(REVIEW ARTICLE)

The impact of electronic health records on healthcare delivery and patient outcomes: A review

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Abstract

This review examines the impact of Electronic Health Records (EHRs) on healthcare delivery and patient outcomes, highlighting the benefits and challenges associated with their use. EHRs enhance healthcare efficiency, improve the quality of care through clinical decision support, and foster better collaboration among healthcare providers. They also contribute to patient safety, engagement, and improved health outcomes, including reduced hospital readmission rates and better chronic disease management. However, data privacy concerns, interoperability issues, and the digital divide pose significant hurdles. The review underscores the critical role of ongoing research and innovation in health informatics to address these challenges, ensuring EHRs continue to evolve positively. This analysis aims to provide a comprehensive overview of the current state of EHRs, offering insights into their potential to transform healthcare delivery and outcomes.

Keywords: Electronic Health Records (EHRs); Healthcare Delivery; Patient Outcomes; Data Privacy; Interoperability; Health Informatics

1. Introduction

Electronic Health Records (EHRs) represent a significant evolution in healthcare. This marks a departure from traditional paper-based records towards a digital and more integrated approach to managing patient information. EHRs systematically collect health-related information on patients that is stored in a digital format that is accessible across different healthcare settings. These records encompass a wide range of data pertinent to the well-being of patients, including their medical history, medication and allergies, immunization status, laboratory test results, radiology images, vital signs, personal statistics like age and weight, and billing information (Reza, Prieto, & Julien, 2020; Taksler et al., 2021; Wang, Zhao, Dang, Zheng, & Dong, 2020). The primary purpose of EHRs is to ensure that accurate and complete patient health information is available promptly, enabling healthcare providers to make informed decisions, provide efficient care, and ultimately improve the health outcomes of their patients (Li et al., 2020; Tanwar, Parekh, & Evans, 2020).

The transition to EHRs has been propelled by the potential to improve the quality of healthcare delivery and patient outcomes significantly. EHRs facilitate the seamless exchange of patient information among healthcare providers,

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contributing to a more coordinated and patient-centred approach to care. By providing healthcare professionals with immediate access to comprehensive patient information, EHRs enhance the ability to diagnose diseases accurately, reduce medical errors, and ensure that patients receive appropriate treatments promptly. Furthermore, EHRs support public health initiatives by aggregating and analyzing patient data, aiding disease surveillance, and advancing population health research (Colombo, Oderkirk, & Slawomirski, 2020; Hohman, 2023; Wood et al., 2021).

Studying the impact of EHRs on healthcare delivery and patient outcomes is paramount. It offers insights into the benefits and challenges of implementing digital health records, including how they influence the efficiency of healthcare services, the quality of patient care, and the safety of clinical practices. The examination of EHRs' impact also sheds light on areas requiring improvement, such as interoperability, patient data privacy, and the usability of EHR systems. Through this analysis, stakeholders can identify strategies to optimize the use of EHRs, enhancing their potential to transform healthcare systems globally.

The objectives of this review are threefold:

- To evaluate how the adoption of EHRs has transformed healthcare delivery, focusing on efficiency, quality of care, and healthcare collaboration.
- To analyze the effects of EHRs on patient outcomes, including safety, engagement, and the overall health of populations.
- To identify and discuss the challenges and limitations associated with EHR implementation and use, providing a balanced view of the benefits and drawbacks of digital health records in contemporary healthcare.

By addressing these objectives, the review aims to provide a comprehensive overview of the current state of EHRs in healthcare, highlighting their impact, potential, and the critical issues that must be addressed to realize their full benefits for healthcare providers and patients.

The journey towards developing and implementing Electronic Health Records (EHRs) has been pivotal in the evolution of healthcare systems worldwide. This transition from paper-based records to digital platforms marks a significant milestone in pursuing more efficient, accurate, and comprehensive healthcare delivery.

1.1. Brief History of EHR Development and Implementation

The concept of digitizing patient records dates back to the late 1960s and early 1970s, with the first instances of computerized medical records emerging in large academic medical centres. These early systems were primarily used for storing patient information and managing billing rather than for comprehensive patient care. However, they laid the groundwork for developing more sophisticated EHR systems (Adler-Milstein, Zhao, Willard-Grace, Knox, & Grumbach, 2020; Argenziano et al., 2020; Koopman et al., 2021; Lorkowski & Pokorski, 2022). Throughout the 1980s and 1990s, the focus shifted towards developing systems that could support clinical decision-making, document patient encounters, and manage medication orders. The real momentum for EHR adoption came in the early 21st century, driven by government initiatives and policies in several countries that recognized the potential of EHRs to improve healthcare quality and efficiency (Delaney, Weaver, Sensmeier, Pruinelli, & Weber, 2022). For instance, the United States government's Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009 provided significant incentives for adopting and meaningful use of EHRs, leading to a substantial increase in their adoption across the healthcare sector (Delaney et al., 2022; Keshta & Odeh, 2021; Shi et al., 2020; Yuan, Li, & Wu, 2021).

