Exploratory Case Study of Barriers and Facilitators Associated With the Pilot Implementation of a New Electronic Healthcare Record in the Military

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ABSTRACT
Introduction: The Military Health System (MHS) overhauled its previous Electronic Health Records (EHRs) system. The MHS is in need of modernizing its healthcare system to improve patient safety and coordination of care between the MHS and Veterans Affairs. In 2015, the DoD awarded Cerner, Leidos, and Accenture a $4.3 billion EHR contract for a commercialized off-the-shelf system model to be used by more than 146,000 end users. This exploratory case study looked to access socio-technical barriers and facilitators to EHR implementation specifically in the military.

Materials and Methods: A document review served as the data source: implementation plans, evaluation reports, congressional reports, news articles, and relevant peer-reviewed literature. A series of a priori codes were developed, and emergent codes arose out of the thematic analysis process.

Results: There were several constructs that emerged from the analysis, placing emphasis on the uniqueness of EHR implementation in the MHS. The constructs of people, communication, and hardware and technical factors were strongly tied to EHR implementation. Additionally, medical readiness was identified in the analysis as a unique factor specific to the EHR implementation in the MHS.

Conclusion: This research identified three strategic recommendations for the MHS to consider: hire clinical informaticists, parallel EHR implementation, and enhance EHR training. This research also informed a Socio-Technical Leadership Framework for EHR Implementation to guide MHS leaders during health information technology implementation. Although significant health information technology changes may occur only once every few years, having issues during implementation impacts mission success, overall threatening the vital role that the MHS provides to national defense.

INTRODUCTION
Today’s health outcomes are complex and require detailed measurement and analysis to help manage population health improvements.1 Biomedical and health informatics play an important role because they help organizations optimize population health. Electronic Health Records (EHRs) have been shown to maximize population health efforts.2 As researchers in healthcare posited the potential benefits of EHRs for the general community, President George W. Bush noted the positive use of EHRs to modernize its healthcare system healthcare during his 2004 State of the Union address. Subsequently, President Barack Obama established the first government regulation specific to the field of informatics by signing the Health Information Technology for Economic and Clinical Health Act (HITECH).3 The intent behind this first-ever biomedical informatics legislation was to promote greater healthcare quality, safety, and moreover, to optimize efficiency in American healthcare operations.4 Today, healthcare providers use EHRs for managing administrative and clinical data in hospital and clinical settings.

In a report by the Center for American Progress, it was stated that between 2001 and 2012, the budget allotted for military healthcare grew by 300%.5 With ongoing military operations in Afghanistan, Iraq, and Syria, healthcare costs supporting veterans of these conflicts consumed ~56% of total healthcare expenditures.6,7 Given the impact of healthcare spending on the defense budget, the high costs directly impact the U.S. National Defense to protect force readiness.
As healthcare costs in the military increase, the Military Health System (MHS) must modernize its healthcare system to improve patient safety, reduce costs, and enhance coordination of care between the MHS and Veterans Affairs (VA). Biomedical and health informatics play an important role in the development of today’s military healthcare. EHRs can reduce health costs by effectively monitoring clinical decision making. With these considerations in mind, the MHS plans to overhaul its previous EHR system by 2023. In 2015, the DoD awarded Cerner, Leidos, and Accenture a $4.3 billion EHR contract for a commercialized off-the-shelf system model (GENESIS) to be used by more than 146,000 end users and support over nine million beneficiaries. This study specifically addressed socio-technical facilitators and barriers associated with EHR implementation in the military. Socio-technical factors are defined as the interrelatedness of social (i.e., people) and technical (i.e., hardware and software infrastructure) aspects of a health information system.

