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E-Prescription: Opportunities and Challenges

Ahmad Mochtar Jamil[1], Ansarul Fahrudda[2], Mundakir Mundakir[3], Offia Melda Permata Hartamto[4], Sholihul Absor[5], Heru Suswojo[6], Muhammad Anas[7], Laila Rahmah[8]

[1,2,4,5,6)] Master of Hospital Administration Program, Faculty of Medicine, Universitas Muhammadiyah Surabaya, East Java, Indonesia
[3)] Department of Nursing, Faculty of Health, Universitas Muhammadiyah Surabaya, East Java, Indonesia
[7)] Department of Obstetrics and Gynecology, Faculty of Medicine, Universitas Muhammadiyah Surabaya, East Java, Indonesia
[8)] Department of Tele-health, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran

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Correspondence:
jachmad_elmi@yahoo.com

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Abstract

Background: The research explores the advancements and implications of e-prescribing systems within modern healthcare.

Objective: The primary objective is to assess the growing body of literature, examining global trends, effectiveness, and challenges associated with e-prescribing implementation.

Methods: Using a comprehensive literature review methodology, data were sourced from the Scopus database, revealing many publications from 1980 to 2024.

Results: A notable increase in scholarly interest was observed, particularly from 2015 to 2024, highlighting e-prescribing as a mature research subject. The results indicate a high concentration of research activity in advanced healthcare systems, contrasting with the limited contribution from developing contexts such as Indonesia.

Conclusion: The study identifies that while e-prescribing improves medication safety and efficiency, gaps in understanding its long-term impacts on patient outcomes persist. Additionally, disparities in technology adoption among demographic groups emerge as significant barriers. This research contributes to existing knowledge by underscoring the need for localized studies and international collaboration to enhance e-prescribing practices. Future research directions should focus on evaluating long-term outcomes, improving digital literacy, and assessing training impacts on healthcare professionals.

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INTRODUCTION

Electronic prescription (e-prescription) systems have transformed the healthcare landscape, enhancing pharmacy practices and improving patient safety and medication adherence[1]. E-prescribing is a critical component of healthcare digitization that contributes significantly to efficiency, accuracy, and quality of care. This technological advancement is significant as hospitals and clinics implement e-prescription technology to mitigate errors associated with handwritten prescriptions and improve patient access to medications. Studies indicate that e-prescribing can reduce medication errors and enhance health outcomes, reinforcing its importance across various health systems worldwide[2,3]. Furthermore, research has shown increased scholarly publications on e-prescription systems over the years, reflecting heightened academic interest in this domain, particularly in developed nations [3–5].

Countries such as the United States, the United Kingdom, and Canada exemplify the successful integration of e-prescription systems, resulting in improved efficiency and patient safety [3]. These countries have adopted advanced digital health solutions that streamline the prescribing process, minimizing the risks associated with traditional manual prescription methods. In contrast, nations with emerging healthcare systems, like Indonesia, face challenges in adopting such technologies, as indicated by the lack of scholarly literature in this field [3,4]. The barriers to implementing e-prescribing in Indonesia are complex, involving infrastructural issues and geographical challenges that hinder consistent technological uptake nationwide [3,6]. The existing literature emphasizes the need for comprehensive regulatory frameworks and targeted training to facilitate the introduction of e-prescribing technologies tailored to local conditions [7].

The core research problem focuses on the inadequacies and challenges in adopting e-prescriptions in various healthcare systems, especially in Indonesia, where the technology is underutilized. Insufficient standardized protocols and regulatory guidance have led to infrastructural barriers that impede effective implementation[7–10]. Proposed solutions in academic discourse recommend systemic reforms that include clear regulatory guidelines, enhanced training programs, and infrastructure improvements to promote the effective incorporation of e-prescribing systems. These solutions aim to address the foundational causes of inefficiencies while fostering an environment conducive to technological adoption, ultimately bettering healthcare delivery.

