Tong & Kapinos, 2023). Alternative approaches to assess the effectiveness and efficiency of the MHS GENESIS implementation can include qualitative studies in the form of surveys to capture subjective experience with new system. These studies can be focused on all healthcare staff experience or specific experiences for different healthcare staff categories such as doctors, nurses, or support staff. The patient experience could also be a focus of a qualitative study to assess the impacts of MHS GENESIS implementation from the patient's perspective. Currently there is no available literature analyzing the impact of MHS GENESIS through qualitative methods. However, literature does exist assessing the impact of other civilian EHR implementation through the healthcare staff and patient perspectives.

C. RECOMMENDATIONS

My main recommendation is for the evaluation and analysis of MHS GENESIS on a broader scale, as this thesis focused on a narrow set of outcomes based on time and data

availability. Additional studies should evaluate the effect of MHS GENESIS on other aspects of patient care and facility performance measures specific to the MHS, as well as measures that allow for comparison with civilian benchmarks. Examples include access to care metrics, health screenings completion rates or inpatient care-related outcomes.

Furthermore, there are numerous additional patient outcomes that could also support efficiency and improvement resulting from an EHR implementation. For example, the CMS has established metrics based on certain diagnosis that result in unplanned hospital visits (Centers for Medicare & Medicaid Services, 2023) . According to CMS, the unplanned visits category encompasses rates of readmission, rates of hospital visits following an outpatient procedure or hospital return days. These measures focus on orthopedic or urology procedures or conditions such as heart failure, pneumonia, or myocardial infarction, for example. Diagnosis-specific analysis is outside of the scope of this thesis due to the complexity of these measures and medical coding nuances. However, these diagnostic specific measures provide insight into the complexities of the healthcare system and should be considered in future studies.

Although this thesis included some controls to analyze the outcomes, there are other variables that may impact these outcomes that we could not control for, such as resource or capability changes, mobilizations or staffing allocation changes within the hospitals we studied. Therefore, in further evaluations of MHS GENESIS my recommendation is to account for manning, capability, and mobilizations in the analysis of the selected outcomes.

Finally, there have been previous GAO reports as well as media reports citing challenges with the implementation of MHS GENESIS in various settings, to include recruiting. For example, in 2021, the GAO reported system defects, unresolved incident reports, as well as training and communication challenges (Government Accountability Office, 2021). These system challenges may also have contributed to our unexpected findings in this analysis. As further standardization continues and the data integrity of MHS GENESIS improves additional analysis should be conducted to evaluate the continued impact of MHS GENESIS in the MHS.

In the recruiting arena, the implementation of the Health Information Exchange associated with MHS GENESIS has led to an increase in the review of medical records during the recruitment process, uncovering more initial, potentially disqualifying conditions (Abel, 2024). As an example, the author cites that this transition has impacted the initial qualification rate of Air Force applicants at MEPS, dropping from 81% in Fiscal Year 2021 to 58% in Fiscal Year 2023. Therefore, further analysis is needed to assess the ongoing impact of MHS GENESIS on recruitment efforts, particularly regarding the increased review of medical records and its effects on qualification rates.

APPENDIX

A. MHS GENESIS FUNCTIONAL CAPABILITY REQUIREMENTS

Figure 11. Summary of MHS GENESIS Functional Capability Requirements. Adapted From Mendez (2019)

Health Service Delivery		
• Quality Assurance • Risk Management • Patient Safety • Quality Improvement • Screening • Health Counseling • Community Health Education • Immunization • Preventive Dentistry Services • Public Health Laboratory Services • Ambulatory Diagnostic (Medical and Dental) • Transitional Services	• Inpatient, Radiology, and Laboratory Diagnostic Services • Radiology Diagnostic Services • Non-Emergency Medical Transportation • Emergency Medical Services • Primary Care • Routine Ambulatory (Specialty Care and Dental) • Ambulatory Surgery • Medical Management • Inpatient Nonsurgical Treatment • Intensive Care	• Pharmacy Services • Therapeutic Radiology Services • Physical Therapy • Sensory Rehabilitation-Hearing and Audio-Vestibular Care • Vision Care • Occupational Therapy • Amputee Care • Burn Care • Occupational Rehabilitation • Disability Counseling and Coaching • Medical Support to Disability Evaluation
Health System Support		
• Health Services Contract Development and Management • Joint and Service Medical Education and Training • Create and Sustain the Healing Environment	• Partnership Development • Medical Financial Management • Medical Logistics	• Total Medical Force (Medical Professionals) • Medical Information Management • Medical Research and Development
Health Readiness		
• Joint Human Performance Enhancement • Non-Clinical Preventive Medicine/Health Surveillance • Shared Situational Understanding and Awareness • Detainee Medical Care	• Healthy and Fit Force (Health and Wellness) • Global Patient Movement • Support to Security, Stability, Transition, and Reconstruction Operations	• Public Health/Veterinary Services • Casualty Management • Support to Homeland Defense and Civil Operations • Operational Medical Logistic Support
Force Health Protection		
• Joint Medical Logistics and Infrastructure Support • Public Health/Veterinary Services • Medical Command and Control • Detainee Medical Care	• Human Performance Optimization • Non-Clinical Preventive Medicine/Health Surveillance • Global Patient Movement • Shared Situational Understanding and Awareness	• Health and Fit Force (Health and Wellness) • Casualty Management • Support to Stability Operations • Support to Homeland Defense and Civil Operations

