OPEN ACCESS

ISSN: 2835-9496

Karaferis D, et al. (2025): 800
Ameri J Clin Med Re, 2025; 5(1): 100184
DOI: 10.71010/AJCMR.2025-e184

Research Article

American Journal of Clinical and Medical Research

Design and Development of Data-Driven AI to Reduce the Discrepancies in Healthcare EHR Utilization

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Abstract

Background: Information regarding health is classified as sensitive personal data. Researchers are leveraging Electronic Health Records (EHRs) to enhance resource management and diagnostic procedures in healthcare. Yet, managing EHR data is challenging due to their diverse characteristics and time-related elements. It is a difficult undertaking to categorize and examine scanty data stemming from patient diagnoses, medications, and lab events. Reasonable standards of security are essential for safeguarding EHRs and adequate explanation is required for handling all personal data. Expanding access to health-related information, notably in less developed nations, would lead to improved global health outcomes and enhanced human welfare.

Objective: This article delves into how applying AI to EHR systems can help healthcare professionals by improving their predictive ability, efficiency and decision-making, meeting their professional needs, and showcasing how they can improve patient health and well-being in lower care costs.

Results: Regrettably, there are still nations that impede the transferability of medical documents. Many instances have demonstrated that transferring medical data between General Physicians (GPs) still requires weeks. Cross-border portability is extremely challenging because of the absence of technical infrastructure and standardization. We show the challenge of transferring medical records by using case studies in a collaborative exercise to map data and analyze EHR portability methods. Our suggestion is a blockchain-powered EHR system for safe sharing of medical data across borders. The study also examined the ethical and technical obstacles associated with implementing such a system.

Conclusion: AI-integrated EHR systems can significantly enhance clinicians' capabilities to identify patients' health problems, assess risk at the individual level by leveraging integrated data, and offer essential assistance to clinics and hospitals. AI has the potential to transform the healthcare sector by improving diagnostic processes and the delivery of clinical services. This advancement can lead to enhanced clinical decision support, elevated quality of care, and increased patient safety.

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Citation: Karaferis D, Balaska D, Pollalis Y (2025) Design and Development of Data-Driven AI to Reduce the Discrepancies in Healthcare EHR Utilization. J Clin Med Re: AJCMR-184.

Received Date: 06 January, 2025; **Accepted Date:** 13 January, 2025; **Published Date:** 17 January, 2025

Keywords: artificial intelligence; health data quality; electronic health records; clinical decision support; data security; ethics.

1. Introduction

Healthcare professionals have been utilizing artificial intelligence (AI) more frequently in hopes of enhancing patient results and lowering diagnostic expenses in various healthcare sectors like medical image evaluation, medication development, personalized medicine, and virtual healthcare support. Utilizing AI for calculations and analysis is essential for investigating the extensive array of data found within the healthcare sector. The health sector manages, oversees, and analyzes a diverse range of information, such as administrative records, research findings, insurance claims, imaging results and medical trial data [1].

Electronic Health Records (EHRs) refer to a systematically organized collection of medical data pertaining to individuals and populations, usually recorded in a digital format during healthcare encounters. Furthermore, the EHR has the capability to supply health care professionals with essential information in a secure and private environment, which can be shared between different providers for patient care requirements. The benefit of keeping such a record would provide a more comprehensive and detailed insight into the patient's medications and overall health status. Notably, EHRs have significantly changed the landscape of medical information management, offering a stark contrast to conventional paper-based systems. Their widespread adoption in healthcare settings has introduced the capability to track various metrics and has the potential to enhance safety protocols. Although EHRs can improve aspects of patient safety, certain established practices in data entry may compromise professionalism, accountability, communication, and clinical competence, especially for learners who lack experience with traditional medical record-keeping methods. The examination of EHRs is crucial for medical research and holds the promise of enhancing the quality of patient care. The medication data contained within EHRs can facilitate the recommendation of appropriate treatments, categorize patients based on their specific attributes, support healthcare facilities in managing resources effectively, and inform patients about the potential risks linked to their medical conditions. Additionally, this would enable the physician to acquire a deeper understanding of the patient's condition and improve their therapeutic strategy [2-6].