Research underscores the necessity for increased investment in training and education regarding e-prescribing among healthcare professionals. Literature suggests inadequate training is a significant factor contributing to resistance against adopting e-prescribing technologies[7,11]. Furthermore, developing interoperable systems that can easily integrate with electronic health records is essential to alleviate data fragmentation and improve cohesive patient care practices[12,13]. Targeted policy interventions to address these systemic challenges could create an environment where e-prescribing flourishes, enhancing healthcare delivery standards.

Despite the advancements and potential benefits of e-prescribing, several gaps in the

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literature require attention. A primary concern is the limited exploration of long-term outcomes associated with e-prescribing technology adoption[9]. Although numerous studies have identified prescription errors, there is a significant gap in comprehensive research assessing the long-term impacts on patient health outcomes and medication adherence[7,10]. Additionally, barriers to effective e-prescribing, including interoperability issues and healthcare professionals' perceptions, warrant further examination to promote meaningful integration into existing healthcare frameworks [7,12].

The objectives of this study are twofold: first, to explore the current landscape of e-prescribing adoption in Indonesia while identifying barriers that impede its widespread use; and second, to propose evidence-based interventions that could facilitate the effective implementation of e-prescription systems. This investigation aims to bridge the literature gaps by thoroughly analyzing qualitative and quantitative aspects influencing e-prescribing dynamics within underrepresented regions. By leveraging existing research, the study seeks to enhance understanding and stimulate discourse regarding advancing e-prescribing practices in contexts facing infrastructural challenges.

Ultimately, the relevance of this research extends beyond Indonesia, offering valuable insights applicable to various healthcare systems encountering the complexities of digital transformation. As global healthcare transitions towards more interconnected paradigms, understanding e-prescribing adoption intricacies and the necessary infrastructural enhancements will be crucial for shaping future healthcare strategies. By addressing identified gaps and advocating for comprehensive policy adjustments, this study aims to contribute significantly to enhancing the quality of healthcare delivery and ensuring patient-centered systems.

METHOD

Investigating electronic prescription (e-prescription) systems and their implications on healthcare practices requires a systematic approach to collecting, analyzing, and interpreting relevant literature and data. This study employs a comprehensive literature review methodology to aggregate insights and evidence from various research studies between 2015 and 2023. Such a period is selected to ensure the relevance and recency of the findings, aligning with the accelerated adoption of e-prescribing technologies across diverse healthcare contexts.

Literature Review Design

The methodology for this literature review is grounded in a structured and replicable approach. Data was gathered from the Scopus database, a leading resource for scientific publications. The specific search criteria included the keyword "e-prescription," filtered for studies published from 2015 to 2023. The subject area was limited to "medicine," the search was further refined by incorporating the keywords “human” to ensure the focus remains on relevant human health-related contexts. Furthermore, the results were restricted to English-language journals, allowing for a more straightforward comprehension and synthesis of the findings.

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The formula used for the search in the Scopus database was as follows:

TITLE-ABS-KEY (e AND prescription) AND PUBYEAR > 2014 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA, "MEDI")) AND (LIMIT-TO (EXACTKEYWORD, "Human")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j"))

This formula was designed to extract relevant literature directly addressing the nuances surrounding e-prescribing in clinical practice.

Data Acquisition and Selection Criteria

Following the execution of the search, the selected documents were exported in RIS format for further analysis. This method captures bibliographic data and facilitates subsequent organizational steps, making it feasible to utilize in co-authorship and co-occurrence analysis. Such analyses are essential for identifying trends, collaborations, and thematic clusters within the e-prescribing literature [14].

The selection criteria for the literature included empirical studies, observational analyses, and qualitative research that examined various aspects of e-prescribing. Studies focused on technological implementations, user experiences, and the impact of e-prescribing on patient outcomes were prioritized. Specific features like medication adherence, error rates, and patient and physician perspectives contributed to the relevance of selected studies. Disqualifying factors for exclusion included papers that failed to address e-prescribing specifically or were outside the designated review years.

