The Impact Of Electronic Health Records On Patient Safety Outcome

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Abstract:

Introduction: *The introduction of electronic health records (EHRs), has greatly improved healthcare delivery and patient outcomes. This extensive literature analysis identifies important findings from previous research on the effects of EHRs on patient care and outcomes. The use of EHRs has greatly improved patient care by making medical records more accessible and accurate. Because EHRs make patients' medical histories, prescriptions, and test results readily available, healthcare providers are able to better coordinate their patients' treatment and make educated decisions. Better care coordination and fewer medical mistakes are two additional benefits of EHRs that aid communication among healthcare practitioners.*

Objective: *To establish the impact of electronic health records on patient safety outcomes*

Methodology: *Using keywords reflecting electronic health records, we searched four electronic databases: PubMed, MEDLINE, IEEE Xplore, and PsycINFO, for material pertaining to our paper.*

Results: *One of the most evident outcomes is the decrease in medication errors caused by automated testing and signals for decision assistance. Additionally, electronic health records allow for safer treatment decisions and provide more accurate and thorough clinical data. Particularly in acute care settings, EHRs facilitate the prompt implementation of interventions and the early identification of adverse events through real-time monitoring and alarms. By standardising departmental communication, EHRs improve continuity of care by lowering the likelihood of misunderstandings during transitions.*

Conclusion: *The efficiency and effectiveness of patient safety outcome in healthcare delivery processes could be enhanced by the use of electronic health records (EHR).*

Keywords: *Early Detection, Electronic Health Records, Improved Patient Care, Patient Outcomes, Patient Risk Monitoring*

I. Introduction

Safe and effective care of patients with complicated illnesses requires timely access to the appropriate information. One of the main causes of adverse hospital events is inefficient information sharing between patients and carers, which also significantly impairs the quality and safety of patient care [1]. Medical care-related harm is widespread, significantly links to morbidity and mortality, and impacts both the financial viability of institutions and the mental health of their employees [2]. Most adverse events are categorised into a few types of patient impairment. Most programs aiming to reduce damage have included improving patient communication and documentation as part of the transition to electronic health records [1]. According to the general consensus, the use of EHRs and other forms of thorough documentation and communication should, in theory, lead to safer healthcare delivery [3].

EHRs can help address several of these problems, such as communication, medication safety, and incorrect diagnosis, if they are implemented effectively [2]. Drug errors have been demonstrated to decrease with computerised physician order entry (CPOE) [3]. Research shows that properly using interoperable health information technology (HIT) systems may make patients safer by making communication easier [1]. Using electronic health records (EHRs) to help collect and combine patient data, find missed diagnoses, and send diagnostic mistake notifications can make practices safer for patients [4]. As a result, many healthcare facilities around the world are switching to computerised records. Some of the items that these data include are personal information, medical history, diagnosis, and treatment information. The UK's National Health Service (NHS) believes that electronic records can make patients safer and more productive [5].

A number of factors, including attractive government incentives and new technology, contributed to the rise in the utilisation of EHRs around the turn of the century. President George W. Bush set up the Office of the National Coordinator for Health Information Technology (ONC) in 2004 to make sure that EHRs were used by all Americans within ten years [6]. Electronic health records were widely adopted due in large part to

financial incentives provided by the Health Information Technology for Economic and Clinical Health Act (HITECH) of 2009 to healthcare providers. These incentives were in return for the deployment and meaningful use of these systems [7-8]. In 2017, almost 86% of primary care doctors in the US used an electronic health record database [6]. EHRs have had a big effect on patient treatment and outcomes since then.

The recent extensive use of EHR systems made it more likely that clinical staff would be able to share information more easily. It was thought that staff members would gradually spend less time writing down information and more time actively caring for patients after the switch from paper to electronic health records [9]. EHR documentation is typically done using a personal digital assistant (PDA), central computer, or bedside terminal. One advantage of EHR systems is the ability to integrate CPOE, computerised prescribing, and decision support tools [4]. Specifically, it has been demonstrated that computer-based decision support systems increase patient safety by lowering the frequency of adverse events that follow prescription and documentation errors [2]. When compared to human prescribers, they are more capable of alerting staff to proposed corollary actions, possible drug interactions, and dose adjustments [9].

There has to be more research using up-to-date data to determine the effects of electronic health record (EHR) implementation on healthcare quality and safety in the long run [10]. Smaller non-teaching hospitals see an improvement in mortality following the use of EHRs [1]. While electronic health records (EHRs) equipped with "meaningful usage" capabilities do reduce the number of reported adverse events, it is not apparent if this is because of better practice or a shift in how these events are reported [11]. There has been a lack of emphasis on patient safety outcomes in the technical standards for electronic health record (EHR) adoption and metrics for meaningful usage [12]. Therefore, in light of the growing adoption of EHRs, it is necessary to analyse the available data regarding this particular aspect of care. This systematic review aims to map important ideas as a foundation for a more thorough comprehension of how electronic record systems affect widely used clinical safety metrics. It also identifies knowledge gaps to guide future research and the development of more efficient EHRs.

