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Review

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TECHNOLOGY-DRIVEN PRESCRIBING ERRORS AND ADVANCEMENTS: ANALYSIS OF THE IMPACT OF ELECTRONIC MEDICAL ON MEDICATION ERRORS

Toka Taha Taha Abdelaziz[1], Elsye Maria Rosa[1]

[1]Department of Hospital Administration, University Muhammadiyah Yogyakarta, Yogyakarta, Indonesia

Correspondence:
Toka Taha Taha Abdelaziz (e-mail:toka.taha.psc23@mail.umy.ac.id)

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Ankara Yıldırım Beyazıt University Faculty of Medicine
Department of Family Medicine

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Abstract

Prescribing errors significantly threaten patient safety, incurring substantial costs and jeopardizing well-being. The emergence of electronic medical records (EMRs) and clinical decision support systems (CDSS) within them offers a potential solution.

This abstract explores the impact of this combined technology on prescribing errors. Studies suggest a positive influence, with some reporting reductions of up to 46%. EMRs, with features like e-prescribing and medication history integration, can improve legibility, reduce misinterpretations, and prevent duplicate prescriptions. CDSS further enhances safety by offering real-time alerts for drug interactions, allergies, dosage errors, and potential contraindications. These alerts promote informed decision-making at the point of care.

However, research also acknowledges limitations. While some studies show significant reductions, others report mixed results or even potential increases in reported errors, which might reflect improved detection rather than an actual increase in occurrences. Additionally, usability issues and alert fatigue may diminish the effectiveness of CDSS.

The bibliometric analysis acknowledges the undeniable benefits of technology in reducing medication errors, However, it emphasizes the need for ongoing optimization to minimize unintended consequences. Finally, the analysis paves the way for future research, suggesting the exploration of artificial intelligence and machine learning integration to personalize CDSS interventions and further enhance patient safety.

In conclusion, the integration of EMRs with CDSS holds significant promise for reducing prescribing errors. However, continuous research, system development, and user-centered design are crucial to maximize their effectiveness and ensure optimal patient safety.

Keywords: Electronic medical record, patient safety, medication errors, prescribing errors.

Introduction

Medication errors are an unfortunate but common occurrence in medical care [1,2] and are defined as "any mistake made in the process of prescribing, dispensing, or administering medication."[3] The following are frequent factors leading to avoidable drug-related visits to the emergency room, hospitalizations, and fatalities. Occasionally, these errors can lead to adverse drug events, which encompass any harm caused by medicine given during medical therapy or diagnostic operations. [2] According to data from 1993, over 7,000 deaths were attributed to medication errors. [4]

Medication errors have a significant impact on healthcare. The global prevalence of medication errors is reported to be 3%, with higher rates in elderly settings and intensive care units. [5] These errors can be potentially life-threatening, with a significant proportion occurring during the prescribing stage and involving central nervous system medications.[6] Medication errors are associated with increased morbidity and mortality, prolonged hospitalizations, and higher costs of care.[7] They can also lead to adverse drug events, including harm to patients. Medication errors are often underreported, and there is a need for a safe medication error reporting system to foster medication safety. Healthcare professionals, including hospital pharmacists, play a crucial role in identifying and preventing medication errors. Strategies to mitigate medication errors should be implemented to ensure patient safety during pandemics and beyond. [8]

Medication errors are primarily caused by prescribing errors. These occur in both general practice and hospitals, and while rarely fatal, they can impact patient safety and quality of care. According to the definition, a clinically meaningful prescribing error reduces the likelihood of timely and effective treatment or increases the risk of harm relative to commonly accepted practice. [9] This term focuses on the outcome of an error. However, it does not account for failures that may occur throughout the prescribing process, regardless of potential harm. [10] Prescription errors refer to the act of prescribing while prescribing faults include irrational, inappropriate, under, over, and ineffective prescribing due to faulty medical judgment or treatment decisions. To accomplish appropriate prescriptions, prescribers must limit errors and actively strive for improvement. Prescription errors constitute 70% of drug errors that have the potential to cause serious side effects. [11,12]

