Prospectus

Digitization of Perioperative Surgical Flowsheets

(Technical Topic)

The Challenges and Nuances of Implementing an Electronic Medical Record System in Developing Nations

(STS Topic)

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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.

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Background

I have spent much of my time at the University of Virginia working to improve accessibility and affordability for patients at Oak Street Health in Chicago, Praava Health in Bangladesh, and the University Teaching Hospital of Kigali (CHUK) in Rwanda. Through these experiences, I have become familiar with the challenges of electronic medical records and their enormous potential to improve the quality patient care. Oak Street Health has reams of electronic data and models. Praava Health had electronic data, but had yet to make significant use of it due to a lack of models. CHUK has no electronic medical records in their preoperative, intraoperative, or post-operative procedures. All patient information resides in each patient's respective chart at the foot of their beds. Electronic medical data advances the aim to provide a higher quality of care while increasing efficiency and allocation of resources. Electronic medical records are a tool that should be attainable and sustainable for all nations, yet implementation continues to vary greatly.

Electronic Medical Records (EMR) have a tremendous advantage over paper records to reduce errors, improve patient safety, and support patient outcomes while containing costs (Retchin, 1999). A study comparing the difference in quality of healthcare between hospitals that had adopted EMR and hospitals that used paper-based records found significantly higher quality of care in EMR-adopted hospitals than the latter (Omar, 2019). This is no secret, as The World Health Organization claims a steady growth in the adoption of national electronic health record systems over the past 15 years, and a 46% global increase in the past five years. Adoption rates are much lower in lower-middle income countries (35%) and stand at a mere 15% in low-income countries (World Health Organization, 2020). This paper aims to address the barriers, biases, and unintended consequences of building an EMR system in developing nations. This paper will

focus on developing nations, as they face the greatest barriers to adopting a system primarily built for developed nations.

Digitization of Perioperative Surgical Flowsheets

Around five billion people, disproportionately living in low and middle income countries, are unable to access safe, timely, and affordable surgical and anesthesia care (Felizaire, 2019). The perioperative mortality rate (POMR) is measured by the World Health Organization to identify the quality of surgical and anesthesia procedures. Perioperative data, data collected during surgery, can be used to predict factors that lead to adverse surgical outcomes. Access to such data is essential for decreasing perioperative mortality rates and improving medical treatment. In low and middle income countries, perioperative data is often manually recorded on paper flowsheets. While these flowsheets capture essential information, their non-digital format leads to difficulty in analysis of perioperative data, as aggregating data and observing trends is a time-consuming and tedious task. A variety of factors affect POMR, including patient blood pressure, heart rate during surgery, medications administered intravenously and previous medical afflictions. POMR cannot be effectively calculated without data on such factors. Therefore, we aim to make patient data digitally available so that metrics such as POMR can be calculated.

In a general sense, the goal of this project is to facilitate better management of electronic medical data for hospitals in Rwanda and potentially other low and middle-income countries. A Systems Engineering Capstone project from last academic year was carried forward by Mary Blankemeier over the summer of 2020, and currently by the Systems Engineering, Data Science Capstone, Artificial Intelligence teams. The project aims to implement a digital surgical flowsheet system within CHUK, the primary teaching hospital of Kigali.

Currently, the Digital Intraoperative Surgical Flowsheet (DISF) process is threefold. Transmission, the first phase, includes the hospital staff scanning the patient sheet using a scanning apparatus for remote access (SARA), a box specifically designed to control lighting, angles, and aperture. This image is sent to a computer and then uploaded through a web application. The second phase processes the scanned flowsheet, crops it into sections, and extracts data through checkbox detection and graph-reading algorithms. The data is then stored in a PostgreSQL database.

Understanding the trends observed in previous surgeries and the effects that medications had upon patients allows the doctors to analyze what worked and what did not. These sheets provide invaluable records of operations, and can be used for long-term efficacy studies. The availability of clean, readable medical data could provide insights into care and best practices, helping to increase positive outcomes for care and minimize patient mortality. A secondary benefit provided by this system is highlighting a use for these patient charts. Often, said sheets are put away in storage and never revisited. Utilizing machine learning to read the sheets requires a much higher level of these attributes for consistent results and therefore incentives in increased focus in recording, legibility, and thorough patient records.

There are several inefficiencies that could be improved to not only make processing of sheet records easier, but also drastically increase the number of sheets sent, and increase the scalability of this system to other hospitals. In the current system, the process for uploading a single sheet requires several devices (a phone and laptop in most cases) as well as an app and the SARA box. In our proposed approach, we will explain a more streamlined process that can decrease time and resources needed for uploads, which will decrease time spent by already busy hospital workers. The user will open the app, log in to their account, take a photo of the patient

chart using SARA, and simply click the upload button with the associated patient identifier. This further improves the user experience by providing instant feedback to Kigali's primary teaching hospital as a sheet is uploaded, processed, and compiled. An additional benefit to a more streamlined system is improved scalability. In limiting the number of steps required, the breadth of users who have the resources to adopt the digitization system increases. This is a significant asset to our long-term goal of EMR utilization across different hospitals and countries.