II. Methods

Search Strategy

Publications found in academic journals and papers found in the references of the publications that were vetted for inclusion were considered for inclusion. Our search covered articles that were published in the period from March 2025 to June 2025. PubMed, MEDLINE, IEEE Xplore, and PsycINFO were the databases searched in May 2025 for papers published EHR and patient safety outcome. Additional searches were conducted on Google Scholar. The databases were chosen for their comprehensiveness and breadth of coverage across many fields. There were restrictions on the database search in terms of language, subject, and type. PEO framework was adopted and it helped us establish clear and concise research questions, especially since we conducted a qualitative study [13]. Finding the Population, Exposure, and Outcome components of a research topic was made easier with its guidance. Before the examination of studies for review was conducted, the inclusion criteria and research question were established. The main research question guided the selection of search terms:

What is the impact of electronic health records on patient safety outcome?

The PEO search term table was created by combining the Boolean operator "AND" with terms that were presented in Table 1 as distinct concepts. Using the keywords ("Electronic Health Records" OR "EHR" OR "Electronic Medical Records" OR "EMR") AND ("Patient Safety" OR "Medical Errors" OR "Adverse Events" OR "Medication Errors" OR "Clinical Outcomes"), a literature search was carried out and matched each idea in Table 1. Through electronic searches, the reference lists of primary and review publications were reviewed to find more pertinent research.

Component	Description	Keywords / Search Terms
P – Population	Patients receiving healthcare (in any setting)	"Patients" OR "Inpatients" OR "Outpatients" OR "Healthcare recipients" OR "Hospitalised individuals"
E – Exposure	Use of Electronic Health Records (EHRs)	"Electronic Health Record" OR "EHR" OR "Electronic Medical Record" OR "EMR" OR "Digital Health Record"
O – Outcome	Patient safety-related outcomes	"Patient Safety" OR "Adverse Events" OR "Medication Error" OR "Medical Error" OR "Clinical Outcome" OR "Preventable Harm"

Table 1: PEO search term table

Study Selection Criteria

Inclusion and exclusion criteria for study selection were defined a priori. Inclusion criteria included Empirical studies: quantitative (RCTs, cohort, cross-sectional) and qualitative designs published between 2015 and 2025, reporting Patient safety outcomes (e.g., medication errors, adverse events, preventable harm) and technological integration and exposure. Activities classified as documentation tasks included Use of Electronic Health Records (EHRs) or Electronic Medical Records (EMRs) for the purposes of this systematic review. Exclusion criteria included studies with Non-human subjects; studies focused only on healthcare providers without patient data. The selection of articles that met the inclusion criteria was done in two steps. The abstracts of every article found through searches were first checked by one author, who eliminated those that did not fit the inclusion requirements. All publications that were not excluded in Stage 1 had their full manuscripts acquired, and reference list searches were used to find other articles that were considered to be potentially relevant. After that, two authors independently reviewed the complete articles in Stage 2 before making final inclusion judgements. Any contradictions were settled by dialogue between the parties.

Criteria Category	Inclusion Criteria	Exclusion Criteria
Population	Human patients in hospitals, clinics, or primary care settings	Non-human subjects; studies focused only on healthcare providers without patient data
Exposure	Use of Electronic Health Records (EHRs) or Electronic Medical Records (EMRs)	Studies not involving EHRs or focusing on other health IT systems (e.g., telemedicine only)
Outcome	Patient safety outcomes (e.g., medication errors, adverse events, preventable harm)	Outcomes not related to patient safety (e.g., cost, billing efficiency only)
Study Design	Empirical studies: quantitative (RCTs, cohort, cross-sectional) and qualitative designs	Editorials, commentaries, conference abstracts, or protocols
Language	English	Non-English articles
Time Frame	Published between 2015 and 2025	Studies published before 2015
Accessibility	Full-text available	Full-text not available
Setting	Healthcare delivery settings (e.g., hospitals, clinics, nursing homes)	Studies conducted outside healthcare settings (e.g., academic simulations)