Data Analysis Methods

The analysis of the selected literature was conducted using the VOSviewer software version 1.6.20, which specializes in bibliometric analysis, particularly co-authorship analysis, and keyword co-occurrence analysis. This study's analysis unit involves authors and keywords, allowing for a comprehensive visualization of research trends and patterns over time.

Through keyword co-occurrence analysis, central themes within the body of literature were identified, revealing how various topics converged within the discussions of e-prescribing. This tactic facilitates understanding which areas are heavily researched and highlights gaps where further investigation is necessary. For instance, literature suggests that previous studies have highlighted the effectiveness of e-prescribing in reducing medication errors, while more qualitative analyses need emphasis to understand user experiences and perceptions [2,15].

Qualitative and Quantitative Data Integration

Integrating qualitative insights and quantitative data is paramount in assessing the implications of e-prescribing technologies. Previous findings in the literature have emphasized that adopting electronic prescribing can significantly decrease illegibility-related errors, with some studies reporting around 90% in errors[12]. Such statistics underscore the need for a robust framework that combines numerical data with personal and clinical experiences documented in qualitative studies[15].

The literature review also allows for triangulation of findings, where diverse methods can inform one another. For example, studies regarding the impact of alert systems in e-prescribing demonstrated mixed results—

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some indicating a potential for "alert fatigue," which could undermine compliance among prescribers, highlighting the necessity for ongoing training and modification of alert thresholds [15,16]. Including qualitative overviews of clinician and patient experiences contextualizes such quantitative measures, revealing more profound insights into the operational dynamics of e-prescription implementations.

Identification of Research Gaps

While the literature surrounding e-prescribing is increasingly robust, notable gaps persist, particularly surrounding the long-term impacts on patient health outcomes. Many scholarly works focus extensively on the prevalence and rates of errors, but they often do so without correlating these findings with longitudinal patient outcomes[10]. Furthermore, literature exploring integrating e-prescribing within resource-limited settings has been largely insufficient. This study aims to document existing knowledge and emphasize these gaps, proposing future research avenues that could benefit from targeted explorations of e-prescribing implications on various population segments.

Ethical Considerations

The current methodology adheres to ethical standards by ensuring that all reviewed literature is publicly accessible and appropriately cited. No primary data collection involving human subjects was conducted in this review, thus minimizing ethical concerns related to human subjects research. Nonetheless, the implications of the findings directly affect health equity and access to quality healthcare services, highlighting the responsibility to relay these results accurately and ethically.

RESULTS

The results of this study present an overview of the landscape surrounding e-prescription research from 1980 to 2023. Over this period, 22,342 documents have been identified concerning e-prescription, denoting its evolution from niche technology to a more mainstream practice in health care, as evidenced by the significant rise in publications observed since the 1990s, as shown in Figure 1. This trend underscores an increasing scholarly interest in the ramifications and implications of electronic prescribing.

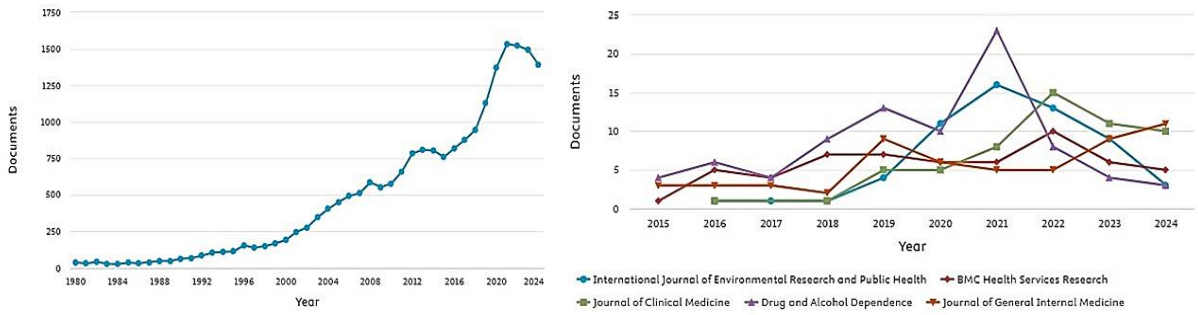

Figure 1. Number of publications and journal sources using the keyword "e-prescription".

