

Integrating Digital Technologies and Artificial Intelligence into Electronic Health Records to Enhance Healthcare Outcomes

Seham Ahmad Alanazi¹, Asma Obied Alanazi², Hamidah Saliman Alanazi³, Tahani Gadeb Alanazi⁴, Maha Horesan Almutiri⁵, Adel Ali Salem Alharbi⁶, Ali Nasser Almarqan⁷, Mansour Mohammed Al Hutaylah⁸

¹Health Information, Alnadheem South Primary Health Care Center, Riyadh

²Health Information, Ishbiliah primary health care center, Riyadh

³Health Information, Aljanadriyah East Primary Health Care Center, Riyadh

⁴Health Information, Ishbiliah primary health care center, Riyadh

⁵Health Informatics Technician, Al-Nadwa Health Center, Riyadh

⁶Health Informatics, King Fahad Specialist Hospital, Buraidah

⁷Health information, Najran General Hospital, Najran

⁸Health information, Najran General Hospital, Najran

ABSTRACT

The healthcare sector is undergoing a rapid transformation driven by digital technologies and artificial intelligence, with electronic health records (EHRs) at the forefront of this revolution. EHRs offer many benefits, including improved patient care, enhanced diagnosis, and treatment accuracy, as well as reduced administrative burden on healthcare providers. However, their integration with AI technologies is critical to addressing ongoing challenges, particularly around data security, privacy, and improved clinical decision-making. AI tools such as machine learning, natural language processing, and optical character recognition are enhancing the accuracy and efficiency of EHR systems, making them more powerful in detecting diseases, predicting risks, and improving healthcare outcomes. This paper reviews the important role of EHRs in modern healthcare, explores how AI can enhance their functionality, and discusses challenges related to data security, integrity, and bias in AI algorithms. Despite these challenges, the future of healthcare looks promising as EHR systems evolve into smarter and more secure platforms.

Keywords: Electronic Health Records (EHR), Healthcare Transformation, Artificial Intelligence, Healthcare Outcomes.

Introduction

The current era is witnessing a revolution in digital technologies and artificial intelligence, and healthcare has witnessed a pivotal transformation as a result of adopting digital transformations, which has led to improving healthcare and enhancing patient outcomes [1].

Electronic health records (EHR) are one of the manifestations of digital transformation in healthcare, which effectively contributes to managing patients' health data and facilitating cooperation between medical teams, which improves and enhances

healthcare [2]. Electronic health records (EHR) enable quick access to accurate information and patient medical history, which increases the efficiency of treatment decisions, and developing treatment plans that are consistent with the patient's condition and medical history [2,3].

In addition, the use of electronic records reduces human tasks and thus reduces errors resulting from handwriting and quick and accurate access to medical information, which contributes to enhancing healthcare [4]. However, there are many threats and issues related to electronic health records (EHR) such as information security and patient privacy [5]. Accordingly, the role of artificial intelligence in enhancing the security and privacy of electronic health records (EHR) emerges through artificial intelligence technologies that have the ability to identify potential threats and predict risks related to big data [6]. Technologies such as natural language processing (NLP) can also be integrated to analyze unstructured data from clinical records, enhancing the system's ability to detect potential risks [7].

Artificial Intelligence not only enhances the security of electronic health records [8]. It also enhances healthcare by analyzing medical data and providing medical recommendations based on accurate medical information [8,9]. Diagnosis and treatment can be improved based on a comprehensive and accurate patient record. At the same time, electronic health records facilitate compliance with regulatory standards as AI helps automate auditing processes and ensure ongoing compliance [10].

Accordingly, this review seeks to explore electronic medical records and their role in enhancing healthcare and patient outcomes. In addition, digital technologies and artificial intelligence can help address the challenges facing electronic medical records.

Digital Transformation in Medical Records and Its Impact on Healthcare

Digital transformation in medical records contributes to improving the quality and efficiency of healthcare through the use of digital health technologies [1]. This includes the use of electronic medical records and telecommunication technologies to improve access to healthcare services and facilitate communication between patients and doctors [11].

