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A Qualitative Analysis of the Impact of Electronic Health Records (EHR) on Healthcare Quality and Safety: Clinicians' Lived Experiences

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ABSTRACT

PURPOSE: There have been mixed findings of clinicians' perceptions of Electronic Health Record (EHR). This study aims to explore the lived experiences of clinicians, to assess the role of EHR in improving the quality and safety of healthcare.

BASIC PROCEDURES: A qualitative study design was used. We collected the opinions from different groups of clinicians (physicians, hospitalists, nurse practitioners, nurses, and patient safety officers) using semi-structured interviews. Organizations represented were trauma hospitals, academic medical centers, medical clinics, home health centers, and small hospitals.

MAIN FINDINGS: Our study found clinicians' ambivalent assessments toward EHR, which confirms extant literature. We compared the responses by job roles and found that nurses were positive about improving efficiency with EHR while others regarded EHR as time-consuming. While many underscored the importance of EHR in avoiding medical errors by improving data accessibility, nurses had concerns regarding data accuracy. Interoperability appeared to be a concern given limited system integration.

PRINCIPAL CONCLUSIONS: Lived experiences of clinicians further tease out the mixed views about the effectiveness of EHR and highlight the challenges in EHR implementation. Redesigning the EHR and improving its implementation process may be potential solutions to increase its effectiveness.

KEYWORDS: Electronic Health Record, EHR, healthcare quality, patient safety, semi-structured interview, EHR challenges

Introduction

The implementation of Electronic Health Record (EHR) systems is meant to assist providers' evidence-based decision-making[1] and streamline providers' workflow via efficient coordination for patient care.[2] Extant literature has highlighted the benefits of implementing EHR, including improved patient outcomes, enhanced patient safety measures, as well as reduced costs.[1]

Although the benefits of EHR are well-received and Health Information Technology for Economic and Clinical Health (HITECH) Act encourages the use of EHR to improve care quality and efficiency, prior studies show mixed results of implementing EHR.[3] Recent studies suggest that full adoption of EHR might not be sufficient to ensure the benefits of EHRs; instead, meaningful use[4] or meaningful assimilation of EHR is the key determinant for the realization of EHR benefits. It points to the direction of further investigations of providers' usage behavior.

The clinicians' first-hand experiences with EHR need to be carefully reviewed to identify the possible benefits, costs, drivers, and barriers of EHR implementation. The clinicians are end-users of EHR; their perceptions and behaviors would impact how well the system is utilized. However, most of the prior studies in this area take an observation approach or secondary-data analysis[2,5] and focus on hospital-level outcomes.[6,7] It remains unclear how EHR implementation affects clinicians' daily practices. Only a few studies examine clinicians' assessment of EHR[8] such as how EHR affect clinicians.[9] A recent study also suggest that it is essential to understand the key factors that support or hinder the use of EHR from clinicians' perspective in order to optimize the use of EHR.[10]

After more than a decade of EHR implementation in the U.S. hospitals, clinicians may have become more familiar with EHR in their daily practices. It therefore warrants further investigation with recent data to identify the long-term impacts of EHR implementation on healthcare quality and safety outcomes. Although prior studies reported nationwide surveys on the adoption of EHR systems, they mainly focus on the usability of EHR[9] or emphasize the hospital-level usages and adoptions.[11] This study instead employs a qualitative research approach, as the primary objective was to explore clinicians' in-depth assessment of factors relevant to a complex system.[10] The usage and impact of EHR on healthcare quality and safety con be considered as a complex system as it involves organization culture, technical design features, personal practices, and the interaction of these factors.
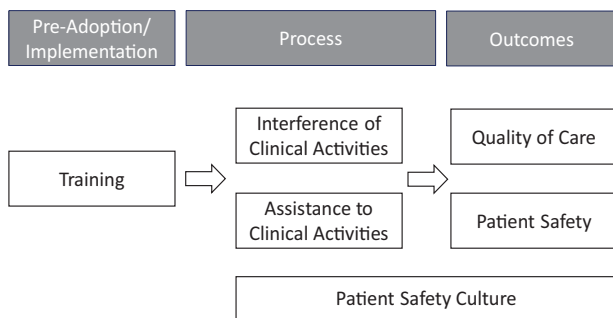
Figure 1. Framework of analysis results.

The purpose of this study is to explore the lived experiences of clinicians in different job roles, focusing on their assessment of EHR. By doing so, we can offer new insights into the impacts of EHR after a decade of encouraging EHR implementation in the U. S. hospitals. The opinions from clinicians in various job roles can also help further delineate how EHR impacts patient care activities and patient safety. We aim to find the common theme of successful EHR implementation and make recommendations to practitioners.

