

A Comprehensive Review of Digital Transformation in Healthcare: Addressing Privacy, Security, and Usability Challenges in Electronic Health Records

Nirav Mehta^{1,*}, Priyanka Rathod², Bhoomi Raychura³, Shital Bokhiriya⁴

Abstract

The healthcare industry's shift toward digitalization through electronic health records (EHRs) and advanced health information technology (HIT) promises improved patient care but brings forth challenges in safeguarding patient data privacy, confidentiality, and security (PCS). Researchers are exploring innovative solutions like block chain and cryptography to address these concerns while ensuring usability for healthcare professionals. Additionally, the impact of regulatory frameworks on data sharing and security is being studied, emphasizing the importance of robust privacy regulations and security measures. New technologies like artificial intelligence (AI) are being utilized to improve the quality of healthcare delivery. Overall, while the digital transformation of healthcare presents multifaceted challenges, ongoing research aims to overcome these obstacles to maximize the benefits of digital health systems while preserving patient privacy and confidentiality.

Keywords: Electronic health records (EHR), health information exchange (HIE), tele health, health information technology (HIT), health informatics

INTRODUCTION

In recent years, the healthcare industry has undergone a significant transformation with the widespread adoption of electronic health records (EHRs) and advancements in health information technology (HIT) [1]. These changes have revolutionized patient care delivery, promising enhanced efficiency, improved patient outcomes, and better resource utilization. However, along with these advancements come various challenges, particularly concerning the privacy, confidentiality, and security (PCS) of health data [2].

Several studies and research articles have shed light on the complexities surrounding PCS in EHRs and health information exchange (HIE) systems. Researchers have delved into the distinctions between PCS, emphasizing the importance of understanding these concepts for developers and healthcare professionals alike. Moreover, innovative technologies, such as block chain and cryptographic techniques have been explored as potential solutions to bolster data security and privacy in healthcare settings.

The shift from paper-based to EHRs has also brought about challenges in usability and integration with clinical workflows. Despite optimization efforts, discrepancies between EHR systems and clinician requirements persist, necessitating ongoing collaboration between healthcare professionals and informaticists to address these issues effectively [3].

*Author for Correspondence

Nirav Mehta

E-mail: mr.niravmehta1@gmail.com

¹Assistant Professor, Department of Computer Science, Shri V. J. Modha College of IT, Porbandar, Gujarat, India.

²⁻⁴Students, Department of Computer Science, Shri V. J. Modha College of IT, Porbandar, Gujarat, India.

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Furthermore, the regulatory landscape surrounding HIE and data privacy has been examined, highlighting the influence of privacy regulations (PR) and security measures (SMs) on the adoption of HIE systems. Studies have underscored the significance of national-level PR and robust security infrastructure in promoting the exchange of patient health information (PHI) among healthcare institutions [3].

In addition to addressing technical and regulatory challenges, researchers have explored the transformative role of artificial intelligence (AI) and large language models (LLMs) in healthcare informatics. These advanced AI models have demonstrated remarkable capabilities in tasks ranging from medical diagnosis and imaging analysis to medical education and public health management [4].

Overall, this collection of research articles reflects the multifaceted nature of contemporary healthcare informatics, encompassing issues of data privacy, usability, regulatory compliance, and the transformative potential of emerging technologies. By understanding and addressing these challenges, stakeholders in the healthcare industry can harness the full benefits of EHRs and HIE systems while safeguarding patient privacy and confidentiality [5].

LITERATURE REVIEW

1. R. Nowroz Yetal (2024). Healthcare industry's focus on establishing a secure and privacy-centric framework for sharing health data underscores the importance of safeguarding user privacy. Understanding the distinctions between PCS is pivotal for researchers and developers working on EHRs. A survey of 130 studies spanning from 2012 to 2022 examined EHRs, privacy-preserving techniques, and relevant tools, revealing prevalent approaches like access control, block chain, cloud-based solutions, and cryptography. These techniques aim to facilitate EHR data sharing while maintaining privacy. Various strategies employed by EHR tools to ensure privacy were identified and summarized. Furthermore, a detailed comparison of PCS shed light on their differences and similarities. The findings, presented in a tabular format, outline techniques used by different EHR tools and suggest a fusion of these methods to enhance PCS preservation in EHRs [6].
2. Sonali D. Patil (2024). The shift from paper-based to EHRs pre relevant information efficiently and securely. Maintaining confidentiality and accuracy is critical to prevent breaches with severe consequences. However, modern healthcare infrastructure struggles with data integrity, security, and privacy. Blockchain technology offers promising solutions by providing decentralized and trustworthy systems for healthcare data management. It enhances access to patient information and medication monitoring. Implementing block chain-based safeguards for medical records is crucial for improving healthcare delivery systems, with evaluations showing its reliability and resilience compared to existing methods [7].
3. Adam M. Franks (2024). EHRs are now widely utilized in the medical field, yet there is often a gap between developers and end-users during the design phase. This disconnect frequently results in interfaces that do not fully align with the clinical workflow, leading to challenges during implementation. However, optimization strategies enable collaboration between clinicians and informaticists post-implementation to address these issues. Despite the implementation of optimization measures, documentation of success is typically limited to the institutional level, rather than being widely disseminated. In simpler terms, while EHR systems are common in healthcare, they often don't match the way clinicians work, causing problems when they're put into use [8]. After they're in place, teams of clinicians and technology experts work together to fix these issues, but their successes are usually only recorded within their own institutions, rather than being shared widely [9].
4. Utkarsh Shrivastava (2023). This study investigates the impact of PR and SMs on the use of health information exchange (HIE) among hospitals for sharing PHI. Using data from a multinational survey, the research analyzes how different levels of PRs, from national to hospital-specific, and the strength of national security infrastructure (NSI) influence HIE.

