The Role of AI-Based Clinical Decision Support Systems (AI-CDSS) In Modern Pharmacy Practice

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ABSTRACT

Artificial intelligence-based clinical decision support systems (AI-CDSS) are emerging tools leveraging machine learning and healthcare data to aid pharmacists in managing clinical complexity. They offer real-time insights for identifying high-risk prescriptions, preventing drug interactions, and aiming to improve patient outcomes. While the strength of AI-CDSS lies in data-driven support, human-centered design focusing on trust and usability is crucial for adoption. Applications of AI-CDSS extend to patient care (e.g., disease prediction, medication adherence) and pharmacy practice, including prioritizing prescription reviews (e.g., Lumio Medication) and early detection of cognitive impairment. Although AI-CDSS shows potential in optimizing pharmacy workflows and identifying drug-related issues, direct evidence of improved patient outcomes within the pharmacy remains limited. Implementation faces challenges like technical constraints and workflow misalignment. This paper synthesizes current research, highlighting the potential of AI-CDSS to transform pharmacy practice while acknowledging the need for further investigation into their impact on patient outcomes and the practical barriers to their widespread use.

Keywords: Clinical decision support systems, Artificial intelligence, Medication safety, Drug interactions, Machine learning.

INTRODUCTION

Today's pharmacists are central to patient safety, but managing increasing clinical complexity is no small feat. That's where artificial intelligence-based clinical decision support systems (AI-CDSS) come in. These tools combine machine learning with healthcare data to support pharmacists in identifying high-risk prescriptions, preventing drug interactions, and improving patient outcomes. The strength of AI-CDSS lies in their ability to deliver real-time, data-driven insights—empowering pharmacists to act faster and more confidently. However, their success depends on more than just algorithms. A human-centered approach, emphasizing trust, explainability, and ease of use, is crucial for adoption in real-world settings (1). Recent advancements in medical sciences focusing on machine learning-based AI models, like AI-CDSS, help pharmacists prioritize interventions by predicting which prescriptions may require attention. These tools are changing the way pharmacy works—quietly but significantly.

Basic Concept Of Ai Based Cdss

Clinical decision support systems (CDSS) are becoming empowered by artificial intelligence (AI) technology, which offers patient-specific recommendations to enhance clinical work. It is essential to consolidate the information and experiences presented in previous work and provide insight for future work, given the increasing interest in human-centered design and evaluation of such tools (1). It is widely acknowledged that human variables (such as explainability, privacy, and justice) as well as the social and organizational aspects of medical practice play an equally significant role in deciding the success of AI-CDSS implementation, even in spite of the technological improvement that has actually boosted AI-CDSS (2). AI-empowered CDSS interventions (AI-CDSS) are anticipated to have a significant impact on the patient-provider relationship and transform clinical decision-making (3).

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Application Of Ai-Cdss In Patient Care

Diabetes prediction using machine learning (ML)-CDSS and a comparison between traditional ML and deep learning (DL) techniques. The results of their research indicated that random forest outperformed support vector machines (SVM) and convolutional neural networks (CNN) (4). According to a study that used an ML model to forecast tooth loss, models that take into account extra socioeconomic factors outperform those that only use routine dental care records (5). AI was used in mental health care by Rosenfeld A. et al. AI monitors patients and analyzes their daily data to determine whether they are in excellent mental health (6). In a different trial, they put a microelectronic sensor on a pill bottle's cap to track patients' adherence to their prescription regimen. The physician verified whether the patient's medication adherence was less than 50% after the sensor recorded and transmitted the timestamps of opening the bottle. According to the experimental findings, the system was successful in keeping track of patients' medication compliance (7). A Convolutional Neural Network (CNN) model was created in one study to detect tuberculosis infection from X-ray pictures. They evaluated the suggested model using a data set of 4701 X-ray pictures, 453 of which were normal and 4249 of which were aberrant. The accuracy of the model they obtained was 85.68%. (8). Another study used a CNN model to classify chest X-ray images, but instead of detecting only tuberculosis, it also found pleural thickening, otosclerosis, and pulmonary interstitial hyperplasia. Over 16,000 annotated X-ray pictures were needed to train this multi-classification model, which produced an accuracy of 82.2% (9). Data from low- and mid-income countries are being used for AI research, according to a study that reviewed AI health applications in various nations. To diagnose strokes and provide treatment plans, an expert system with a neural network model and production rules was suggested (10).