Electronic medical records are one of the most important digital health technologies used in healthcare. These records allow patient information to be stored and documented electronically, which facilitates access to and sharing of medical information between different healthcare institutions [12]. Electronic medical records also reduce the use of paper, improve the accuracy of recorded information, and save a lot of time and effort for patients and doctors alike. In addition to electronic medical records, telecommunication technologies contribute to improving healthcare considering the digital transformation [13]. Patients can communicate with doctors and nurses remotely using online healthcare applications and video medical consultations. These technologies contribute to facilitating access to healthcare services, reducing costs, and providing comprehensive coverage of healthcare services, including peripheral areas [14].

Digital transformation also enhances the exchange of medical information between healthcare institutions, providing an opportunity to enhance scientific research and innovation in the field of healthcare. digital technology, healthcare institutions can exchange information quickly and easily, which contributes to improving diagnosis and the efficiency of treatment decisions [11,13].

The Role of Electronic Health Records in Improving Patient Care

Electronic Health Records provide important tools that help reduce the workload of medical staff and contribute to better patient outcomes.

Better Patient Engagement

Electronic Health Records (EHRs) are an essential means of communication between patients, doctors, nurses, and other healthcare professionals. They contribute to improving diagnostic accuracy and treatment decision-making by providing accurate and comprehensive information about the patient's health condition [3,15]. They also contribute to enhancing the patient experience by scheduling treatment appointments online, which reduces the workload on healthcare workers. Moreover, integrated scheduling systems also reduce patient waiting times in clinics and healthcare centers, providing a better patient experience [15].

Preventive Care

Electronic Health Records (EHRs) enhance the ability of patients and healthcare professionals to manage diseases and continuously monitor health status, as they are an important tool in early detection of diseases and risk factors [4]. EHRs can also be used to manage patients and medical examinations and remind patients of them, which helps patients educate themselves and manage health risks, thus enhancing patient outcomes and healthcare [16].

Improving diagnostic accuracy

Electronic Health Records (EHRs) have the potential to provide physicians and other healthcare professionals dealing with patients with organized, accurate, and timely information that is collected and recorded in electronic health records, making the patient's health problem clear [3]. These technologies also allow physicians, hospitals, and systems to examine the big data in their databases to accurately measure diagnostic errors, thus reducing the recurrence of errors in the future.

Improving Patient Outcomes

Effective patient care requires a collaborative, multidisciplinary approach, and therefore, consistent, accurate information about a patient's health status must be available to members of the multidisciplinary team. An electronic health record (EHR) program implemented in clinics allows administrative staff to collect, observe, store, and monitor patient health information from virtually anywhere, while care providers have complete visibility into every patient encounter, including physicians, nurses, lab technicians, and others [17]. This provides better access to healthcare data, improves care coordination, and ultimately improves patient outcomes.

Reduces duplicate tests and procedures

Because EHRs contain all of a patient's health information in one place, providers are less likely to have to repeat requests for unnecessary tests, screenings, and procedures [18].

Electronic Prescription Accuracy

Electronic health records enhance the accuracy of electronic prescriptions, reduce medication errors, verify drug interactions, reduce costs, and improve care. By securely exchanging information between physicians and pharmacists [19].

The Role of Digital Technologies and Artificial Intelligence in Electronic Health Records

Digital technologies and AI tools offer several benefits that enhance electronic health records to improve patient outcomes and healthcare. Health information professionals and technicians can integrate digital technologies and artificial intelligence into electronic health records to enhance operational efficiency, improve decision-making, and ensure secure and compliant management of patient data [20].

Data Management and Organization:

AI algorithms help in classifying and organizing health data in a way that enables quick and accurate access to patient data [21].

Data Analysis and Insights:

AI tools through machine learning algorithms help in analyzing patient data from multiple sources such as medical files, lab results, and radiological images. Which provides finding patterns and trends, most of which may not be immediately apparent to a human analyst. This contributes to early detection of diseases, better diagnoses, and better treatment plans [22].