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Historical Trends in E-Prescription Research

The growth trajectory of e-prescription literature has seen noteworthy peaks, with an evident surge in published research since 2015. Focusing specifically on documents generated between 2015 and 2023, the total count of relevant academic publications rose to 11,420, as shown in Figure 1. This indicates a robust interest in exploring the functionality, safety, and implementation challenges of e-prescribing systems in contemporary healthcare settings.

Filtering and Selection Process

Upon filtering for specific subject areas, further refinements yielded 8,298 documents under "medicine." Applying additional filters, such as the keyword "human" and restricting to English language journals, the dataset was narrowed down to 6,579 documents. Finally, selecting only those entries classified as journal articles resulted in 6,539 documents deemed suitable for analysis—a significant pool for any comprehensive literature review on this topic.

Co-Authorship Patterns

The analysis of co-authorship patterns utilizing VOSviewer software revealed that the most prolific contributors to e-prescription research were concentrated in specific nations. The United States led the list, followed by the United Kingdom and Canada, as shown in Figure 2a. This pattern highlights the prominence of research institutions in these countries and their contributions to the global discourse on e-prescribing.

Geographic Distribution of Publications

The affiliations contributing to e-prescription publications indicate that prestigious institutions such as Harvard Medical School and the University of Toronto were among the top contributors, as shown in Figure 2b. This emphasizes the critical role of leading academic centers in shaping the knowledge base that informs e-prescription practices.

Author Clusters and Collaborative Networks

A more granular examination of author collaborations revealed 188 authors divided into 12 distinct clusters through co-authorship analysis. The clusters varied, with the largest comprising 18 items, while others had as few as three items, as shown in Figure 2c. This co-authorship visualization emphasizes the collaborative nature of research in e-prescribing, with numerous clusters reflecting the expertise required from various disciplines—including pharmacology, health informatics, and general medicine—to address multifaceted challenges in implementing e-prescription systems.

Keyword Co-Occurrence Analysis

Utilizing keyword co-occurrence analysis enabled the identification of thematic trends within the e-prescription literature. From the analysis, 1,000 keywords were segmented into six main clusters, as shown in Figure 3a. Each cluster highlighted recurring themes in e-prescribing research, providing insight into prevalent issues, applications, and discussions. For instance, clusters often contained keywords such as "safety," "efficacy," "patient adherence," and "health information technology," signifying pivotal topics of discussion that researchers have prioritized over the years.

Publication Trends and Novel Insights

To illustrate the novelty and relevance of publications within the e-prescription domain,

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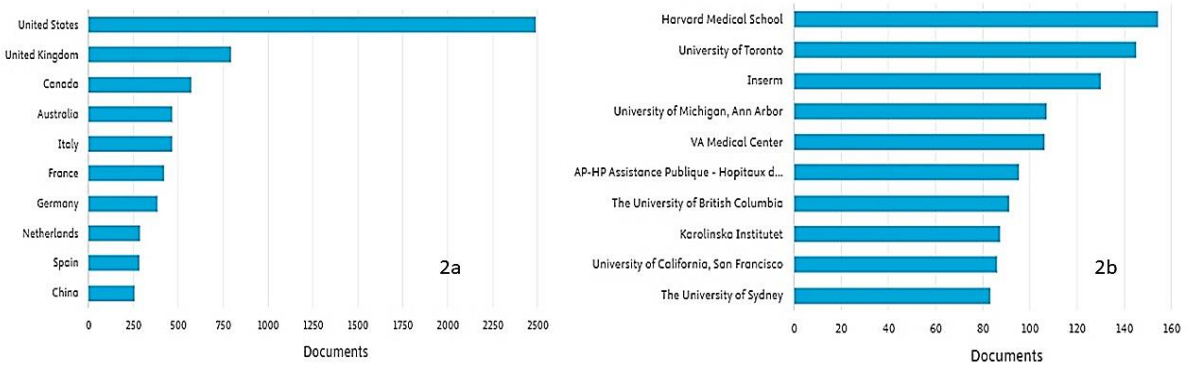

