EHR IN HEALTHCARE DATA ANALYTICS – AN OVERVIEW

Mr. T. MATHANKUMAR
Ph.D. Research Scholar,
Department of Computer Science,
Bharathiar University, Coimbatore
mathankavi98@gmail.com

Dr. S. VIJAYARANI
Associate Professor,
Department of Computer Science,
Bharathiar University, Coimbatore
vijayarani@buc.edu.in

Abstract—**EHRs have transformed healthcare by changing the way patient information is kept and used. This article examines the history, benefits, implementation, and impact of EHRs. It explores positive outcomes like better patient care and data analytics and challenges like privacy and interoperability issues. The article highlights EHRs' importance in public health and future trends. This study offers insights for healthcare professionals and policymakers in their pursuit of better patient care and management.**

Keywords—*EHR, Medical Domain, Definition, Importance.*

I. INTRODUCTION

Technology is rapidly changing the healthcare industry, and Electronic Health Records (EHRs) have played a significant role in this transformation. EHRs provide a digital solution for patient information management, revolutionizing healthcare delivery. This research paper provides an overview of EHRs, including their historical growth, benefits, challenges, and future possibilities. EHRs have become synonymous with healthcare modernity, bridging the gap between paper-based records and a digitally integrated healthcare system. The significant objective of the education process is to divulge the insights, talents, standards, principles, views, practices, and individual growth. It initiated the traditional culture transformation from one generation to the next. Today, it contains vocational skills, empathy, and critical thinking. Education is considered the persistent movement to succeed in our specific goals, primarily knowledge transmission. Education reform movements seek to improve the quality and efficiency of education and make it more relevant to students' lives.

This article examines the history, advantages, adoption, and impact of EHRs in the healthcare industry. It investigates the benefits of EHRs, such as improved patient care and better data analytics, as well as the drawbacks, such as privacy concerns and interoperability difficulties. The study also explores the importance of EHRs in public health and future advancements. By exploring the world of EHRs, this study offers significant visions for physicians, medical practitioners, healthcare professionals, and officials who are looking to enhance the healthcare system and patient care. [1]

II. HISTORY OF EHR

Electronic health records (EHRs) have a fascinating history that spans several decades, progressing from simple digital record-keeping systems to sophisticated, integrated healthcare information platforms.

2.1 1960s AND 1970S - FIRST STEPS

With the introduction of computers in healthcare, the concept of EHRs took shape. Early EHR systems were rudimentary, serving primarily administrative functions and storing only a limited amount of clinical data. 1980s - Birth of Clinical Information Systems: More sophisticated clinical information systems emerged in the 1980s, with the ability to store and manage patient data. These systems were designed to target specific clinical departments, such as laboratories and radiology.

2.2 1990s - RISE OF ELECTRONIC MEDICAL RECORDS (EMR)

The phrase "Electronic Medical Records" (EMR) became popular in the 1990s. EMRs were digitized representations of patient charts that were developed and stored inside a single healthcare facility. They boosted data accessibility within universities but had limited interoperability.

2.3 EHR TRANSITION IN THE 2000s

The twenty-first century saw the transition from EMRs to more complete EHR systems. EHRs were designed to connect patient information across healthcare organizations, enhancing data exchange and continuity of treatment. In 2009, the US government announced steps to encourage EHR use, such as the HITECH Act.

2.4 WIDESPREAD ADOPTION AND INTEROPERABILITY IN THE 2010s

EHR use has skyrocketed globally. However, interoperability issues emerged as different EHR systems failed to communicate and exchange data efficiently. To solve these concerns, open standards and protocols such as HL7's FHIR (Fast Healthcare Interoperability Resources) gained traction.

2.5 2020s AND BEYOND - ONGOING CHANGE

EHRs are evolving further, including sophisticated capabilities such as artificial intelligence, machine learning, and data analytics to improve clinical decision support and patient involvement. Data privacy and security remain key concerns, especially in light of high-profile data breaches. The global COVID-19 epidemic has highlighted the need for EHRs in public health and patient care. The evolution of EHRs represents the healthcare industry's journey towards

digital transformation, as well as continued initiatives to improve data sharing, patient care, and healthcare outcomes. As technology advances, the EHR role is very important for the future of the healthcare system which enables more personalized and efficient medical care. [1]

III. BENEFITS OF EHR

Electronic health records (EHRs) provide several advantages that have altered the healthcare business. These advantages have enhanced not just patient care but also healthcare operations. Here are some of the most important advantages of EHRs:

3.1 IMPROVED PATIENT CARE

EHRs offer a complete and updated patient record to healthcare providers, including medical history, medications, allergies, and test results, enabling accurate and personalized clinical decisions. They also provide real-time alerts, reminders, and evidence-based recommendations, improving the quality of care.