B. ROUTINE VISITS

Table 10. Routine Visits Appointment Types

Appointment Types	Encounter Types
24HR	Clinic
24HR$	Observation
ACUT	Outpatient
ACUT$	Outpatient Day Surgery
FTR	Outpatient in a Bed
FTR$	Recurring
FTRG	
PCM	
ROUT	
ROUT$	
VIRT	
WALKIN	
WELL	
WELL$	
SPEC	
SPEC$	
SPECG	
TCON*	
PROC	
PROC$	
PROCG	

C. TELEHEALTH VISITS

Table 11. Telehealth Visit Procedure and Procedure Modifier Codes

Procedure Codes			Procedure Modifier Codes
92227	95719	G0427	GT
92228	95720	G0459	GQ
93264	95721	G0508	G0
93293	95722	G0509	FQ
93294	95723	G2010	93
93295	95724	G2012	95
93296	95725	G2061	
93297	98968	G2062	
93298	98969	G2063	
93299	98970	G9481	
95700	98971	G9482	
95705	98972	G9483	
95706	99091	G9484	
95707	99453	G9485	
95708	99454	G9486	
95709	99457	G9487	
95710	99458	G9488	
95711	D9995	G9489	
95712	D9996	G9868	
95713	G0071	G9869	
95714	G0406	G9870	
95715	G0407	Q3014	
95716	G0408	S9110	
95717	G0425	T1014	
95718	G0426	T2025	

D. COMPLETE LPM REGRESSIONS

Table 12. Effects of MHS GENESIS on ED Revisits within 72 Hours (Expanded)

	(1) Post-GENESIS	(2) Demographics	(3) Diagnosis FE	(4) Interaction
Post-GENESIS <= 6 months	0.457***	0.242	-0.033	-0.262
	(0.171)	(0.173)	(0.174)	(0.180)
Post-GENESIS > 6 months	1.332***	1.109***	0.887***	
	(0.127)	(0.130)	(0.131)	
Travis post-GENESIS > 6 months				-0.206
				(0.255)
San Diego post-GENESIS > 6 months				1.498***
				(0.156)
Madigan post-GENESIS > 6 months				0.152
				(0.226)
Portsmouth (reference MTF)				
Travis	0.156	0.168	0.130	0.605***
	(0.142)	(0.142)	(0.142)	(0.169)
San Diego	0.714***	0.744***	0.725***	0.602***
	(0.079)	(0.079)	(0.079)	(0.081)
Portsmouth	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Madigan	-1.064***	-1.052***	-1.069***	-0.462**
	(0.141)	(0.141)	(0.142)	(0.206)
Male		-0.296***	-0.154**	-0.158**
		(0.066)	(0.068)	(0.068)
Officer		-0.433***	-0.469***	-0.471***
		(0.139)	(0.138)	(0.138)
White (reference race)				
Black		0.074	0.073	0.073
		(0.083)	(0.082)	(0.082)
Asian		-0.320**	-0.312**	-0.328**
		(0.139)	(0.138)	(0.138)
American_Indian		0.291	0.280	0.271
		(0.330)	(0.329)	(0.329)
Other		-0.576***	-0.579***	-0.559***
		(0.080)	(0.079)	(0.079)
Age		-0.247***	-0.246***	-0.244***
		(0.028)	(0.028)	(0.028)
Age_squared		0.003***	0.003***	0.003***
		(0.000)	(0.000)	(0.000)
Month/Year Fixed Effects	X	X	X	X
Diagnosis Fixed Effects			X	X
Constant	4.302***	9.233***	9.187***	9.160***
	(0.050)	(0.432)	(0.431)	(0.431)
Outcome Mean	4.8	4.8	4.8	4.8
R-Squared	0.001	0.002	0.008	0.008
Observations	488,157	488,157	488,157	488,157

Standard errors in parentheses * p<.10, ** p<.05, *** p<.01

Table 13. Effects of MHS GENESIS on ED Revisits within 30 Days (Expanded)