Table 2: Inclusion and Exclusion Criteria Table

Data Extraction and Synthesis

A standardised Microsoft Excel spreadsheet was used to complete data extraction by the first reviewer. The other two reviewers subsequently went over the information to make sure the data was consistent and of high quality. Information gathered from each study included author names, publication dates, study designs, settings, outcome measures, and patient safety outcome findings. The insights obtained from the included research were assessed using a thematic analysis approach. Through the utilisation of this synthesis framework, we discovered, examined, and documented recurrent concepts or themes within the qualitative data [14]. We used a systematic approach to data organisation and analysis in order to address the research questions [15].
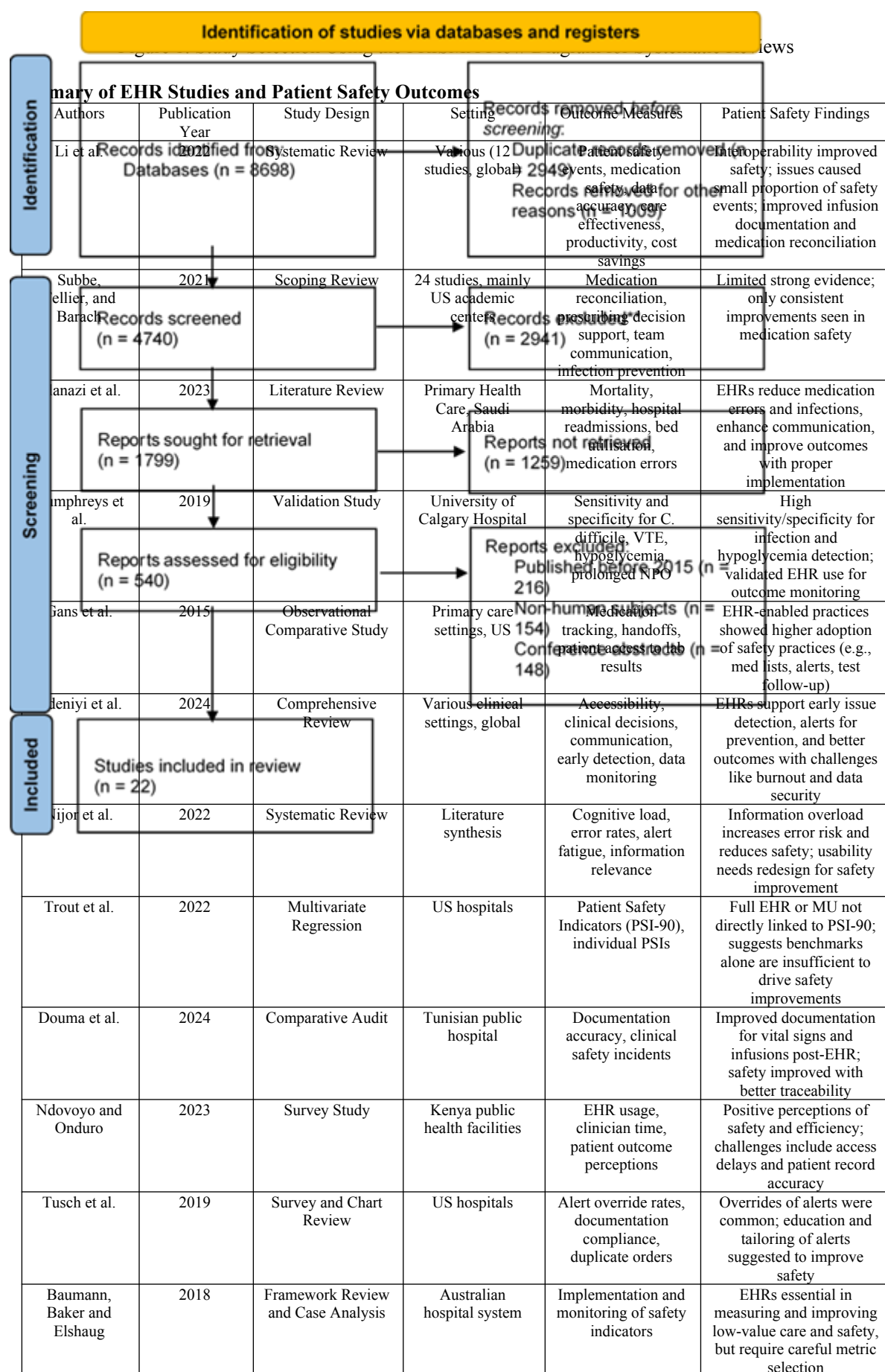
Study Quality

The MMAT was used to evaluate methodological quality and bias risk. To evaluate the methodological quality of the included studies in systematic reviews, the (MMAT) offered a framework that was used with mixed-methods, quantitative, or qualitative study designs. Through the provision of a regulated procedure for evaluating the merits of different study kinds inside the review, it guaranteed a more solid and reliable compilation of data.

III. **Results**

Overview

A total of 8,698 papers were obtained from the initial database search (Fig 1). There were 3958 papers eliminated before to screening. 2,941 publications that did not fit the inclusion criteria were eliminated after the titles were screened. 1,259 articles were eliminated after the abstracts were further screened because they were either irrelevant or not studies but rather opinion pieces or commentary. After the three reviewers reached a consensus and completed full-text screening, 512 publications were disqualified for failing to meet all PEO (population, exposure, and outcomes) inclusion criteria. 22 papers were ultimately chosen for this systematic review.

Identification of studies via databases and registers

Figure ... study selection using the PRISMA 2020 flow diagram for systematic reviews

Identification
- Records identified from Databases (n = 8698)
- Records removed before screening: Duplicate records removed (n = 2949); Records removed for other reasons (n = 1009)

Screening
- Records screened (n = 4740) → Records excluded (n = 2941)
- Reports sought for retrieval (n = 1799) → Reports not retrieved (n = 1259)
- Reports assessed for eligibility (n = 540) → Reports excluded: Published before 2015 (n = 216); Non-human subjects (n = 154); Conference abstracts (n = 148)

Included
- Studies included in review (n = 22)