Methodology

We conducted semi-structured interviews with clinicians, focusing on the advantages and challenges of EHR in improving healthcare quality and safety. We obtained IRB approval for the procedure, participant recruitment, and interview questions. Two investigators conducted the interviews from October 2018 to May 2019. The participants were recruited from Nevada and California in the U.S. These geographical areas were used because this study aims to provide an accurate representation of the western United States. The respondents were chosen based on whether they have been using EHR on a consistent and regular basis for at least 12 months. Participants represented different job roles: physicians (6), hospitalists (2), nurse practitioners (4), nurses (6), and patient safety officers (2). Hospitalists are essentially physicians who are dedicated to hospitalized patients, and in our study patient safety officers are essentially senior nurses with a separate designation at the patient safety department. Although we had only 2 participants of each of the above 2 occupations, they are representative of the clinician population. They were from trauma hospitals, academic medical centers, small size hospitals, and medical clinics, and home health centers. There were 20 participants in this study. Participants belonged to different organizations and might not use the same EHR vendor. The interviews were conducted by phone/Skype and lasted approximately an hour for each.

The interviews were de-identified, audio-taped, transcribed, and reviewed by both investigators. The transcripts were coded using Qualitative Research Software (QSR Nvivo version 12) to derive themes and summarize concepts. Until thematic saturation was achieved, investigators recruited new participants and conducted interviews. With a sample of 15, assigned codes

and themes were repeated in subsequent participant interviews, yielding no new themes. There were 5 additional participants interviewed after thematic saturation was obtained. This practice is consistent with prior literature that thematic saturation can be obtained with the data from 15 interviewees.[12,13]

The investigators reviewed the transcripts independently before the discussion to identify emerging patterns. We conducted an iterative process to identify major domains, and persistent and important themes and patterns. We examined 652 quotes and phrases. Respondents' own words helped in guiding code development. For instance, 1 clinician responded: "with EHR there is less chance of an error which affects the quality and patient safety." This phrase was given 3 codes: EHR, quality, and safety. As a result of our analyses, we assigned 52 codes and created 10 major domains.

Study Results

We organized the emerged themes in chronological order for clinicians' EHR experience. As shown in Figure 1, the topics are categorized as pre-adoption and implementation stage, the process of EHR use, and the outcomes of EHR implementation; we also identified organizational culture as a supporting factor for the process and outcomes.

We summarized the main findings as shown in Table 1. In general, the clinicians have ambivalent assessments toward EHR. By comparing and contrasting the views on advantages and challenges of EHR implementation broken down by job roles, we obtained several interesting findings: (1) Nurses were positive about improving efficiency with EHR while others regarded EHR as time-consuming. (2) Physicians, nurse practitioners, and patient safety officers collectively underscored the importance of EHR in avoiding medical errors by improving the accessibility and readability of patient data. However, nurses indicated concerns regarding the accuracy of the data. (3) Interoperability appeared to be a concern for physicians and patient safety officers, given limited system integration.

Next, we present and discuss the main themes that emerged from the interviews in detail according to the categories shown in Figure 1.

Training on EHR

The participants found the training of EHR to be superficial and of insufficient duration. Some obtained training for a few hours before using EHR for clinical activities. Some others were trained as they performed clinical activities, and others got trained over the phone.

> *"I had one day training each year when the software is updated. But um.. training is not enough to cover each scenario."*

Prior research suggests that user training can effectively promote user acceptance of a system, system utilization, job satisfaction, and system satisfaction directly or indirectly.[14] Although

Table 1. Compare and contrast views of respondents by job roles.

JOB ROLE	ADVANTAGES OF EHR IMPLEMENTATION	CHALLENGES OF EHR IMPLEMENTATION
Physicians	1. With reminders and alerts in EHR, quality and patient safety can be improved. 2. EHR enables reporting of adverse events. 3. It is easier to find patient data and easier to read their information clearly.	1. Time-consuming. 2. It takes away valuable time from patient care. 3. There is no national and integrated EHR. Different hospital systems use their own EHR, and that makes it very fragmented.
Patient safety officers	Doctor's notes and patients' history within EHR is very useful to avoid patient safety mistakes.	1. EHR created issues for the quality of care. Maybe very difficult to extract data from these systems. 2. Spend too much time on documentation. 3. It is not integrated and is very fragmented.
Nurses	1. EHR enables the review of a patient's history even before seeing the patient and makes clinicians' work more efficient. 2. The usage of abbreviations makes documentation more effective. 3. Can check side effects and clarify notes with physicians before administering medication	If notes are just copied and pasted from one shift to the next, it may not represent accurate patient information.
Hospitalists	1. It reduces time spent on paper documentation. 2. Massive data can be gathered from the EHR, which can be very useful for research and analysis.	It takes time to get used to the EHR system and requires plenty of documentation, making EHR less efficient.
Nurse practitioners	1. EHR promotes an understanding of the doctor's plan in real-time. 2. The audit and compliance office can detect medical errors in real-time.	1. Sometimes the software is extremely slow and slows down clinicians' practice, having the patient wait. 2. EHR has become more complex over time, and completing EHR documentation makes them exhausted.

training is an essential cost in implementing EHR, the clinicians might not receive sufficient training in their practices.

