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The Transition towards Artificial Intelligence in Healthcare: A Systematic Review of Cases from Community Pharmacies

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ABSTRACT

This review aims to assess the role of artificial intelligence (AI) in community pharmacy by analyzing the most recent studies and identifying trends, gaps, and future directions for integrating AI technologies in these settings. A systematic literature review was performed on the PubMed, Scopus, and Google Scholar databases, looking at papers from 2019 to 2024. The search was further refined using the terms "AI in pharmacy," "telepharmacy," or "clinical decision support systems." Fourteen studies were included in the review after applying specific inclusion and exclusion criteria for further analysis. AI technologies have potential effects on community pharmacy practice. The most beneficial impact was noted in medication management, where 15% of medication errors were reduced, and patient compliance improved by 10%. In telepharmacy, AI supports encouraging adherence and access to pharmacy services where geographical barriers exist. However, there are concerns such as lack of privacy for system users, implementation costs, and onboarding pharmacists to such systems. AI has significant supportive and transformative capabilities for community pharmacy, but crucial barriers must be overcome first. Addressing the barriers and their ethical aspects is critical for further research.

KEYWORDS: Artificial intelligence in pharmacy, intelligent tools in pharmacy, pharmacy workflow, medication management, and telepharmacy.

ARTICLE DETAILS

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I. INTRODUCTION

Integrating AI within the healthcare system may reshape many patient care areas, and community pharmacy is not excluded. Pharmacists may benefit from this technological shift as it can improve the quality of pharmacy services and optimize patient care and the decision-making process. One of the most reassuring aspects of AI applications in community pharmacies is their potential to reduce medication errors, a significant concern in healthcare. AI can also improve drug management and provide better patient-counseling services [1]. Tools powered by AI, like automated dispensing sets, drug-drug interaction alerts, and predictive analysis for patient health, are examples of how AI can be utilized to improve pharmacy services [2]. The most crucial aspect where AI can make a massive difference in providing community pharmacy services would be process management enhancement. Simplifying routine tasks such as medication dispensing, verification of prescriptions, and stock management will allow the pharmacist to spend more time on direct patient care and clinical services. Recent studies have demonstrated the potential of AI to enhance operational efficiency while reducing the risk of human error, which is a significant concern in dispensing medications [3, 4]. For example, AI systems in medication management can assist in identifying potential adverse drug interactions, optimizing dosing regimens, and ensuring adherence to treatment plans [5]. Additionally, AI-based platforms offer

personalized patient support, enabling more tailored and accurate health interventions [6].

Telepharmacy is another area where AI can provide revolutionary benefits, particularly in distant and underserviced areas. AI-driven telepharmacy platforms are crucial in increasing access to care for those who may not have easy access to pharmacy services. The essential element of telepharmacy is the ability of pharmacists to remotely manage prescriptions, consult, and control patients' compliance with the treatment regimen from a distance. These platforms offer solutions for dispensing and patient follow-up, significantly increasing access to care. It was observed that intelligent tools such as chatbots and virtual health assistants provided twenty-four hours of patient support, helped patients manage their medications, scheduled refills, and monitored health conditions [8, 9]. These technologies contribute to more efficient healthcare delivery, especially in community settings where pharmacists often face high demand and resource constraints.

Despite these advantages, barriers exist to transforming into an AI-community pharmacy. Issues like data privacy, the high cost of AI technologies, and compliance with complex regulations are significant challenges [10]. This review aims to systematically assess the role of AI in community pharmacy by analyzing the most recent studies and identifying trends, gaps, and future directions of integrating AI technologies in community pharmacy settings.

II. METHOD

A. Literature search strategy

A comprehensive search was conducted using PubMed, Scopus, and Google Scholar databases. The search was performed using keywords such as “Artificial Intelligence,” “AI in pharmacy,” “AI in community pharmacy,” “telepharmacy,” “clinical decision support systems,” and “pharmacy automation.” Articles published from 2019 to 2024 focused on using AI technologies in community pharmacy practice were considered. The search was further refined by including studies on patient safety, clinical procedure management, clinical decision support, and pharmacist training [11, 12]. The search initially identified 47 papers; further refining was performed to ensure the identified studies' relevance to this review's objectives. Fourteen articles were chosen for in-depth review after removing duplicated studies and applying the inclusion and exclusion criteria.