Summary of EHR Studies and Patient Safety Outcomes

Authors	Publication Year	Study Design	Setting	Outcome Measures	Patient Safety Findings
Li et al.	2022	Systematic Review	Various (12 studies, global)	Patient safety events, medication safety, data accuracy, care effectiveness, productivity, cost savings	Interoperability improved safety; issues caused small proportion of safety events; improved infusion documentation and medication reconciliation
Subbe, Tellier, and Barach	2021	Scoping Review	24 studies, mainly US academic centers	Medication reconciliation, prescribing, decision support, team communication, infection prevention	Limited strong evidence; only consistent improvements seen in medication safety
Alanazi et al.	2023	Literature Review	Primary Health Care, Saudi Arabia	Mortality, morbidity, hospital readmissions, bed utilisation, medication errors	EHRs reduce medication errors and infections, enhance communication, and improve outcomes with proper implementation
Humphreys et al.	2019	Validation Study	University of Calgary Hospital	Sensitivity and specificity for C. difficile, VTE, hypoglycemia, prolonged NPO	High sensitivity/specificity for infection and hypoglycemia detection; validated EHR use for outcome monitoring
Gans et al.	2015	Observational Comparative Study	Primary care settings, US	Medication tracking, handoffs, patient access to lab results	EHR-enabled practices showed higher adoption of safety practices (e.g., med lists, alerts, test follow-up)
Adeniyi et al.	2024	Comprehensive Review	Various clinical settings, global	Accessibility, clinical decisions, communication, early detection, data monitoring	EHRs support early issue detection, alerts for prevention, and better outcomes with challenges like burnout and data security
Nijor et al.	2022	Systematic Review	Literature synthesis	Cognitive load, error rates, alert fatigue, information relevance	Information overload increases error risk and reduces safety; usability needs redesign for safety improvement
Trout et al.	2022	Multivariate Regression	US hospitals	Patient Safety Indicators (PSI-90), individual PSIs	Full EHR or MU not directly linked to PSI-90; suggests benchmarks alone are insufficient to drive safety improvements
Douma et al.	2024	Comparative Audit	Tunisian public hospital	Documentation accuracy, clinical safety incidents	Improved documentation for vital signs and infusions post-EHR; safety improved with better traceability
Ndovoyo and Onduro	2023	Survey Study	Kenya public health facilities	EHR usage, clinician time, patient outcome perceptions	Positive perceptions of safety and efficiency; challenges include access delays and patient record accuracy
Tusch et al.	2019	Survey and Chart Review	US hospitals	Alert override rates, documentation compliance, duplicate orders	Overrides of alerts were common; education and tailoring of alerts suggested to improve safety
Baumann, Baker and Elshaug	2018	Framework Review and Case Analysis	Australian hospital system	Implementation and monitoring of safety indicators	EHRs essential in measuring and improving low-value care and safety, but require careful metric selection

Clarke et al.	2016	Mixed Methods Evaluation	National Health Service (NHS), UK	Implementation effects, documentation quality, patient monitoring	Positive safety impacts were mixed and dependent on implementation quality and clinical engagement
Farhan et al.	2024	Descriptive Qualitative Study	Iraq, clinical and administrative settings	Perceived EHR benefits and barriers, communication, safety, accuracy	Reported improved accuracy and safety; but highlighted key challenges including technical issues and user adaptation
Tabche et al.	2023	Literature Review	Low- and Middle-Income Countries (LMICs)	EHR impact on efficiency, safety, documentation, communication	EHRs improve safety but constrained by infrastructural and training limitations in LMICs
Kissi et al.	2023	Quantitative Cross-Sectional Study	Ghanaian hospitals	EHR usage, system quality, user satisfaction	Improved safety perceptions linked to ease of use and staff training
Motsi and Chimbo	2024	Qualitative Case Study	Zimbabwe public healthcare	Workflow, data quality, interoperability, staff acceptance	Positive impact on coordination and documentation accuracy; concerns about system failures and user resistance
Campanella et al.	2015	Systematic Review	International settings	Health outcomes, cost-effectiveness, patient satisfaction	EHRs improve health outcomes and satisfaction but inconsistent evidence for cost-effectiveness
Upadhyay and Hu	2022	Review Paper	Global healthcare environments	Documentation efficiency, usability, burnout, safety risks	Mixed findings; some systems improved efficiency, others increased burden and risk
Cahill, Cleary and Cullinan	2025	Mixed Methods Literature Review	Ireland, EU healthcare systems	EHR usability, clinician satisfaction, safety performance	Identified poor usability as a barrier; emphasised user-centered design for safe EHR adoption
Al-Shammari, Jaafar and Elfeshawy	2024	Systematic Review	Pediatric Hospitals and Ambulatory Clinics	Medication errors, documentation accuracy, user satisfaction, continuity of care	EHRs improved documentation quality and medication safety; reduced errors and improved provider communication
Hydari, Telang and Marella	2015	Quantitative Analysis	US Hospitals (pre- and post-EHR adoption)	Patient safety incidents, hospital performance ratings	Full EHR implementation correlated with improved safety scores; partial adoption showed no significant effect

Table 3: Summary Characteristics of Included Studies

Findings

Table 4: Patient Safety Themes and Codes from EHR Studies

Theme	Description	Codes	Sources
Reduction in Medication Errors	EHR systems reduce medication-related adverse events by providing alerts, decision support, and structured prescribing tools.	Medication error reduction, Adverse drug event alerts, Structured prescribing	Alanazi et al. (2023); Campanella et al. (2015); Al-Shammari et al. (2024); Subbe et al. (2021); Tusch et al. (2019)
Improved Clinical Documentation Accuracy	More accurate and complete documentation through EHRs improves tracking of vital signs, infusions, and clinical incidents.	Accurate charting, Traceability of care, Reduced documentation errors	Douma et al. (2024); Humphreys et al. (2019); Al-Shammari et al. (2024); Farhan et al. (2024)
Enhanced Provider Communication and Coordination	EHRs support patient safety by enabling timely information sharing across providers, which reduces care delays and miscommunication.	Information sharing, Cross-provider coordination, Continuity of care	Alanazi et al. (2023); Adeniyi et al. (2024); Tabche et al. (2023); Farhan et al. (2024)
Patient Risk Monitoring and Early Detection	Real-time access to patient data and automated alerts from EHRs help identify deteriorating patients and prevent harm.	Real-time alerts, Early warning, Monitoring patient condition	Adeniyi et al. (2024); Humphreys et al. (2019); Li et al. (2022)
Impact on Mortality and	Use of EHRs has been associated with reductions in patient mortality and hospital	Reduced mortality, Fewer readmissions,	Alanazi et al. (2023); Hydari et al. (2015); Campanella et al. (2015);