Interference of EHR

Clinicians thought that EHR documentation could consume time away from patients, and they observed that EHR takes away much attention from the patients. Some suggested that their organizations were aware of the issue and started redesigning patient rooms so that clinicians would face the patients, rather than the computer.

"A lot of my attention goes to doing the documentation on the EHR."

Some respondents perceived that EHR slows down their practice, especially for senior physicians who tend to take longer to use EHR as compared to junior physicians. EHR also slows down the practice because there might be areas in which much documentation is needed, making clinicians less efficient for delivering clinical care. Clinicians perceived that due to the excessive documentation and regulatory requirements, they got exhausted by using EHR.

"There are these areas in which I'm covering tons of documentation on EHR, and EHR is less efficient in some areas."

The complexity of EHR also makes them feel that they do more "button clicking" than engaging in conversations with patients. Nurse respondents commented that EHR allows the nurse from a later shift to copy and edit notes from the previous shift. Once notes are edited, the nurse might not be able to see accurate information. Furthermore, clinicians expressed that although they can draw on EHR to explain clinical conditions to patients, it does not have a way of documenting the drawings, which can be a disadvantage.

"Lots of time spent logging in when pulling out data in EHR. Really looking for Internet of Things (IOT), more advanced technology, and limiting clicks."

Another downside that most respondents referred to was not having an integrated EHR system and the lack of communication between different EHR systems. Respondents noted that the effectiveness of EHR can be increased by having more integrated rather than fragmented systems.

"I think the EHR currently is very fragmented, because one hospital system uses one; another hospital system uses another, the government has its own EHR at the V.A. system."

In addition to the initial cost and the difficulties in using EHR, the respondents also expressed concern about the long-term costs, including the dependency on technologies and the need to keep up with evolving technologies.

"We are very dependent on it, and there are downsides to it."

Although HITECH Act provides an incentive program to encourage meaningful use of EHR and to build an infrastructure to digitally exchange health information,[15] EHR systems

are still not designed in a way that supports such purposes. Our study results are in line with the literature but further suggest that some system design improvements are needed to streamline the workflow for clinicians. Most respondents perceived that EHR was a necessary evil, implying that the disadvantages of EHR were not as much as the benefits that it provides.

Assistance of EHR

Respondents affirmed that EHR assists with clinical activities by preventing important information from being lost and allowing the flexibility to accomplish documentation needs even while being away from a clinic. Certain features of EHR, such as the provision of abbreviations, can enable efficient documentation. Nurse respondents thought that EHR's assistance in administering medication was great support for clinical activities. Physician respondents observed that repetitive work is significantly reduced.

> *"You can cut down on the daily needs on doing a repetitive. . . ...umm orders or repetitive verbiage, dictation."*

Respondents perceived that EHR keeps clinicians organized by providing them with a systematic way of recording patient information. Respondents perceived that EHR makes their clinical work effective by providing reminders about tests, medications, bills, etc. EHR provides alerts regarding allergies that make it easier for clinicians to be cognizant of adverse reactions of medications while ordering these medications. Respondents perceived that EHR helps in improving core measures, internal benchmarking, and overall processes.

> *"It really helps with core measures; it helps with internal benchmarking. It has definitely improved our processes."*

EHR can also help in improving the understanding between providers via clearer communication. Respondents also indicated that the ability to share patients' records across institutions saves effort and time. It also assists doctors in planning and documenting.

> *"It helps the patient treatment process and collaboration with a ton of other specialties and department team in itself to communicate with one another and to pull information."*

An EHR system can be very advantageous to clinicians as it helps in streamlining clinical activities. Early qualitative research finds that EHR facilitates regulatory compliance, access to patient data, and communication among practitioners.[16] Our study results confirm most of the benefits in the literature and further point to the benefit of reminding or alerting of critical events in the treatment processes. Our study also confirms the importance of EHR in helping communication

and information exchange, aligned with the criteria of Stage 2 and Stage 3 of meaningful use in the HITECH Act.