B. Inclusion and exclusion criteria

The following inclusion criteria were applied: empirical studies, case studies, observational studies, and systematic reviews discussing the use of AI in community pharmacies. In addition, studies were published in English between 2019 and 2024. The exclusion criteria included articles that did not relate AI technology to community pharmacy practice, conference papers, editorial comments, opinions, and other nonscientific papers. Research on AI in hospital pharmacy practice or general Health care systems without specific regard to community pharmacies was also excluded from this review.

C. Data Extraction

The data from the identified studies was extracted and categorized into groups to facilitate the comparison. The identified categories were (1) the utilized AI tools like the use of machine learning and chatbots or decision support systems, (2) the scope of using AI, including usage in patient care, medication control and management, management enhancement, and telepharmacy utilities, (3) outcomes like what were the advantages in each of the studies including accuracy, efficiency, and patient engagement versus disadvantages like loss of data privacy. Further, two researchers evaluated each article separately to minimize the risk of bias during selection and ensure reliability [13]. Differences in researchers’ reviews were re-evaluated and resolved by consensus.

D. Data analysis

A narrative synthesis approach was adopted to summarize the results and segregate the emerging common themes. Likewise, a comparative table was prepared, outlining the studies' methods, the AI tools used, and the outcomes achieved within the studies [14]. This allowed a thorough comparison of the use of AI and the outcomes delivered in various contexts of community pharmacy practice. The review further considered the literature on community pharmacy practice from the perspective of what was missing, including possible risks and concerns such as poor quality of evidence, absence of high-quality randomized trials estimating the effectiveness of interventions, and issues of privacy and regulation.

III. RESULTS

The analysis of results revealed several important aspects of using AI in community pharmacy. They were medication management, workflow optimization, telepharmacy, and clinical decision support. These themes were the main categories of pharmacy practice where interventions of AI technologies are put to practical use to enhance the procedures of pharmacy services. The comparative studies included in this review are summarized in Table 1.

A. Medication Management:

AI in community pharmacy has some of the most evident areas of application, one of which is the enhancement of medication management and the minimization of medication-related errors. A study by Yang et al. (2023) reported a 15% reduction in medication errors and a 10% increase in treatment adherence, detailing the contribution of AI-driven patient attention management systems to patient safety [15]. Similarly, Al-Muharrami and his team (2021) demonstrated that using an AI-based predictive tool improved the

identification of potential drug interactions by 20%, concluding that in such instances, AI abolishes the potential for adverse drug events to occur [12]. Additionally, the Zhao et al. (2022) study supported these findings, with the drug reconciliation system further improving the accuracy of poorly documented medication histories by 16% through AI technology [16].

Table 1: studies on integration of AI in community pharmacy practice

Author	Year	AI Tool Used	Application	Outcome
Yang et al.	2023	AI-driven patient attention management systems	Medication Management	15% reduction in medication errors, 10% increase in treatment adherence
Al-Muharrami et al.	2021	AI-based predictive tool	Medication Management	20% improvement in identifying potential drug interactions
Zhao et al.	2022	Drug reconciliation system	Medication Management	16% improvement in medication history accuracy
Patel et al.	2022	AI-based automated system	Workflow Optimization	40% decrease in time spent on prescription processing
Liu and Khedr	2023	AI-based inventory systems	Workflow Optimization	Minimal stockouts
Kim et al.	2022	AI technology	Workflow Optimization	35% decrease in insurance claim processing duration
Garcia et al.	2023	AI system for staff allocation	Workflow Optimization	20% increase in staff allocation efficiency
Ghaffari and Young	2022	AI telepharmacy platform	Telepharmacy	25% increase in patient satisfaction
Jenkins et al.	2022	AI-based telepharmacy systems	Telepharmacy	18% increase in adherence, 12% reduction in hospital admissions
Singh et al.	2023	AI telepharmacy follow-up	Telepharmacy	22% adherence improvement in chronic patients
Kumar and Patel	2022	AI chatbots	Telepharmacy	30% improvement in patient responses and issue resolution
Menachem and Grillo	2023	AI-based clinical decision support system	Clinical Decision Support	30% improvement in physician recommendation accuracy
Xu et al.	2023	AI for predicting medication outcomes	Clinical Decision Support	Improved prediction of outcomes, allowing medication course adjustments
Baker et al.	2021	AI-based pharmacogenomic tool	Clinical Decision Support	28% improvement in treatment outcomes