METHODS
An exploratory case study using a document review focusing on the MHS assessed socio-technical barriers and facilitators to EHR implementation in the military and identified lessons learned. A qualitative document review methodology was employed with the following data sources: implementation plans, evaluation reports, congressional reports, news articles, and relevant peer-reviewed literature related to military EHR implementation. Documents reflected peer-reviewed literature from Armed Forces Health Longitudinal Technology Application (AHLTA) and more recent documents on the pilot-testing sites that first implemented GENESIS. Articles were included if they were from peer-reviewed journals and documents related to sociotechnical facilitators and barriers of EHR implementation in the MHS. Because of the limited sample size of relevant available data, the timeframe of the articles was based on availability past a decade. A thematic analysis approach was applied. Key terms were identified before data collection for data analysis as a series of a priori codes (n = 14); emergent codes (n = 30) arose out of the thematic analysis process. Factors and their corresponding definitions are provided in Table I.

Documents were uploaded to ATLAS.ti qualitative analysis software program for data management. The codes were applied to the entire sections of each article and documents and evaluated for themes, patterns, convergences, and divergences. A second coder, with experience in qualitative analysis, reviewed three different data sources. Discrepancies were discussed and consensus reached on final codes. Co-occurrences were examined which helped point toward further analyses, and all documents were re-read, revised, re-coded, and collapsed as needed. Furthermore, the researcher made self-addressed memos to help guide the final conceptualization needed to answer the research questions. Lastly, stakeholder checks from key informants to evaluate interpretations and conclusions that emerged from the data. This research was classified as exempt research by U.S. Air Force 60th Medical Group (Air Mobility Command) institutional approval (IRB) Research Study FDG201700025E and by the University of Illinois at Chicago Office for the Protection of Research Subjects Protocol # 2017-0983.

RESULTS
Fourteen unique factors were identified in the documents that placed emphasis on the uniqueness of EHR implementation in the MHS. Table II provides a summary of the frequency

| Factor                          | Definition                                                                 |
|--------------------------------|---------------------------------------------------------------------------|
| Accuracy                       | Defined as the completeness of a healthcare record                        |
| Communication                  | Defined as communication disseminated orally, verbally, or written from the internal organization related to EHR implementation that has impacted its deployment |
| Cost                           | Defined as costs associated with the EHR, can include savings or other expenditures |
| Culture of data use            | Defined as a strong data culture results when an organization believes in continuous improvement and regularly puts that belief into practice |
| Delay                          | Defined as system interface problems that leads to a delay in the EHR implementation |
| Efficiency                     | Defined as patient records being readily available, the need to provide more information, and to enhance information sharing within the organization |
| Federal, state, and local healthcare regulations | Defined as regulations or laws or legislation such as HIPAA or HITECH that could impact EHR implementation |
| Hardware and software computing infrastructure | Defined as mention of hardware or software required to run system applications, includes mention of cyber security |
| Health data                    | Defined as any data related to health conditions, reproductive outcomes, causes of death, and quality of life |
| Healthcare management          | Defined as a profession that provides leadership and direction to organizations that deliver personal health service |
| Human computer interface       | Defined as interfaces that enables unrelated entities to interact with the system and includes aspects of the system that users can see, touch, or hear |

(continued)
### TABLE I. (Continued)