Application Of Ai-Cdss In Pharmacy Practice

Corny et al. compare the model performance metrics of likelihood scoring of prescriptions requiring pharmacist intervention with two pre-existing prioritization methods (medication order and patient-related). Lumio Medication is a hybrid AI CDSS designed for use in healthcare environments that combines machine learning with rule-based expertise. Prioritizing prescription checks based on the likelihood that a prescription would require PI was the technology's goal. The technology's goal was to help clinical pharmacists anticipate or identify drug-related issues, which would enhance patient safety and clinical results (11). According to a study, hospital pharmacists use the Lumio Medication hybrid technology to calculate the likelihood that a prescription may require PI. By classifying high- and low-risk medicines, the goal is to better prioritize workflow and enhance patient outcomes (12). Prescriber behavior, data from electronic health records, and pharmacy orders are all integrated into a machine learning categorization model. Hospital pharmacists are expected to use this technology to identify and categorize prescription orders that need PI. Without endangering patient privacy or data security, the goal was to continue improving patient health outcomes through PI while lessening the workload of the pharmacists responsible for their care (13). Community pharmacists can more effectively screen for people with early signs of MCI by using another ML data-driven model that used risk factor data from the literature. This enables the pharmacist to refer patients who may have early-stage MCI to the right medical services for diagnosis (14).

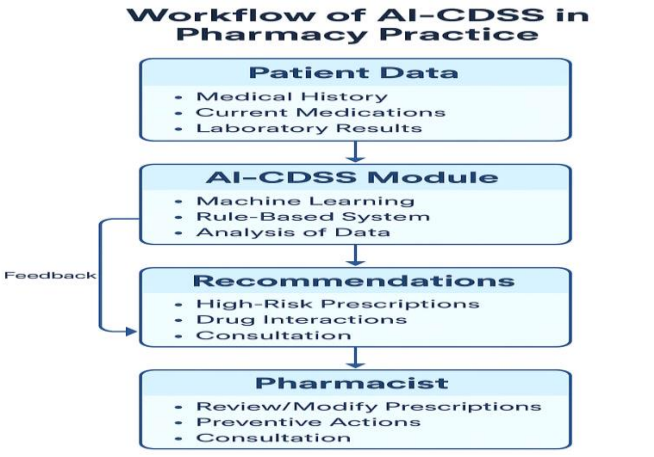

Fig:1 Workflow of Al-CDSS in Pharmacy Practice

Impact Of Ai-Cdss In Healthcare Outcomes

AI-CDSS can improve health care delivery in a number of ways. These include applications for population health management (e.g., public health surveillance or predictive epidemiological modelling), diagnostic (e.g., early cancer diagnosis, diabetes retinopathy screening, or COVID-19 diagnosis based on computed tomography images), therapeutic (e.g., precision medicine in chemotherapy and for combination drug therapy), and regulatory or administrative (e.g., coding of records or economic evaluations) (15,16, 17). There is little data to back up their use of AI in pharmacy practice, despite the encouraging results seen. In both hospital and community pharmacy settings, artificial intelligence (AI) has a proven role in helping pharmacists prioritize their tasks and manage their workload. Nevertheless, benefits in patient outcomes have not yet been directly demonstrated by AI applications in the pharmaceutical area (18).

Challenges And Limitations

Technical constraints, workflow misalignment, attitudinal hurdles, informational barriers, usability issues, and environmental barriers are some of the difficulties in implementing and utilizing AI-CDSS in clinical settings (1). Medical professionals would be worried about the repercussions for patients in the event of technical difficulties if the system generated an incorrect prediction. These would include the extra work of following up on a referral, the expense of managing an incorrect diagnosis, and the psychological stress that a false positive or other incorrect prediction could cause (19). Due to attitudinal hurdles, clinicians may be reluctant to embrace or use AI-CDSS because they do not trust or comprehend its potential (20). The acceptance and development of trust in AI-CDSS may also be hampered by a discrepancy between the information needs of physicians and the outputs of the system (21). Clinicians find it difficult to understand how to use AI in CDSS, and it takes up valuable time. The onboarding procedure and the absence of comprehensive training made these problems worse (22).

CONCLUSION

Artificial intelligence-based clinical decision support systems (AI-CDSS) are emerging tools leveraging machine learning and healthcare data to aid pharmacists in managing clinical complexity. They offer real-time insights for identifying high-risk prescriptions, preventing drug interactions, and aiming to improve patient outcomes. While the strength of AI-CDSS lies in data-driven support, human-centered design focusing on trust and usability is crucial for adoption. Applications of AI-CDSS extend to patient care (e.g., disease prediction, medication adherence) and pharmacy practice, including prioritizing prescription reviews (e.g., Lumio Medication) and early detection of cognitive impairment. Although AI-CDSS shows potential in optimizing pharmacy workflows and identifying drug-related issues, direct evidence of improved patient outcomes within pharmacy remains limited. Implementation faces challenges like technical constraints and workflow misalignment. This research synthesizes current research, highlighting the potential of AI-CDSS to transform pharmacy practice while acknowledging the need for further investigation into their impact on patient outcomes and the practical barriers to their widespread use.

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