Safety culture and management support

Some of the participating organizations conduct a Safety Culture survey provided by the Agency for Healthcare Research and Quality (AHRQ) on a regular basis to ensure that a positive environment of patient safety is maintained. Hospitals have made efforts to improve safety culture by having a reporting system for unusual occurrences, including the use of visual dashboards.

> *"New employees can attend webinars and get education on patient safety cultures and patient safety."*

Respondents perceived that management was somewhat supportive of patient safety; for example, some rewards were given when the number of falls and injuries were low. Staff is also praised for their accomplishments; for instance, 1 hospital provides a "Zero Hero" award for achieving zero hospital-acquired infection for at least 1 full month in a quarter. Participants also perceived that management listens to staff suggestions, which is extremely important for sustained improvement. Staff nurses could speak up about safety issues in department meetings or send an email to the manager. Respondents also thought that EHR could be used as an error assessment tool in the framework of patient safety and safety culture for the entire organization.

> *"We're constantly looking at patient care. . . or patient safety initiatives and things like that. It's really helped do that because if we didn't have EHR, it would all be manual."*

A recent study suggests mixed results regarding the relationship between EHR adoption and patient safety culture.[17] Our interview results indicate that patient safety culture is underscored in hospitals, and EHR implementation can help promote such a culture.

Improvement in care quality

EHR makes communication between clinicians and patients more efficient because our respondents noted that they are able to view patients' history and the procedure those patients underwent. Respondents also reported that it is easier to read clearly and find pertinent data. With better communication, EHR improves mutual understanding among clinicians of different disciplines, such as physicians, nurses, and therapists. Respondents perceived that EHR makes their work effective by providing sufficient patient information even before the patient gets seen. Respondents also indicated that having a central system where all patient records can be found provides a more comprehensive clinical history of patients. Respondents

thus perceived that having EHR allows providers to make informed decisions and improve care outcomes. With EHR, reporting quarterly or monthly has become much more manageable, making improvement activities efficient.

> *"We know it's a better barometer and a better dashboard that allows us more timely data."*

Our interview results are aligned with the literature regarding how EHR enhances the quality of care. Respondents illustrated the EHR features that assist with clinical activities and improve the quality of care. Information exchange facilitated by EHR, as highlighted in the HITECH Act as meaningful use of EHR, appears to be a critical factor that improves care quality.

Improvement in patient safety

Patient safety leaders thought that EHR streamlines the process of requesting records; thus, EHR also improves patient safety procedures. Surgeon respondents perceived that having medical history, surgical notes, surgical operation details, and examination details available avoids potential mistakes and fosters patient safety. Additionally, the ability to create incident reports in case of falls and injuries boosts the safety culture for continuous improvements based on the incident reports.

Respondents said that reminders and alerts of giving the correct medication at the right time are helpful to mitigate the risk of medical errors. Medical errors can be detected if they occur, and the root cause can be analyzed to avoid future errors. Nurse respondents commented that they could look at the side effects or interactions with other drugs before administering medications to the patient. Without EHR, nurses would have to sometimes clarify notes with physicians, which becomes difficult during night shifts when physicians or other resources are unavailable. Surgeon respondents reported that EHR provides alerts to avoid mistakes such as incorrect medication dosage and wrong-site surgeries.

> *"There is a pop up in the system which questions are you supposed to give that medication right now?"*

Having EHR allows data analyses for research purposes, findings from which can be implemented to improve patient safety. Participants also noted that there are opportunities for EHR to be further developed on improving patient safety. For instance, EHR can produce patients' "safety dashboards" and gather patient information for susceptibility to hospital-acquired infections.

> *"We are able to extract digitized data from all these patients. That's very important data; this data is clinical data, with numbers that can*

be interpreted, and that research can be done to improve patient outcomes."

Overall, the participants confirmed that EHR improves patient safety by offering reminders, notifications, and alerts. Due to the advancement in data analytics, EHR can further improve safety by offering predictive reminders and notifications. While few prior studies investigate the application of predictive analysis by leveraging EHR data, the new direction of EHR development can be expected in the future. Nevertheless, security and privacy issues pose new challenges for EHR development and data analysis.

Discussions

According to our interview results, the clinicians' overall experience using EHR was positive. The benefits identified by the participants are in general aligned with those reported in the literature and the design principle of EHR. The following perceived benefits of EHR were illustrated in the interview: EHR keeps clinicians organized by providing them a systematic way of recording patient information; EHR makes communication between healthcare providers efficient; reminders and alerts on EHR are helpful to mitigate the risk of medical errors; EHR allows providers to make informed decisions; and EHR enables the flexibility for documentation even away from a clinic.

