INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Review Article

Artificial Intelligence in Clinical Pharmacy: Current Applications, Challenges, and Future Perspectives – A Narrative Literature Review

Dr. Keerthika R*

Department of Pharmacy Practice, Thanthai Roever College of Pharmacy, Perambalur-621212

ARTICLE INFO

Published: 20 Aug 2026

Keywords:

Artificial intelligence; clinical pharmacy; machine learning; generative AI; ChatGPT; medication safety; pharmacovigilance; clinical decision support; personalized medicine; pharmacy practice.

DOI:

10.5281/zenodo.22030982

ABSTRACT

Background Artificial intelligence (AI) is rapidly transforming healthcare by enabling the analysis of large and complex datasets and supporting clinical decision-making. Clinical pharmacy is an emerging area in which AI can assist with medication management, medication safety, pharmacovigilance, clinical decision support, personalized pharmacotherapy, and patient care. Objective This narrative literature review aims to describe the current applications of AI in clinical pharmacy, evaluate its potential benefits and limitations, and discuss future perspectives and research priorities for its responsible integration into clinical pharmacy practice. Literature Search A literature search was conducted using PubMed/MEDLINE, Scopus, and Embase to identify relevant literature on AI and clinical pharmacy. The search included publications primarily from January 2020 to August 2026, with additional earlier seminal publications included when relevant. Search terms included "Artificial Intelligence," "Machine Learning," "Deep Learning," "Natural Language Processing," "Generative Artificial Intelligence," "ChatGPT," "Large Language Models," "Clinical Pharmacy," "Pharmacy Practice," "Medication Safety," "Clinical Decision Support," "Pharmacovigilance," "Adverse Drug Reactions," "Drug–Drug Interactions," "Personalized Medicine," and related terms. Results Current evidence indicates that AI has potential applications across multiple areas of clinical pharmacy, including medication safety, clinical decision support, pharmacovigilance, adverse drug reaction detection, drug–drug interaction prediction, medication therapy management, personalized medicine, medication adherence, antimicrobial stewardship, drug information, patient counselling, and pharmacy education. Generative AI and large language models have introduced additional opportunities for clinical documentation, information retrieval, education, and medication-related communication. However, concerns remain regarding data quality, accuracy, algorithmic bias, explainability, privacy, cybersecurity, ethical and legal responsibility, regulatory requirements, workflow integration, and pharmacist competency. Conclusion AI has considerable.

***Corresponding Author:** Dr. Keerthika R

Address: *Department of Pharmacy Practice, Thanthai Roever College of Pharmacy, Perambalur-621212*

Email : keeki2126@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

potential to augment the role of clinical pharmacists and improve the efficiency, safety, and personalization of medication-related care. However, AI should not replace professional clinical judgment. Future research should prioritize prospective clinical validation, external validation, patient-centred outcomes, explainable and trustworthy AI, health-economic evaluation, and responsible human–AI collaboration.

INTRODUCTION

Artificial intelligence (AI) refers to computational technologies capable of performing tasks that traditionally require human intelligence, including learning, reasoning, pattern recognition, prediction, and decision-making. The rapid development of machine learning (ML), deep learning (DL), natural language processing (NLP), and generative AI has expanded the application of AI across healthcare. AI can analyse large volumes of clinical data and identify patterns that may support healthcare professionals in diagnosis, treatment selection, monitoring, and decision-making.[1–4]

Clinical pharmacy focuses on the optimization of medication therapy and the provision of patient-centred pharmaceutical care. Clinical pharmacists contribute to medication review, identification of drug-related problems, therapeutic monitoring, adverse drug reaction prevention, medication counselling, and optimization of pharmacotherapy. The increasing complexity of medication regimens and the growing volume of electronic healthcare information create opportunities for AI-supported clinical pharmacy services. Recent reviews have demonstrated that AI is increasingly being explored across pharmacy practice, including medication management, clinical decision support, medication safety, and personalized care.[5–8]

AI can support pharmacists by analysing patient characteristics, medication histories, laboratory results, clinical notes, and other healthcare information. AI-powered clinical decision support systems may identify potential medication-related problems and help pharmacists prioritize interventions. In particular, AI-based approaches have been investigated for optimizing medication alerts because conventional clinical decision support systems can generate excessive alerts and contribute to alert fatigue.[9]