Unprocessed EHRs frequently contain a range of patient characteristics and attributes. These include demographic information, past medical conditions, diagnoses, medications, prescriptions, imaging reports, laboratory test results, vaccination records, and fluctuating vital signs. Nevertheless, dealing with raw EHR data presents significant obstacles such as managing the temporal aspect, the data's high dimensionality, and sparsity. The problem of temporality in EHR arises from the need to accurately record and depict the sequence and timing of events in a patient's medical records. For example, the sequence in which a patient is given specific medications or treatments

can influence how well they work, and this data must be recorded correctly in the electronic health record system. Additionally, certain data contains timestamps that are crucial for examining their temporal relationships. Different methods, such as time series analysis and longitudinal data analysis, can be employed to handle the issues related to timing in EHR data, allowing for the modeling of data over time and the identification of links among different events in a patient's medical past. High dimensionality, alongside temporality, can also present significant difficulties [7-9].

The intricacies associated with high dimensionality create challenges in analyzing and comprehending the data, as there are a multitude of potential relationships and patterns that need to be considered. For instance, in attempting to forecast the likelihood of a specific illness in a patient, there might be hundreds or even thousands of factors in the data that could influence the result. Determining the most important variables can be challenging in these situations. Furthermore, as the dimensions increase, the speed of training the model will decrease. Additionally, there are often missing values in the data features, leading to sparsity. This may happen due to different factors like the EHR system not being complete, information being absent during data input, or a lack of standardization in data collection and recording methods. The outcome of this lack of density is that numerous cells in an EHR data matrix are vacant or lack recorded values. The accuracy and reliability of predictive models can be affected by missing data, leading to bias in the model. Different techniques, like imputation methods, can be utilized to deal with the problem of sparse EHR data. Alternatively, machine learning algorithms tailored for sparse data can be used for analysis and prediction. Modern deep learning models have the ability to address the challenges mentioned above [10-12].

The study aims to offer important perspectives on incorporating AI in healthcare, particularly focusing on the challenges of integrating multisource and multimodal data in EHR systems, and transforming them into more effective tools for healthcare delivery. It highlights the significance of examining diverse health observational data to enhance our comprehension of patient health and improve AI implementations. Ultimately, this article explores meticulous data management and creative approaches to enhance its potential effect on improving patient results and guiding public health initiatives. Leveraging AI in this context stands to benefit both healthcare providers and patients alike, promoting a more effective and patient-focused strategy for health management.

2. Methods

2.1. Purpose of the study

The article examines the complex challenges related to incorporating AI into EHR systems. In particular, we explore the challenges and factors linked to this integration, ultimately highlighting the importance of thoughtfully addressing these complexities to guarantee the safe and effective implementation of AI in EHR systems, as EHRs have become a fundamental component of modern medicine. Thus, the aim of this article is to establish the foundation for a theoretical framework to be utilized in future research efforts.

2.2. Material and analysis

The research drew on literature regarding the implementation of AI in EHR systems and examined how this application can enhance effectiveness of professionals, patient outcomes, and healthcare administration. How well the publications' methodologies aligned with the subject matter dictated their validation and qualification. The literature review was conducted by accessing various databases and digital journals, including Scopus, PubMed, Medline, EBSCO, CINAHL, Elsevier Direct, Web of Science, and PsycINFO. Relevant information was gathered through keyword searches across these databases, online repositories, and digital libraries, while considering factors such as publication date, authorship, and article type. The selected literature comprised research articles deemed critical for answering the research questions posed in this study.

3. Results

3.1. Utilization of AI models in Electronic Health Records (EHR) systems and their significance in healthcare

While the primary objective of EHR systems is to facilitate the storage and fundamental retrieval of patient information for clinical purposes. However, the data amassed through EHRs can also serve a supplementary function in public health by contributing to disease surveillance and evaluating its effects on communities. Initially, the integration of AI models in EHR systems allows healthcare professionals to improve patient safety and the overall quality of care by minimizing the errors commonly linked to conventional paper-based records. Additionally, EHRs are also essential for fulfilling regulatory requirements and performance standards that assess the effectiveness of healthcare. This is particularly evident in their incorporation into programs designed to decrease the incidence of falls among hospitalized patients [13]. However, the complexity and demands of EHR systems can lead to significant user burdens, impeding healthcare delivery [14]. Numerous issues related to the integration of artificial intelligence with electronic health records remain unrecognized. The dearth of legitimate guidelines and criteria permissions leaves room for the improper treatment of vulnerable personal health information [15-17].