Natural Language Processing (NLP):

The same can also be attributed to the technological advancements that have led to AI having the ability to read and process human language. When this NLP is applied to electronic medical records, the required data can be extracted, as it is composed of free text clinical notes and narrative reports, which leads to the creation of a unified patient profile to be analyzed [23].

Optical Character Recognition (OCR) and Intelligent Document Processing (IDP)

Optical Character Recognition (OCR) and Intelligent Document Processing (IDP) are essential for transforming physical, unstructured digital documents into searchable electronic records. These technologies automate the extraction of relevant data, such as patient information and history, from various formats, including handwritten notes [24]. The combination of OCR and IDP ensures accurate digitization, improves data accessibility, and reduces errors.

Integration with Electronic Health Records Systems

An effective digitization solution should be seamlessly integrated with existing electronic health records platforms, allowing digital data to be seamlessly integrated into the broader healthcare ecosystem [21,22]. This integration unifies patient records, enhancing decision-making processes by providing clinicians with comprehensive, timely information without the need for redundant data entry.

Scalability and Customization

Digital tools and AI must meet the scalability requirements to accommodate the evolving demands of healthcare organizations. They should be able to handle increasing volumes of medical records while providing the flexibility to customize workflows according to the needs of healthcare systems. This adaptability ensures operational efficiency and long-term sustainability, allowing the system to evolve along with the requirements of the healthcare organization [1].

Challenges in Electronic Health Record Digitization and AI Adoption

Despite the benefits of digitizing health records and integrating AI into healthcare, there are several challenges that need to be addressed to improve healthcare and patient outcomes.

Data Security and Privacy Concerns

As AI tools rely on processing vast amounts of patient health data, data security and privacy are some of the most significant challenges facing the digitization of health records. Data breaches, inadequate encryption, and unauthorized access can all lead to harm to patient data. As such, health information systems professionals must develop comprehensive plans to prevent and respond to data breaches to effectively mitigate risks [25].

Bias and Discrimination in AI Algorithms

Bias in AI algorithms is a critical issue, as the data used to train these systems may reflect biases that lead to unfair outcomes for certain patient groups. For example, algorithms trained on unrepresentative datasets may exhibit lower accuracy for underrepresented populations, such as those with darker skin or specific races [21]. To address these biases, healthcare providers should use diverse datasets, regularly monitor AI performance across different groups, and use fairness correction techniques to ensure equitable healthcare outcomes.

Integration and Resistance to Change

Integrating AI with existing EHR systems poses technical and systemic challenges. Incompatibility between AI solutions and existing health information systems can hinder seamless integration, and resistance to adoption by medical staff can delay progress [11,20].

Patient Acceptance and Adoption of AI

Patients continue to be skeptical about the accuracy and reliability of AI tools. Ensuring that AI solutions are tailored to patient needs and offering alternative options to those who are hesitant to adopt AI are key strategies to increase patient acceptance of health records and digital technologies [26].

Conclusion

The integration of digital technologies and artificial intelligence into Electronic Health Records represents a transformative force in modern healthcare. By enhancing the efficiency, security, and decision-making processes within healthcare systems, these technologies significantly improve patient care and outcomes. The continuous evolution of AI tools and the development of secure, interoperable EHR systems promise to address current challenges, including data security concerns and the risk of algorithmic bias. However, overcoming technical barriers, fostering patient acceptance, and ensuring the seamless integration of these innovations are essential for realizing their full potential. Moving forward, healthcare providers and policymakers must collaborate to create a framework that addresses these issues while leveraging the full capabilities of digital health technologies.