All operations associated with prescribing are steps that generate errors. A prescribing error can occur when the incorrect drug is chosen, the wrong dose is administered, the wrong route of administration is used, or the treatment is given for the wrong frequency or duration. Additionally, prescribing errors can result from inappropriate or incorrect prescribing based on the patient's characteristics or other concurrent treatments. Inadequate evaluation of potential harm from a specific treatment can also contribute to prescribing errors.[11] The most frequent type of prescribing errors, accounting for about 50% of all mistakes, are related to dose selection. [13]

Ensuring patient safety (PS) is a worldwide priority to deliver healthcare of exceptional quality. More than 80% of safety events seen by patients can be avoided by promoting ongoing improvement in safety culture. [14] Transparency, communication, teamwork, and strong leadership are crucial elements of a patient safety culture in the health systems of developing nations. These factors are necessary to guarantee that patients receive dependable and secure care. [15] In addition, other detrimental conditions, including a scarcity of personnel, inadequate infrastructure and congestion, a deficit of medical resources, and insufficient hygiene and sanitation, all contribute to the dangerous provision of healthcare in developing nations. [16] An exhaustive and all-encompassing approach is required to handle this problem efficiently. [17]

The healthcare industry is seeing an unparalleled technological shift from traditional paper-based medical records to electronic medical records (EMRs). Although the implementation of EMRs shows great potential for enhancing efficiency, quality, and safety, there have been significant obstacles mostly related to the technology's failure to meet the cognitive requirements of clinical end-users. Healthcare professionals are currently facing heightened levels of stress and dissatisfaction, while also encountering additional safety risks. Applied psychologists have a noteworthy possibility to tackle numerous of these difficulties. [18]

Electronic medical records (EMRs) are digital forms of medical records that offer numerous benefits in terms of economic, clinical, and access to clinical information. In terms of economic benefits, EMRs can lead to cost savings, effectiveness, and cost efficiency. [19] Clinically, EMRs can reduce medical errors, improve data readability, enhance the quality of care services, and increase the productivity of medical personnel. [20] Additionally, EMRs improve the accessibility of patient history information, enhance patient confidentiality, and assist in the decision-making process. [21] However, the implementation of EMRs faces challenges such as privacy concerns, technical scalability, and usability. [20] It is crucial to involve end users in the early stages of designing and implementing EMRs to improve usability. Overall, EMRs have the potential to revolutionize healthcare delivery by providing timely access to patient information and improving the quality and efficiency of care. [22]

Electronic medical records (EMRs) have shown mixed results in their impact on medication errors. EMRs are a helpful tool in epidemiological studies and can contribute to improving healthcare outcomes. Hospitals must maintain medical records, which serve as health service facilities. [23] Some studies have found that the implementation of integrated electronic medication management systems (EMMS) can reduce medication deviations and errors in the transition of care in hospital settings [24]. However, other studies have shown that the adoption of EMRs can lead to an increase in medication errors, particularly in the detection and reporting of errors. [25] Providing patients with access to their medical records through a patient portal has been found to improve medication management safety, including medication adherence and patient-reported experience.[26] The introduction of an electronic patient record (EPR) has been shown to reduce the omission of pre-admission

medications at discharge, but it may also lead to a reduction in deliberate discontinuation of medications.[27] Overall, the effectiveness of EMRs in reducing medication errors depends on various factors, including the specific system design and implementation strategies.[28]

The main objective of this research is to gain a full understanding of the influence of Electronic Medical Records (EMRs) on medication mistakes in hospital environments. With the growing shift towards digital platforms in healthcare systems, it is crucial to evaluate the efficiency and possible obstacles related to incorporating electronic medical records (EMRs) into medication management. The objective is to provide valuable perspectives that can guide enhancements in patient safety, healthcare excellence, and the overall effectiveness of drug procedures.

The research seeks to fill various gaps in the current literature about the correlation between EMRs and medication mistakes. The gaps encompass the following: Inadequate comprehension of the various aspects of EMRs that either contribute to or alleviate pharmaceutical mistakes.