3.2 ENHANCED PATIENT SAFETY

Pharmaceutical error reduction: EHRs can aid in the reduction of pharmaceutical mistakes by giving correct dose information and drug interaction alerts. Allergy management: To minimize adverse responses to drugs or treatments, EHRs incorporate allergy information. Improved legibility: Because digital records are readable, mistakes caused by illegible handwriting are reduced.

3.3 EFFICIENCY AND PRODUCTIVITY

EHRs eliminate the need for paper-based records and streamline recordkeeping, saving time for healthcare practitioners. Easy information retrieval: Electronic records make it possible to retrieve data quickly, avoiding the time-consuming process of looking through paper files. Administrative functions may be automated using EHRs, like as appointment scheduling, invoicing, and insurance claims processing.

3.4 COST REDUCTION

EHRs minimize the need for paper records and reduce storage space, saving on physical storage and related costs. Improved billing and coding: EHRs can assist healthcare institutions in getting timely reimbursements by improving billing accuracy.

3.5 INTEROPERABILITY AND INFORMATION SHARING

EHRs provide seamless data sharing, allowing healthcare professionals to exchange patient data with other physicians, laboratories, and hospitals, increasing care coordination. Authorized individuals can access patient records from multiple places, enabling telehealth and remote consultations.

3.6 DATA ANALYTICS AND RESEARCH

Population health management: EHRs allow for the larger-scale analysis of patient data, which is critical for population health management and preventative medicine. Clinical research: EHRs give a lot of data for clinical research and studies, increasing medical knowledge creation.

3.7 PATIENT ENGAGEMENT

EHRs enable patients to access their personal health records, empowering them to take a more active role in their treatment and effectively accomplish their health. EHRs frequently contain secure messaging services that enable patients to connect with their healthcare professionals.

3.8 REGULATORY COMPLIANCE

Meeting regulatory requirements: EHRs may help healthcare organizations comply with government rules and standards such as Meaningful Use in the United States and GDPR in the European Union.

3.9 DISASTER RECOVERY AND DATA SECURITY

Data backup and security: To secure patient information in the case of an emergency or a data breach, EHRs typically have strong data security and backup mechanisms in place. [5]

IV. IMPLEMENTATION OF EHR

Implementing an EHR system in a healthcare organization necessitates a step-by-step strategy. The following steps should be taken to ensure a successful EHR implementation:

4.1 NEEDS ASSESSMENT

Firstly, conduct a comprehensive needs assessment to identify your healthcare organization's specific requirements. This will help you understand the goals and objectives of EHR implementation, including improving patient care, enhancing efficiency, and meeting regulatory requirements.

4.2 SELECT THE RIGHT EHR SYSTEM

Research and evaluate EHR systems that best align with your organization's needs and goals. Consider factors such as cost, scalability, ease of use, and interoperability.

4.3 ENGAGE STAKEHOLDERS

Involve all relevant participants, including healthcare workers, the managerial team, and the IT workforce, in the policymaking process. Their involvement is vital to ensuring a smooth implementation.

4.4 DEVELOP AN IMPLEMENTATION TEAM

Create a dedicated implementation team responsible for overseeing the entire process. This team should include project managers, EHR specialists, and end-users who can provide valuable insights.

4.5 PLANNING AND TRAINING

Develop a comprehensive implementation plan that outlines timelines, tasks, and responsibilities. Provide thorough training for all users to ensure they are proficient with the new EHR system.

4.6 DATA MIGRATION

Existing paper-based, manually maintained health records of the patients are converted into digital form. Migration of patient data is a critical step that requires accuracy to prevent errors and data loss.

4.7 DATA CONFIGURATION AND CUSTOMIZATION

After the conversion of health data into EHR, it is necessary to do the customization because it should match the workflows and the organization's requirements. Templates, order sets, and clinical decision support rules are to be configured properly.