1.2. Technological Advancements Facilitating EHR Adoption

Several critical technological advancements have facilitated the widespread adoption of EHRs. The rise of the internet and improvements in data storage and computing power have made it feasible to store and manage large volumes of health information. Cloud computing has enabled more flexible and scalable EHR systems, allowing for easier access to patient records by authorized personnel from virtually any location. Additionally, advancements in data security technologies have helped to address concerns about the privacy and security of sensitive health information. Interoperability standards, such as Health Level 7 (HL7) and Fast Healthcare Interoperability Resources (FHIR), have been developed to enable the exchange of healthcare information across different EHR systems and healthcare providers, promoting more coordinated and integrated care (Gulden et al., 2021; Strasberg et al., 2021; Vorisek et al., 2022).

1.3. Current State of EHR Integration in Healthcare Systems Globally

Globally, the integration of EHRs into healthcare systems varies significantly by region, influenced by factors such as government policies, healthcare infrastructure, and the availability of resources. In many developed countries, EHR adoption rates are high, and these systems have become a cornerstone of healthcare delivery, supporting a wide range of functions from clinical documentation to patient engagement and population health management. For instance, in Europe, countries like Denmark and the Netherlands have achieved near-universal EHR adoption, heavily supported by national healthcare IT strategies.

In contrast, in developing countries, the integration of EHRs is often more challenging due to limited resources, infrastructure constraints, and varying levels of government support. However, there is a growing recognition of the potential benefits of EHRs in these regions, and efforts are underway to increase adoption, often with the support of international organizations and partnerships.

Despite these advances, challenges remain. Interoperability between different EHR systems and healthcare providers is a significant issue worldwide, impacting the seamless exchange of patient information. Additionally, there is an ongoing need to balance the benefits of EHRs with concerns about patient privacy and data security. The current state of EHR integration reflects a healthcare landscape in transition, moving towards more connected, data-driven, and patient-centred care. While significant progress has been made, the journey of EHR development and implementation continues, driven by technological advancements, policy initiatives, and the ongoing pursuit of improving healthcare delivery and patient outcomes globally (Colombo et al., 2020; Faulkenberry, Luberti, & Craig, 2022; Serbanati, 2020).

2. Impact on Healthcare Delivery

The adoption of Electronic Health Records has profoundly impacted healthcare delivery, touching on every aspect, from efficiency and productivity to the quality of care and interdisciplinary collaboration. This comprehensive integration of digital records into the healthcare system has streamlined administrative and clinical processes and significantly enhanced patient care delivery.

2.1. Efficiency and Productivity

The influence of EHRs on the efficiency of healthcare services is multifaceted, offering both direct and indirect benefits. By digitizing patient records, EHRs have substantially reduced the need for manual record-keeping and paperwork, decreasing administrative burdens and allowing healthcare providers to allocate more time to patient care. This shift has led to improved operational efficiencies, such as faster patient processing, reduced waiting times, and the ability to see more patients within the same timeframe (Kumar & Mostafa, 2020).

Moreover, EHRs have optimized clinical workflows by integrating various functionalities such as electronic prescribing, order entry systems, and access to complete patient histories at the point of care. This integration facilitates a smoother workflow, enabling quicker decision-making and reducing the likelihood of errors. For instance, EHRs can alert physicians to potential medication interactions or allergies, enhancing patient safety. The automation of routine tasks, such as the generation of referral letters and patient instructions, further contributes to increased productivity, allowing healthcare professionals to focus on more critical aspects of patient care (Gill et al., 2020; Melton, McDonald, Tang, & Hripcsak, 2021).

2.2. Quality of Care

EHRs play a crucial role in improving the quality of healthcare services through several mechanisms. Clinical decision support systems (CDSS) integrated within EHRs provide healthcare professionals with evidence-based guidance at the point of care, helping them make informed decisions regarding patient treatment plans. These systems can offer recommendations based on the latest clinical guidelines and research, potentially leading to better patient outcomes.