Readmissions	readmission rates in some studies.	Improved clinical outcomes	Trout et al. (2022)
Prevention of Hospital-Acquired Infections	By minimising physical paperwork and standardising processes, EHRs reduce contamination and infection transmission risks.	Infection control, Digital record hygiene, Lower transmission risk	Alanazi et al. (2023); Tabche et al. (2023)
Safety Risks from Poor EHR Usability	Poor EHR design, alert fatigue, and cognitive overload contribute to errors, increasing patient safety risks.	Alert fatigue, Cognitive overload, Usability-induced errors	Nijor et al. (2022); Cahill et al. (2025); Upadhyay & Hu (2022); Tusch et al. (2019)

Thematic Synthesis and Discussion of EMR on Patient Safety Outcomes
Reduction in Medication Errors and Improved Clinical Documentation Accuracy

The studies affirm that the usage of EHRs has improved patient treatment and outcomes by making patient information more efficient and accessible. Examining the effects of EHRs on accessibility and efficiency, the studies highlights the following benefits: reduced test duplication and medical errors; easier access to patient records; and simplified record-keeping and documentation. EHRs' main benefit is the improved accessibility of patient data [16-20]. Regardless of their physical location, physicians and other medical staff can easily access patient information thanks to electronic health records [17–19]. Rapid access to vital patient records is crucial in an emergency because it could save lives [20]. Electronic health records provide access to a patient's complete medical history, including all tests, prescriptions, diagnoses, and allergies [18]. Medical practitioners can more accurately evaluate their patients' needs and create treatment plans when this information is easily accessible [17].

Electronic health records have made paperwork and record-keeping easier, increasing efficiency and reducing errors [10, 1]. Medical staff can lessen the need for paper records by transferring patient data into electronic health records. Compared to handwritten notes, electronic documentation reduces the chance of error [17–23]. Medical professionals can save time and effort by not having to manually sort through mountains of paper data thanks to electronic health records, which also offer a central location for all patient information [18–19]. For example, electronic health records (EHRs) can automate billing and coding, which further boosts the productivity of documentation [9]. Electronic health records have also reduced medical errors and unnecessary tests [1–5]. Because they give physicians access to more thorough patient records, electronic health records (EHRs) reduce the possibility of errors and improve the accuracy of diagnosis and treatment decisions [24]. By warning physicians about potential drug combinations or allergies, EHRs further lower the risk of adverse events.

Patient Risk Monitoring and Early Detection through EHRs

Because EHRs make it easier to assess risks, identify issues early, and obtain patient data instantly, they have completely changed the healthcare industry. EHRs are helpful for preventative care, but how effectively they work depends on a variety of things, such as how well they are designed, how well they work with other systems, how involved clinicians are, and how these tools are used. The study by [22] is a great illustration of how EHRs help find problems early. It highlights how EHRs combine clinical decision support systems (CDSS) with alerts that happen in real time. These traits can assist find and treat high-risk patients immediately, like those whose diseases are getting worse quickly or whose vital signs are not normal. Another good thing about EHRs is that they let care teams keep an eye on clinical symptoms all the time, which helps them stay up to date and intervene before problems get worse. This is confirmed by the findings of the validation study by [28], which demonstrated that EHRs had high sensitivity and specificity in identifying conditions like Clostridium difficile infections and low blood sugar. They found evidence that EHRs can be used for accurate surveillance of urgent patient issues, lending credence to the premise that such a system is practicable.

Additionally, Li et al. stress that interoperability amongst EHRs is very important for finding risks early [17]. They assert in their systematic evaluation that connecting infusion pumps to EHR systems greatly cut down on mistakes in paperwork and infusion. These improvements make it possible to spot therapeutic mismatches or bad changes in a patient's condition earlier. EHRs protect us by constantly gathering and combining data to show little indicators of decline that might not be seen in paper-based systems. Even if these are good things, there are also important problems and concerns that need to be recognised. One problem is alert tiredness, which is a common topic in the literature. Both Nijor et al. and Humphreys *et al.* assert that too many vague alarms can overwhelm doctors, making them less sensitive and more likely to ignore important cautions [23, 28]. This implies that although EHRs provide the means for early detection, their safety benefits may be compromised by improper setup or excessive use of alarm systems. Therefore, striking a balance between minimising the cognitive load on providers and generating responsive alerts is crucial to the efficacy of risk monitoring.