4.8 INTEGRATION

Ensure that the EHR integrates with other systems, such as laboratory and radiology systems, for seamless data exchange.

4.9 TESTING

Thoroughly test the EHR system to identify and rectify any issues. User acceptance testing is crucial to ensure that the system meets user expectations.

4.10 GO-LIVE AND TRANSITION

When the system is ready, carefully plan the go-live date and transition from paper records or legacy systems to the EHR. It's important to have support in place during this period to address any issues that may arise.

4.11 MONITORING AND SUPPORT

Continuously monitor system performance and provide continuous assistance to the end users. Respond quickly to any user complaints and give extra training as required.

4.12 DATA PRIVACY AND SECURITY

Implement strong data security procedures to safeguard patient information. Confirm that necessary data protection requirements, such as HIPAA in the United States, are followed.

4.13 QUALITY IMPROVEMENT AND OPTIMIZATION

Regularly review the EHR system's performance and gather feedback from users. Use this information to make improvements and optimize the system for better efficiency and patient care.

4.14 REGULATORY COMPLIANCE

Ensure that your EHR system meets all regulatory requirements, including meaningful use criteria in the United States or other relevant standards in your country.

4.15 USER FEEDBACK AND ITERATION

Based on users' feedback and needs, iterative improvements are made to the EHR system. [6]

V.   IMPACT ON PATIENT CARE

The implementation of Electronic Health Records (EHR) has significantly impacted patient care in several ways, leading to numerous benefits that enhance the quality and safety of healthcare services. Here are some of the ways in which EHRs have positively influenced patient care:

5.1. IMPROVED ACCESS TO PATIENT INFORMATION

EHRs provide healthcare providers with easy access to comprehensive patient records, including medical history, medications, allergies, and diagnostic results. This instant access to critical information allows for more informed and timely decision-making.

5.2. ENHANCED CARE COORDINATION

EHRs facilitate better communication and care coordination among healthcare providers. Multiple specialists and care teams can access the same patient's record, enabling seamless collaboration and ensuring that all team members are on the same page.

5.3. REDUCED MEDICATION ERRORS

EHRs include built-in clinical decision support systems that can check for potential drug interactions, allergies, and the correct dosage of medications. This helps in reducing medication errors and adverse drug reactions.

5.4. EFFICIENT DIAGNOSIS AND TREATMENT

EHRs provide tools for clinicians to quickly access relevant clinical guidelines, research, and best practices. This supports accurate diagnosis and evidence-based treatment, leading to improved patient outcomes.

5.5. PREVENTIVE CARE AND ALERTS

EHRs can generate automated reminders and alerts for preventive care, such as immunizations and screenings. These features help in identifying and addressing health issues proactively, ultimately improving patient health.

5.6. ENHANCED PATIENT ENGAGEMENT

Patients can access their own EHRs, allowing them to actively participate in their healthcare. They can review their medical records, and test results, and communicate with healthcare providers, promoting a greater understanding of their health and treatment plans.

5.7. REMOTE MONITORING AND TELEHEALTH

EHRs support remote monitoring and telehealth, facilitating patients to receive medical attention while staying comfortably in their homes. This is predominantly important during public health emergencies and for managing chronic conditions.

5.8. FASTER AND MORE ACCURATE RECORD KEEPING

EHRs eliminate the need for paper-based record-keeping, leading to more accurate and legible records. This can reduce the risk of errors and improve the quality of documentation.

5.9. POPULATION HEALTH MANAGEMENT

EHRs aid in the management of the health of the patient population.' Healthcare practitioners may discover trends,

risk factors, and service gaps, which allows them to build focused treatments and public health programs.

5.10. DATA-DRIVEN DECISION-MAKING

EHRs create massive volumes of data, which may be analyzed to find patterns, trends, and opportunities for improvement. This data-driven decision-making method has the potential to result in more effective and efficient care delivery.

5.11. ENHANCED PATIENT SAFETY

EHRs aid in ensuring that patients receive the appropriate care at the appropriate time, enhancing patient safety and lowering the chance of medical mistakes.