3.2. Enhanced data handling and evaluation

The implementation of AI in EHR systems is more and more acknowledged as a revolutionary method to tackle gaps and inefficiencies in healthcare documentation. Also, AI technologies encourage a more refined method for managing patient care, as they are capable of forecasting patient risks, customizing treatment strategies, and observing health status in real time. Especially, AI technologies like machine learning (ML), natural language processing (NLP), and predictive analytics are increasingly being incorporated into EHR systems to address significant challenges in healthcare, including data saturation, the burden of documentation, and the necessity for enhanced predictive functionalities. This integration is focused on making workflows more efficient, increasing data precision, and ultimately enhancing patient care. Nevertheless, with the rapid increase in healthcare data, AI provides a solution to utilize this data effectively, enhancing the intelligence and utility of Electronic Health Records for healthcare professionals, individuals, and officials [18, 19].

3.2.1. Time reduction for administrative tasks of clinicians

Recent researches showed that AI-driven clinical documentation tools notably decreased the amount of time clinicians dedicated to EHR duties. Almost half of healthcare providers said they are dedicating fewer hours to electronic health records (EHRs) at home, with a similar percentage experiencing a reduction in EHR-related responsibilities outside of regular work hours. The AI tools helped the intervention group significantly decrease their documentation time in comparison to the control group, indicating that AI has the potential to lessen the administrative tasks that lead to clinician burnout. Simultaneously, by automating data entry and management processes, healthcare professionals can markedly decrease their administrative responsibilities, thereby enabling them to concentrate more on providing patient care instead of engaging in clerical tasks. For instance, the implementation of AI-assisted fall predictive analytics, as seen in various healthcare settings, not only streamlines the fall risk assessment process but also enhances the efficiency of healthcare delivery overall. Also, the advancement of laboratory medicine via automation can facilitate precise testing and prompt results, thereby reducing the time clinicians dedicate to follow-up activities and administrative tasks. All these advancements underscore the potential for AI-driven solutions to foster a more efficient and effective healthcare environment, ultimately improving both clinician satisfaction and patient outcomes by reducing the distraction of non-clinical responsibilities [20, 21].

3.2.2. Enhancing clinical decision support and improved data accuracy

EHR systems powered by AI have the capability to provide immediate clinical decision support (CDS) through the analysis of patient information and the provision of evidence-based suggestions to medical practitioners. The extensive adoption of EHR platforms across healthcare institutions enables the collection of comprehensive clinical data from a large patient cohort. These expansive EHR datasets afford researchers the opportunity to: 1) construct more precise predictive models that encompass a wider range of patient attributes; 2) perform more frequent updates to these models with diminished engineering demands; and 3) improve the overall quality of these predictive models, thereby addressing challenges such as the common generalization issue [22-24]. A modern approach to the creation of predictive models incorporates the use of machine learning techniques. As a branch of computer science that is intricately linked to artificial intelligence, machine learning has garnered significant interest in recent years. These techniques enable the extraction of patterns and the prediction of diverse outcome variables based on training datasets. Machine learning approaches have demonstrated enhanced predictive capabilities across various real-world scenarios, particularly in biomedical contexts, where they often surpass traditional statistical methods in prognostic accuracy and predictor richness. Additionally, sophisticated features like Natural Language Processing (NLP) and predictive analytics enhance the ability to extract and interpret patient data, resulting in tailored treatment suggestions. The integration of NLP with Electronic Health Records enables the extraction of essential information from unstructured clinical documents, thereby creating detailed patient profiles for further analysis. This functionality not only reduces the likelihood of errors but also empowers healthcare professionals to make swift and informed clinical choices [24-26]. The primary aim of AI should not be to replace the clinical expertise of healthcare professionals; instead, it is designed to aid them in efficiently prioritizing patient symptoms and assessing a range of diagnostic alternatives.

