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Abstract: Healthcare organizations may reap benefits transitioning to electronic health records (EHRs), such as decreased healthcare costs and better care. However, severe unintended consequences from implementation and design of these systems have emerged. Poorly implemented EHR systems may endanger the integrity of clinical or administrative data. That, in turn, can lead to errors jeopardizing patient safety or quality of care. A literature review of 40 sources identified how EHR implementation and design can impact provider centric, patient centric, and outcomes. These categories provided the basis for a comprehensive EHR impact model that was evaluated in non-hospital settings through focus groups interviews.

INTRODUCTION

Electronic health record usability refers to the efficiency and effectiveness of the system's use and the satisfaction of the users when accomplishing specific tasks within their environment; this includes user–friendly workflow design supporting efficient, effective quality care. The lack of standard user interfaces remains a challenge for clinicians who work in multiple care settings (Middleton, 2013) potentially influencing provider productivity and patient safety. EHR-related errors, their potential impact on patient safety, quality of care, and usefulness, have been widely documented.

Given that EHR issues have the potential to impact patient wellness, provider burnout, and general healthcare, mitigating potential problems as well as improving EHR usability poses one possible way to improve healthcare as well as better facilitate general wellness. Healthcare organizations are motivated to transaction to EHR's as they reap substantial benefits such as decreased healthcare costs and improved care. The United States healthcare spending per GDP is approximately twice that of other developed countries, yet fails to deliver high-quality healthcare based on international standards (Baron, 2007). While this may lead to the assumption that United States healthcare is an improvement on other healthcare systems in developed countries, this is far from the case. The US excels on dimensions involving chronic disease management, the doctor-patient relationship, shared decision-making between primary care and specialty providers, end-of-life discussions, and performed moderately better on wellness counseling linked to healthy behaviors. The US performs poorly on numerous coordination measures, however, including information flows between primary care, specialty, and social service providers (Doty, 2017).

Technology has proven its potential to increase patient safety, but only if we can minimize the risk tradeoff. Health information technology (HIT), which includes EHRs, health information exchanges, and patient portals, has been promoted as powerful leverage in healthcare reform. When designed and implemented adequately, health IT can expedite patient engagement and care coordination (National Patient Safety Foundation, 2015 February).

The broad use of health IT has led to valid reductions in medical errors. Computerized physician order entry (CPOE) has demonstrated a decrease in medication errors by nearly 50% in acute care settings (Bates, Leape, Cullen et al. 1998). More importantly, electronic ordering has the potential to drastically lessen dosing errors, prescription theft, prescription forgery, and identified medication allergy errors (Knoll, M. 2016). Health IT has also reduced errors related to clinical care by using techniques such as bar-coding and smart pumps for transfusion. These types of technology can also improve patient outcomes; for example, implementation of high-level EHRs have been associated with declines in mortality among hospitalized patients (National Patient Safety Foundation, 2015 February).

Healthcare IT may also introduce new adverse events, however, such as patient misidentification, alert fatigue, copy and paste errors, or even software malfunction. A recent study validated the existence of these adverse events, stating that they had potential to lead to "an appreciable incidence of severe harm and death," (National Patient Safety Foundation, 2015 February). Some systems may be faulty. A simulation study of a CPOE system at 62 hospitals discovered that the system failed to recognize 52% of potentially fatal errors (Declerck, Aimé, 2014). Poor interoperability between systems results in integration failure, and thus interrupts the transfer of data across the care continuum (Premier, 2014). Some systems also produce poor usability, which can provoke new errors.[2.1.12]

Health IT has also been connected to clinician burnout; primary care providers utilizing EHR systems with numerous complex functions had higher burnout rates than others utilizing systems with fewer complex functions.[3.1.2] Underlying these concerns is the absence of clear, enforceable criteria for the development and use of these

systems.[3.4.2] Even when regulations do exist, adherence is not guaranteed (Harrington, 2013).

Although EHR-related errors and their impact on patient safety, quality of care, and usefulness have been documented for years, considerable work still needs to be done to assess the occurrence of these errors, determine the causes, and implement resolutions. System certifications exist, but this does not guarantee successful implementation, operational use, or patient safety.

METHODS

Literature Review

We used a grounded approach to search for relevant articles. Articles were included if the title contained the terms "electronic health records," "EHR usability," "EHR alert fatigue," "EHR workarounds," "EHR implementation" or "EHR patient safety". As a synonym for "EHR," "electronic medical records (EMRs)" were used interchangeably with the above search terms. The exhaustive literature review used PubMed, ProQuest, and Google Scholar databases, and focused on case studies and research studies rather than overview papers or opinion pieces. After a preliminary review of all articles for relevance to the purpose, the collection included over 300 articles. This number was refined to the five most frequently cited articles for each subcategory.