5.12. STREAMLINED ADMINISTRATIVE TASKS

EHRs make administrative duties like appointment scheduling, billing, and insurance claim processing easier. This allows healthcare providers to focus more on patient care.

5.13. DATA PRIVACY AND SECURITY

Developed to provide rigorous data security safeguards, securing patient information and guaranteeing compliance with data privacy legislation. [8] [2]

VI. HEALTHCARE DATA ANALYTICS

Healthcare data analytics extracts important information from Electronic Health Records (EHR) to improve clinical decision-making, patient care, and healthcare systems.
Here are some ways healthcare data analytics is utilized within EHR systems.

6.1. CLINICAL DECISION SUPPORT

CDS systems suggest evidence-based treatment options, alert providers to drug interactions, and recommend preventive care.

6.2. QUALITY IMPROVEMENT

EHRs collect and analyze data on healthcare processes and outcomes, enabling organizations to implement quality improvement initiatives.

6.3. POPULATION HEALTH MANAGEMENT

EHRs support population health management by identifying at-risk patients, tracking health trends, and developing targeted interventions.

6.4. PREDICTIVE ANALYTICS

Predictive analytics use historical patient data to forecast outcomes, proactively address health issues, allocate resources efficiently, and reduce healthcare costs.

6.5. RESEARCH AND CLINICAL STUDIES

EHRs provide a rich source of data for clinical research and studies, contributing to medical knowledge.

6.6. MONITORING AND EARLY DETECTION

Real-time monitoring of patient data within EHRs can identify early warning signs of health deterioration, allowing providers to intervene promptly.

6.7. PATIENT OUTCOMES ANALYSIS

Healthcare data analytics in EHRs help assess patient outcomes, enabling providers to evaluate treatment plans and improve patient care. 8. Resource Utilization and Cost Management: EHR data analytics can optimize resource utilization, including staff allocation, equipment management, and medication inventory.

6.8. DATA VISUALIZATION AND REPORTING

EHR analytics tools include data visualization capabilities, helping with decision-making and communication.

6.9. REGULATORY REPORTING AND COMPLIANCE

EHRs with analytics capabilities simplify the process of generating regulatory reports.

6.10. PATIENT ENGAGEMENT AND EDUCATION

EHRs identify patient needs and preferences, enabling personalized patient engagement and health education.

6.11. FRAUD DETECTION AND PREVENTION

Data analytics in EHRs identify potential fraudulent activities, billing irregularities, and discrepancies in healthcare claims.
Incorporating data analytics into EHR systems transforms healthcare by delivering personalized, effective, and efficient services while contributing to medical knowledge through research and analysis. [2]

VII. EHR AND PUBLIC HEALTH

Electronic Health Records (EHRs) have a significant role in public health by contributing to disease surveillance, epidemiology, healthcare policy development, and improving population health. Here's how EHRs and public health are interconnected

7.1. DISEASE SURVEILLANCE

EHRs capture and store data on patients' diagnoses, symptoms, and laboratory results. Public health agencies can access this data to monitor disease trends, detect outbreaks, and respond rapidly to public health emergencies such as infectious disease outbreaks like influenza or COVID-19.

7.2. EPIDEMIOLOGICAL STUDIES

EHRs provide data that can be anonymized and used for epidemiological research. Public health researchers can analyze EHR data to identify risk factors, study disease patterns, and investigate the effectiveness of various interventions.

7.3. IMMUNIZATION AND PREVENTIVE CARE

EHRs facilitate immunization tracking and monitoring. Public health agencies can use EHR data to assess immunization coverage rates, identify communities at risk, and promote vaccination campaigns for diseases like measles, polio, and influenza.

7.4. HEALTH POLICY DEVELOPMENT

EHR data can inform public health policy development and decision-making. Policymakers can identify healthcare disparities, assess the impact of policy changes, and develop targeted interventions to improve public health outcomes by analyzing population-level EHR data.

7.5. CHRONIC DISEASE MANAGEMENT

EHRs support the management of chronic diseases like diabetes, hypertension, and heart disease. Public health agencies can use EHR data to identify individuals at risk, develop preventive programs, and monitor the effectiveness of interventions.

7.6. HEALTH DISPARITIES REDUCTION

EHRs help public health agencies identify and address health disparities within specific communities or populations by analyzing data on demographics, socioeconomic status, and health outcomes. Interventions can be tailored to reduce disparities and improve health equity.

