Infectious Diseases Data Analysis Program:
A Proof of Concept for User-Friendly Patient Data Analysis

(Technical Paper)

The Influence of Researchers, Clinicians, and Legislation on one another, and the Effects on Electronic Health Records

(STS Paper)

A Thesis Prospectus Submitted to the

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Introduction

Electronic health record systems (EHRs) access, store, and organize patient medical records. While EHR systems revolutionized the accessibility of patient files, the layout of these software programs makes sorting through copious numbers of patient files difficult and inefficient.

Medical professionals prescribe therapies based on the patient's symptoms and background: sex, age, fitness, weight and other genetic factors. Antimicrobial stewardship promotes the appropriate prescription of antimicrobial agents, such as antibiotics, to improve patient outcomes and prevent microbial resistance. However, incorrect patient diagnosis remains a prominent issue. In a study of 1,000 outpatient visits in the United States (2009-2011), 64% of the antimicrobial therapies prescribed for adults with respiratory tract infection were deemed inappropriate (Schroeck et al. 2015). The rise in patient complexity, the co-occurrence of multiple medical conditions, further raises concerns for the quality of patient care (Safford, Allison, and Kiefe 2007). Searching through multiple patient files with respect to user specifications, namely symptoms and background, can aid physicians in making informed treatment plans.

To combat the limitations of EHRs, the **technical project** of this prospectus focuses on constructing a computational diagnostic tool for clinicians in the Department of Infectious Diseases at UVA that will filter and sort inputted patient data sets, given user specifications. The **STS project** traces the co-production of the actors that influence the development of EHRs since their introduction in the 1960s and the respective implications on health care systems, with the intent of supplementing the technical topic. The theory of co-production will elucidate the dynamic between policy and clinicians, and will identify the factors that come into play when

designing EHR systems. Future EHR systems can apply the findings of this STS topic towards combatting the negative social implications of current EHR systems on clinical practices.

Technical Project: Infectious Diseases Data Analysis Program: A Proof of Concept for User-Friendly Patient Data Analysis

How can a computational diagnostic tool analyze and present patient data in a meaningful way in order to help medical professionals make more informed decisions?

The frequency of clinical trials, the sheer number of patients worldwide, and the interconnected structure of treatment plans significantly increase the magnitude of patient data files. Currently, in the hospital at UVA, data from numerous patient files are stored on several systems. The unique nature of each patient makes manually matching past and present patient cases extremely difficult and time consuming. Unfortunately, the current data-mining software platform being used, EPIC, is cumbersome with a layout that makes sorting through a large number of patient files difficult and inefficient. Although 85% of large hospitals use the Electronic Privacy Information Center, the EPIC platform is unorganized, non-intuitive, and limited in its data-mining functionalities. ("Epic, Cerner control 85% of large hospital EHR space, KLAS reports," n.d.). There are several critical gaps in the application of EHR platforms when collecting data. Critics explain that patient files are either individually accessed in EPIC or compiled into an excel file, and thus, EHRs increase workload and catalyze physician burnout (Arndt et al. 2017). When medical professionals are attempting to access patient files for a specific field they must sift through the data by hand as the varying formats across the system makes the data difficult to filter. On average clinicians spend two hours on EHR tasks per hour of face-to-face patient contact, accumulating to nearly more than one-half of their work day (Arndt et al. 2017). A rapid filtering of past and present patient data via a computational tool will

help doctors and researchers make more informed decisions, help them modify their current practices to improve standards of care, and reduce workload (Figure 1).

Figure 1 Informed Decision Making: Informed decision making requires research evidence, contextual evidence, and a problem definition (Ghajar-Rahimi, 2019).