Nevertheless, the following downsides of EHR were also highlighted in the interviews: Training on EHR was less than sufficient, which prevents them from fully benefiting from EHR; EHR takes away clinicians' attention from patients and slows down their practices; EHR has created a dependency for providers, which may generate potential issues when the system is down; and not having integrated EHR poses disadvantages to providers.

The responses from different job roles also offer intriguing insights. Nurses have frequent interactions with patients and carry heavy documentation loads; their perspectives could differ from the physicians'. It points to the importance of data quality; only when the data entered by different roles in the healthcare system are accurate, the clinicians can make timely and correct decisions and improve healthcare quality and safety.

While some participants thought that EHR could reduce paper charting, thus allowing more time to be devoted to patients, others perceived that EHR might take time away from patient interactions. This finding suggests that a proper balance between time spent with patients during clinical activities and the documentation needs to be maintained. First, EHR can be better designed to fit the clinicians' daily practices and reduce the effort required from clinicians to learn and use EHR. Second, the EHR system and the patient room can also be improved to minimize interferences in clinical activities and

patient communications. Third, the management can support clinicians by offering proper and sufficient training on EHR and reducing the pressure of documentation. By doing so, the EHR can be utilized to its full potential in improving the quality of care delivered to patients.

Conclusions

Our study provides an update from the clinicians' perspective on EHR after a decade of development and advocacy by the government. Our study further teases out the possible factors leading to the mixed findings in the literature and also associates the critical factors to healthcare quality and patient safety. While prior research analyzes hospital-level usage and adoption factors with patient safety, this study analyzes the individual-level usages and operations of EHR. Our study not only obtains the lived experience from the clinicians but also compares and contrasts the assessments of clinicians in different job roles. Based on the findings, we identify that data accuracy could be a key in EHR implementation outcomes, in terms of healthcare quality and safety. Every clinician, including physicians and nurses, must enter the notes accurately; the subsequent medical decisions and medication administration can be made correctly based on the prior note history. Further, when EHR is considered a burden that slows down the practices and interferes in clinicians' activities, its effect on the quality of care and patient safety might not be significant.

Second, the findings provide a point of departure to understand the factors leading to clinicians' acceptance and resistance to EHR. The results are in line with the technology acceptance literature. The clinicians' perceived ease of use (eg, accessing patient data) and perceived usefulness (eg, providing alerts and reminders) are keys to their acceptance of EHR. On the other hand, the physical burdens (eg, documentation effort) and mental burdens (eg, interference with patient interaction) lead to their possible resistance to EHR. Although some studies have adopted the System Usability Scale (SUS) to examine physicians' assessment of EHR (eg, Melnick et al[9]), they use a single SUS score and possibly overlook the other critical factors contributing to clinicians' acceptance and resistance to EHR. Our study suggests that future studies can examine the clinicians' acceptance and resistance to EHR with a theoretical framework to understand the phenomena systematically.

Third, the study results provide empirical evidence on the critical individual-level factors that can impact the effectiveness of EHR on improving quality of care and patient safety. Even if the clinicians use EHR systems with similar features, the improvement of healthcare quality and patient safety may vary, due to the clinicians' usage experience (eg, data entry effort, and training and support received). Our study thus suggests further investigations into the possible mediation or moderation factors between EHR implementation and its consequences, such as data quality, decision-support functionalities, communications between clinicians, and system interoperability.

We also offer practical suggestions for redesigning EHR and improving the implementation process. Specifically, EHR systems should be designed to reduce the learning curve; the functions for documentation should also be enhanced to minimize data entry errors and track the changes in the patients' notes. The vendor and hospitals should also provide sufficient training in order to reduce burdens on clinicians. The physical environment for using EHR should also be updated to lessen interference clinicians' interactions with patients.

Finally, this study could be extended in several directions. Additional studies might achieve more robust empirical results by employing a survey analysis and examining clinicians across different types of practices or states. Second, further studies that adopt a longitudinal design could investigate the evolving roles of EHR over time, which is particularly critical as organizations and clinicians gain experience with increasingly mature EHR. Third, we did not ask the respondent to indicate the software implemented in their facilities due to their concerns of potential violations of confidentiality. Nevertheless, software design and software implementation play critical roles in EHR implementation, and future survey studies can tap into this area. **[AQ: 3]**

Author Contributions

SU conceptualized the project. SU and HH wrote the grant proposal. SU collected data and analyzed it. SU and HH wrote the manuscript. HH revised the manuscript.

Ethical Approval

IRB approval was obtained from the University of Nevada Las Vegas Institutional Review Board.

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