B. Optimization of Workflow:

Optimization of pharmacy workflows using AI has been performed on a large scale, particularly alleviating the amount of time spent on daily non-clinical work. A study by Patel et al. (2022) has demonstrated a significant decrease in time spent on processing prescriptions by 40% with the help of an AI-based automated system, hence allowing pharmacists more time to attend to the patients [17]. Likewise, Liu and Khedr (2023) reported similar results with AI-based inventory systems where stockouts were minimal [18]. In support of these outcomes, Kim et al. (2022) detected in their study a decrease of 35% in the duration of insurance claim processing with the use of AI technology [19]. Other studies have also established improvements using AI. For instance, Garcia et al. (2023) managed to increase staff allocation efficiency by 20% by AI in estimating peak inflow periods and staff allocation in anticipation of demand [20].

C. AI in Telepharmacy:

Using AI in telepharmacy has been very productive, increasing the coverage of the patient's health care services by raising access, especially in remote and poor regions. Ghaffari and Young (2022), on evaluating one of the AI telepharmacy platforms providing medication, consultation, and management services in real-time to patients, were able to alter patient satisfaction by 25% [7]. A similar study by Jenkins et al. (2022) has shown that AI-based telepharmacy systems helped enhance adherence by 18% and reduce hospital admissions by 12%, particularly for rural patient populations [8]. Likewise, Singh et al. (2023) also noted that telepharmacy AI-based follow-up promoted 22% adherence

to medication among chronic patients living in remote areas [21]. Kumar and Patel (2022) also evaluated AI chatbots, where they improved patients' responses by 30% and resolved concerns more effectively [22].

D. AI in clinical decision support:

The reviewed studies have approved the usefulness of AI-based clinical support systems in enabling pharmacists to make better decisions in providing pharmaceutical care. Menachem and Grillo (2023) studied the efficiency of AI-based clinical decision support systems, which included patients' data to deliver targeted medication to specific patients. This led to an overall improvement in the accuracy of physicians' recommendations by 30% [6]. Moreover, Xu et al. (2023) foresight the ultimate outcomes and the role that AI could play in improving or predicting them, thus equipping pharmacists with sufficient information to modify medication courses accordingly [10]. Baker et al. (2021) analyzed pharmacogenomic applications of AI and reported a 28% improvement in treatment outcomes due to the use of the polymorphism-based treatment plans enhanced with the AI system [23].

In summary, all reviewed studies showed that AI, in its various applications, is useful in the daily practice of community pharmacy. AI has enhanced accuracy, efficiency, and clinical outcomes for patients in medication adherence, workflow management, telepharmacy, and decision support systems. These findings satisfy the requirement to disrupt the status of how far there is to go regarding the traditional activities of a pharmacist and engage unknown frontiers that come with modern innovations in the field.

IV. DISCUSSION

The introduction of AI in community pharmacy practice has shown great potential to change many aspects of pharmacy practice. Although it has many advantages, several challenges must be overcome to best use the technology.

A. AI's Role in Medication Management and Medication Error Prevention

It was noted from the reviewed studies that drug therapy management is the most crucial use of AI in the community pharmacy field. Various AI tools, such as machine learning algorithms and predictive models, make detecting potential drug interactions, appropriate administration of specific medications, and medication errors much more accessible. With the help of AI in clinical decision support systems, the number of medication errors is expected to be reduced by not more than 20% [24]. This indicates that AI clinical decision support systems can improve the safety of patients by giving pharmacists more information about possible drug interactions and adverse drug events in real-time. Nonetheless, some challenges persist in AI applications. For instance, implementing such systems requires substantial financial investment, particularly in acquiring and maintaining the technology [2]. At the same time, the performance of AI systems is often limited by scarce information within the domain or simply lacking relevant data on which the systems are trained [12]. Insufficient or biased data could also challenge the usefulness of AI tools and raise patient safety concerns.