There are over 1,100 vendors involved with EHR systems (Cerner Retains Largest Market Share in EMR Industry, Report Says n.d.). Commonly used EHR systems include EPIC, eClinicalWorks, and Allscripts. International Classification of Disease (ICD-10-CM) codes are one of the ways in which patient data is organized (ICD.Codes - Your Free Medical Coding Resource n.d.). ICD-10-CM codes use an alphanumeric code for identifying known diseases and other health problems (Figure 2). Alphanumeric systems map health conditions to generic categories, limiting the ability to trace complex patient histories.

R Shiny in the R studio and/or the MATLAB App Designer will be used to create a computational medical diagnostic tool that is easy to install across all computers. The final

Figure 2 Alphanumeric Code: alphanumeric code is a method for identifying disease and other health problems (ICD-10 Conversion and Mapping - AAPC n.d.)

computational medical diagnostic tool will assist clinicians in reviewing prior treatment methods and outcomes, and making more informed decisions for each patient. The optimized computational medical diagnostic tool will provide a proof-of-concept for user friendly patient data-mining tools.

This technical project will be completed in a team of three biomedical engineering undergraduates alongside Dr. Jason Papin, and PhD candidate, Laura Dunphy at UVA. The group will interview clinicians in the UVA Department of Infectious Diseases and employees in the Department of Quality and Performance Improvement in the Fall 2019 semester to determine the criteria for an efficacious computational medical diagnostic tool. The computational medical diagnostic tool will be developed after the interviews and continued throughout the Spring 2020 semester.

At the completion of the project the team hopes to provide a fleshed-out software that medical professionals can use to access, sort, and analyze patient data. This would allow clinicians to make more informed research decisions and hopefully shift current quality improvement research towards providing clinicians with appropriate measures for analyzing critical data.

STS Topic: The Influence of Researchers, Clinicians, and Legislation on one another, and the Effects on Electronic Health Records

Poorly designed EHR systems compromise the accuracy of medical diagnoses; thereupon, potentially instigating repercussions that threaten patient well-being (Afsar-manesh et al. 2014). However, finely tuned EHR systems could help medical professionals diagnose rare diseases/complications like those seen in the Netflix documentary series *Diagnosis.* In *Diagnosis,* Dr. Lisa Sanders underscores the prevalence of medical mysteries in present day healthcare as she attempts to help patients with complex and undiagnosed illnesses (Scott Rudin,

Eli Bush, Garrett Basch, P.G. Morgan, Jonathan Chinn, Simon Chinn 2019). Uncovering the social implications of present EHRs in medical systems will encourage the development of technically and socially relevant EHR systems in the future.

Electronics and EHR systems constantly evolve as research progresses and as governmental policies change. Governmental policy and hospital regulation can either limit or propel the use of EHR systems. The converse also holds true. EHR systems can influence governmental policy. The Patient Protection and Affordable Care Act (PPACA) requires health systems to transition from paper health records to EHRs (Fontenot n.d.). Medical systems and centers that resist PPACA's legislation risk financial penalization (Strokoff and Grossman 2010). Benefits of the adoption of EHRs include cost reduction, facilitation of data mining, and detection of fraudulent billing practices (Fontenot n.d.). Although companies such as Lockheed Martin have been developing EHRs since the 1960s, EHR systems remain extremely complicated (Atherton 2011). Non-medical professionals require Institutional Review Board (IRB) approval before accessing patient data due to patient confidentiality laws. The lengthy IRB approval process makes it extremely difficult for researchers and scientists to access data in a timely manner. Furthermore, medical professionals rely on quality assurance professionals to actually extract data files. Exploring the interplay and dynamic between clinicians, researchers, and legislation will pinpoint the means necessary to effectively implement change in future EHR systems.

As seen in the examples listed in the previous paragraph, policy and electronic software influence one another, and ultimately influence user-interactions. The **stakeholders** are medical professionals, patients, and researchers. The **physical artifacts** are paper medical records, computers, and hand-held electronics; while the **non-physical** artifacts are government

legislation, software, and data analysis methods. **Sheila Jasonoff's theory of co-production** best describes the influence of the stakeholders, physical artifacts, and non-physical artifacts on one another (Figure 3)**.** Pfsorzheimer Professor of Science and Technology Studies at the Harvard Kennedy School, Jasanoff defines co-production as "the simultaneous process through which modern societies form their epistemic and normative understandings of the world" (Jasanoff - Co-production.pdf n.d.).