| Factor                                         | Definition                                                                                                                                 |
|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Implementation of policies and practices       | Defined as policies or practices that may affect EHR implementation                                                                      |
| Improved clinical decision support             | Defined as an application that helps healthcare providers make clinical decisions                                                         |
| Improved coordination of care                  | Defined as better availability of patient information                                                                                  |
| Inadequate training                            | Defined as the action either of teaching a person, a particular EHR skill through computer-based training, lectures, or one on one, which is not adequate to meet the users’ needs |
| Interoperability                               | Defined as the ability of computer systems or software to exchange and make use of information, includes spread of the information across the federal healthcare system |
| Lack of clinical data                          | Defined as collected during the course of ongoing patient care or as part of a formal clinical trial program and mention of this function within the EHR |
| Lack of coordination of care                   | Defined as a lack of availability of patient information                                                                                 |
| Lack of efficiency                             | Defined as patient records not being readily available, provide more information, and enhance information sharing within the organization |
| Lack of patient safety                         | Defined as hindering patient safety outcomes through EHR adoption                                                                         |
| Lack of suitability                            | Defined as the lack of an appropriate EHR for the MHS                                                                                    |
| Lack of survivability                          | Defined as the lack of potential for a EHR to function for a long time within a medical organization                                        |
| Lack of usability                              | Defined as a lack of effectiveness, efficiency, and satisfaction with which specific users can achieve a specific set of tasks in a particular environment |
| Lack of workflow                               | Defined as the lack of steps needed to ensure that each patient receives the care they need at the time they need it. Often times a workflow design is defined in the EHR system |
| Lack of improved clinical decision support     | Defined as a lack of application that helps healthcare providers make clinical decisions                                                   |
| Leadership characteristics                     | Defined as one self or someone else demonstrating potential to lead, coordinate, be in charge of the EHR implementation                   |
| Learning health system                         | Defined as a system in which could be a department that tracks its patient’s outcomes or EHR lessons learned in order to learn and improve its practice |
| Medical readiness                              | Defined as enables a medically ready force and prepares personnel and equipment to deliver world-class expeditionary health care across a full range of military operations |
| Mental workload                                | Defined as the portion of operator information processing capacity or resources that is actually required to meet system demands          |
| Operational workarounds                        | Defined as a temporarily “fix” perceived workflow hindrances to meet a goal or to achieve it more readily, includes violations, deviations, problem solving, improvisations, procedural failures, and shortcuts |
| Organizational readiness                       | Defined as the ability to initiate and respond to organizational change in ways that create advantage, minimize risk, and sustain performance |
| Patient privacy                                | Defined as practice of maintaining the security and confidentiality of patient records                                                   |
| Patient safety                                 | Defined as improving patient safety outcomes through EHR adoption                                                                        |
| People                                         | Defined as humans (e.g., software developers, system configuration and training personnel, clinicians, and patients) involved in all aspects of the design, development, implementation, or use of the EHR |
| Process improvement                            | Defined as proactive task of identifying, analyzing, and improving upon existing business processes within an organization for optimizations. Also includes meeting new quotas or standards of quality |
| Provider productivity                          | Defined as rate at which providers see patient                                                                                           |
| Suitability                                    | Defined as an appropriate EHR for the MHS                                                                                                |
| Support and constraints from higher headquarters or consultant | Defined as support or constraint factors exhibited by higher headquarters that impact EHR implementation                                      |
| Survivability                                  | Defined as the potential for an EHR to function for a long time within a medical organization                                             |
| System measurement and monitoring              | Defined as the measure and monitoring of the effects of health information technology on a regular basis. This could be communicated to higher headquarters or system programmers, which also includes mention of testing |
| Training                                       | Defined as the action of teaching a person a particular EHR skill either through computer-based training, lectures, or one on one          |
| Usability                                      | Defined as effectiveness, efficiency and satisfaction with which specific users can achieve a specific set of tasks in a particular environment |
| User satisfaction                              | Defined as the combination of ease of use and the degree to which the system supports work and is useful                                      |
| Workflow                                       | Defined as the steps needed to ensure that each patient receives the care they need at the time they need it. Often times a workflow design is defined in the EHR system |