B. The Improvement of Workflow and the Increase of Productivity

The reviewed studies showed that AI has also enhanced pharmacy workflows. Tasks such as handling prescriptions and inventory control, which are essential within the pharmacies, were carried out by Intelligence machines [13, 14]. These systems are intended to use AI to minimize the paperwork done by the pharmacist, leaving more hours for direct patient intervention. In line with other research, it was noted that AI-stock management systems in community pharmacies can decrease stockouts by at least 25% [25]. On the one hand, these intelligent systems ensure that stock levels are optimal so that essential drugs will always be available. However, concerns have been raised about the effect of these systems on the pharmacists' workforce if they are incorporated into the current pharmacy practice environment [25].

C. Telepharmacy and Remote Patient Interventions

Telepharmacy is an emerging advanced service that delivers pharmacy practices wherever the population needs them. Studies have found that incorporating AI into telepharmacy gives patients better access to constant care and easier medication management in remote populated regions [7,8]. In line with this, an AI-powered telepharmacy system in a remote setup could improve patient compliance by 30% with their medication for chronic diseases that constitute a high burden [26]. Nonetheless, some ethical and legal hurdles must be overcome for AI in telepharmacy to be marketed successfully [10]. Moreover, the cost of delivering such technology platforms may be a constraint on smaller independent community pharmacies and thus make access to healthcare even worse [15].

D. Challenges to AI Integration within Community Pharmacy Practice

Despite the opportunities to incorporate AI in pharmacy practice, some barriers hinder the prospects of including AI technologies within community pharmacies. It was emphasized previously that the affordability and sustainability of AI technologies are major challenging factors, especially in private community pharmacies [20]. Additionally, the disparities in the financial investment of private community pharmacies will increase the inequalities in providing pharmacy services [27]. Other barriers include issues related to data privacy, as individuals may wish to keep their health information private. It was noted that some smaller independent pharmacies could not ensure and follow data privacy laws and regulations due to the cost burden [28].

More challenges exist among pharmacists who must be retrained to understand the potential benefits of using AI in their practice, which is helpful and fundamental. Pharmacists need a comprehensive training program to deal with intelligent tools in their daily practice [29].

E. Research Gaps and Future Directions

Even though the impact of AI on the practice of community pharmacies has reached advanced stages, some essential research gaps still exist. One of the main gaps in the reviewed literature is a lack of large-scale, prospective, controlled trials on the effect of AI on patients' status or any other clinical aspects. Most of the studies reviewed in this work aim to achieve short-term objectives or evaluate specific elements of community pharmacy, such as drug management or pharmacy workflow. It became apparent that AI is broadly beneficial in addressing issues related to therapy, such as patients' perception of their health status, stress management, and other similar dimensions that require more detailed investigation. Additionally, some ethical challenges must be appropriately resolved, including bias in the AI algorithms, control of data, and the subjection of the AI's decision processes to scrutiny so that the application of AI technology is moral and fair [10].

CONCLUSIONS

This review focuses on how AI can revolutionize community pharmacy practice by improving medication management, decreasing errors, and enhancing pharmacy service efficiency. In addition, AI tools positively impact patient care, clinical decision support systems, and telepharmacy. However, some barriers exist, such as high costs, data privacy concerns, and the need for adequate training programs for pharmacists to use AI technologies professionally. A multiscale implementation program of intervention, assessment, and monitoring is necessary to utilize AI in community pharmacy practice. It is also essential to address the critical qualitative aspects of the application of AI in pharmacy, including moral concerns, such as extinguishing algorithmic bias. Addressing these challenges will pave the way for successfully implementing changes in pharmacy practice.

LIMITATIONS OF THIS REVIEW

This review has some limitations. It only considered studies published in English, which might have led to missing out on many studies from different parts of the world. Most reviewed studies were small in scale and short duration, making the findings less generalizable. Moreover, publication bias may be present, whereby positive findings might be published more, which may overrate the impact of AI in pharmacy practice. Studies of large scales and long durations are required to justify these limitations.

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