The fact that different contexts have different uses for EHRs for risk monitoring raises additional concerns. Nijor et al. discovered that although EHRs promote pharmaceutical safety, there is still conflicting data regarding more general safety outcomes, like deterioration monitoring [23]. This could be because of differences in infrastructure, training, or how mature the system is. Cahill et al. also assert that user-centred design is important for making sure that monitoring systems are properly integrated into clinical workflows [19]. Poor usability might make it harder to notice whether a patient is getting worse, especially if doctors have trouble understanding or getting to the right data. All things considered, there is strong empirical evidence that EHRs have the ability to improve patient risk monitoring and facilitate the early identification of adverse events [6,21,23]. Studies show that EHRs make it possible to keep track of data all the time, send alarms, and encourage quick clinical responses [17-22]. These systems' effectiveness, however, hinges on their thoughtful deployment, astute alert design, and proactive physician involvement. In the absence of these components, patient protection systems could introduce new risks. To get the most out of EHRs in this area, they need to be constantly evaluated, tailored to the needs of the situation, and included in larger safety plans.

Enhanced Provider Communication and Coordination

Because electronic health records allow doctors to view previous test results, they can assess the usefulness of earlier tests before ordering new ones, reducing the likelihood of unnecessary testing [17, 25]. This strategy potentially protects patients from harm, reduces costs, and ensures that tests are only performed when absolutely necessary [24, 25]. The convenience and accessibility of EHRs have considerably enhanced patient treatment and results. EHRs have transformed healthcare delivery by improving access to patient information, speeding up record-keeping and paperwork, and reducing medical errors and test duplication [26]. As long as there are persistent attempts to improve EHR systems and address outstanding challenges, electronic health records will further impact patient care and results. In hospital settings, electronic health records have supposedly transformed communication and collaboration, leading to better patient care and results [6, 22].

A comprehensive analysis of electronic health records' effects on communication and care coordination reveals that these tools improve communication between healthcare providers, contribute to more consistent and coordinated patient care, and influence patients' active participation in their own care [2-6]. One of the main benefits of electronic health records is the improvement of provider communication. EHRs facilitate improved communication and teamwork by providing healthcare providers with easy access to patient records [5]. Real-time patient record viewing by physicians and nurses is one way that electronic health records facilitate care coordination. Additionally, by serving as a central database for patient records, electronic health records facilitate communication by giving professionals from various specialities and locations access to the same data [1–5]. Better treatment coordination is thus encouraged. Electronic health records further enhance provider collaboration by enabling communication through tools like electronic referrals and secure messaging [3-5, 18, 22, 23].

Clinical Decision

Electronic health records have had an enormous impact on both how well therapies work and how doctors make judgements. This in-depth study investigated into the link between electronic health records and clinical decision-making and treatment outcomes, with a focus on how electronic health records affect evidence-based practices, the use of clinical decision support tools, overall treatment outcomes, and patient safety [27]. One patient safety outcome advantage of EHRs is that they support practices that are based on evidence. EHRs can give medical personnel up-to-date, evidence-based information at the moment of service by directly incorporating clinical standards and practices into the system [28]. This integration improves outcomes by making it easier for providers to make better decisions regarding how to care for patients [6]. Clinical decision support systems are another way that electronic health records enable evidence-based practices. Doctors and nurses can use these tools to find out about possible drug interactions, allergies, and other variables that could affect their treatment choices [16, 29].

EHRs assist doctors make safer and more successful treatment decisions because they show information in real time [15, 9]. EHRs make it easier to use clinical decision support systems, which leads to better clinical decisions and better treatment outcomes. These tools could be as simple as reminders and alerts or as complex as algorithms that examine patient data and make personalised suggestions [16, 17]. For instance, electronic health records may suggest preventative care or let doctors know about possible drug interactions based on a patient's medical history [16, 18]. These EHR decision support systems help people with chronic illnesses get better care by reminding them to get screenings or testing on a regular basis [17–21]. EHRs have a big effect on how safe patients are and how well treatments work. EHRs give doctors a lot of information on their patients, which helps them diagnose and treat them better.

Summation of Findings

Table 5 shows the specific effects of EHR on patient safety outcomes that were found through theme review and synthesis. The table below shows twelve direct effects of EHRs on patient safety outcomes that are in accordance with what research has found. The elimination of human mistake in drug testing and decision-making is a clear advantage of automated testing and decision-support signals. EHRs also make clinical data more complete and reliable, which helps doctors make safer treatment decisions. Particularly in emergency care settings, EHRs allow for the earlier identification of adverse events and the faster execution of treatments through real-time monitoring and alerts. Through departmental communication standardisation, EHRs improve continuity of care by lowering the likelihood of misunderstandings during handoffs. There is some indication that using EHRs can lead to fewer hospital readmissions and deaths among patients. Fewer hospital-acquired illnesses and fewer repeat tests are two more safety benefits that minimise patients' exposure to dangers. The trend towards digital records has pushed this tendency forward. Most importantly, identity-related errors can be decreased by using EHRs to standardise data and promote better adherence to treatment recommendations. They also make it easier and more complete to report incidents, which makes monitoring safety better. In the end, these data show that EHRs may make healthcare facilities safer when they are designed and used correctly.