Deploying Interactive SocioTechnical Analysis to Digital Medical Records

Digital medical records can be enormously powerful but may also lead to unintended consequences for hospitals, as well as current and future patients. *Unintended Consequences of Information Technologies in Health Care* elaborates on the socio-technical systems that exist within healthcare organizations that are made up of social, technological, and organizational subsystems (Harrison, 2007). The Interactive Sociotechnical Analysis (ISTA) framework uses the case of Human Information Technologies (HIT) to examine uses, impacts, and reinterpretations, rather than through the designers' original intentions. Contrary to the engineering approach, which finetunes until the optimal solution is achieved, ISTA highlights five core interactions: (1) the new HIT innovation, (2) the technical and physical infrastructure's response, (3) the social system response, (4) HIT's effect on the social system, and finally, (5) the impact of HIT-social system interactions and the HIT's redesign (Harrison, 2007). These five core interactions may lead to a myriad of unintended consequences within the electronic medical record space and can further be applied to our technical goal of digitizing intraoperative surgical flowsheets (DISF).

The first core interaction of ISTA revolves around the impact a new HIT has on its social system. This would occur in the first phase of the DISF, requiring the hospital staff to upload patient sheets. In an extremely chaotic and understaffed hospital, this simple task may require a tremendous amount of time from the hospital worker. Once SARA - the box which controls lighting, angles, and aperture - is assembled, the provider must run their patient's sheet from the patient's location to the box. A photo, captured using a phone, must be scanned and sent to a computer. Once the sheet reaches the computer, it must be uploaded with the associated MRNO number in order for any patient data to be captured. These cumbersome steps may lead to a substantial decrease in attention, time, and resources given to patients. The data collection processes required of the hospital staff must be intricately planned out so that patient care is not compromised. These changes may not only affect the communications, patterns, practices and training within the hospital, but may have further implications as the COVID-19 pandemic adds to an already stressed and fragile system (Louis, 2020).

Cheryl Amoroso performed a study assessing the impact of Partners In Health's 2005 implementation of an EMR system in two critical provinces in rural Rwanda, looking to support and improve HIV care. The Eastern Province has internet access through social power systems in remote health centers running a local server. On the contrary, in the Northern Province, only the district hospital has internet access, and data officers travel to the district hospital to enter the health center's data into a shared database, returning with printouts of upcoming consultations. The EMR system aims to improve patient care at different stages of their HIV treatment by overseeing patients' clinical profiles, alerting doctors to missed appointments, and identifying potentially at-risk patients (Cheryl, 2009). The proportion of patients enrolled who were still alive and receiving care after five years was 93.5%, an incredible feat compared to the results of

33 studies in Africa that found a median retention rate of 70% at the three-year mark (Partners In Health, 2012). This virus suppression demonstrates the enormous impact of digitizing patient sheets. The statistics and analytics referred to in the technical project contain no patient identification to align with the International Review Board approval. This creates an inability to mimic the automated personalized results. However, is the foundation to build broader trends and patterns associated with increased patient risk.

The second pillar of ISTA focuses on the technical and physical infrastructure that mediates HIT use, such as the current paper patient sheets, which hold patient histories and data securely within the hospital. The third pillar of ISTA elaborates on the social system that mediates the use of HIT. The ability of the system to adopt the HIT as the designer attended. This would include busy physicians entering data in the wrong sections or in the wrong patient record altogether, or simply being unable to transition from handwriting to typing patient information effectively. In DISF, a misrecording of patient data occurs as some doctors write checkmarks on the right side of the word instead of within the checkbox on the left side. Other nuances in the intraoperative patient data processing result in misleading data that fail to account for human, cultural, and systematic differences in how Kigali's medical professionals use typical intraoperative patient sheets relative to those in other parts of the world (Richard, 2015). Although the patient sheet design is established globally, its practical use is not. The fourth pillar of ISTA elaborates on HIT's impact on the social system. Altering the power structure and physician autonomy, or creating an overdependence on technology, relies on decision support for real-time information and error prevention. The fifth and final pillar of ISTA refers to the continual demands which must be met to have a sustainable EMR system (Harrison, 2007). These five pillars are represented in Figure 1 as transitions from New HIT to HIT's influence on

the social system, the social system's influence on hit, and the technical and physical infrastructure under which the new HIT operates. The potential unintended consequences of implementing an EMR system in Kigali's Primary Teaching Hospital are vast. As shown in the simple task of uploading the patient charts, HIT's effect on the hospital's workers and patients is tremendous. Using the ISTA framework I hope to identify barriers, biases, and unintended consequences of building an EMR system in developing nations.

