

# A Scoping Review on the Impacts of Electronic Health Record Systems on Healthcare Delivery

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## ABSTRACT

**Background:** Electronic health record (EHR) systems have evolved significantly since their introduction in the early 1960s, replacing traditional paper-based medical records with computerized storage of patient health information. The adoption of EHR systems has expanded across various healthcare settings due to advancements in technology, necessitating systems that offer diverse functionalities and seamless integration capabilities. As healthcare technology continues to progress, EHR systems must adapt by incorporating additional features such as predictive algorithms and clinical decision support. However, the widespread use of EHR systems has also led to challenges in interoperability, prompting the development of standards.

**Methodology:** This scoping review uses the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews checklist to systematically search and select relevant literature from PubMed. A research inquiry included full-text studies published in 2023, utilizing keywords "electronic health record system," "quality care," "patient safety," "clinical outcomes," and "hospital." Initial screening involved reviewing abstracts and titles, followed by a full-text review of 5 selected articles. Three articles that met eligibility criteria were synthesized to explore the impact of EHR systems on healthcare delivery.

**Conclusion:** This study draws conclusions based on the evidence synthesized, which highlights the critical role of standardized EHR systems in improving hospital patient outcomes through enhanced safety, care coordination, and data quality. The integration of advanced functionalities like clinical decision support systems, SNOMED CT, and closed-loop electronic medication management systems has demonstrated significant benefits in reducing errors, streamlining workflows, and supporting informed decision-making. Despite these advancements, challenges such as scalability, alert fatigue, and implementation costs persist, requiring ongoing collaboration among stakeholders and continuous research efforts. Future research on harnessing the capabilities of artificial intelligence and machine learning to further enhance EHR systems and address remaining barriers can ultimately optimize patient care and safety in hospital setting.

**Keywords:** electronic health record, information system, information technology management

## INTRODUCTION

Electronic health record (EHR) systems, introduced in the early 1960s, are computer-based software for managing medical

records, replacing traditional paper-based folders with enhanced structural storage of patient health information.<sup>[16]</sup> The continued growth of technology has led to increased

adoption of EHR systems in various healthcare operations. The large-scale and diverse nature of the healthcare environment causes a need for EHR systems to offer a wide range of functionality and integration.<sup>[17]</sup> As technology continues to advance, EHR systems must continue to offer additional capabilities and remain interoperable with newly emerging systems. Many innovative EHR systems are offering additional functionalities and algorithm-based predictions, including the ability to predict lung cancer screening results.<sup>[5]</sup> The increased use of EHR systems has created interoperability challenges, which creates a need for governing standards, such as the Fast Healthcare Interoperability Resources, to enhance semantic interoperability and improve the quality of clinical data exchange.<sup>[9]</sup>

Effective EHR systems provide structured organizational data sets for studying large populations with chronic conditions, which allows researchers to explore disease progression, risk factors, and management strategies without the need for in-person recruitment.<sup>[10]</sup> Although EHR systems hold vast amounts of real-time organizational data, many healthcare organizations underutilize such systems due to challenges in automated data extraction. Recent advancements in computer assisted EHR analysis shows promise for feasibility and clinical utility.<sup>[11]</sup> Including critical data points, such as patient emergency contacts in the EHR, enables healthcare organizations to connect vital information to patients, enhancing clinical workflows, such as during urgent admissions to the emergency department.<sup>[14]</sup>

EHR systems are widely used across the globe. Experienced surgeons and small practice physicians have varied feelings about innovative EHR systems, necessitating focused engagement to optimize implementation and user satisfaction in community healthcare settings.<sup>[13]</sup> Various EHR systems are available on the market. Epic Systems Corporation is the most adopted EHR

system across the globe.<sup>[1]</sup> As of 2021, four inpatient EHR vendors that collectively held 86% of the U.S. market share, causing substantial industry consolidation, with each vendor potentially suitable depending on hospital size and complexity.<sup>[7]</sup> Machine learning is effective at assessing large data sets extracted from EHR systems, which can deliver real-time, documentation-driven evidence to clinicians at the point of care.<sup>[2]</sup> Many innovative EHR vendors are implementing artificial intelligence and machine learning integration to automate tasks, such as data analysis, clinical decision support, and predictive analytics, aiming to enhance healthcare delivery and patient outcomes.<sup>[12]</sup>