7.7. ENVIRONMENTAL HEALTH

EHRs can include environmental health data, such as patients' exposure to environmental hazards. Public health agencies can use this data to identify environmental risks and develop strategies to mitigate health-related environmental concerns.

7.8. EMERGENCY RESPONSE

During public health emergencies or disasters, EHRs enable rapid access to patient records, which is critical for identifying individuals with specific health needs, ensuring the continuity of care, and facilitating disaster response efforts.

7.9. PUBLIC HEALTH REPORTING

EHRs support the reporting of specific diseases to public health authorities as required by law, which helps public health agencies track the spread of notifiable diseases and take appropriate actions to prevent further transmission.

7.10. RESEARCH AND SURVEILLANCE

Public health researchers can access aggregated, de-identified EHR data to conduct research on a wide range of health topics, including population health trends, disease prevalence, and healthcare utilization patterns.

7.11. TELEHEALTH AND TELEMEDICINE

EHRs support telehealth and telemedicine services, enabling public health agencies to reach underserved populations, provide healthcare access in remote areas, and respond to public health crises with virtual care. [8]

VIII. EHR CHALLENGES

Electronic health records (EHRs) provide significant benefits, but their deployment and usage are fraught with difficulties and concerns. It is critical to solve these issues to ensure the effective implementation and continuous functioning of EHR systems. Some of the major issues and concerns with EHRs.

8.1. COST OF IMPLEMENTATION

EHR implementation can be expensive. It involves the cost of software, hardware, training, and data migration. Smaller healthcare facilities may struggle to afford these investments.

8.2. INTEROPERABILITY

Ensuring that EHR systems can effectively communicate and share data with other healthcare providers' systems is a major challenge. Interoperability issues can hinder care coordination and data exchange.

8.3. DATA SECURITY AND PRIVACY

Protecting patient data from breaches and unauthorized access is a top concern. EHRs are attractive targets for cyberattacks, and healthcare organizations must invest in robust security measures and staff training.

8.4. DATA INTEGRITY AND ACCURACY

Incomplete or inaccurate data input might result in inaccuracies in patient records analysis. Maintaining data accuracy and integrity is vital for patient safety and quality of care.

8.5. USER BURNOUT AND TRAINING

Healthcare providers may experience burnout due to the increased time spent on data entry and documentation in EHRs. Effective training and support are essential to mitigate this issue.

8.6. WORKFLOW DISRUPTION

Implementing EHRs can disrupt established workflows and lead to temporary decreases in productivity as healthcare providers adapt to the new system.

8.7. CUSTOMIZATION CHALLENGES

Configuring EHRs to match specific healthcare workflows and needs can be complex and time-consuming. Poorly customized EHRs may not meet user requirements.

8.8. Legal and Regulatory Compliance

EHRs must comply with several legal and regulatory standards, including HIPAA in the United States. Noncompliance might lead to penalties and legal problems.

8.9. VENDOR LOCK-IN

Healthcare organizations may become dependent on a specific EHR vendor, making it difficult to switch systems or negotiate favorable contract terms in the future.

8.10. DATA ACCESS AND OWNERSHIP

Questions about who owns and controls patient data in EHRs can arise, potentially impacting data sharing and patient engagement.

8.11. HEALTH DISPARITIES

The digital divide can lead to disparities in EHR adoption and use, with some patients or healthcare providers lacking access to necessary technology.

8.12. USABILITY AND USER EXPERIENCE

EHRs should be user-friendly to ensure efficient and accurate data entry. Poor usability can lead to frustration and reduced adoption.

8.13. PATIENT PRIVACY AND CONSENT

Clear policies regarding patient data access, sharing, and consent are essential to address privacy concerns and establish trust.

8.14. TECHNICAL CHALLENGES

EHR systems may face technical issues such as system crashes, slow performance, or data corruption, which can disrupt healthcare operations.

8.15. DATA EXCHANGE AND STANDARDIZATION

Standardizing data exchange formats and protocols between different EHR systems and healthcare providers is an ongoing challenge.