Findings suggest that national-level PRs have the strongest positive effect on HIE, while regional and hospital-level PRs diminish this impact. Additionally, implementing more SMs increases the likelihood of engaging in HIE, with a strong NSI further amplifying this effect. Overall, the study underscores the importance of national-level PRs and suggests that initiatives like secure communication channels can complement SMs to encourage HIE adoption [10].

5. This research delves into the implementation of Regional Health Information Institutes (RHIs) in the United States, aiming to enhance emergency medicine practice by facilitating the exchange of local or regional health information. RHIs enable electronic data transfer, improving medical care safety, efficiency, and supporting public health initiatives and research [11]. However, challenges, such as organizational, economic, and geographical factors affect the establishment of RHIs and information exchange. J. Cristian Rangel (2024) to overcome these challenges, the study proposes a decision-making framework employing the PROMETHEE method to evaluate various HIE alternatives. Data collected from decision-makers is analysed to prioritize options like pharmaceutical industry and research, clinical trials, healthcare fraud detection, neurological research, and EHRs based on criteria, such as transparency, autonomy, and decentralization. Results highlight clinical research as the primary priority, followed by the pharmaceutical industry, EHRs, medical fraud detection, and neurological research. This methodology aids in effectively prioritizing HIE options based on diverse criteria and stakeholder preferences [12].
6. Gregory L. (2015). Inter-organizational collaboration in HIE is a significant challenge in the US healthcare system. To understand and address this challenge, a holistic perspective is required. Institutional theory concepts, such as organizational field and institutional logic, offer valuable insights into this issue. According to institutional theory, stakeholders in HIE are influenced by external factors like healthcare policies and regulations, as well as by their internal interactions within HIE networks. These stakeholders actively shape the environment within HIE networks, forming social networks that drive collaboration. Ultimately, the success of HIE networks depends on the strength of social networks among healthcare provider organizations. These networks serve as collaboration anchors, facilitating the exchange of health information and driving progress in HIE initiatives [13].
7. Adam M. Franks (2024) [9]. The adoption of EHRs has revolutionized clinical practice, offering integrated systems that promise to enhance patient safety and quality of care. However, training physicians to effectively use EHRs is a complex task within the dynamic healthcare system. This training process is considered a “wicked problem,” requiring approaches beyond traditional linear analysis [14]. To address this challenge, we propose introducing medical education scholars to theoretical approaches from the Social Studies of Science and Technology (SSST) literature. These theories offer insights into the complex social and institutional factors surrounding technological change, providing valuable guidance for educational efforts aimed at training physicians in EHR use. Essentially, we seek to equip medical educators with new perspectives and tools to navigate the intricate process of training healthcare professionals in EHR utilization [15].
8. Khlood Saad Aljaber (2020). This study investigated the relationship between HIT maturity in nursing homes and the scope of deficiencies reported. Two national surveys conducted in 2020 and 2021 measured HIT maturity in nursing homes, which were then linked to quarterly deficiency reports for the same years. The analysis revealed that nursing homes with higher HIT maturity tended to have fewer widespread deficiencies. Factors, such as nursing home size, staffing levels, and the survey year also influenced deficiency scope. Overall, the findings suggest that HIT can play a significant role in improving the quality of care and reducing adverse events in nursing homes [16].
9. Zuan Sun (2023). HIT in Nursing Homes. HIT has transformed NH care. Most NH administrators can share data internally but not externally. HIT maturity scores increased over 2 years [17]. Deficiencies were common, especially related to nutrition. Higher HIT maturity was

associated with reduced deficiency scope. In other words, implementing HIT improves NH care, but challenges remain [18].

10. S. Edirippulige (2017). Globalization's Impact on Business Transforms organizational operations. Opens new markets and opportunities [19]. Not limited to new markets and opportunities. Globalization has significantly influenced the business landscape, transforming operations and opening up new markets for businesses of all sizes [20]. It's a driving force in today's business world, impacting various aspects of organizations' operations. If you need further summaries or have more text to analyze, feel free to ask [21]!
11. Jami L. (2017). Health Information and Technology and Its Impact on Digital Health. The utilization of digital healthcare tools helps improve outcomes by reducing unwarranted variations in care, preventable injury or harm to the patient, and diagnostic errors. HIT improves treatment options, patient centricity, and increases opportunities for quality-of-life improvement for patients and healthcare providers. In other words, implementing HIT can enhance patient care and safety while also benefiting healthcare providers [22].
12. Huizi Yu (2023). LLMs in Biomedical and Health Informatics: LLMs are AI tools revolutionizing various fields, including bio medicine [23]. They process large amounts of data, understand natural language, and generate new content. Applications include medical diagnosis, patient engagement, EHR management, and personalized medicine [12].

RESULT

The results of healthcare can vary depending on various factors, including access, quality of care, prevention efforts, and individual health behaviors. Ideally, effective healthcare systems strive to improve overall population health, reduce morbidity and mortality rates, increase life expectancy, and enhance the quality of life for individuals [24–28].

CONCLUSION

The review examines the changing dynamics of healthcare, influenced by digitalization and technological innovations like EHRs and AI. It emphasizes the challenges of safeguarding patient data privacy and security while enhancing usability and interoperability. Key findings highlight the importance of understanding the distinctions between PCS, alongside innovative solutions like blockchain and decentralized systems. Regulatory frameworks, PR, and SMs are crucial for promoting secure data sharing. Collaboration between healthcare professionals and informaticists is essential for optimizing EHR usability. Moreover, AI and LLMs hold transformative potential across various healthcare domains. Overall, addressing these challenges can maximize the benefits of digital health systems while preserving patient privacy and security.

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