Medication management is another area where EHRs have made a significant impact. By automating the prescribing process and maintaining comprehensive medication lists, EHRs help reduce medication errors and adverse drug events. The system's ability to cross-reference patient information with prescribed medications ensures that contraindications and allergies are identified before administering medication.

Error reduction is a direct benefit of the transition to EHRs. The use of standardized formats and the elimination of illegible handwriting reduce the risk of misinterpretations and errors. Additionally, access to complete and accurate

patient information supports better clinical decision-making, which is fundamental to improving patient safety and care outcomes (Holmes et al., 2021; LAKA, MILAZZO, & MERLIN, 2020; Morris et al., 2023).

2.3. Healthcare Collaboration

The impact of EHRs on interdisciplinary collaboration among healthcare providers is significant, fostering a more integrated approach to patient care. EHRs enable real-time sharing of patient information across different healthcare settings, from primary care to specialists and hospitals. This seamless exchange of information ensures that all healthcare team members, regardless of their physical location, have access to the same comprehensive patient data, facilitating coordinated care and reducing the duplication of tests and procedures (Margam, 2023).

Furthermore, EHRs support the development of care teams by allowing healthcare providers to communicate and collaborate on patient care plans easily. Through features such as shared notes, alerts, and messaging systems within the EHR platform, providers can quickly relay information, discuss patient care strategies, and make joint decisions, enhancing patient care quality (Dhruva et al., 2020; Meadows et al., 2020).

In conclusion, the impact of EHRs on healthcare delivery is profound, driving improvements in efficiency, productivity, and quality of care while fostering better collaboration among healthcare providers. By streamlining administrative tasks, enhancing clinical workflows, and promoting integrated patient care, EHRs are instrumental in advancing healthcare systems towards more effective, efficient, and patient-centred models of care.

3. Impact on Patient Outcomes

The implementation of Electronic Health Records has significantly influenced patient outcomes, contributing to enhanced patient safety, increased patient engagement, and overall improvements in health outcomes. EHRs have become a cornerstone for higher-quality care and better patient health through error reduction, improved patient monitoring, and enhanced communication.

3.1. Patient Safety

EHRs have profoundly impacted patient safety, primarily by reducing errors and preventing adverse events. The digitization of patient records and the integrating of clinical decision support systems (CDSS) within EHRs have been instrumental. CDSS provide real-time alerts to healthcare providers about potential medication interactions, allergies, and other critical patient-specific information, significantly reducing the likelihood of medication errors and adverse drug reactions. Moreover, EHRs facilitate the accurate and timely documentation of patient care activities, which is crucial for avoiding errors related to miscommunication or incomplete information (Mukashev, 2023; Rolla, 2023).

The role of EHRs in improving patient monitoring and follow-up care is another critical aspect of patient safety. EHRs enable the continuous monitoring of patient's health statuses, allowing healthcare providers to respond promptly to any changes in a patient's condition. This capability is particularly beneficial for managing chronic diseases, where timely interventions can prevent complications and hospital readmissions (Facchinetti et al., 2020; Liang, Hann Lin, Yu Chang, Mei Wu, & Yu, 2021). Additionally, EHRs support effective follow-up care by enabling providers to track patients' progress over time, schedule follow-up appointments, and send reminders for preventive screenings and tests, ensuring ongoing patient care continuity (Anandkumar, 2022; Ullah et al., 2023; Wong, Bhyat, Srivastava, Lomax, & Appireddy, 2021).

3.2. Patient Engagement

EHRs have also played a significant role in enhancing patient engagement and empowerment. Through the use of patient portals, which are often integrated with EHR systems, patients can actively participate in their healthcare processes. These portals provide patients with secure online access to their health information, including lab results, medication lists, and visit summaries. By facilitating easy access to this information, EHRs encourage patients to become more involved in their care, leading to increased patient knowledge, better adherence to treatment plans, and more informed decision-making.

Patient portals also significantly improve patient-provider communication. They allow patients to communicate directly with their healthcare providers, request prescription refills, schedule appointments, and receive educational materials relevant to their health conditions. This direct communication fosters a more collaborative relationship between patients and providers, increasing patient satisfaction and engagement (Bao, Singh, Meyer, Kirksey, & Bardhan, 2020; Richwine, Johnson, & Patel, 2023).

3.3. Health Outcomes

The correlation between EHR use and improvements in health outcomes has been the subject of numerous studies and reviews. These investigations have generally found that EHRs contribute to better health outcomes through various mechanisms, such as improved disease management, enhanced preventive care, and reduced rates of hospital readmissions.