References

- Alanazi A. Clinicians' Views on Using Artificial Intelligence in Healthcare: Opportunities, Challenges, and Beyond. *Cureus*. 2023 Sep 14;15(9):e45255. doi: 10.7759/cureus.45255. PMID: 37842420; PMCID: PMC10576621.
- Alowais SA, Alghamdi SS, Alsuhebany N, Alqahtani T, Alshaya AI, Almohareb SN, Aldairem A, Alrashed M, Bin Saleh K, Badreldin HA, Al Yami MS, Al Harbi S, Albekairy AM. Revolutionizing healthcare: the role of artificial intelligence in clinical practice. *BMC Med Educ*. 2023 Sep 22;23(1):689. doi: 10.1186/s12909-023-04698-z. PMID: 37740191; PMCID: PMC10517477.
- Basil NN, Ambe S, Ekhatior C, Fonkem E. Health Records Database and Inherent Security Concerns: A Review of the Literature. *Cureus*. 2022 Oct 11;14(10):e30168. doi: 10.7759/cureus.30168. PMID: 36397924; PMCID: PMC9647912.
- Bekbolatova M, Mayer J, Ong CW, Toma M. Transformative Potential of AI in Healthcare: Definitions, Applications, and Navigating the Ethical Landscape and Public Perspectives. *Healthcare (Basel)*. 2024 Jan 5;12(2):125. doi: 10.3390/healthcare12020125. PMID: 38255014; PMCID: PMC10815906.
- Bhati D, Deogade MS, Kanyal D. Improving Patient Outcomes Through Effective Hospital Administration: A Comprehensive Review. *Cureus*. 2023 Oct 26;15(10):e47731. doi: 10.7759/cureus.47731. PMID: 38021686; PMCID: PMC10676194.
- Cutting, Graham A., and Anne-Françoise Cutting-Decelle. "Intelligent Document Processing--Methods and Tools in the real world." *arXiv preprint arXiv:2112.14070* (2021).
- Evans RS. Electronic Health Records: Then, Now, and in the Future. *Yearb Med Inform*. 2016 May 20;Suppl 1(Suppl 1):S48-61. doi: 10.15265/IYS-2016-s006. PMID: 27199197; PMCID: PMC5171496.
- Gala D, Behl H, Shah M, Makaryus AN. The Role of Artificial Intelligence in Improving Patient Outcomes and Future of Healthcare Delivery in Cardiology: A Narrative Review of the Literature. *Healthcare (Basel)*. 2024 Feb 16;12(4):481. doi: 10.3390/healthcare12040481. PMID: 38391856; PMCID: PMC10887513.
- Haleem A, Javaid M, Singh RP, Suman R. Telemedicine for healthcare: Capabilities, features, barriers, and applications. *Sens Int*. 2021;2:100117. doi: 10.1016/j.sintl.2021.100117. Epub 2021 Jul 24. PMID: 34806053; PMCID: PMC8590973.
- Herzog, Nitsa J., Dilek Celik, and Rejwan Bin Sulaiman. "Artificial Intelligence in Healthcare and Medical

Seham Ahmad Alanazi, Asma Obied Alanazi, Hamidah Saliman Alanazi, Tahani Gadeif Alanazi, Maha Horesan Almutiri, Adel Ali Salem Alharbi, Ali Nasser Almarqan, Mansour Mohammed Al Hutaylah

Records Security." *Cybersecurity and Artificial Intelligence: Transformational Strategies and Disruptive Innovation*. Cham: Springer Nature Switzerland, 2024. 35-57.

Hossain, Elias, et al. "Natural language processing in electronic health records in relation to healthcare decision-making: a systematic review." *Computers in biology and medicine* 155 (2023): 106649.

Hunt LM, Bell HS, Baker AM, Howard HA. Electronic Health Records and the Disappearing Patient. *Med Anthropol Q*. 2017 Sep;31(3):403-421. doi: 10.1111/maq.12375. Epub 2017 May 16. PMID: 28370246; PMCID: PMC6104392.

Jerfy A, Selden O, Balkrishnan R. The Growing Impact of Natural Language Processing in Healthcare and Public Health. *Inquiry*. 2024 Jan-Dec;61:469580241290095. doi: 10.1177/00469580241290095. PMID: 39396164; PMCID: PMC11475376.