Inadequate investigation of the viewpoints, encounters, and difficulties healthcare professionals face in using electronic medical records (EMRs) for medication administration.

Insufficient understanding of how organizational policies, culture, and leadership support impact the incorporation of EMRs in medication safety efforts. Limited understanding of the contextual variables that could potentially affect the effects of EMRs on medication mistakes.

The research aims to fill these gaps to gain a more comprehensive and intricate comprehension of the intricate interactions between EMRs and prescription errors. Ultimately, this will aid in the creation of evidence-based suggestions for healthcare practitioners and policymakers.

The hospitals used to rely on paper-based medical records and faced various obstacles, including delayed retrieval of vital patient data which resulted in the postponement of decision-making and the provision of medical attention to patients, documentation Prone to errors as handwritten notes are vulnerable to mistakes, which jeopardize patient safety and the effectiveness of treatment, inefficient workflow as manual manipulation of records leads to inefficiencies in the clinic's workflow, affected the productivity of the personnel and the experience of the patients, and heightened risk of recording errors especially medication errors. These difficulties hindered the smooth transmission of information among hospital healthcare practitioners and also undermined the quality of patient care. The importance of implementing EMR in the clinic in this setting cannot be emphasized enough, as it holds the potential to fundamentally transform the management, sharing, and utilization of healthcare data.

The research seeks to offer useful context-specific insights for both the selected hospital and similar healthcare settings by carefully choosing a hospital with distinct characteristics and potential obstacles.

Materials and Methods

Research on Scopus Database: This study analyzed global papers on clinical decision-support systems and electronic health records in the diagnosis field from the Scopus database using bibliometric analysis. Scopus was chosen for its exceptional scientific papers, abstracts, and references, which are of high quality and significance, establishing it as a worldwide acknowledged data source.[29]

Database Selection: To avoid redundancy of articles and authors from several sources, Scopus was selected as the data source due to its inclusion of journals from other databases. The investigation intended to access more prominent papers. To establish the search word, a general study was undertaken on clinical decision support and electronic health records.

Search Terms: Given that the terms "clinical decision support" and "clinical decision making" are commonly found in the titles and keywords of research publications, the search term "clinical decision support" was selected along with "electronic health records" and "prescribing." The search results were refined based on the publication year, publishing language, publication type, and scanned index criteria. we limited the research to next words: electronic medical records, prescribing errors, and language English,

Search Filters: This research limited exact keywords: electronic medical record, medication error, prescription, electronic prescribing, electronic health records, drug use, health information technology, decision making, drug-related side effects and adverse reactions, drug interactions, prevalence, adverse drug reaction, information technology, medical record review, Clinical Decision Making, physician order entry system, hospital information system, clinical decision support system, prescribing error, medical information system, drug safety, patient care, computerized provider order entry, medication therapy management, and patient safety. The publication year for the study results considered was between 2007 and 2024 to encompass all recent studies. By March 2024, 744 articles meeting these criteria were identified. The data for these articles were stored in 744 files retrieved via the Scopus interface, each containing distinct records.

This study will employ crucial procedures to achieve our research objectives. These include quantifying the occurrence rate of keywords, identifying keywords with high frequencies, constructing a co-occurrence matrix, grouping keywords into clusters, and analyzing the intellectual framework of topics through social network

analysis. Before doing a co-word analysis, it is important to establish the analysis unit. Researchers typically choose keywords taken from articles as fundamental units of analysis. For this study, we have used terms retrieved from projects in Scopus as our research data. The temporal duration is a decade, commencing in 2003 and concluding in 2024.

Data Collection: We collected 744 relevant articles, including original research, reviews, and conference papers. In conclusion, we obtained keywords 1017 from the 744 research studies.

Analysis with VOSviewer Program: Using Vosviewer to analyze the data by inserting the data which were downloaded from Scopus and creating a map based on bibliographic data, then the data was chosen in according to analyze all co-occurrence keywords. We conclude all minimum keywords with 4 times co-occurrence, 991 keywords meet the threshold.