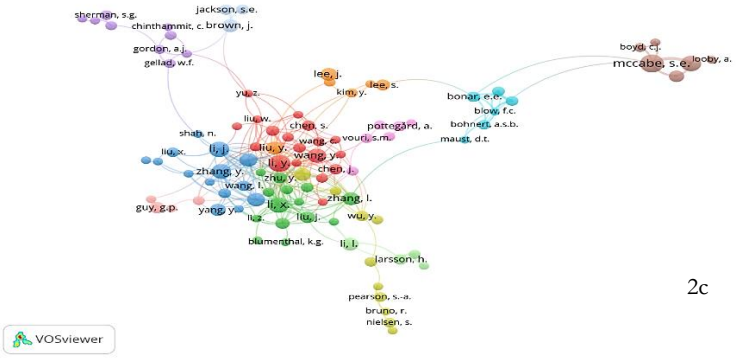

Figure 2a, 2b. Countries (US, UK, Canada, Australia, Italy, France, Germany, Netherlands, Spain, China) and Affiliations contributing documents in the last 10 years. **Figure 2c**. 12 cluster authors on network visualizations by keyword "e-prescription"

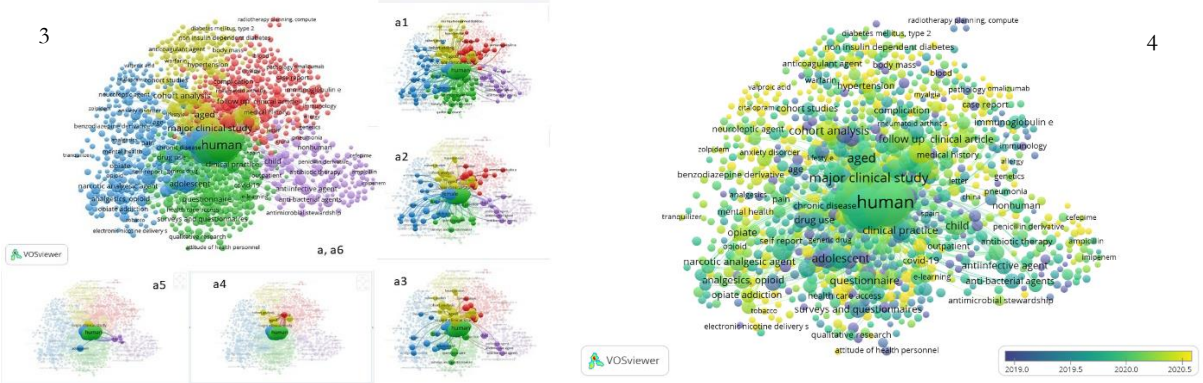

Figure 3. Network visualization 6 clusters by keyword "e-prescription;" 3a: 6 cluster, 3a1: cluster 1, 3a2: cluster 2, 3a3: cluster 3, 3a4: cluster 4, 3a5: cluster 5, and 3a6: cluster 6; **Figure 4**. Overlay visualization from 6 clusters by keyword "e-prescription".

an overlay visualization of the six clusters, with color gradations indicating publication timelines, elucidates how recent years have seen a higher frequency of newly published documents, signifying ongoing advancements in technology and research focus in the field.