3.2.3. Acquisition of improved data management and predictive analytics

Diagnostic inaccuracies represent a significant challenge within the healthcare system and pose a threat to patient safety, as the majority of individuals are likely to encounter at least one diagnostic error during their lifetime. As such, the capacity of data analytics to improve diagnostic precision stands out as one of its most significant advantages in the healthcare sector. Conventional diagnostic approaches, although useful, frequently depend substantially on the clinician's knowledge and experience, which can occasionally lead to inconsistencies and inaccuracies. The capacity of artificial intelligence algorithms to organize and classify data significantly enhances the accessibility and comprehension of relevant patient information, which is a fundamental advantage of incorporating AI into electronic health records. AI possesses the capability to scrutinize diverse types of patient data, encompassing test outcomes, imaging results, medical histories, and, in certain cases, genetic information. Prior studies suggest that AI technologies are particularly effective in assessing medical images, including X-rays and MRIs, as well as physiological signals such as electrocardiograms (ECGs or EKGs), to detect anomalies that can aid in diagnostic processes. Moreover, AI algorithms utilize extensive image datasets to identify inefficiencies, enhance accuracy, improve resource allocation, and optimize patient throughput. The development of robust ML models that utilize detailed patient data representations captured in disease histories is crucial for accurately predicting future health events. The potential for misdiagnosis remains a significant concern for medical professionals and healthcare systems, as errors in healthcare diagnostics can result in substantial costs and potentially life-threatening consequences. Consequently, the development of accurate classification models with comprehensive patient representations is essential to providing healthcare professionals with precise instruments to forecast patient outcomes and facilitate proactive, personalized medical interventions [26-28].

3.2.4. Enhanced usability and user experience

Numerous clinicians have voiced their concerns regarding the intricacies and user-unfriendliness of existing EHR systems. The incorporation of AI could significantly improve the usability of these platforms, consequently alleviating the administrative load faced by medical professionals. Such enhancements are crucial for boosting clinician satisfaction and enabling them to focus more on patient care instead of administrative responsibilities [29].

3.2.5. Addressing implementation challenges and cost savings

In resource-constrained environments, such as primary healthcare facilities, AI can help overcome barriers to EHR implementation, including unreliable network connectivity and

insufficient training. The implementation of artificial intelligence in automating standard administrative functions diminishes the necessity for extra personnel, consequently decreasing labor expenditures. Additionally, AI enhances the precision of diagnoses and treatment strategies, which mitigates the risk of expensive medical mistakes, including erroneous diagnoses or unsuitable treatments. Moreover, AI can optimize the billing procedure, guaranteeing that claims are filed accurately and in a timely manner, thus reducing potential revenue losses stemming from claim rejections or delays. Even more, AI technologies can help remote healthcare facilities reduce costs associated with administrative tasks, errors, and unnecessary tests or procedures [30].

3.2.6. Readiness of the emergency services

The integration of AI with EHR data has proven to be effective in multiple medical disciplines. Notably, this synergy allows for timely alerts to emergency services, thereby enabling critical life-saving measures. As the amount of EHR data expands, the potential for extracting valuable insights increases significantly, contingent upon the implementation of innovative and efficient data management strategies. Data visualization methods enable physicians to track essential indicators, including oxygen saturation and pulse rates, thereby facilitating prompt decision-making regarding patient care. Recent studies indicate that healthcare professionals can more efficiently discern trends and patient histories, allowing for quicker decision-making when they have access to patients' prior tests and laboratory results, especially when these are displayed graphically. The emergence of interactive data visualization has greatly enhanced the understanding of data by utilizing visual representations and fostering user involvement. In recent years, a variety of interactive data visualizations derived from EHRs have been developed to support healthcare professionals in performing data-driven tasks and activities. [31-33].