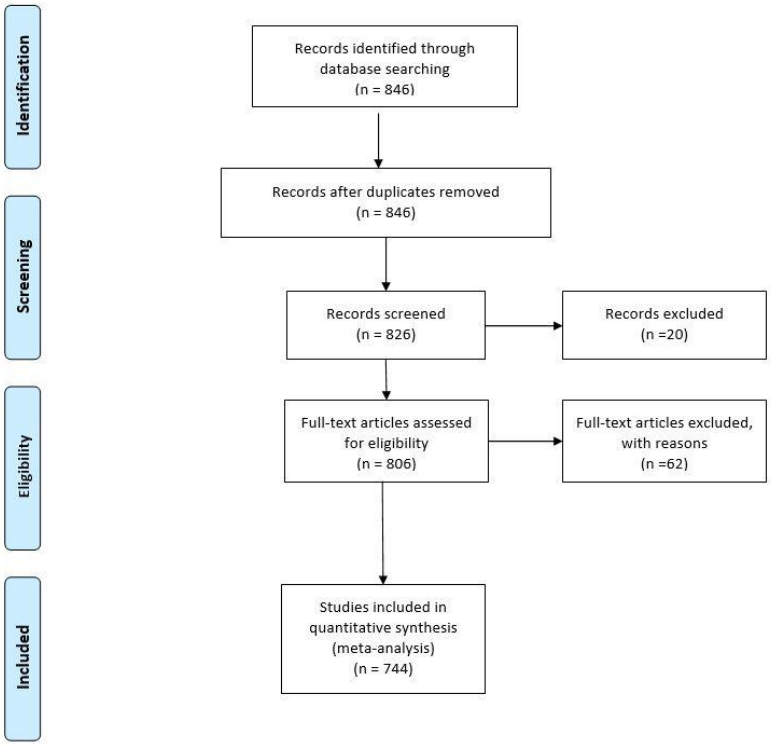

Figure 1. Flow diagram of the article selection process Scopus.

Results

A total of 744 publications that met the criteria were chosen for inclusion in the study. Of these, 527 (70.8%) were original articles, 138 (18.5%) were reviews, 26 (3.5%) were conference papers, and the remaining articles were included in other categories. It is important to point out that the year 2022 saw the publication of a significant number of papers (11.4%). In the end, there were 744 research articles authored in English that were incorporated into the bibliometric study.

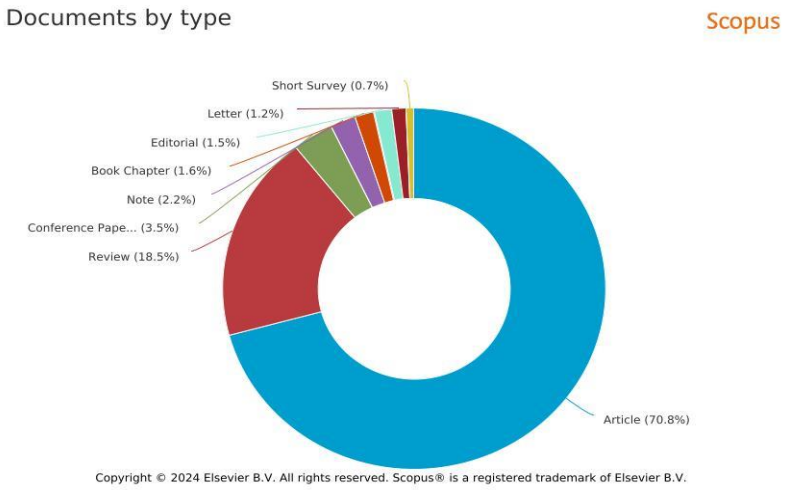

Figure 2. Document types of Published Articles

This study looked into the effects of the implementation of both electronic health records and clinical decision support systems together in hospitals and clinics to reduce medication errors and early While previous studies investigated the impact of clinical decision support systems only, they did not explicitly address its influence on detecting medication errors with electronic health records.

We found that the integration between the two systems correlates with the potential to revolutionize healthcare by providing doctors with the information they need to guide doctors and alert them to errors.