For instance, studies have shown that EHRs can help reduce hospital readmission rates by enabling better discharge planning and coordination of care post-discharge. By ensuring that patients receive appropriate follow-up care and support, EHRs play a crucial role in preventing avoidable readmissions (Abraham, Meng, Tripathy, Kitsiou, & Kannampallil, 2022; Krzesiński, 2023). In managing chronic diseases, EHRs facilitate the tracking and managing of patients' conditions over time, enabling healthcare providers to adjust treatment plans as needed and intervene early when patients' conditions worsen. This proactive approach to disease management has been shown to improve outcomes for patients with chronic conditions such as diabetes, hypertension, and heart disease. Furthermore, EHRs enhance preventive care by reminding providers and patients about routine screenings and vaccinations based on patient age, health status, and family history (Willis et al., 2022). This ensures that preventative measures are taken promptly, potentially preventing the onset of diseases and health complications (Ninduwezuor-Ehiobu et al., 2023; Uchechukwu, Amechi, Okoye, & Okeke, 2023).

In summary, the impact of EHRs on patient outcomes is profound and multifaceted. Enhancing patient safety promotes patient engagement and improves overall health outcomes. EHRs represent a pivotal advancement in healthcare delivery, underscoring their value in achieving better patient health.

4. Challenges and Limitations

Despite the significant benefits of Electronic Health Records, their implementation and use come with challenges and limitations. These issues range from technical and financial obstacles to data privacy and security concerns. Understanding these challenges is crucial for addressing them effectively and maximizing the potential of EHRs to improve healthcare delivery and patient outcomes.

One of the foremost concerns regarding EHRs is the protection of patient data privacy and security. As digital records, EHRs are susceptible to cyber threats such as hacking, phishing, and ransomware attacks. The sensitivity of health information necessitates stringent security measures to protect against unauthorized access and breaches that could expose personal health information. Healthcare organizations must invest in robust cybersecurity infrastructures, including encryption, secure user authentication protocols, and regular security audits. Additionally, compliance with legal frameworks such as the Health Insurance Portability and Accountability Act (HIPAA) in the United States and the General Data Protection Regulation (GDPR) in the European Union poses ongoing challenges to ensure that EHR systems meet strict standards for data protection and patient privacy (Bani Issa et al., 2020; Enaizan et al., 2020; Keshta & Odeh, 2021).

Interoperability, or the ability of different EHR systems to exchange and utilize information, remains a significant challenge. Despite progress in establishing standards for data exchange, such as Health Level 7 (HL7) and Fast Healthcare Interoperability Resources (FHIR), many EHR systems still struggle to communicate effectively with each other. This lack of interoperability hinders the seamless sharing of patient information across different healthcare settings, leading to inefficiencies, potential errors, and gaps in care. Achieving full interoperability requires technical solutions and alignment among various stakeholders on data standards, sharing protocols, and legal agreements (Afolabi, Danladi, & Ilugbusi, 2022; Chidolue & Iqbal, 2023; Johnson et al., 2023).

The digital divide, referring to the gap between those with access to digital technology and those without, presents another challenge to the equitable implementation and use of EHRs. This divide can be seen across different dimensions: among patients, where factors such as age, socioeconomic status, and geographical location affect access to and engagement with digital health tools like patient portals; and among healthcare providers, particularly affecting small practices and rural healthcare facilities that may lack the resources to implement and maintain sophisticated EHR systems. This disparity threatens to exacerbate existing health inequities, as those without adequate access to EHR technology may receive lower-quality care.

In addition to these primary concerns, several other challenges impact the implementation and use of EHRs:

- Poorly designed EHR interfaces can lead to user frustration, reduced efficiency, and increased risk of errors. Ensuring that EHRs are user-friendly and meet the needs of clinical workflows is critical for their successful adoption and use.
- The high costs associated with EHR implementation, including hardware, software, training, and ongoing maintenance, can be prohibitive for some healthcare organizations, particularly small practices and hospitals with limited budgets.
- Transitioning from paper-based records to EHRs requires significant organizational culture, workflows, and practice changes. Managing this change effectively is essential for ensuring buy-in from all stakeholders and minimizing disruption to patient care.

Addressing these challenges and limitations is essential for the continued evolution and success of EHRs in healthcare. It requires a concerted effort from governments, healthcare organizations, EHR vendors, and other stakeholders to develop and implement strategies that mitigate these issues, ensuring that EHRs can fully deliver on their promise to enhance healthcare delivery and patient outcomes (Lopez et al., 2021; Madandola et al., 2024).