3.2.7. Improved Patient Outcomes

The incorporation of AI-driven EHR systems presents substantial advantages, particularly in enhancing patient outcomes. By processing extensive datasets, such as medical histories, laboratory findings, and imaging results, AI improves diagnostic precision by uncovering patterns and relationships that might elude human practitioners. The ability to identify diseases at an early stage and to formulate personalized treatment plans tailored to the unique needs of each patient is significantly enhanced by this capability. Additionally, artificial intelligence systems are capable of monitoring patient progress in real-time, alerting healthcare providers to any notable changes that might require intervention. This proactive approach not only reduces the risk of complications but also improves the overall quality of patient care.

3.3. Challenges and Considerations associated with the utilization of AI into EHR systems

The management and analysis of extensive, intricate, and diverse data derived from EHR systems presents significant challenges; however, it holds the promise of delivering transformative insights for both individuals and broader populations. AI has already shown significant promise in various different domains, such as drug discovery, autonomous robot-assisted surgery, medical diagnosis, and prognostic predictions. With the healthcare sector generates an astounding 50 petabytes of data annually, which poses considerable challenges for EHRs, including issues encompass data fragmentation and complex user interfaces, many other challenges such as, complexity of clinical workflows, and clinical information retrieval tasks need to be addressed before practical adoption and usage [3, 19, 34, 35].

3.3.1. Missingness, heterogeneity and variability of data in EHR systems

The integration of AI into EHR systems presents a significant challenge, primarily due to the necessity for extensive, high-quality datasets to effectively train AI algorithms. According to previous studies, many EHR systems lack the necessary data quality and standardization to support AI development. What does it matter if healthcare organizations are gathering and retaining electronic health information on an unmatched scale? Handling and interpreting this extensive, intricate, and diverse data are challenging, which in turn can hinder AI algorithms from accurately and efficiently analyzing patient information. The risk of bias in AI algorithms is big if the datasets used to train the algorithms are not diverse, the algorithms may not perform as well for certain populations, leading to disparities in care. Usually, AI models' effectiveness is fundamentally linked to the quality of the data utilized during their training phase, and the presence of biases within this training data can result in unequal healthcare outcomes. For instance, an AI model developed predominantly using data from a specific demographic may exhibit diminished performance when applied to data from different populations. Such limitations can lead to skewed treatment suggestions or erroneous predictions. It is imperative for healthcare practitioners to guarantee that AI models are developed using a wide range of datasets and to maintain ongoing oversight for potential biases, thereby promoting fair and equitable care for every patient [36-38].

3.3.2. Data privacy, security, and confidentiality

EHR systems are tasked with managing substantial volumes of highly sensitive health information, and any breach of this data can have serious implications for individual privacy and security. It is essential, even if albeit challenging, for EHR systems to comply with stringent security protocols and to incorporate effective encryption and authentication strategies. The complexity of this issue is further exacerbated by the cross-border integration of EHR systems within European Union member states, where discrepancies in data protection laws exist. Each country operates under its own legal framework concerning data privacy, which reflects differing levels of concern and various methodologies regarding privacy protection. The transfer of data across borders amplifies the potential for cybercriminal activity and complicates the consistent application of security measures. Moreover, technological infrastructure exhibits significant variation across nations, with certain countries boasting advanced and sophisticated health information technology systems. Conversely, others are hindered by outdated or basic technological frameworks. This disparity has implications for the effective integration of diverse systems and platforms. Nations with underdeveloped infrastructure may encounter challenges in facilitating the advanced features necessary for integrated electronic health record systems, including real-time data exchange, high availability, and robust disaster recovery capabilities. Detractors contend that the incorporation of

artificial intelligence may heighten the likelihood of data breaches and cyberattacks, adding another layer of difficulty in safeguarding this sensitive information. Consequently, healthcare organizations must prioritize adherence to regulatory requirements and implement comprehensive cybersecurity strategies to protect patient data effectively [39-41].