The proposed method in this study tended to have an inordinately higher proportion of specific findings relevant to medication errors. The essential substance of an article can be represented by its keyword, and the frequency of occurrence and co-occurrence might somewhat indicate the topics emphasized in a specific field.[30]

VOSviewer offers the capability to integrate clustering and mapping for visualization. Additionally, VOSviewer provides zoom and scroll functionality, allowing users to obtain more detailed information from a map. Keywords inside each cluster are displayed in distinct colors. When keywords are organized into the same cluster, they are more likely to represent the same themes. Each cluster possesses a distinct quantity of subject keywords. The comprehensive information regarding the clusters presented in Figure 3 reveals that cluster 1 possesses the highest quantity of terms, suggesting that theme cluster 1 garnered more attention from researchers. Therefore, cluster 5 might be considered the most concentrated among the fields. To clarify, the keywords in cluster 5 have received increased focus in the domain of utilizing clinical decision support systems with electronic health records for reducing medication and prescribing purposes.

CLUSTER	NUMBER KEYWORDS
1	328
2	228
3	98
4	94
5	91
6	87
7	65

Figure 3. Clusters in VosViewer

Our findings indicate that higher complexity is not associated with poor performance in diagnosis accuracy. The proposed method may benefit from increased complexity without negatively affecting diagnosis accuracy. An analysis of the keywords utilized in the research revealed a total of 3818 keywords. When a term was repeated at least five times, 443 keywords were classified as such. As the number of repetitions grows, the number of keywords that may be classified inevitably decreases.

Figure 4 shows most countries where hold mostly research on using electronic medical records on medication errors and prescribing errors.

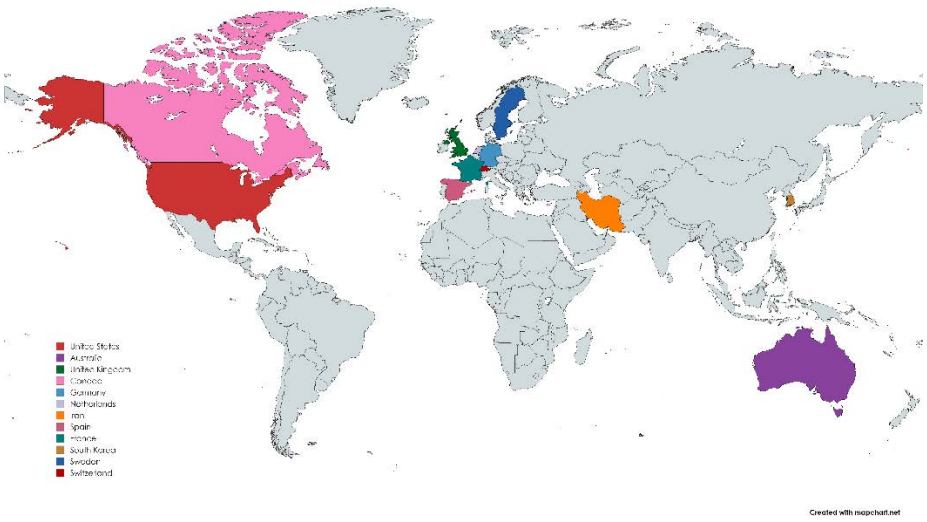

Figure 3. Most Countries that have Publications in clinical decision Support Systems and Electronic Health Records

Figure 5 indicates the published research on the role of electronic medical records in reducing medication errors especially prescribing errors.