Survey and Interview Questions

After analysis of the results of the literature review, the identified categories and subcategories provided the basis for tailored survey and set of interview questions to add to the effort of evaluating the various aspects of EHR systems. A preliminary electronic survey to be used prior to focus groups was developed to gather basic demographic information as well as questions pertaining to electronic health records. These questions focus on seven different areas of interactions with EHR's: design, implementation, workload, quality, care coordination, safety, and patient-provider relationship. The focus group questions delve further into these categories and allow for participants to expand and verbalize their thoughts in an open-ended format.

Focus Groups

A co-sponsorship with Michigan Medical Group Management Association (MiMGMA) was established in an effort to recruit medical offices for focus group participation. Additional networking was also conducted to enlist offices willing to volunteer. Participants in the study are informed of the goal of the research and will be given the results of the general research. The survey is administered to focus group participants prior to the interview and the interview questions are informed by the survey results.

RESULTS

The selected articles were reviewed for key themes and topics, which were then grouped into appropriate categories and sub-categories. A total of three categories (provider centric, patient centric, and outcomes) and eight sub-categories (design, implementation, workload, safety, quality, care coordination, patient-provider relationship, and health outcomes) emerged.

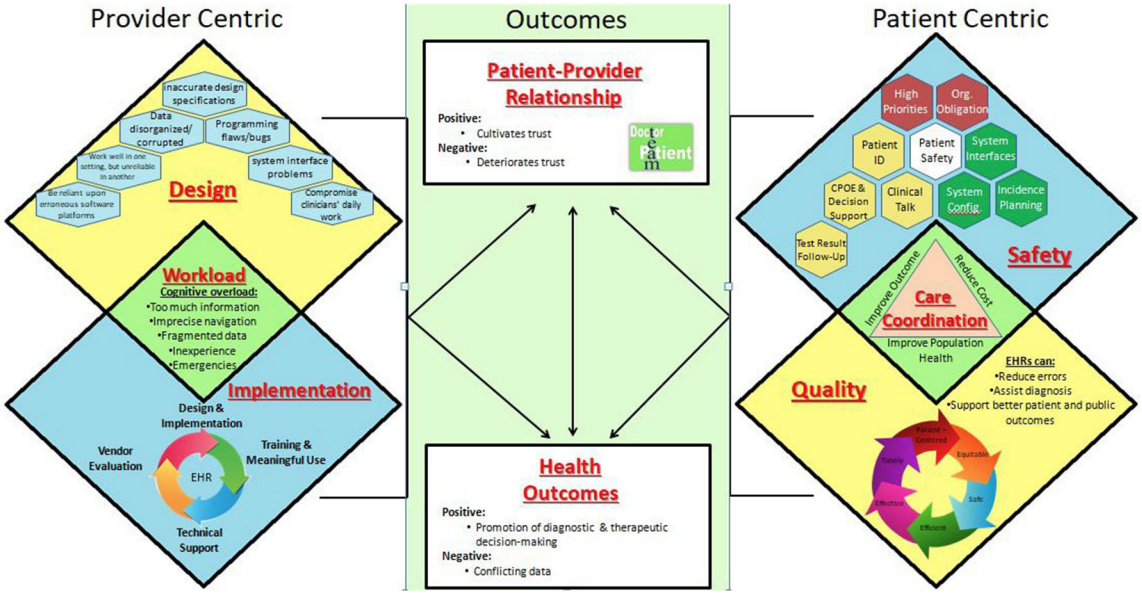

Figure 1: EHR Usability Impact Model Developed via Literature Review

A model was developed (Figure 1), based on the categories/subcategories, that addresses the EHR challenges of interaction complexity within the socio-technical context, specific clinical collaboration patterns, and challenges of measuring the influence on clinical outcomes. The model depicts the various relationships and interconnections between the eight sub-categories and links them to findings from the literature. This model was the basis for evaluating EHR use in primary care offices through surveys and interviews. It is expected that the evaluation research aspect of this project will further refine the model to better understand the very complex and challenging aspects of EHRs use in healthcare, and thus ultimately improve patient safety and health outcomes. This study is in the data collection phase and recruiting participants for focus groups.

CONCLUSIONS

Electronic health records have the potential to impact all areas of healthcare. Using the comprehensive literature review, it was determined that three main areas of effect can be observed: what the physician sees, the safety of the patient both electronically and medically, and how the electronic records impact the relationship a provider develops with the patient. Additionally, the literature review revealed that most analyses of electronic health records were conducted at the hospital setting, thereby making the model most appropriate for that setting. With future focus group work specifically aimed at the non-hospital settings of healthcare, it is anticipated that this model will further develop and be improved upon for specifically non-hospital settings.

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