3.3.3. Human-centered design and acceptance

Learning from past experiences with EHR implementations, it is essential that AI systems are developed for use in existing EHRs must focus on human-centered design. As the process of manual data entry is essential for EHRs, yet it is inherently time-consuming. Moreover, this method is susceptible to human error, which can result in inaccuracies within the data. In past, poor usability has been a significant contributor to clinician burnout; thus, integrating AI must prioritize seamless workflow integration to avoid similar pitfalls. A human-centered approach to AI merges an ethnographic understanding of healthcare systems with AI technologies. This begins with user-centered research aimed at identifying core challenges. It is advisable to utilize a qualitative research methodology to investigate critical questions such as 'what is the problem?', 'what are the underlying causes?', 'who is impacted?', 'why has this issue remained unresolved?', and 'why is it currently neglected?'. This study should additionally evaluate the requirements, limitations, and operational procedures present in healthcare settings, alongside the factors that promote or hinder the incorporation of artificial intelligence into clinical practice. For AI technologies to achieve their intended efficacy, it is essential that healthcare professionals possess confidence in and a readiness to utilize these tools. Certain healthcare practitioners may exhibit reluctance to depend on AI for clinical decision-making, apprehensive that it could diminish their professional authority or complicate their existing workflows. In reality, the EHR system was initially developed not with research objectives in mind, but rather to enhance billing processes, manage clinical documentation, and facilitate scheduling. However, the evolving requirements of the healthcare sector necessitate that healthcare organizations cultivate a collaborative culture that integrates artificial intelligence with human expertise. It is essential to underscore that AI is intended to enhance, rather than supplant, clinical judgment [42-45].

3.3.4. Multitasking and complexity of clinical workflows

Each hospital and healthcare provider possesses a unique approach to treatment, leading to diverse expectations within a single system. As such, clinical workflows are complex and multifaceted, involving numerous stakeholders and requiring precision. The implementation of an EHR in a large hospital environment is anticipated to enhance the current workflow without imposing additional burdens by disrupting established processes. While some clinicians are able to adapt to the existing functionalities and any modifications that may arise in the workflow, others encounter significant challenges. Reasonably, inherent limitations in health application architectures and standards for information exchange frequently hinder the scalability of such applications across different institutions. Consequently, EHRs frequently contain incomplete, inconsistent, or inaccurate information, which can negatively impact the efficacy and precision of AI models [46, 47].

3.3.5. Cost and Return on Investment (ROI)

Implementing AI technology in healthcare involves upfront costs for infrastructure, software, training and ongoing maintenance. Notably, those healthcare facilities that successfully attained a faster break-even point exhibited enhanced capabilities in leveraging EHR within workflow domains associated with patient information. This encompasses the efficient upkeep of patient problem lists, the management of test results, and compliance with national coding standards, all contributing to a more streamlined and rapid preparation for patient interactions [48].

3.3.6. Integration Challenges

The incorporation of AI tools into current EHR systems presents considerable challenges, especially for smaller healthcare entities that may lack sufficient resources. EHR systems are frequently diverse in their design and operational capabilities, necessitating substantial customization to integrate AI solutions effectively. Furthermore, personnel must receive adequate training to utilize these AI tools proficiently, which contributes to the overall complexity of the implementation process [49].

3.3.7. Training and Familiarity

Studies show that only a small percentage have received training in AI applications within medicine. This shortage of AI experts in the healthcare field, making it challenging for healthcare organizations to implement and maintain AI systems. Errors in AI algorithms may arise from this situation, resulting in diminished trust in the technology among healthcare practitioners [50].

4. Discussion

The recent surge in the adoption of smartphones, wearable sensors, and Internet of Things (IoT) technologies has positioned these tools as essential data sources for health care research. These innovations are fostering greater patient engagement by markedly enhancing digital capabilities. Additionally, the accessibility of affordable devices aimed at monitoring and promoting healthy lifestyles has led to an increase in personal health information. Consequently, the use of patient-generated health data (PGHD) provides essential information for evaluating disease risk and recognizing health concerns that require prompt attention [51].