Direct Effect	Explanation
Fewer Medication Errors	Automated checks reduce prescription mistakes, drug interactions, and dosage errors.
Improved Detection of Adverse Events	Real-time alerts and surveillance identify safety threats like hypoglycemia or infections early.
Enhanced Accuracy and Completeness of Patient Records	More reliable documentation supports safer clinical decisions.
Timelier Clinical Interventions	Faster recognition of clinical deterioration through real-time monitoring systems.
Improved Continuity of Care	Shared access to records across departments prevents gaps and duplications during transitions.
Reduced Hospital Readmissions	Better discharge planning and follow-up supported by comprehensive digital records.
Lower Patient Mortality in Some Settings	Early identification and treatment of critical conditions contribute to life-saving care.
Decrease in Hospital-Acquired Infections	Reduced paper handling and better hygiene practices linked to digital systems.
Fewer Duplicate Tests and Procedures	Access to past investigations minimises unnecessary exposures or delays.
Improved Compliance with Clinical Guidelines	Integrated decision support nudges clinicians toward evidence-based practices.
Reduced Incidence of Identity-Related Errors	Standardised electronic systems decrease wrong-patient or wrong-procedure incidents.
Enhanced Reporting of Safety Incidents	EHRs support easier documentation and audit trails for tracking and learning from events.

Table 5: Direct Effects of EHR on Patient Safety Outcomes

Quality of Included Studies
MMAT Evaluation

Criterion 1: Is the research question clearly stated and justified? This ensures that the study is addressing a relevant issue with a defined objective.

Criterion 2: Is the study design appropriate for the research question? This evaluates whether the chosen method is suitable to produce valid findings.

Criterion 3: Are the data collection methods clearly described and appropriate? This involves assessing how reliably the data were gathered.

Criterion 4: Are the analyses conducted rigorously and clearly reported? This ensures the analysis is methodologically sound.

Criterion 5: Are the interpretations and conclusions supported by the results? This checks if the conclusions align with the presented evidence.

Study	Study Design	MMAT Score	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Notes
Li et al. (2022)	Systematic Review	High	Yes	Yes	Yes	Yes	Yes	Comprehensive search and synthesis, clear inclusion criteria
Subbe et al. (2021)	Scoping Review	Moderate	Yes	Yes	Yes	No	No	Systematic process, but lacked risk of bias appraisal
Alanazi et	Literature	Low	No	No	No	No	No	Descriptive and

al. (2023)	Review						lacks methodological rigor
Humphreys et al. (2019)	Validation Study	High	Yes	Yes	Yes	Yes	Yes	Clear methods and statistical analysis for validation
Gans et al. (2015)	Observational Comparative Study	Moderate	Yes	Yes	Yes	No	No	Good data, limited control for confounders
Adeniyi et al. (2024)	Comprehensive Review	Moderate	Yes	Yes	Yes	No	No	Broad synthesis, lacking systematic approach
Nijor et al. (2022)	Systematic Review	High	Yes	Yes	Yes	Yes	Yes	Clear criteria, bias and relevance well addressed
Trout et al. (2022)	Multivariate Regression	High	Yes	Yes	Yes	Yes	Yes	Robust quantitative methods, good data sources
Campanella et al. (2015)	Meta-analysis	High	Yes	Yes	Yes	Yes	Yes	Rigorous synthesis with quantitative scoring
Douma et al. (2024)	Comparative Audit	Moderate	Yes	Yes	Yes	No	No	Practical findings but small sample and contextual limitations
Ndovoyo & Onduro (2023)	Survey Study	Low	No	No	No	No	No	Small sample, limited validation of tools
Tusch et al. (2019)	Survey and Chart Review	Moderate	Yes	Yes	Yes	No	No	Mixed methods but limited generalisability
Baumann et al. (2018)	Framework Review	Low	No	No	No	No	No	Lacked empirical evaluation, more policy-oriented
Clarke et al. (2016)	Mixed Methods Evaluation	High	Yes	Yes	Yes	Yes	Yes	Integrated qualitative and quantitative approaches
Farhan et al. (2024)	Qualitative Study	Moderate	Yes	Yes	Yes	No	No	Rich insights, but small and context-specific
Tabche et al. (2023)	Literature Review	Low	No	No	No	No	No	Narrative review, limited methodological transparency
Kissi et al. (2023)	Cross-Sectional Quantitative	Moderate	Yes	Yes	Yes	No	No	Reasonable statistical analysis, convenience sampling
Motsi & Chimbo (2024)	Case Study	Moderate	Yes	Yes	Yes	No	No	Focused findings, but lacks triangulation
Upadhyay & Hu (2022)	Review Paper	Low	No	No	No	No	No	Broad overview without systematic structure
Cahill et al. (2025)	Mixed Methods Review	High	Yes	Yes	Yes	Yes	Yes	Strong methodology, clear synthesis
Al-Shammari et al. (2024)	Systematic Review	High	Yes	Yes	Yes	Yes	Yes	Systematic design, appropriate

							quality appraisal
Hydari et al. (2015)	Quantitative Analysis	High	Yes	Yes	Yes	Yes	Yes	Robust statistical approach, large dataset