*Sittig DF, Singh, H: A new socio-technical model for studying health information technology in complex adaptive healthcare systems. Quality and Safety in Health Care 2010; 19 (Suppl 3): i68-74.
## TABLE II. Factors (n = 14) Identified as Key Components of Socio-technical EHR Implementation by Frequency of Mention

| Factor                        | Facilitator/Barrier | Select document key statement                                                                 | Document frequency | Summary of results                                                                 |
|-------------------------------|---------------------|-----------------------------------------------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------|
| People                        | Facilitator         | Military leadership is vital to support users during the transition to eHealth operations.    | 109                 | Limited discussion in the documents that placed emphasis on leadership as being a vital component. People play a key role in EHR deployment. |
| Interoperability              | Facilitator         | We must have a Military Health System capable of documenting health care provided to service members throughout their time in the military and be accessible to the Veterans Administration when they leave military service. | 76                 | The DoD and VA are working towards an EHR system of interoperability.                |
| Hardware and software         | Barrier             | Users reported increased lag times when other IOT&E sites went live, suggesting the current system and supporting network configuration will not support the hundreds of additional sites planned for MHS GENESIS. | 64                 | GENESIS had some technical issues.                                                   |
| Efficiency                    | Facilitator         | We can see lab results easier. We can communicate with each other and our nurses a lot easier. | 44                 | Aspects of GENESIS enables providers to access more health data.                      |
| System measuring and monitoring| Facilitator         | Defense Health Agency will disseminate communications and updates on initial implementation training to the services; track all risks, concerns, issues, and other feedback from the sites. | 42                 | Measuring and monitoring were established in the beginning of EHR implementation and process improvement was a focus. |
| Workflow                      | Barrier             | Pharmacists, in particular, found the system difficult to use. They were working extended hours because of longer prescription order workflows. Pharmacies averaged fill times of 45 minutes or more for prescriptions that previously averaged 15 to 20 minutes. | 42                 | Although workflows were designed before implementation, it was noted in the documents that some workflows caused delays patient care. |
| Communication                 | Facilitator         | The DHA will solicit communications preferences and best practices, and training lessons learned from the MTFs. | 39                 | There were several established communication forums within the MHS.                  |
| Lack of efficiency            | Barrier             | MHS GENESIS is not operationally effective because it does not demonstrate enough workable functionality to manage and document patient care. | 38                 | GENESIS was noted in some documents as not being very effective.                      |
| Implementation of policies and procedures | Facilitator | The MTF Clinical Champion responsibilities will be developed and determined by the Enterprise Clinical Champion. | 33                 | The implementation plans outlined several policies and procedures for the implementation of GENESIS. |
| Training                      | Barrier             | MHS GENESIS exhibited usability problems that the training could not overcome. | 32                 | Usability problems could not be overcome by training; more robust training needed.    |
| Lack of patient safety        | Barrier             | Users questioned the accuracy of the information exchange between external systems and MHS GENESIS, which could jeopardize patient safety because of inaccurate patient medical data. | 16                 | GENESIS posed patient safety concerns because of possible inaccurate information exchange. |

(continued)
of mention for each factor. The six most frequently occurring codes were people, interoperability, hardware and software infrastructure, efficiency, system measuring and monitoring, and workflow. Factors described with greater frequency are mentioned in further detail below.\footnote{These factors were identified as the most frequent and most significant during data analysis. Managed and analyzed in ATLAS.ti qualitative analysis software program.}}

Another important socio-technical factor identified in the documents was hardware and software infrastructure. This was identified as a barrier during EHR implementation. The data sources identified several limiting factors regarding the hardware and software infrastructure for GENESIS. The GENESIS system was often indicated to have increased lag times and operational incidents during the pilot implementation phase.

The factor system measuring and monitoring was also mentioned several times in the documents and mentioned in all five data sources. This factor was identified as a facilitator. System measuring and monitoring is conducted to help improve processes and identify gaps. The established metrics are centered on patient and end-user productivity and effectiveness. Plans to measure and monitor the EHR were established before implementation. Additionally, recommendations were identified in the documents advising military treatment facilities for developing a formal method to track trouble tickets and ensure that the leadership has awareness of system infrastructure issues.

The emergent construct of workflow was mentioned at great frequency and was identified as a barrier. Although workflows were designed before implementation, the source
documents suggested that workflows led to delays in patient care, particularly in pharmacy departments. These delays were primarily because of system difficulty use related to workflows. Additionally, the documents make mention of the need to provide improved cognitive support to the clinicians.