	(1) Post-GENESIS	(2) Demographics	(3) Diagnosis FE	(4) Interaction
Post-GENESIS <= 6 months	0.784***	-0.291	-0.379	-0.564*
	(0.288)	(0.289)	(0.291)	(0.301)
Post-GENESIS > 6 months	1.968***	0.827***	0.786***	
	(0.213)	(0.217)	(0.218)	
Travis post-GENESIS > 6 months				-1.188***
				(0.427)
San Diego post-GENESIS > 6 months				1.537***
				(0.262)
Madigan post-GENESIS > 6 months				0.338
				(0.378)
Portsmouth (reference MTF)				
Travis	0.580**	0.868***	0.898***	1.735***
	(0.238)	(0.237)	(0.238)	(0.282)
San Diego	0.681***	1.029***	0.996***	0.836***
	(0.132)	(0.132)	(0.133)	(0.136)
Madigan	-3.492***	-2.991***	-3.073***	-2.694***
	(0.237)	(0.236)	(0.237)	(0.345)
Male		-3.988***	-3.273***	-3.280***
		(0.110)	(0.114)	(0.114)
Officer		-3.176***	-3.086***	-3.088***
		(0.232)	(0.232)	(0.232)
White (reference race)				
Black		2.111***	1.995***	1.997***
		(0.138)	(0.138)	(0.138)
Asian		-0.299	-0.295	-0.308
		(0.232)	(0.231)	(0.231)
American_Indian		-0.326	-0.327	-0.335
		(0.552)	(0.551)	(0.551)
Other		-2.071***	-2.005***	-1.978***
		(0.133)	(0.133)	(0.133)
Age		-0.901***	-0.895***	-0.893***
		(0.047)	(0.047)	(0.047)
Age_squared		0.011***	0.011***	0.011***
		(0.001)	(0.001)	(0.001)
Month/Year Fixed Effects	X	X	X	X
Diagnosis Fixed Effects			X	X
Constant	14.843***	33.741***	33.206***	33.177***
	(0.084)	(0.722)	(0.722)	(0.722)
Outcome Mean	15.1	15.1	15.1	15.1
R-Squared	0.002	0.011	0.014	0.014
Observations	488,157	488,157	488,157	488,157

Standard errors in parentheses * p<.10, ** p<.05, *** p<.01

Table 14. Effects of MHS GENESIS on Routine Follow-Ups within 7 Days (Expanded)

	(1) Post-GENESIS	(2) Demographics	(3) Diagnosis FE	(4) Interaction
Post-GENESIS <= 6 months	-5.409***	-7.817***	-7.115***	-6.917***
	(0.489)	(0.493)	(0.488)	(0.504)
Post-GENESIS > 6 months	-8.244***	-10.763***	-9.768***	
	(0.367)	(0.374)	(0.370)	
Travis post-GENESIS > 6 months				-7.996***
				(0.650)
San Diego post-GENESIS > 6 months				-10.797***
				(0.476)
Madigan post-GENESIS > 6 months				-9.347***
				(0.598)
Portsmouth (reference MTF)				
Travis	10.963***	11.182***	13.891***	13.125***
	(0.374)	(0.373)	(0.368)	(0.431)
San Diego	-1.645***	-1.142***	-0.300	-0.114
	(0.224)	(0.224)	(0.221)	(0.227)
Madigan	1.965***	2.047***	3.379***	3.033***
	(0.395)	(0.395)	(0.390)	(0.542)
Male		-2.918***	-2.749***	-2.745***
		(0.185)	(0.191)	(0.191)
Officer		-3.504***	-2.587***	-2.589***
		(0.370)	(0.364)	(0.364)
White (reference race)				
Black		-0.051	-0.206	-0.206
		(0.236)	(0.232)	(0.232)
Asian		0.631	0.387	0.402
		(0.390)	(0.383)	(0.383)
American_Indian		-1.311	-1.215	-1.194
		(0.941)	(0.924)	(0.924)
Other		-6.983***	-6.210***	-6.235***
		(0.226)	(0.223)	(0.223)
Age		-1.161***	-0.888***	-0.888***
		(0.080)	(0.078)	(0.078)
Age_squared		0.020***	0.017***	0.017***
		(0.001)	(0.001)	(0.001)
Month/Year Fixed Effects	X	X	X	X
Diagnosis Fixed Effects			X	X
Constant	39.415***	59.614***	53.192***	53.192***
	(0.139)	(1.227)	(1.209)	(1.209)
Outcome Mean	37.9	37.9	37.9	37.9
R-Squared	0.010	0.016	0.051	0.051
Observations	306,449	306,449	306,449	306,449

Standard errors in parentheses * p<.10, ** p<.05, *** p<.01

Table 15. Effects of MHS GENESIS on Routine Follow-Ups within 30 Days (Expanded)