Overview of E-Prescribing Implementation in Various Countries

Implementing e-prescription varies across countries, with healthcare professionals, including doctors, pharmacists, and nurses, utilizing e-prescribing to enhance safety through error reduction. In the United States, challenges include a lack of uniform clinical guidelines and integration difficulties. In the United Kingdom, general practitioners and specialists report mixed outcomes tied to the

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National Health Service's e-prescribing initiatives, with successes in enhancing medication safety alongside challenges related to variable service quality across health regions. Canadian studies indicate improved adherence to prescription guidelines through electronic applications, even as digital health service integration hurdles persist.

Barriers and Challenges to E-Prescription Implementation

Despite the positive impacts of e-prescribing systems, several barriers remain evident across different healthcare environments. Issues surrounding system interoperability and transitions from historical practices to digital solutions are recurrent themes in the literature. Insufficient training among professionals and a lack of familiarity with technology can significantly hinder the successful implementation of e-prescribing methods.

Additionally, the significance of user engagement and familiarity with systems has been highlighted in various analyses as critical to avoiding errors and improving outcomes. These patterns reflect broader issues of how educational gaps and system restructuring hinder optimal functionality and adoption rates.

DISCUSSION

The investigation surrounding e-prescription systems reveals a transformative trend in healthcare delivery, reflecting a significant paradigm shift supported by the increasing volume of published research. From 1980 to 2024, 22,342 documents were identified that utilized the keyword "e-prescription." Notably, a sharp rise in publications occurred in the 1990s, coinciding with the rapid adoption of information technology in healthcare settings, fundamentally altering how healthcare providers interact with their medication systems [15,17]. This surge underscores the growing scholarly interest in the subject. It highlights the critical role of e-prescribing in enhancing efficiency and reducing medication errors, which have become key focus areas in evaluating the technology's effectiveness [3,18]. The increased published studies, especially from 2015 to 2024, particularly during the last decade, illustrate that e-prescription has matured into a significant research domain within modern healthcare contexts [19].

The topic of e-prescribing continues to mature, as reflected in the diverse themes emerging from keyword visualizations. Recent literature addresses various aspects, including the efficacy of e-prescribing, its adoption rates, and the challenges faced during implementation across different healthcare systems. [19] emphasizes that e-prescribing is not a static topic but a dynamic field that evolves alongside changing healthcare challenges. This adaptation underscores the importance of continuous research on optimizing electronic prescribing practices to ensure patient safety and improve medication processes [15].

The primary contributors to e-prescription research have predominantly emerged from advanced healthcare systems such as the United States, the United Kingdom, and Canada, where healthcare institutions play a pivotal role in leading scientific discourse in this field[17]. This concentration reflects the availability of robust healthcare infrastructures and the research funding and collaborative efforts these countries can leverage[15]. However, there is a noteworthy absence of

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contributions from developing countries such as Indonesia, where the lack of digital infrastructure and health professional training limits e-prescribing research[3]. Notably, the absence of Indonesia from the top contributors list indicates that the country is still nascent in e-prescribing, primarily owing to its infrastructural challenges and limited access to healthcare resources[20]. Thus, enhancing research output and fostering international collaborations will be crucial for Indonesia to participate more actively in global e-prescribing research.

The safety and effectiveness of e-prescribing and critical aspects of its implementation demonstrate marked improvements, particularly in mitigating medication errors[18]. The electronic systems reduce the risks associated with illegible handwritten prescriptions and misunderstandings of medication instructions, enhancing overall prescribing quality[3]. While considerable literature supports these advantages, limitations remain in comprehensive evaluations of e-prescribing's long-term impacts on patient health outcomes. For instance, while studies by Cresswell et al.[19] highlight that adopting e-prescribing systems in hospitals has optimized the prescribing process, in-depth assessments linking these improvements directly to patient outcomes have been relatively sparse. In Indonesia, there is a severe lack of specific data concerning the safety and efficacy of e-prescribing, reflecting the urgent need for more localized research efforts focused on these critical metrics [21].