Table 5: MMAT Evaluation of the Quality of Included Studies

MMAT Heatmap Score Matrix
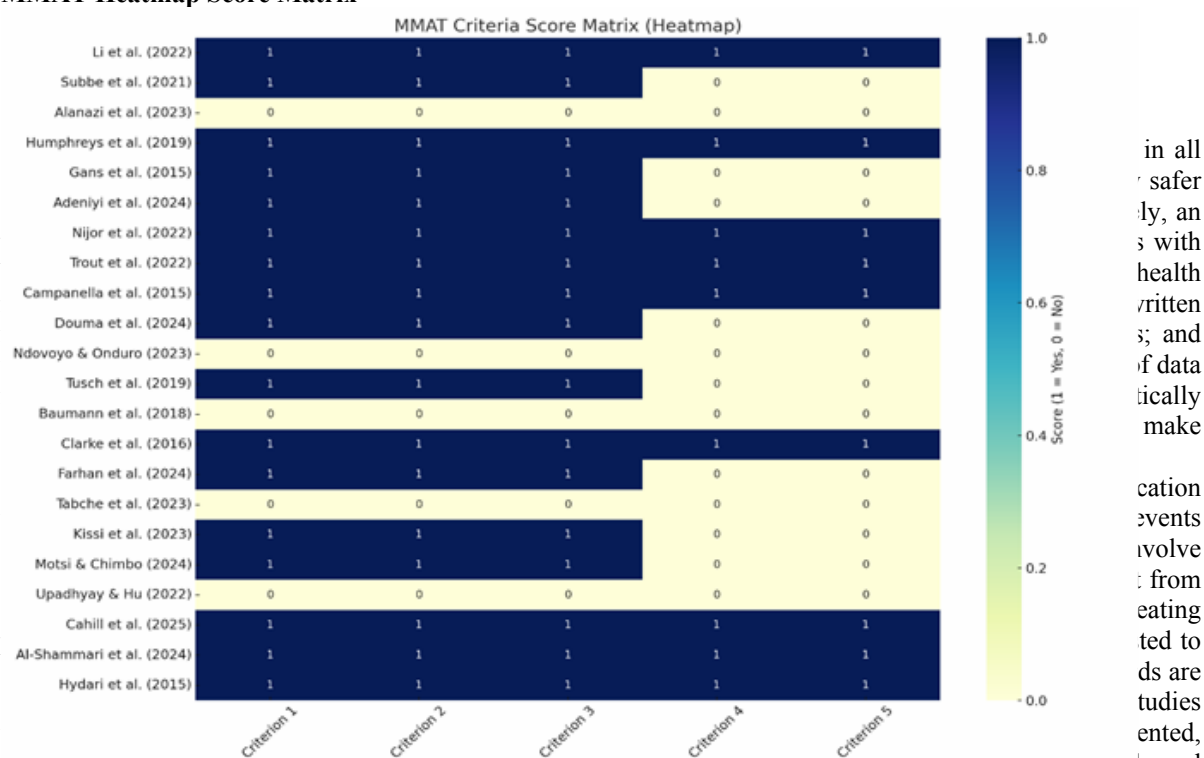
manageable format, enabling doctors to make much safer and quicker decisions about patient care.

The recommendations to address the shortcomings of electronic health records in terms of data quality are based on the observation that workload is associated with a higher likelihood of erroneous data [29]. Based on this, it can be concluded that lowering the workload of medical personnel may also lessen inaccurate data. Additionally, having a committed team and health technician was linked to lesser error. The quality of data collected after an implementation can be improved by establishing norms for data documenting before the project begins. To lessen the possible strain of data quality maintenance, an EHR system that incorporates a tool that automates data integrity and quality checks should be considered [18-22]. It is possible to offer complete, accurate, and real-time patient record updates by integrating many clinical data sources into one electronic health record system [19]. Data integrity and consistency can be improved with digital health data interoperability solutions. Clinicians and other health care workers can improve their proficiency with the EHR system by receiving training on correct data documentation practices [9]. Furthermore, health data can be better

evaluated on a regular basis for correctness, completeness, and internal consistency through activities such as peer review, constructive criticism, workshops, supportive supervision, and improvement work planning.

Strength and Limitations

More than one strength characterises this systematic review. In all, 22 papers were culled from the extensive corpus of information published between 2015 and 2025. Since all of the articles we used are publicly accessible online, our search tactics were transparent and open, and we compiled these results using best practice standards [29]. We considered only research that addressed electronic health records (EHRs), interoperability, care quality, and patient safety. Two researchers were responsible for screening and reviewing the materials, while a third, more senior researcher was there to mediate any disagreements that emerged. Only after all three researchers had established a consensus through iterative consultation was the final set of included studies decided. A widely utilised framework for care quality in health care research was then used to map our findings [19]. However, our systematic review has some significant limitations. The first is the decision to limit the evaluation to articles written in English and focused on well-equipped societies with history of EHR use on human subjects. Because of this, the review cannot adequately reflect the realities of electronic health records (EHRs) in low- and middle-income nations or those whose official language is not English. The authors recognise that these inclusion criteria can present a risk of bias, even as EHR systems are often encountered in well-equipped societies and so presumably have more extensive expertise addressing the problem of patient safety outcomes.

Future Directions and Opportunities

The delivery of healthcare has already been significantly impacted by EHRs, although their full potential has not yet been realised. EHRs' potential to influence patient care and outcomes in the future is expressed in this thorough review, most of which address technological advancements and interoperability and their role in population health management, research, and their potential for integration with telemedicine services and remote monitoring. Artificial intelligence (AI), blockchain, and machine learning are poised to revolutionise electronic health records and their impact on patient safety and care [22]. Massive volumes of patient data can be analysed using AI and ML in the healthcare industry to find patterns and trends, which eventually enhances treatment choices and results. Blockchain technology can make EHRs efficient by safely storing and sharing data. This makes it easier for doctors and other medical professionals to share information.

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