Lastly, medical readiness was identified in the analysis as a unique factor specific to the EHR implementation in the MHS. Medical readiness is a distinguishing factor between the MHS and civilian sector. Whenever an organization transitions to a new EHR, the healthcare system is at risk for record inaccuracy, which has the potential to hinder medical readiness of the forces.

**DISCUSSION**

This analysis highlights the unique socio-technical factors related to EHR implementation in the MHS. This research can also help guide future military treatment facilities that have yet implemented GENESIS as it identifies barriers and tools to help leaders manage challenging implementation projects such as EHR implementation. This research identified three strategic recommendations for the MHS, and most importantly, this research also informed an EHR leadership framework to guide MHS leaders during health information technology implementation. The recommendations involve supporting people and the organization, which is the basis of sociotechnical factors, and some of these recommendations might incur cost on the organization.

The first recommendation is that the MHS should consider hiring clinical informaticists to support EHR implementation and sustainment. The factors, people, communication, interoperability, efficiency, and hardware and software infrastructure, indicate the need for a more robust presence knowledge of clinical informatics in the MHS, to educate leaders and end-users, while having a better understanding of health information technology and its application at the clinical level. The implementation of government regulations, and the military leveraging EHRs and other health information technologies in their healthcare system for the past 10 years justifies the need for clinical informaticists at the military treatment facility level to help integrate EHRs and other health information technologies in the MHS.

The second recommendation is to take a phased approach for large organizations implementing a new EHR. How an organization decides to implement its new EHR will have significant effects on the organization’s overall success. This recommendation emerged because of issues with the identified factor of hardware and software infrastructure. The data indicated several issues with the hardware and software infrastructure of the EHR, the system was too slow and difficult leading some healthcare providers to use workarounds when interacting with the system. The “big bang” approach replaces the old system with the new system at a single point-in-time, while a phased approach module replaces the old systems in a planned, gradual sequence. While all approaches have pros and cons, a phased approach is typically more successful in larger organizations versus a “big bang” approach. The success is a result of a phased approach that allows for larger organizations to meet the various needs of each sub-organization. Although the “big bang” approach has the advantage of speed, the MHS might have been able to fully identify the significant barriers and facilitators upon implementation. This approach would eliminate the need for the clinics to implement workarounds, which opens up health risk to patients. Although the phased approach may take longer and cost more, the approach can be safer and allows for the system to better adapt to various organizations.

The third recommendation is to enhance EHR training. Research indicates that user training is often not treated as essential to the implementation process, but rather more of an afterthought. Training was identified as a barrier in this research. Even though new users received training, the regimen was insufficient to meet their needs, as noted in the data. Most notably, there were too many inconsistencies among trainers and materials mostly because of the constant configuration changes. Training should also occur pre- and post- implementation and must be on a continued cycle as effective training increases overall user satisfaction. Some best practices identified in the literature is for training to be both observation and hands-on activities, build on past computer experiences of the end-user, and imbed clinical champions and positive role models.

In addition to the recommendations provided, this research informed a Socio-Technical Leadership Framework for EHR Implementation. The framework was modeled after and informed by Weiner’s Organizational Readiness for Change Model. The framework outlines four phases (Fig. 1): organizational readiness assessment, which focuses on assessing the organization’s ability to implement an EHR, such as culture, resources, and an organization’s ability to accept change should all be considered before implementation. The next step in the model is for leaders to plan and design the EHR for its organization. This includes the design of workflows, policies, and procedures that align with the organization and identify clinical champions who will help lead implementation efforts. Next is the implementation phase, and this is where leaders of the organization will adjust for friction from a wide spectrum of barriers such as resistance to change or hardware or software infrastructure problems. Lastly, the evaluation, process improvement, and sustainment phase charges leaders to ensure that they have procedures in place to evaluate the EHR and sustain best practices.