	(1) Post-GENESIS	(2) Demographics	(3) Diagnosis FE	(4) Interaction
Post-GENESIS <= 6 months	-3.312***	-6.132***	-5.456***	-6.048***
	(0.486)	(0.488)	(0.485)	(0.501)
Post-GENESIS > 6 months	-4.582***	-7.513***	-6.553***	
	(0.365)	(0.371)	(0.368)	
Travis post-GENESIS > 6 months				-6.445***
				(0.646)
San Diego post-GENESIS > 6 months				-5.379***
				(0.474)
Madigan post-GENESIS > 6 months				-8.677***
				(0.595)
Portsmouth (reference MTF)				
Travis	13.928***	14.545***	16.675***	16.692***
	(0.372)	(0.370)	(0.366)	(0.429)
San Diego	-0.791***	-0.107	0.437**	0.257
	(0.223)	(0.222)	(0.220)	(0.226)
Madigan	1.037***	1.743***	2.502***	4.199***
	(0.393)	(0.392)	(0.389)	(0.539)
Male		-7.328***	-6.407***	-6.406***
		(0.184)	(0.190)	(0.190)
Officer		-3.876***	-2.994***	-2.998***
		(0.367)	(0.362)	(0.362)
White (reference race)				
Black		0.374	0.133	0.128
		(0.234)	(0.231)	(0.231)
Asian		0.371	0.188	0.148
		(0.386)	(0.381)	(0.381)
American_Indian		-1.668*	-1.568*	-1.603*
		(0.933)	(0.920)	(0.920)
Other		-7.950***	-7.217***	-7.196***
		(0.224)	(0.221)	(0.222)
Age		-0.819***	-0.609***	-0.606***
		(0.079)	(0.078)	(0.078)
Age_squared		0.017***	0.015***	0.015***
		(0.001)	(0.001)	(0.001)
Month/Year Fixed Effects	X	X	X	X
Diagnosis Fixed Effects			X	X
Constant	62.607***	78.121***	72.856***	72.817***
	(0.138)	(1.217)	(1.203)	(1.203)
Outcome Mean	62.4	62.4	62.4	62.4
R-Squared	0.018	0.030	0.058	0.058
Observations	306,449	306,449	306,449	306,449

Standard errors in parentheses * p<.10, ** p<.05, *** p<.01

Table 16. Effects of MHS GENESIS on Telemedicine Visits (Expanded)

	(1) Post-GENESIS	(2) Demographics	(3) Diagnosis FE	(4) Interaction
Post-GENESIS <= 6 months	-14.801***	-14.694***	-9.914***	-9.623***
	(0.069)	(0.070)	(0.069)	(0.071)
Post-GENESIS > 6 months	-17.926***	-17.818***	-13.376***	
	(0.050)	(0.051)	(0.052)	
Travis post-GENESIS > 6 months				-19.723***
				(0.082)
San Diego post-GENESIS > 6 months				-11.887***
				(0.067)
Madigan post-GENESIS > 6 months				-10.495***
				(0.076)
Portsmouth (reference MTF)				
Travis	7.412***	7.559***	7.695***	10.723***
	(0.049)	(0.049)	(0.048)	(0.057)
San Diego	3.116***	3.334***	3.533***	3.140***
	(0.034)	(0.034)	(0.033)	(0.034)
Madigan	2.587***	2.867***	2.226***	0.011
	(0.051)	(0.051)	(0.050)	(0.066)
Male		-3.049***	-3.127***	-3.126***
		(0.027)	(0.027)	(0.027)
Officer		1.696***	0.671***	0.685***
		(0.044)	(0.043)	(0.043)
White (reference race)				
Black		0.025	0.101***	0.112***
		(0.035)	(0.034)	(0.034)
Asian		-0.269***	-0.341***	-0.297***
		(0.051)	(0.049)	(0.049)
American_Indian		0.099	-0.016	-0.037
		(0.137)	(0.133)	(0.133)
Other		-0.662***	-0.579***	-0.521***
		(0.032)	(0.031)	(0.031)
Age		0.489***	0.652***	0.652***
		(0.010)	(0.010)	(0.010)
Age_squared		-0.005***	-0.007***	-0.007***
		(0.000)	(0.000)	(0.000)
Month/Year Fixed Effects	X	X	X	X
Diagnosis Fixed Effects			X	X
Constant	16.776***	8.819***	4.064***	4.070***
	(0.020)	(0.163)	(0.159)	(0.159)
Outcome Mean	13.2	13.2	13.2	13.2
R-Squared	0.056	0.059	0.114	0.115
Observations	7,061,796	7,061,795	7,061,795	7,061,795

Standard errors in parentheses * p<.10, ** p<.05, *** p<.01

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