5. Future Directions

The landscape of Electronic Health Records is continually evolving, driven by technological advancements and the changing needs of the healthcare industry. As we look to the future, several potential directions for EHR technology promise to revolutionize healthcare delivery further and improve patient outcomes. Alongside these advancements, the role of policy and regulatory frameworks remains critical in shaping the effective and secure use of EHRs.

5.1. Advancements in EHR Technology

Integrating artificial intelligence and machine learning with EHR systems is a significant future direction. AI and ML can analyze vast amounts of data to identify patterns, predict health outcomes, and provide decision support for clinicians. For example, AI algorithms could predict patients at risk of chronic diseases or readmissions, enabling proactive patient care management. Additionally, AI can enhance diagnostic accuracy by analyzing imaging data alongside patient records. Future advancements are expected to focus on solving interoperability challenges and facilitating seamless data exchange between different EHR systems and healthcare providers. This could involve the development of universal standards and protocols that ensure data compatibility and security across systems, enabling a truly integrated healthcare ecosystem.

Enhancing the usability of EHRs through better interface design and customization options will be crucial. Future EHR systems may offer more intuitive and user-friendly interfaces, reducing the cognitive burden on healthcare providers and allowing them to customize workflows to match their clinical practices better. The integration of telehealth capabilities directly into EHR platforms is likely to expand, reflecting the growing importance of remote care delivery. This integration can streamline the process of documenting telehealth encounters, prescribing medications, and monitoring patient health remotely, further blurring the lines between in-person and virtual care. The future of EHRs includes better integrating patient-generated health data from wearables and other health monitoring devices. This data can provide valuable insights into patient health trends, offering clinicians a more comprehensive view of their patients' health outside the clinical setting.

5.2. Importance of Policy and Regulatory Frameworks

The effective use of EHRs is heavily influenced by policy and regulatory frameworks that ensure the privacy, security, and ethical use of digital health information. As EHR technology advances, these frameworks must evolve to address new challenges and opportunities.

With increasing health data being collected and stored, robust data privacy and security regulations are essential. Policies must ensure that patient data is protected against unauthorized access and breaches while allowing for the beneficial use of data in improving healthcare delivery and outcomes. Policymakers play a critical role in promoting standardization and interoperability among EHR systems. Regulations can encourage or require standardized data formats and exchange protocols, facilitating more efficient and effective healthcare coordination across different care settings. Policy and regulatory frameworks should support innovation in EHR technology, including the development and integration of AI, ML, and telehealth solutions. This can involve funding research and development, offering incentives for adopting innovative technologies, and creating sandbox environments where new solutions can be tested safely. Regulations and policies must also address the digital divide, ensuring that all patients and healthcare providers, regardless of location or socioeconomic status, can benefit from advancements in EHR technology. This can include

initiatives to improve access to digital infrastructure, funding support for healthcare providers in underserved areas, and programs to enhance digital literacy among patients and clinicians.

6. Conclusion

This review has explored the multifaceted impact of Electronic Health Records on healthcare delivery and patient outcomes, highlighting the significant benefits and challenges accompanying their implementation and use. EHRs have been shown to enhance healthcare efficiency and productivity by streamlining administrative tasks and clinical workflows. They improve the quality of care through clinical decision support systems, medication management, and error reduction. Additionally, EHRs foster better healthcare collaboration by facilitating communication and information exchange across different care settings.

On the patient outcomes front, EHRs contribute to increased patient safety by reducing medical errors and adverse events and improving patient monitoring and follow-up care. They also promote patient engagement and empowerment through patient portals, enhancing patient-provider communication. Moreover, studies have linked the use of EHRs to improvements in health outcomes, including reduced hospital readmission rates, better management of chronic diseases, and enhanced preventive care. However, the review also acknowledges significant challenges, such as concerns about data privacy and security, interoperability issues, and the digital divide, which can hinder the full realization of EHR benefits. These challenges underscore the importance of ongoing research and innovation in health informatics. Continuous advancements in technology, alongside thoughtful policy and regulatory frameworks, are essential to address these challenges, ensuring that EHRs can continue to evolve in ways that enhance healthcare delivery and patient outcomes.