There are several strengths identified in this study. First, this research is the first of its kind studying GENESIS in the DoD. Overall research on EHR implementation in the military is limited. Second, the use of qualitative analysis employing emergent coding allowed for a deep analysis of the data which helped to identify potential gaps in the existing literature or frameworks. There were also limitations. First, semi-structured interviews were not approved for use in this study. It is unknown whether or how data gathered via
CONCLUSIONS

Although significant health information technology changes may occur only once every few years, this technology is commonly leveraged in healthcare. As such, understanding the types of challenges related to medical information systems is critically important. Further, examining the facilitators and barriers of sociotechnical factors helps to understand the impact that health information technologies have within a prototypical organization. This research contains several valuable implications for EHR implementation in the MHS, and other organizations can adopt these recommendations in their own organizational context. Findings from this research have several implications for the MHS. The recommendations involve supporting people and the organization, which is the basis of socio-technical factors and an overarching theme identified in the data.

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None declared.

REFERENCES

1. Committee on Public Health Strategies to Improve Health, Institute of Medicine (IOM): For the Public’s Health: Investing in a Healthier Future. National Academies Press (US); 2012. Appendix F, for the public’s health: the role of measurement in action and accountability. Available at https://www.ncbi.nlm.nih.gov/books/NBK201017/; accessed February 4, 2017.

2. Institute of Medicine (IOM): The Computer-based Patient Record. National Academy Press (US); 1997.

3. Blumenthal D: Launching HITECH. N Engl J Med 2010; 362(5): 382-5.

4. Hoyt RE, Yoshihishi AK: Health Informatics: Practical Guide for Healthcare and Information Technology Professionals. 6th ed. Informatics Education. Lulu.com; 2014.

5. Korb LJ, Rothman A, Hoffman M: Reforming Military Compensation, Addressing Runaway Personnel Costs Is a National Imperative. Center for American Progress; May 2012.

6. Punaro A: Chicago, National Guard Association of the United States, 2014. Available at http://bit.ly/1wS6CQT; accessed February 2, 2017, also see https://www.youtube.com/watch?v=C5WcRJUE5EA.

7. Bilmes L: The financial legacy of Iraq and Afghanistan: how wartime spending decisions will constrain future national security budgets. Faculty Research Working Paper Series RWP13-006. Harvard University, John F. Kennedy School of Government; 2013.

8. Mendez BH: MHS genesis: background and issues for congress, Congressional Research Service (CRS). Report no. R45987. CRS; 2019.

9. Sittig DF, Singh H: A new socio-technical model for studying health information technology in complex adaptive healthcare systems. Qual Saf Health Care 2010; 19(Suppl 3): i68-74.

10. Nowell LS, et al: Thematic analysis: striving to meet the trustworthiness criteria. Int J Qual Methods 2017; 16(1): 1-13.

11. Miles MB, Huberman AM, Saldaña J: Qualitative Data Analysis: A Methods Sourcebook. 3rd ed. SAGE Publications Inc.; 2014.

12. Karnas J, Robles J: Implementing the electronic medical record: Big Bang or phased rollout? Creat Nurs 2007; 13(2): 13-14.

13. Pantaleoni JL, Stevens LA, Mailes ES, Goad BA, Longhurst CA: Successful physician training program for large scale EMR implementation. Appl Clin Inform 2015; 6(1): 80-95.

14. McLeanery AS, Robbins J, Kowalczyk N, Chisolm DJ, Song PH: The role of cognitive and learning theories in supporting successful EHR system implementation training: a qualitative study. Med Care Res Rev 2012; 69(3): 294-315.

15. Greenes RA, Shortliffe EH: Medical informatics: an emerging academic discipline and institutional priority. JAMA 1990; 263(8): 1114-20.

16. Weiner BJ: A theory of organizational readiness for change. In: Handbook on Implementation Science. Edward Elgar Publishing; 2020; 215-32.