Health systems often transition between EHR systems. Factors causing EHR transitions are driven by various factors, such as cost, system functionality, corporate consolidation, efficiency improvements, safety concerns, federal incentive programs, and legislative requirements, such as the Health Information Technology for Economic and Clinical Health Act.<sup>[6]</sup> Transitioning between EHR systems is a complex organizational change requiring comprehensive research that integrates human factors, mixed methods, and implementation science to effectively manage workflow adjustments across all personnel.<sup>[15]</sup> The time demands of EHR tasks during and after clinic hours detrimentally impact patient interactions and work-life balance, with patient portals and EHR messaging adding unreimbursed and unaccounted-for patient care responsibilities outside of face-to-face visits.<sup>[2]</sup> Implementing EHR systems must align with clinical workflows and patient-focused care, while also considering patient perspectives and preferences.<sup>[3]</sup> Technical challenges, such as EHR interoperability and data integrity, alongside usability and workflow issues such as inadequate display design and difficulty tracking test results, significantly impede clinicians' ability to effectively manage and act on diagnostic processes.<sup>[8]</sup> Aligning policy and guidelines for EHR

system implementation and usage is crucial to assess the system efficiency, transparency, comparability, and interoperability.<sup>[4]</sup>

The intent of this scoping review is to uncover the current state of EHR systems on healthcare delivery. The review addresses the population, intervention, comparison, and outcome (PICO) question: “Among hospitals, how does the implementation of EHR systems compared to traditional paper-based health records affect patient care, safety, and clinical outcomes?” The scoping review systematically evaluates existing literature related to the study topic and addresses the research question to uncover benefits, challenges, and recommendations for EHR integration.

### MATERIALS & METHODS

A scoping review examines existing research on a specific topic to identify trends and research gaps.<sup>[18]</sup> This scoping review followed the Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews

(PRISMA) checklist and systematically searched PubMed for relevant literature. PubMed is maintained by the U.S. National Library of Medicine and offers access to over 30 million rigorously vetted citations to improve global research and clinical communities.<sup>[19]</sup>

This scoping review used a streamlined search strategy. The research inquiry reviewed full free-text accessible, English language studies on PubMed published in the year 2023. The search keywords included “electronic health record system,” “quality care,” “patient safety,” “clinical outcomes,” and “hospital.” All results based on the research criteria were eligible for evidence. The PubMed search query returned 26 initial results. The author conducted a selection process by first screening the abstracts and titles of each article. Next, at the author’s discretion and based on available applicable evidence, 5 full-text articles were reviewed. Of the 5 articles, the 3 most appropriate and applicable evidence were synthesized.