In conclusion, EHRs represent a cornerstone of modern healthcare, potentially significantly improving how care is delivered and how health outcomes are achieved. The importance of ongoing research, development, and innovation in this area cannot be overstated, as it is crucial for overcoming existing hurdles and unlocking the full potential of EHRs in transforming healthcare for the better.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Abraham, J., Meng, A., Tripathy, S., Kitsiou, S., & Kannampallil, T. (2022). Effect of health information technology (HIT)-based discharge transition interventions on patient readmissions and emergency room visits: a systematic review. *Journal of the American Medical Informatics Association, 29*(4), 735-748.

[2] Adler-Milstein, J., Zhao, W., Willard-Grace, R., Knox, M., & Grumbach, K. (2020). Electronic health records and burnout: time spent on the electronic health record after hours and message volume associated with exhaustion but not with cynicism among primary care clinicians. *Journal of the American Medical Informatics Association, 27*(4), 531-538.

[3] Afolabi, B., Danladi, J. D., & Ilugbusi, S. (2022). DETERMINANTS OF YOUTH ENGAGEMENT IN AGRIBUSINESS: IMPLICATIONS FOR SUSTAINABLE AGRICULTURAL PRACTICES IN SOUTHWEST, NIGERIA. *Fuoye Journal of Management, Innovation and Entrepreneurship, 1*(1).

[4] Anandkumar, M. (2022). Coordination and Continuity Through Electronic Medical Records. *Public Health Behind Bars: From Prisons to Communities*, 475-482.

[5] Argenziano, M. G., Bruce, S. L., Slater, C. L., Tiao, J. R., Baldwin, M. R., Barr, R. G., . . . Gavin, N. (2020). Characterization and clinical course of 1000 patients with coronavirus disease 2019 in New York: retrospective case series. *bmj, 369*.

[6] Bani Issa, W., Al Akour, I., Ibrahim, A., Almarzouqi, A., Abbas, S., Hisham, F., & Griffiths, J. (2020). Privacy, confidentiality, security and patient safety concerns about electronic health records. *International nursing review, 67*(2), 218-230.

[7]   Bao, C., Singh, H., Meyer, B., Kirksey, K., & Bardhan, I. (2020). Patient-provider engagement and its impact on health outcomes: A longitudinal study of patient portal use. *MIS quarterly, 44*(2).

[8]   Chidolue, O., & Iqbal, T. (2023). *System Monitoring and Data logging using PLX-DAQ for Solar-Powered Oil Well Pumping.* Paper presented at the 2023 IEEE 13th Annual Computing and Communication Workshop and Conference (CCWC).

[9]   Colombo, F., Oderkirk, J., & Slawomirski, L. (2020). Health information systems, electronic medical records, and big data in global healthcare: Progress and challenges in oecd countries. *Handbook of global health*, 1-31.

[10]   Delaney, C. W., Weaver, C. A., Sensmeier, J., Pruinelli, L., & Weber, P. (2022). Nursing and Informatics for the 21st Century-Embracing a Digital World, Book 1: Realizing Digital Health-Bold Challenges and Opportunities for Nursing.

[11]   Dhruva, S. S., Ross, J. S., Akar, J. G., Caldwell, B., Childers, K., Chow, W., . . . Dykhoff, H. J. (2020). Aggregating multiple real-world data sources using a patient-centered health-data-sharing platform. *NPJ digital medicine, 3*(1), 60.

[12]   Enaizan, O., Zaidan, A. A., Alwi, N., Zaidan, B. B., Alsalem, M. A., Albahri, O., & Albahri, A. (2020). Electronic medical record systems: Decision support examination framework for individual, security and privacy concerns using multi-perspective analysis. *Health and Technology, 10*, 795-822.

[13]   Facchinetti, G., D'Angelo, D., Piredda, M., Petitti, T., Matarese, M., Oliveti, A., & De Marinis, M. G. (2020). Continuity of care interventions for preventing hospital readmission of older people with chronic diseases: A meta-analysis. *International journal of nursing studies, 101*, 103396.

[14]   Faulkenberry, J. G., Luberti, A., & Craig, S. (2022). Electronic health records, mobile health, and the challenge of improving global health. *Current problems in pediatric and adolescent health care, 52*(1), 101111.

[15]   Gill, H., Carpenter, S., Gueye, P., Wicklund, B., Breitkreutz, M., Ghosh, A., . . . Berntorp, E. (2020). Design and Usability of an Electronic Health Record—Integrated, Point-of-Care, Clinical Decision Support Tool for Modeling and Simulation of Antihemophilic Factors. *Applied Clinical Informatics, 11*(02), 253-264.

[16]   Gulden, C., Blasini, R., Nassirian, A., Stein, A., Altun, F. B., Kirchner, M., . . . Boeker, M. (2021). Prototypical clinical trial registry based on fast healthcare interoperability resources (FHIR): design and implementation study. *JMIR medical informatics, 9*(1), e20470.