8.16. LONG-TERM DATA RETENTION

Decisions regarding the retention of EHR data, especially for historical patient records, can be complex, as they involve compliance with data retention regulations. [9]

IX. FUTURE TRENDS AND INNOVATION

Healthcare organizations need to invest in robust training, security measures, and user support to address these challenges and successfully implement and use EHR systems. Additionally, interoperability standards and open data exchange frameworks are essential for ensuring the seamless sharing of patient data across different healthcare systems. Electronic Health Records (EHRs) will soon have exciting innovations to transform healthcare delivery and improve patient care. Here are some of the upcoming trends: The future of Electronic Health Records (EHRs) is promising, bringing exciting trends and innovations that will transform healthcare delivery and improve patient care. Here are some of the forthcoming developments and advances in HER.

9.1. SHARING OF DATA AND INTEROPERABILITY

Interoperability standards are enhanced and it will allow seamless data exchange between EHR systems, different healthcare providers, and patients. This will support improved care coordination and provide a more comprehensive view of a patient's health history.

9.2. AI AND MACHINE LEARNING INTEGRATION

EHRs will increasingly incorporate artificial intelligence (AI) and machine learning to assist in clinical decision support, predictive analytics, and automating routine administrative tasks, ultimately improving patient outcomes.

9.3. BLOCKCHAIN FOR DATA SECURITY

Blockchain technology will be used to enhance data security and patient privacy within EHRs. Blockchain can provide secure, immutable records of patient data access and changes.

9.4. PATIENT-CENTERED EHRS

EHRs will become more patient-centered, allowing individuals to have greater control over their health records, including the ability to access, update, and share their health information with providers and other stakeholders.

9.5. VOICE RECOGNITION AND NATURAL LANGUAGE PROCESSING

Voice recognition technology and natural language processing will enable healthcare providers to interact with EHRs using speech, simplifying data entry and retrieval, and reducing the burden of manual data entry. 6. Remote Patient Monitoring: EHRs will facilitate remote patient monitoring for chronic disease management and telehealth services. Real-time data from wearable devices and home monitoring systems will be integrated into patient records.

9.6. GENOMIC DATA INTEGRATION

Integration of genomic data into EHRs will provide a comprehensive view of a patient's health, enabling more personalized treatments and medication plans.

9.7. PREDICTIVE ANALYTICS FOR POPULATION HEALTH

Predictive analytics will be used in EHRs to detect at-risk patient populations, forecast disease outbreaks, and optimize resource allocation, eventually improving public health.

9.8. SOCIAL DETERMINANTS OF HEALTH (SDOH)

EHRs will incorporate social determinants of health data, helping healthcare providers address the broader factors that influence a patient's well-being, such as socioeconomic status, housing, and access to healthy food.

9.9. TELEMEDICINE AND TELEHEALTH INTEGRATION

EHRs will be fully integrated with telemedicine platforms, allowing for seamless virtual visits, remote consultations, and telehealth services.

9.10. PERSONALIZED MEDICINE

EHRs will enable personalized medicine by integrating genomics, clinical data, and patient preferences to tailor treatment plans and medication choices for individual patients. Data Mobility and Patient Portability: Patients will have the ability to move their health data between different EHR systems and healthcare providers, ensuring continuity of care.

9.11. 3D IMAGING AND VISUALIZATION

EHRs will support the integration of 3D imaging, enabling better visualization of medical images and aiding in surgical planning and diagnostics.

9.12. DATA STANDARDIZATION AND ONTOLOGIES

EHRs will utilize advanced data standardization and ontologies to ensure consistent and accurate data representation, making it easier to exchange and interpret healthcare information.

9.13. SMART EHRS AND COGNITIVE COMPUTING

To improve the user experience, smart EHRs will leverage cognitive computing to deliver context-aware recommendations, insights, and automated data entry. Integration of Virtual Reality (VR) and Augmented Reality (AR): EHRs will include VR and AR for immersive teaching, surgical planning, and rehabilitation programs. [7] [4]

X.   CONCLUSION

Electronic Health Records (EHRs) have transformed the healthcare industry, improving patient care, and safety, and reducing healthcare costs. Despite challenges, addressing them is essential to maximize the potential of EHRs in healthcare. The integration of AI, Blockchain, and patient-centered features promises to elevate the capabilities of EHRs, supporting personalized medicine and improving population health. There are plenty of research avenues that make it possible to identify the most significant insights by analyzing the EHR.

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