Disparities in technology adoption among various demographic groups pose additional layers of complexity. Research illustrates significant variances in digital health technology adoption, with younger users and healthcare professionals typically exhibiting greater familiarity with and access to e-prescribing technologies compared to older adults and less digitally literate groups [15]. Studies indicate that older adults often face significant challenges in accessing and utilizing digital health technologies due to low digital literacy and internet access constraints, particularly in remote areas[6,15]. Therefore, while the consensus underscores the benefits of e-prescribing systems, the uneven adoption rates across demographics necessitate targeted interventions to bridge these gaps and ensure equitable access to technological advancements in healthcare.

Furthermore, the role of healthcare professionals, including pharmacists and physicians, is paramount in facilitating the successful implementation of e-prescribing systems. However, significant challenges must be addressed; notably, professionals' lack of confidence and training in recommending digital services to patients often impedes the more widespread adoption of such technologies[7,22,23]. In Indonesia, where technological infrastructure is still developing, the challenges are compounded by limited access to professional training that would bolster healthcare providers' confidence in utilizing electronic prescription systems effectively[3,24]. Investment in comprehensive training programs for healthcare professionals and efforts to enhance their technical skills will be vital to implementing e-prescribing effectively and its associated benefits for patient outcomes.

Despite the advantages of e-prescribing, the literature points to various challenges that must be navigated for successful technology inte-

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gration. The inconsistencies in interoperability across different systems and poor integration with electronic health records often serve as critical bottlenecks, undermining the overall efficiency and effectiveness of e-prescribing solutions[25]. Beyond technical issues, psychological factors such as hesitation among patients and healthcare professionals to embrace digital systems further complicate this transition, often rooted in a lack of training or negative perceptions surrounding the technology's efficacy[3]. Addressing these critical implementation barriers necessitates a multifaceted approach that includes technological solutions and clinical training focused on the practical benefits of e-prescribing systems.

The landscape of e-prescription research continues to evolve, revealing opportunities to investigate the interplay between technology practices and patient outcomes. There are substantial research gaps, particularly in long-term effectiveness and user experience. While many studies have focused on process improvements and error reduction metrics, a lack of longitudinal data on patient health outcomes directly resulting from e-prescribing integration exists.

The need for enhanced qualitative studies encompassing patient and healthcare provider user experiences remains critical. Integrating quantitative metrics and qualitative insights is essential to fully understand e-prescribing technology's implications in real-world settings.

The results illustrate a marked growth in e-prescription research over several decades, signifying its importance to modern healthcare practices. This section has highlighted key contributions, prevailing issues, and research gaps in the e-prescribing landscape through extensive bibliometric analysis, collaborative networks, and thematic explorations. While significant advances have been made, further investigation into user experiences, long-term efficacy, and broader integration challenges is imperative for optimizing e-prescribing systems globally.

CONCLUSION

Research on e-prescription systems has grown significantly from 1980 to 2024, highlighting their increasing importance in healthcare. While nations like the United States, the United Kingdom, and Canada are leading the way in both research and implementation, lower-income countries such as Indonesia are lagging behind. This disparity is primarily due to limited digital infrastructure and a lack of proper training for healthcare professionals. The study highlights the need for international collaboration to address these inequalities.

E-prescribing systems can improve medication safety by reducing errors caused by illegible handwriting. Despite these benefits, there is a notable research gap concerning their long-term effects on patient health, especially in non-Western countries. The study also identifies challenges in the adoption of these systems, noting that disparities in digital literacy disproportionately affect older and less-educated individuals. To ensure these advancements benefit everyone, future research must focus on assessing long-term outcomes and improving the digital literacy of vulnerable populations.

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