Maleki Varnosfaderani S, Forouzanfar M. The Role of AI in Hospitals and Clinics: Transforming Healthcare in the 21st Century. *Bioengineering (Basel)*. 2024 Mar 29;11(4):337. doi: 10.3390/bioengineering11040337. PMID: 38671759; PMCID: PMC11047988.

Manca DP. Do electronic medical records improve quality of care? Yes. *Can Fam Physician*. 2015 Oct;61(10):846-7, 850-1. PMID: 26472786; PMCID: PMC4607324.

Murdoch, B. Privacy and artificial intelligence: challenges for protecting health information in a new era. *BMC Med Ethics* 22, 122 (2021). <https://doi.org/10.1186/s12910-021-00687-3>

Ondogan, Ayse Gedikci, Mehmet Sargin, and Kadir Canoz. "Use of electronic medical records in the digital healthcare system and its role in communication and medical information sharing among healthcare professionals." *Informatics in Medicine Unlocked* 42 (2023): 101373.

Porterfield A, Engelbert K, Coustasse A. Electronic prescribing: improving the efficiency and accuracy of prescribing in the ambulatory care setting. *Perspect Health Inf Manag*. 2014 Apr 1;11(Spring):1g. PMID: 24808808; PMCID: PMC3995494.

Quinn M, Forman J, Harrod M, Winter S, Fowler KE, Krein SL, Gupta A, Saint S, Singh H, Chopra V. Electronic health records, communication, and data sharing: challenges and opportunities for improving the diagnostic process. *Diagnosis (Berl)*. 2019 Aug 27;6(3):241-248. doi: 10.1515/dx-2018-0036. PMID: 30485175; PMCID: PMC6691503.

Stoumpos AI, Kitsios F, Talias MA. Digital Transformation in Healthcare: Technology Acceptance and Its Applications. *Int J Environ Res Public Health*. 2023 Feb 15;20(4):3407. doi: 10.3390/ijerph20043407. PMID: 36834105; PMCID: PMC9963556.

Syed, Fayazoddin Mulla, and Faiza Kousar ES. "AI in Securing Electronic Health Records (EHR) Systems." *International Journal of Advanced Engineering Technologies and Innovations* 1.2 (2024): 593-620.

Trout KE, Chen LW, Wilson FA, Tak HJ, Palm D. The Impact of Meaningful Use and Electronic Health Records on Hospital Patient Safety. *Int J Environ Res Public Health*. 2022 Sep 30;19(19):12525. doi: 10.3390/ijerph191912525. PMID: 36231824; PMCID: PMC9564815.

Tsai CH, Eghdam A, Davoody N, Wright G, Flowerday S, Koch S. Effects of Electronic Health Record Implementation and Barriers to Adoption and Use: A Scoping Review and Qualitative Analysis of the Content. *Life (Basel)*. 2020 Dec 4;10(12):327. doi: 10.3390/life10120327. PMID: 33291615; PMCID: PMC7761950.

Vos JFJ, Boonstra A, Kooistra A, Seelen M, van Offenbeek M. The influence of electronic health record use on collaboration among medical specialties. *BMC Health Serv Res*. 2020 Jul 22;20(1):676. doi: 10.1186/s12913-020-05542-6. PMID: 32698807; PMCID: PMC7374868.

Ye J, Woods D, Jordan N, Starren J. The role of artificial intelligence for the application of integrating electronic health records and patient-generated data in clinical decision support. *AMIA Jt Summits Transl Sci Proc*. 2024 May 31;2024:459-467. PMID: 38827061; PMCID: PMC11141850.

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Schaden E, Peng H, Willschke H, van der Laak J, Car J, Rahimi K, Celi LA, Banach M, Kletecka-Pulker M, Kimberger O, Eils R, Islam SMS, Wong ST, Wong TY, Gao W, Brunak S, Atanasov AG. The promise of digital healthcare technologies. *Front Public Health*. 2023 Sep 26;11:1196596. doi: 10.3389/fpubh.2023.1196596. PMID: 37822534; PMCID: PMC10562722.