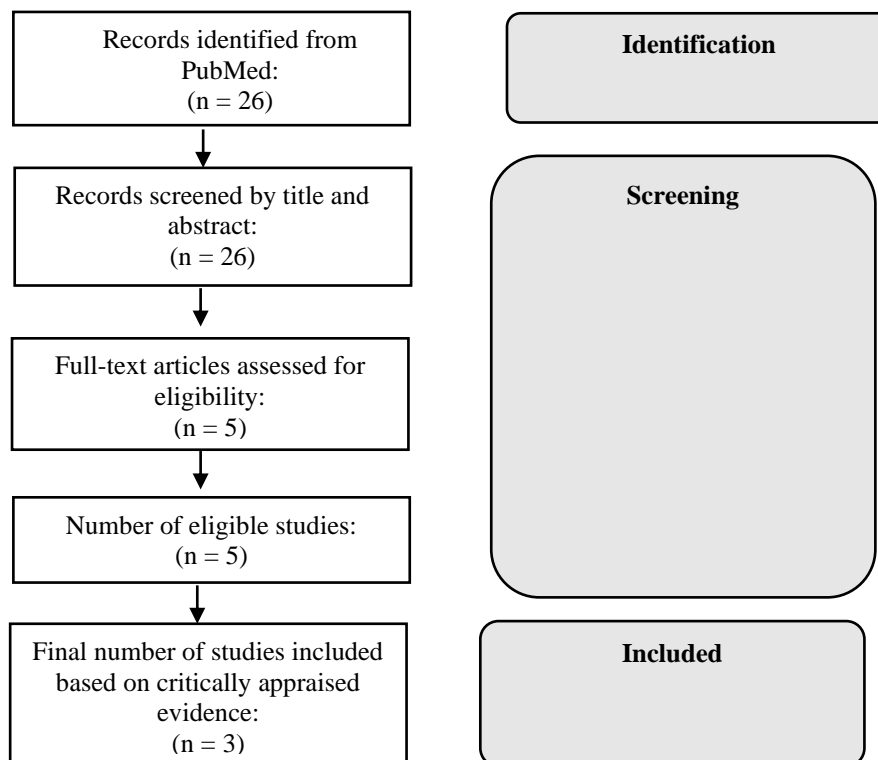


Figure 1: PRISMA Flow Diagram

**RESULT**

This scoping review simplifies the evaluation of study data, organizing it into summarized graphs to identify patterns and trends. It extracts information on scope, study design, population, and statistical significance, while noting article intent, authorship, and publication data. The scope refers to the intent, aim, or purpose of the research. The study design establishes the chosen framework, methods, and procedures

for data collection, aiding researchers in evaluating the rigor and limitations of the study.<sup>[24]</sup> The study population denotes the specific group of individuals under investigation in the study.<sup>[23]</sup> Statistical relevance pertains to the presence, impact, and reliability of study findings, indicating whether statistical significance is applicable and relevant to the current study topic. The evidence presented within the selected articles is presented in Table 1.

Scope	Type of study	Population	Statistical Relevance
Improve safety for hospitalized Parkinson’s Disease patients using standardized EHR tools, focusing on clinical decision support, care plans, and other EHR-based solutions <sup>[20]</sup>	Critical assessment	Hospitalized Parkinson’s Disease patients and healthcare professionals managing their care	Epic Systems Corporation, Verona, WI has the largest market share, over 35% in the U.S.
SNOMED CT’s integration into EHR systems and other clinical applications over the past five years, focusing on main use purposes, phases, and key clinical benefits <sup>[21]</sup>	Systematic literature review	Reviewed 17 research articles documenting SNOMED CT clinical use cases in various clinical settings	SNOMED CT’s core benefits across 17 use cases, emphasizing improved data quality in 47.1% of articles, semantic-level advantages, clinical standardization, Language customization, parallel EHR technology development and standardization, and noted gradual adoption of new data recording approaches by clinicians.
Implementation and comparison of EMMSs in hospitals in the United States and Finland <sup>[22]</sup>	Comparative review	Hospital staff and patients in U.S. hospitals and HUS of Finland	Enhanced clinical decision support to reduce order time of dispenses by 24 hours

**Table 1**

**DISCUSSION**

The first study, a critical assessment, evaluated standardization of EHR tools to enhance safety for hospitalized individuals with Parkinson's disease.<sup>[20]</sup> In partnership with Epic Systems, the Parkinson’s Foundation had devised optimal solutions to enhance clinical decision support, refine care plans, and augment staff education. Key components of the initiative included identifying Parkinson’s patients, mitigating medication errors, and furnishing detailed care protocols. The study revealed that integration of EHR systems in hospital settings offers substantial benefits, including improved patient safety through the identification of Parkinson’s patients, and prevention of medication errors via clinical

decision support. The study also called for standardized care plans and roadmaps to facilitate improved care coordination, ensuring more consistent management of Parkinson’s disease through proper EHR usage. The study also discussed the pivotal role of EHRs in enhancing staff education by providing essential information and training for managing complex cases effectively.<sup>[20]</sup> Challenges presented within the study included the complexity of scaling locally developed EHR solutions and the potential for alert fatigue among healthcare providers due to excessive clinical decision support alerts. Furthermore, the absence of a national standard for neuroleptic to parkinsonism interactions complicates the development of effective EHR alerts.