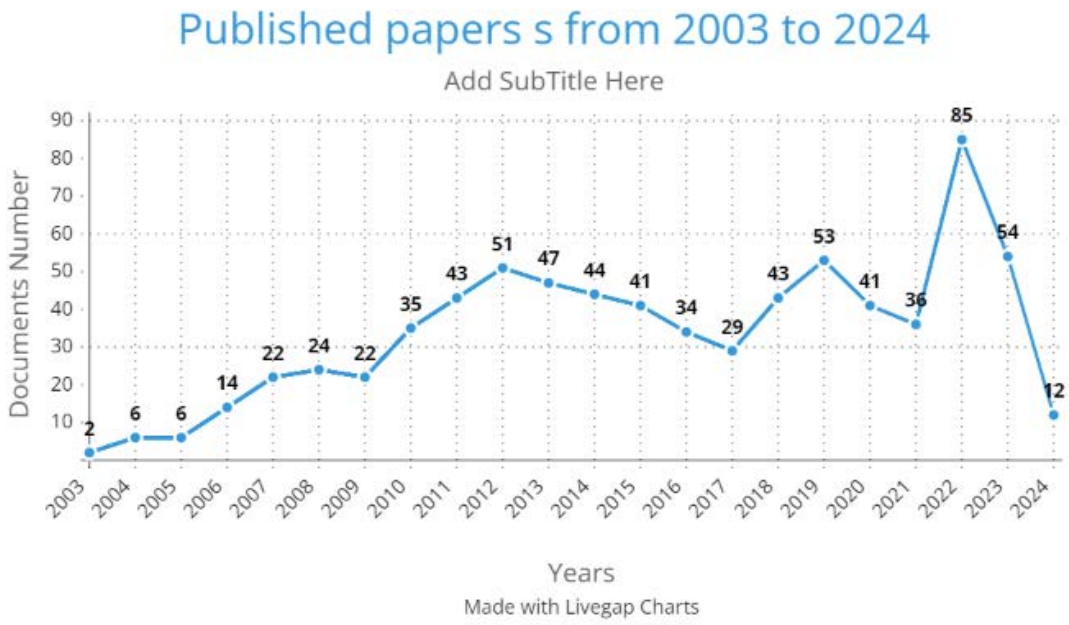

Figure 4. Published papers on clinical decision support systems and electronic health records from 2007 to 2024

Figure 6 shows that the most commonly used terms are "electronic medical records" (327 times), and "medication errors" (252 times). Because the research spans multiple domains, including medical, informatics, pharmacy, and engineering, this condition is mirrored in common word analysis. Figure 6 depicts a diverse range of study topics, disease and medicine names, and scientific procedures within these domains. Word groupings are represented by clusters of various color codes, such as green, yellow, red, and blue. The amount of times colors and words are used together, and the number of repetitions determines their association.

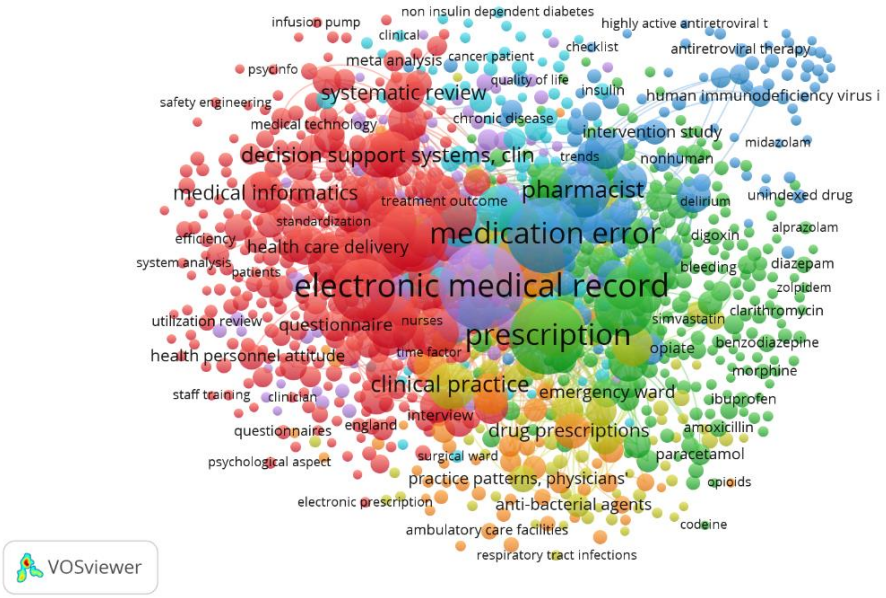

Figure 5. Visual Map of Common Words

In addition, VOSviewer offers an overlay visualization map that can be used to examine the adoption of keywords over several years to evaluate the progression of the study title. Based on the overlay visualization map shown in Figure 7, the yellow node suggests that the keyword is now something that researchers are interested in. The current research trends in electronic medical records, for instance, are centered on prescribing errors, and alert fatigue. Based on these terms, it is possible to predict that the early detection of prescribing errors can be influenced by alert fatigue and not to be indicated by healthcare providers. In addition, researchers are engaged in the process of ensuring that meaningful and important information may be quantified while simultaneously protecting the privacy and security of users and the system.