[17]   Hohman, K. H. (2023). Development of a hypertension electronic phenotype for chronic disease surveillance in electronic health records: key analytic decisions and their effects. *Preventing Chronic Disease, 20*.

[18]   Holmes, J. H., Beinlich, J., Boland, M. R., Bowles, K. H., Chen, Y., Cook, T. S., . . . Gabriel, P. E. (2021). Why is the electronic health record so challenging for research and clinical care? *Methods of information in medicine, 60*(01/02), 032-048.

[19]   Johnson, D., Pranada, E., Yoo, R., Uwadiunor, E., Ngozichukwu, B., & Djire, A. (2023). Review and Perspective on Transition Metal Electrocatalysts Toward Carbon-neutral Energy. *Energy & Fuels, 37*(3), 1545-1576.

[20]   Keshta, I., & Odeh, A. (2021). Security and privacy of electronic health records: Concerns and challenges. *Egyptian Informatics Journal, 22*(2), 177-183.

[21]   Koopman, C., Jones, P., Simon, V., Showler, P., McLevey, M., & Collaboratory, C. G. (2021). When data drive health: an archaeology of medical records technology. *BioSocieties*, 1-23.

[22]   Krzesiński, P. (2023). Digital health technologies for post-discharge care after heart failure hospitalisation to relieve symptoms and improve clinical outcomes. *Journal of Clinical Medicine, 12*(6), 2373.

[23]   Kumar, M., & Mostafa, J. (2020). Electronic health records for better health in the lower-and middle-income countries: a landscape study. *Library Hi Tech, 38*(4), 751-767.

[24]   LAKA, M., MILAZZO, A., & MERLIN, T. (2020). Factors that impact the adoption of clinical decision support systems (CDSS) in healthcare settings for evidence-based decision making.

[25]   Li, Y., Rao, S., Solares, J. R. A., Hassaine, A., Ramakrishnan, R., Canoy, D., . . . Salimi-Khorshidi, G. (2020). BEHRT: transformer for electronic health records. *Scientific reports, 10*(1), 7155.

[26]   Liang, H. Y., Hann Lin, L., Yu Chang, C., Mei Wu, F., & Yu, S. (2021). Effectiveness of a nurse-led tele-homecare program for patients with multiple chronic illnesses and a high risk for readmission: a randomized controlled trial. *Journal of Nursing Scholarship, 53*(2), 161-170.

[27] Lopez, K. D., Chin, C.-L., Azevedo, R. F. L., Kaushik, V., Roy, B., Schuh, W., . . . Morrow, D. (2021). Electronic health record usability and workload changes over time for provider and nursing staff following transition to new EHR. *Applied ergonomics, 93*, 103359.

[28] Lorkowski, J., & Pokorski, M. (2022). Medical records: A historical narrative. *Biomedicines, 10*(10), 2594.

[29] Madandola, O. O., Bjarnadottir, R. I., Yao, Y., Ansell, M., Dos Santos, F., Cho, H., . . . Keenan, G. M. (2024). The relationship between electronic health records user interface features and data quality of patient clinical information: an integrative review. *Journal of the American Medical Informatics Association, 31*(1), 240-255.

[30] Margam, R. (2023). The Importance of EHR in Revolutionizing Healthcare Delivery and Financial Success. *International Journal of Computer Trends and Technology, 71*(7), 52-55.

[31] Meadows, G., Michaels, M., Michel, J., Miller, K., Jacob, V., Thota, A., . . . Bates, D. (2020). To share is human! Advancing evidence into practice through a national repository of interoperable clinical decision support. *Applied Clinical Informatics, 11*(01), 112-121.

[32] Melton, G. B., McDonald, C. J., Tang, P. C., & Hripcsak, G. (2021). Electronic health records. In *Biomedical Informatics: Computer Applications in Health Care and Biomedicine* (pp. 467-509): Springer.

[33] Morris, A. H., Horvat, C., Stagg, B., Grainger, D. W., Lanspa, M., Orme Jr, J., . . . Grissom, C. K. (2023). Computer clinical decision support that automates personalized clinical care: a challenging but needed healthcare delivery strategy. *Journal of the American Medical Informatics Association, 30*(1), 178-194.