Looking ahead, advancing, and standardizing EHR tools represent crucial steps toward enhancing patient outcomes. Collaboration among EHR vendors, specialty societies, and healthcare organizations is imperative to develop scalable solutions. Continuous refinement of EHR tools, coupled with ongoing research efforts, will help address current deficiencies and elevate the overall quality of care for hospitalized individuals with Parkinson's disease.<sup>[20]</sup>

The second study, a systematic literature review, explored the integration of SNOMED CT into EHR systems and clinical applications over the past five years from the year 2023.<sup>[21]</sup> Through a review of 17 articles documenting various clinical use cases, researchers identified SNOMED CT's primary purposes, implementation phases, and key benefits. Predominantly used as a standard in EHR systems, SNOMED CT significantly enhances data quality by ensuring accurate and consistent clinical documentation by standardizing the indexing, storage, retrieval, and aggregation of clinical data to improve clinical coding and reduce time of data entry.<sup>[25]</sup> SNOMED CT supports better decision-making and improves the overall quality and continuity of patient care by providing a standardized, scientifically validated representation of clinical information.<sup>[21]</sup> Challenges included the need for more systematic research to validate and generalize SNOMED CT benefits across diverse clinical settings and EHR systems, highlighting issues of scalability, comparability of use cases, and the necessity for further empirical studies. Future comprehensive research is required to substantiate SNOMED CT's benefits in clinical care and patient safety, emphasizing contextual factors and leveraging previous frameworks to enhance scalability and comparability across different healthcare environments. Enhanced integration of SNOMED CT into EHR systems promises improved clinical data, improved data quality, and ultimately, enhanced patient outcomes.<sup>[21]</sup>

The third study, a comparative review, explores medication errors, which pose significant risks in hospital settings due to manual, error-prone processes.<sup>[22]</sup> The study evaluates closed-loop electronic medication management systems (EMMSs) integrated into EHRs to automate and reduce medication errors. Comparing traditional U.S. implementations with Helsinki University Hospital's (HUS) Epic-based system, the study highlights differences in workflows and safety protocols. HUS's pioneering closed-loop EMMS demonstrates improvements alongside integration and training challenges. EMMSs, supported by EHRs, automate medication management stages, enhancing workflow efficiency through automated order entry and dispensing.<sup>[26]</sup> Features like barcoded medication administration, clinical decision support systems (CDSS), and automated dispensing cabinets (ADCs) improve patient safety by reducing errors and enhancing documentation accuracy. Challenges presented within the study included high implementation costs, system integration complexities, and potential alert fatigue from CDSS.<sup>[22]</sup> Future developments aim to integrate medication management components within EHRs, incorporate artificial intelligence (AI) and machine learning (ML) for decision support, and promote global collaboration to enhance EMMS practices worldwide, addressing challenges through advanced integration strategies, enhanced training, and global benchmarks for improved medication safety and workflow efficiency in hospitals.<sup>[22]</sup>

The three studies highlighted key themes, trends, patterns, benefits, and challenges in the realm of EHR systems aimed at improving hospital patient outcomes. <sup>[20-22]</sup> These studies emphasize efforts to standardize EHR tools and integrate advanced functionalities, including CDSS, SNOMED CT, and closed-loop EMMS. Standardization initiatives, often in collaboration with EHR vendors, such as Epic Systems, focus on enhancing patient safety through improved medication

management, streamlined workflows, and standardized care plans.<sup>[22]</sup> Benefits identified include heightened patient safety through error reduction, improved care coordination via automated processes, and enhanced data quality for better decision-making. Challenges persist in scaling these solutions across diverse healthcare settings, managing alert fatigue from CDSS, and addressing the high initial costs and training needs associated with EHR system implementations.<sup>[20-22]</sup> Trends indicate incremental advancements influenced by policy, economic factors, and technological innovations, underscoring the importance of ongoing collaboration among stakeholders and continuous research to refine EHR capabilities. Future research should explore AI and ML for enhanced decision support, foster global benchmarks for best practices, and address remaining challenges to further optimize patient outcomes in hospital settings.<sup>[20-22]</sup>

## CONCLUSION

In summary, the critically appraised articles highlight the pivotal role of standardized EHR systems in enhancing hospital patient outcomes through improved safety, care coordination, and data quality.<sup>[20-22]</sup> While advancements in technologies, including clinical decision support systems, SNOMED CT, and closed-loop EMMS, offer substantial benefits, challenges such as scalability, alert fatigue, and implementation costs persist. Moving forward, continued collaboration among stakeholders and ongoing research efforts will be essential to optimize EHR utilization; integrate emerging technologies, including AI and ML; and address remaining barriers to further enhance patient care and safety in hospital settings.

### *Declaration by Authors*

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