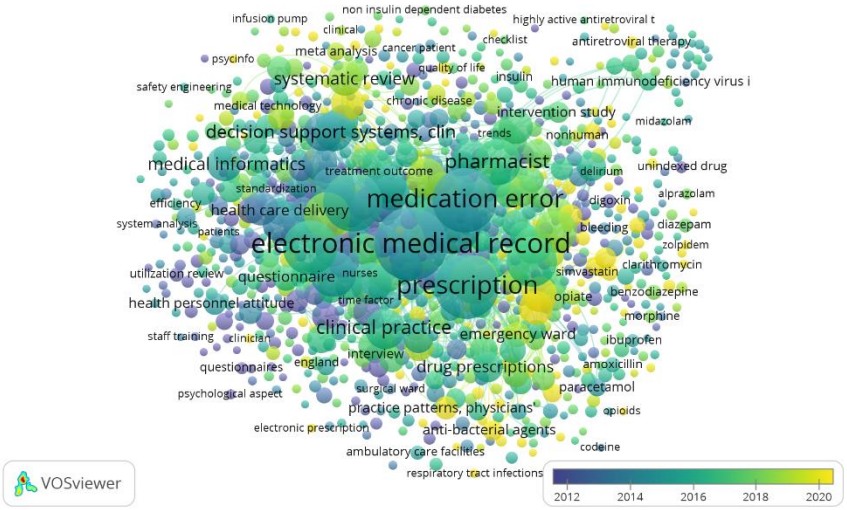

Figure 6. The overlay visualization map of the keywords by using VOSviewer software

To acquire further information regarding these phrases, we procured a graph that illustrates density visualization, as depicted in Figure 8. In the item density visualization, items are represented by their label, similar to the network visualization. Every location on a map is allocated a color according to the density of things found at that point. This hue is inherently a shade that is between the colors yellow and blue. As the quantity of objects in the area of a specific location grows and their magnitudes increase, the hue of the location shifts towards yellow. Conversely, if there are a smaller number of things around a point and those objects have lower weights, the color of the point will be more similar to blue. By examining the density picture, we can readily determine that electronic medical records, and medication error, have a high density representing these keywords and have a strong relationship with other keywords. The user's text is empty. It is a legitimate inference that a higher density of research indicates a greater level of maturity and development in the study of the issue. Nevertheless, we cannot disregard the fact that there are fewer terms in the yellow area, with the majority of keywords being located around the blue area. It is evident that there are fewer key research disciplines, and a significant number of these fields are still in their early stages of development.