The integration of AI algorithms in EHR systems signifies a transformative approach for healthcare professionals to:

a) organize and categorize better the elements of EHR systems, as traditional EHRs frequently encounter challenges in managing extensive amounts of patient data, resulting in inefficiencies and complications in information retrieval. AI algorithms possess the capability to systematically categorize and index medical records, thereby facilitating quicker access to pertinent data for healthcare professionals. For instance, AI can organize patient records according to various criteria, including diagnosis, treatment history, and laboratory results. This automation not only saves time but also reduces the probability of errors associated with manual data entry and organization. The sorting and indexing capabilities of AI are particularly advantageous in extensive healthcare facilities, where the vast amount of patient data can be overwhelming. By streamlining these processes, AI guarantees that healthcare providers can promptly access essential information, thus enhancing their ability to make well-informed decisions efficiently [19, 43, 52, 53].

b) incorporate a range of functionalities aimed at enhancing the comprehensive management of patient information. For instance, AI can facilitate the identification of discrepancies or inaccuracies within medical records, thereby alerting healthcare providers to potential concerns that require

attention. This proactive approach plays a significant role in maintaining the accuracy and integrity of patient information. Additionally, AI can optimize administrative tasks related to EHR management. Capabilities such as voice recognition and NLP empower healthcare professionals to update patient records via dictation, thereby minimizing the time allocated to manual data entry. Furthermore, AI can offer autocomplete suggestions for clinical terminology and coding, which further improves the efficiency of data entry procedures [54, 55].

c) summarize medical records, as often medical records contain extensive patient histories, requiring physicians to navigate through a significant amount of information to extract pertinent details, a process that can be quite labor-intensive. AI-driven systems possess the ability to evaluate patient data and generate concise summaries that highlight essential elements, including prior diagnoses, treatment histories, and current medication regimens. This capability proves particularly beneficial during patient consultations, enabling physicians to swiftly access vital information and focus on providing superior care. Additionally, employing AI for the summarization of medical records improves communication among healthcare professionals. For example, when a patient is referred to a specialist, the summarized records can offer a clear and concise account of the patient's medical background, thereby facilitating continuity of care [55-57].

Additionally, it is essential to concurrently develop supplementary policies aimed at tackling particular challenges associated with the implementation of AI in EHR systems, as well as considering the viewpoints of healthcare personnel and patients, such as:

- Data privacy and security, stakeholders must prioritize privacy and security when designing AI systems. This includes implementing: a) robust encryption techniques, to protect patient information effectively is essential. This process encompasses the encryption of data both during storage (data at rest) and while it is being transmitted (data in transit) across various systems. Robust encryption serves as a critical defense mechanism, thwarting unauthorized access and ensuring that any intercepted data remains inaccessible and secure. This methodology is essential for maintaining the integrity and confidentiality of patient data, which is crucial not only for building patient trust but also for complying with rigorous regulatory standards [58], b) effective access controls, are crucial for guaranteeing that only authorized individuals are permitted to access sensitive patient information. This necessitates the establishment of rigorous authentication methods, including two-factor authentication, alongside the diligent maintenance of access and modification logs. By regulating who is permitted to view or modify patient data, healthcare institutions can markedly diminish the likelihood of internal security breaches and unauthorized information disclosures. Such measures contribute to a well-defined accountability framework, which is vital for identifying the origins of any potential security concerns [58, 59], and c) data anonymization, the process of anonymizing data employed in the training and functioning of artificial intelligence systems is an essential tactic for reducing privacy concerns. By eliminating or concealing personal identifiers, anonymized datasets can be used to train AI models without jeopardizing individual privacy. This approach allows researchers and developers to leverage vast data assets for the progress and improvement of AI technologies, all while ensuring the protection of individual privacy. Furthermore, data anonymization aids in adhering to privacy regulations and promotes public confidence in the application of AI within the healthcare industry [60, 61].
- Good quality data and standardization within EHR systems are essential for AI to derive accurate insights. Consequently, significant investment in data cleansing and normalization is imperative to guarantee the consistency and dependability of the data. This process requires the establishment of standardized formats and appropriate coding systems to enhance interoperability; hence facilitating data exchange among systems that utilize various EHRs [62].
- Continuous Monitoring and Improvement, it is essential to continuously monitoring the performance of AI systems, allowing for the ongoing enhancement of AI algorithms through feedback mechanisms to ensure accuracy. Collaboration with other healthcare institutions, researchers, and AI specialists is crucial for exchanging experiences, identifying best practices, and deriving valuable lessons. Only through these collective efforts can the acceleration of AI adoption led to shared advancements in healthcare outcomes [63]
- Continuous learning and training, ongoing education is crucial for ensuring that healthcare personnel remain informed about the latest advancements in artificial intelligence (AI) technology. As AI in healthcare continues to progress, training programs must also evolve, integrating the most recent research findings, best practices, and updates regarding legal and ethical standards. This adaptive strategy guarantees that healthcare practitioners are proficient in utilizing AI tools and are cognizant of new functionalities that can be incorporated into their workflows. Furthermore, providing consistent updates and support can alleviate any concerns or resistance among staff regarding new technologies, thereby promoting a culture of acceptance and innovation. Support structures may include access to AI experts, regular training sessions, and a feedback mechanism that allows healthcare professionals to exchange experiences and insights related to AI technology. Additionally, training programs should include not only the practical application of AI tools but also a thorough examination of their underlying principles, ethical considerations, and possible impacts on patient care. It is essential for professionals to grasp how AI can improve decision-making processes and identify which elements of patient care can be enhanced by AI while maintaining the essential human element in healthcare. This thorough educational approach should incorporate case studies and real-life examples that illustrate both successful AI integrations and common challenges encountered during implementation [64, 65].
- Ethical governance in the application of AI is essential, as it guarantees that these technologies not only improve operational efficiency but also uphold patient confidentiality and the integrity of healthcare. This holistic approach is crucial for fostering trust in digital health solutions [66].