[34] Mukashev, N. (2023). *Adoption of Computerized Clinical Decision Support Functionalities and the Quality of Hospital Care.* Tulane University,

[35] Ninduwezuor-Ehiobu, N., Tula, O. A., Daraojimba, C., Ofonagoro, K. A., Ogunjobi, O. A., Gidiagba, J. O., . . . Banso, A. A. (2023). TRACING THE EVOLUTION OF AI AND MACHINE LEARNING APPLICATIONS IN ADVANCING MATERIALS DISCOVERY AND PRODUCTION PROCESSES. *Engineering Science & Technology Journal, 4*(3), 66-83.

[36] Reza, F., Prieto, J. T., & Julien, S. P. (2020). Electronic health records: origination, adoption, and progression. *Public Health Informatics and Information Systems*, 183-201.

[37] Richwine, C., Johnson, C., & Patel, V. (2023). Disparities in patient portal access and the role of providers in encouraging access and use. *Journal of the American Medical Informatics Association, 30*(2), 308-317.

[38] Rolla, K. J. (2023). Trends and Futuristic Applications of Big Data and Electronic Health Record Data in Empowering Constructive Clinical Decision Support Systems. *Bio Science Research Bulletin-Biological Sciences, 39*(2).

[39] Serbanati, L. D. (2020). Health digital state and Smart EHR systems. *Informatics in Medicine Unlocked, 21*, 100494.

[40] Shi, S., He, D., Li, L., Kumar, N., Khan, M. K., & Choo, K.-K. R. (2020). Applications of blockchain in ensuring the security and privacy of electronic health record systems: A survey. *Computers & security, 97*, 101966.

[41] Strasberg, H. R., Rhodes, B., Del Fiol, G., Jenders, R. A., Haug, P. J., & Kawamoto, K. (2021). Contemporary clinical decision support standards using health level seven international fast healthcare interoperability resources. *Journal of the American Medical Informatics Association, 28*(8), 1796-1806.

[42] Taksler, G. B., Dalton, J. E., Perzynski, A. T., Rothberg, M. B., Milinovich, A., Krieger, N. I., . . . Einstadter, D. (2021). Opportunities, pitfalls, and alternatives in adapting electronic health records for health services research. *Medical Decision Making, 41*(2), 133-142.

[43] Tanwar, S., Parekh, K., & Evans, R. (2020). Blockchain-based electronic healthcare record system for healthcare 4.0 applications. *Journal of Information Security and Applications, 50*, 102407.

[44] Uchechukwu, E. S., Amechi, A. F., Okoye, C. C., & Okeke, N. M. (2023). Youth Unemployment and Security Challenges in Anambra State, Nigeria. *Sch J Arts Humanit Soc Sci, 4*, 81-91.

[45] Ullah, M., Hamayun, S., Wahab, A., Khan, S. U., Rehman, M. U., Haq, Z. U., . . . Awan, U. A. (2023). Smart technologies used as smart tools in the management of cardiovascular disease and their future perspective. *Current Problems in Cardiology, 48*(11), 101922.

[46] Vorisek, C. N., Lehne, M., Klopfenstein, S. A. I., Mayer, P. J., Bartschke, A., Haese, T., & Thun, S. (2022). Fast healthcare interoperability resources (FHIR) for interoperability in health research: systematic review. *JMIR medical informatics, 10*(7), e35724.

[47] Wang, Y., Zhao, Y., Dang, W., Zheng, J., & Dong, H. (2020). The evolution of publication hotspots in electronic health records from 1957 to 2016 and differences among six countries. *Big Data, 8*(2), 89-106.

[48] Willis, V. C., Thomas Craig, K. J., Jabbarpour, Y., Scheufele, E. L., Arriaga, Y. E., Ajinkya, M., . . . Bazemore, A. (2022). Digital health interventions to enhance prevention in primary care: scoping review. *JMIR medical informatics, 10*(1), e33518.

[49] Wong, A., Bhyat, R., Srivastava, S., Lomax, L. B., & Appireddy, R. (2021). Patient care during the COVID-19 pandemic: use of virtual care. *Journal of medical Internet research, 23*(1), e20621.

[50] Wood, A., Denholm, R., Hollings, S., Cooper, J., Ip, S., Walker, V., . . . Whiteley, W. (2021). Linked electronic health records for research on a nationwide cohort of more than 54 million people in England: data resource. *bmj, 373*.

[51] Yuan, B., Li, J., & Wu, P. (2021). The effectiveness of electronic health record promotion for healthcare providers in the United States since the Health Information Technology for Economic and Clinical Health Act: An empirical investigation. *The International Journal of Health Planning and Management, 36*(2), 334-352.