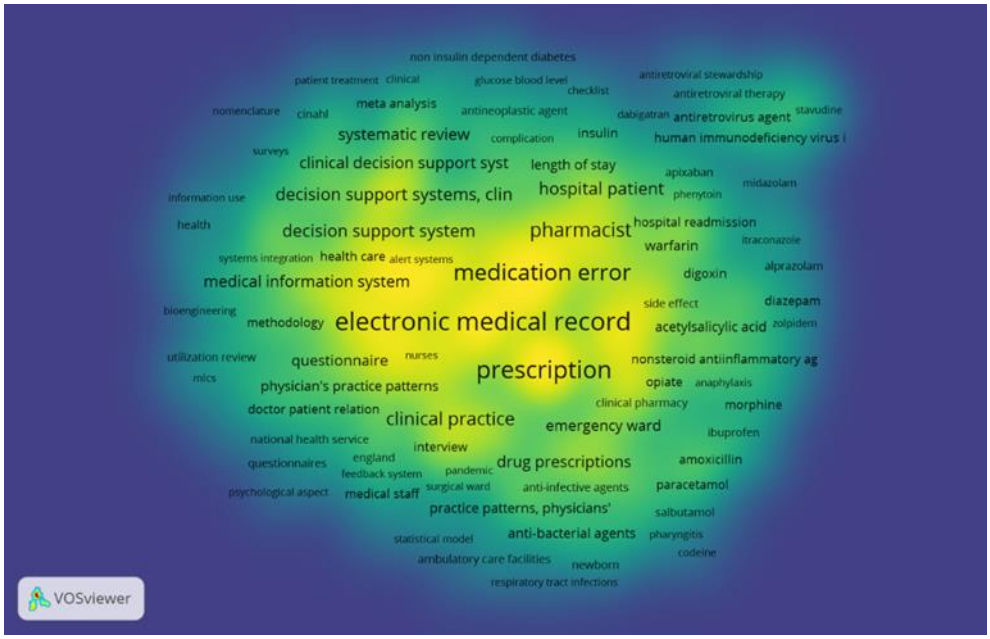

Figure 7. A density visualization map was performed with VOSviewer

Discussion

In Figure 4 it's obvious that the published articles on electronic medical records and their impact on medication errors all of them have well-established and robust economies. Upon examining the nations, the low ranking of emerging and underdeveloped countries in this list can be attributed to various difficulties faced by researchers, including limited proficiency in foreign languages, overwhelming academic workload, and inadequate support for project grants.

In Figure 5 it's obvious that the world's attention has increased from 2003 and gradually until 2024 and it's expected to increase in the next years 2022 is the most year has article published in this field.

In Figure 6 The visual map of common words related to the impact of electronic medical records (EMRs) on medication errors, particularly prescribing errors, offers valuable insights into the current research landscape.

Dominant themes: The most frequent words (large nodes) likely represent the core concepts explored in the research articles. Analyzing these words can reveal the primary focus of the research. For example, if "EMR," "alert," and "prescribing error" are prominent, it suggests a strong emphasis on the use of EMR alerts in identifying prescribing errors.

Interconnected concepts: The thicker lines connecting words highlight frequently co-occurring terms, indicating important relationships between concepts. Examining these connections can reveal key areas of discussion and potential research gaps. For instance, a thick line between "EMR" and "dose" suggests frequent exploration of how EMRs can be used to identify medication dosage errors, indicating a well-investigated area.

Emerging sub-themes: Clusters of interconnected nodes represent specific sub-themes within the research. Identifying these clusters and analyzing the associated words can reveal emerging areas of interest or potential under-researched aspects. For example, a cluster containing "adverse drug event," "pharmacist," and "communication" might suggest a growing focus on the role of pharmacists and communication in preventing adverse drug events related to EMR-identified prescribing errors.

In Figure 7 the overlay visualization provides a general overview of the research articles included in bibliometric analysis. While it highlights the focus on cancer research, clinical aspects, and the potential link between EMRs and medication errors, it lacks the specific details necessary for a more in-depth discussion.

In Figure 8 the density visualization indicates that there are many studies conducted on electronic medical records and their effect on medication errors and according to the presence of prescribing errors in a blue area in Figure 8, it indicates that there are few research on the impact of electronic medical records on finding prescribing errors and there's a need for further researches in this area.

This study investigated a comprehensive analysis of EMR data and the development of using this system to find medication errors. However, additional and in-depth research may be required to confirm its generalizability and applicability to find prescribing errors, particularly regarding potential biases in the data and variations in healthcare practices across different populations. Our research shows that the EMR is more resilient than traditional methods in identifying medication errors. Future research may look into further refining the model and developing practical tools for integrating it into clinical workflows, such as decision support systems for healthcare professionals to identify prescribing errors. Recent observations indicate that the increased availability of electronic health records (EHRs) has opened up new opportunities for utilizing data-driven approaches in healthcare. Our findings offer definitive proof that prescribing errors can significantly reduce and development of EMR, rather than solely relying on traditional methods that may be limited by human subjectivity and lack of comprehensive data analysis.

Ethical Considerations: Since public data and related literature were analyzed in our study, there was no ethical violation.

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

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