Leveraging AI to optimize EHR usability is not only a necessity but a pivotal step towards alleviating inefficiencies and enhancing patient outcomes. Conventional approaches to data entry and analysis are susceptible to human mistakes, potentially resulting in inaccurate or incomplete patient records. AI mitigates these risks through the automation of data entry processes, the identification of discrepancies, and the cross-referencing of information from various sources, which helps maintain the accuracy and timeliness of patient records. Notably, key priorities for many governments include the establishment of "data trusts", the deployment of digital connectivity infrastructure including 5G and comprehensive fiber networks, the development of shared supercomputing facilities, the provision of fiscal incentives, and the creation of open-source software libraries. This evolution aims to make EHR systems more accessible and user-friendly [26, 30, 67-69].

5. Conclusions

The health sector encounters numerous challenges, such as rising costs and a deficiency of healthcare practitioners. In traditional healthcare environments, information is maintained in paper format, and medical professionals typically make decisions based on data obtained during patient interactions. Nevertheless, this data presents a restricted perspective of the patient's overall health, capturing only isolated instances rather than facilitating continuous evaluations outside the clinical context.

As we move forward, EHRs are the backbone of modern medicine, and it is expected that will evolve from being mere static repositories to becoming dynamic and interactive engagement platforms. Presently, EHRs are characterized by a rigid structure; however, forthcoming advancements are expected to adopt a more flexible, responsive, and tiered framework. Furthermore, the existing transactional model of EHRs is projected to evolve into a more dialogic format, facilitating enhanced interactions between healthcare professionals and patients.

The integration of AI into EHR systems offers significant opportunities for enhancing both their usability and dependability. Consequently, a thoughtful and ethical deployment of AI technologies is essential for alleviating the difficulties associated with EHR utilization, ultimately fostering a more effective, equitable, and patient-focused healthcare environment. Through the application of machine learning algorithms, AI can optimize data entry procedures, thereby lessening the manual workload on healthcare providers while simultaneously increasing precision and uniformity. These algorithms can intelligently autofill patient information, suggest relevant medical codes, and even flag potential errors or omissions in real-time, thus streamlining workflows. Furthermore, AI can analyze user interaction patterns to identify pain points within EHR interfaces, enabling developers to create more intuitive designs tailored to user needs. This proactive approach can significantly mitigate user frustration and increase overall adoption rates among healthcare providers. Ultimately, the synergistic effect of AI technologies not only promises to alleviate the administrative burdens that accompany EHR usage but also ensures that the reliability of patient data is upheld, fostering better clinical outcomes and enhanced patient safety.

Declaration of Interest: The authors declare no conflict of interest.

Conflict of Interest: Each author declares that he or she has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

Funding: None

Author's contribution: Dimitris Karaferis is the first author of this manuscript. All authors were involved in all steps for preparation of this article, including final proofreading and gave final approval of the version to be published.

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