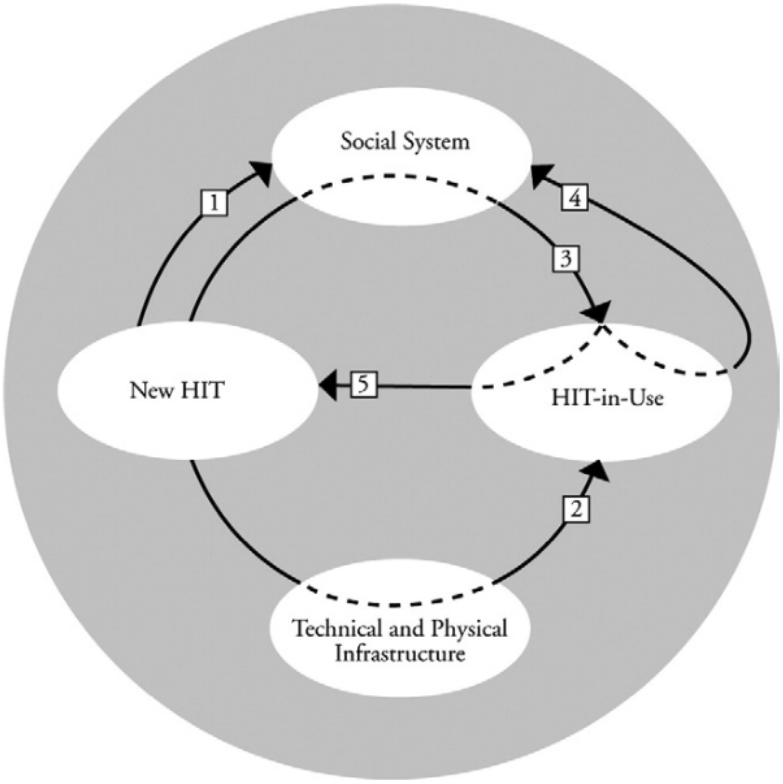

Figure 1. Five pillars of interactive socio-technical systems. (Image source: Harrison et al., 2007)

Research Design

I aim to identify how the implementation and integration of electronic medical records can better serve low-income countries. By simultaneously improving patient care and decreasing patient costs as well as medical staff efforts and errors, EMR systems have an enormous ability

to improve healthcare worldwide. While medical information management and utilization in Africa would have this incredible potential, the EMR system faces many barriers to effective implementation and integration. Using the interactive sociotechnical analysis through the phases described above and shown in Figure 1, I plan to conduct interviews to obtain primary evidence. I am particularly interested in hearing from the following individuals and their experiences with EMR adoption: Dr. Christian Nbaribitse, an MD and Senior Resident in the primary teaching hospital of Kigali, Dr. Marcel Duriex, an MD, Ph.D., professor of Emeritus Anesthesiology, Glocal Health, and clinical researcher, with vast experience in assisting Rwanda's Department of Anesthesia and academic development since 2012, Sylvana Quader Sinha, the Founder, Chairman, & CEO of Praava Health in Bangladesh, and Kat Wendelstadt, an Advisor to the World Bank TechEmerge Programme, who brings together global healthcare entrepreneurs while serving as a Co-Founder of Healthforce Africa, Advisor to Praava Health, and a Healthcare consultant in Brazil and Bangladesh. From these four influential people, I hope to understand the difficulties in implementing and sustaining EMR systems in their respective experiences, and to continue reaching more voices through snowball sampling afterwards. I plan to analyze these interviews in accordance with the five core pillars of the ITSA framework. Through content analysis of the interview transcripts, I hope to achieve a foundation of what aided and hindered these clinics in developing nations in their attempts to build effective EMR systems. Next, I aim to combine this knowledge with prior literature to better gauge historical context and fill in gaps to the final discussion and recommendation, which aims to identify and address barriers, biases, and unintended consequences of building an EMR system in developing nations. The week of November 2nd will be spent developing purposeful, specific, and insightful questions for the foundation of the interviews and reaching out to the above parties. The following two weeks will

be spent interviewing and recording first-hand experiences. The week of November 23rd will be spent organizing all interview materials and aggregating critical gaps and points of confusion for the following prior literature research. I hope to spend the remainder of the time researching and organizing a recommendation to thoroughly and impactfully address the complex EMR integration and implementation challenges that developing nations face.

Conclusion

EMRs have an incredible ability to increase the quality of health care services (Ayaad, 2019). However, EMR systems have shown severe unintended consequences towards healthcare's socio-technical system consisting of complex workflows, diverse cultures, social interactions, and innovative technologies. Drawing on prior successes and failures in implementing EMR systems in developing nations will unlock a discussion towards an effective recommendation towards the Primary Teaching Hospital of Kigali and the UVA teams who aim to build electronic health records in the hopes of decreasing the perioperative mortality rate.

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