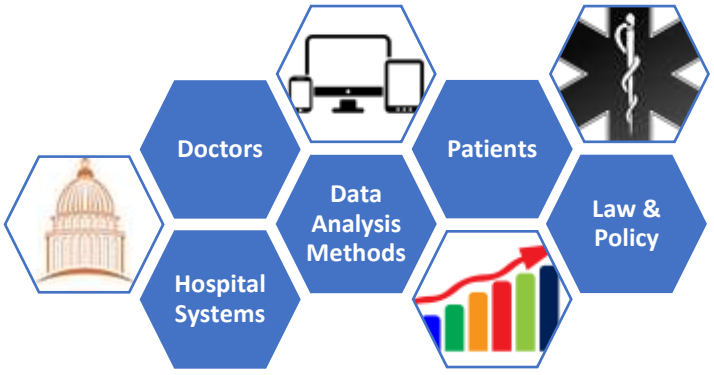

Figure 3 Theory of Co-Production: graphic depicting the interconnection of the stakeholders, physical artifacts, and non-physical artifacts chosen for this STS topic (Ghajar-Rahimi, 2019)

Exploring the evolution of electronics and the health care system with respect to one another will help identify the medical government legislation, regulations on privacy, and software companies that shape EHRs. The theory of co-production will also guide the anthropological analysis of EHR system technologies. When an EHR system takes hold, physicians may be suspectable to prioritizing political and corporate stakeholders, rather than purely focusing on clinical care (Hunt et al. 2017). The patient becomes a digital entity, and physician-patient interactions become impersonal. Anthropological analyses acknowledge the social implications that are integral to thoroughly investigating the effects of EHRs on healthcare systems. The wide acceptance of the theory of co-production will promote a cogent analysis and conclusion of the STS topic.

Research Questions and Methods

The following STS research question is proposed: **How do health system actors influence one another in the development of electronic health records since their introduction in the 1960s?** The STS research question seeks to analyze the interaction between stake holders that influences the development of EHRs. Documentary analysis, historical case studies, and interviews will be used to answer the research question. Documentary analysis and historical case studies guide the results and analysis presented in this investigation. The data assembled for the documentary analysis and historical case studies includes scientific and peer-reviewed articles pertaining to current and previous electronic medical technology; secondary sources of paper health records, organized chronologically; and comments from medical professionals regarding their experiences with electronic medical technology, respectively.

The literature for documentary analysis and historical case studies will be retrieved from the New England Journal of Medicine, British Medical Journal, New England Journal of Medicine, AnthroSource, JSTOR, and PubMed.

Conclusion

Hospitals and medical offices use EHR systems with the intention of enhancing patient care, improving diagnosis efficiency, and maximizing treatment success. However, interface complexity and governmental legislation make the identification and extraction of patient data very difficult. The STS portion of this thesis will explore the ways in actors in medical systems influence one another and ultimately the effect on EHR systems through the theory of co-production. It is hypothesized that the relationship between legislation, clinicians, and researchers is inseparable, and that each group possesses the potential to either limit or enhance the other. The expected research findings will provide physicians with a clear understanding of

the means necessary to implement change when designing EHRs. Difficulty accessing patient data and limited usability of data-mining software are prominent issues for clinicians. The technical project attempts to solve the latter by providing clinicians in Department of Infectious Diseases at UVA with a novel software program that intakes patient data sets and outputs the necessary information for making medical decisions. The computational medical diagnostic tool developed for the technical topic of this thesis seeks to create a user-friendly platform for data-mining patient histories.

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