Pharmacovigilance represents another important area for AI application. Machine learning and NLP can process large quantities of safety information and may support adverse drug reaction detection, safety-signal identification, drug–drug interaction extraction, and risk prediction. A systematic review of AI in pharmacovigilance found applications across adverse drug event identification, safety-report processing, drug–drug interaction extraction, and prediction of medication-related risks.[10]

The emergence of generative AI and large language models has further expanded the potential role of AI in clinical pharmacy. ChatGPT and related systems can generate human-like responses and may assist with drug information, medication therapy management, clinical documentation, patient education, and pharmacy education. However, studies evaluating ChatGPT in clinical pharmacy have also demonstrated limitations in accuracy, particularly for complex patient-specific questions, emphasizing the need for pharmacist verification and professional oversight.[11–14]

Therefore, understanding the current evidence regarding AI in clinical pharmacy is important for identifying realistic opportunities while recognizing limitations and potential risks. This narrative literature review aims to summarize current applications of AI in clinical pharmacy, discuss its benefits and challenges, identify research gaps, and explore future directions for responsible implementation.

LITERATURE SEARCH

A literature search was conducted using PubMed/MEDLINE, Scopus, and Embase to identify literature related to artificial intelligence and clinical pharmacy practice. The search focused primarily on publications from January 2020 to August 2026, while selected earlier publications were included when they provided important foundational information regarding AI, machine learning, clinical decision support, or healthcare applications.

The search strategy included combinations of keywords related to AI and pharmacy practice. The major search terms included "Artificial Intelligence," "Machine Learning," "Deep Learning," "Natural Language Processing," "Generative Artificial Intelligence," "ChatGPT," "Large Language Models," "Clinical Pharmacy," "Pharmacy Practice," "Clinical Pharmacist," "Hospital Pharmacy," "Medication Management," "Medication Safety," "Clinical Decision Support," "Pharmacovigilance," "Adverse Drug Reactions," "Drug–Drug Interactions," "Personalized Medicine," "Medication Adherence," and "Antimicrobial Stewardship."

Boolean operators AND and OR were used to combine search terms. A representative search strategy was:

("Artificial Intelligence" OR "Machine Learning" OR "Deep Learning" OR "Generative Artificial Intelligence" OR "ChatGPT" OR "Large Language Models") AND ("Clinical Pharmacy" OR "Pharmacy Practice" OR "Clinical Pharmacist" OR "Hospital Pharmacy") AND ("Medication Safety" OR "Clinical Decision Support" OR "Pharmacovigilance" OR "Adverse Drug Reactions" OR "Drug–Drug Interactions" OR "Personalized Medicine" OR "Medication Management").

Relevant original research studies, systematic reviews, scoping reviews, narrative reviews, observational studies, and relevant clinical studies were considered. Studies unrelated to healthcare or pharmacy practice, duplicate publications, and articles without relevance to the objectives of this review were excluded.

Titles and abstracts were screened for relevance, followed by full-text assessment when required. Relevant information was organized according to author, publication year, study design, AI technology, clinical pharmacy application, major findings, and limitations. The identified literature was synthesized narratively according to major themes.

As this manuscript is designed as a narrative literature review, it was not conducted as a formal systematic review or meta-analysis and therefore does not claim PRISMA systematic-review methodology. Recent pharmacy-specific reviews have similarly demonstrated the growing evidence base for AI applications in pharmacy practice and clinical pharmacy.[5–8]

ARTIFICIAL INTELLIGENCE IN CLINICAL PHARMACY

The principal applications of artificial intelligence in clinical pharmacy and their potential contributions are summarized in Table 1.

Table 1: **MAJOR APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN CLINICAL PHARMACY**

Application	Common AI approaches	Potential pharmacist contribution	Key limitation
Medication safety	Machine learning; NLP	Prioritize medication-related risks, inappropriate prescriptions and alerts	False positives; external validation
Clinical decision support	Machine learning; predictive models	Support medication review and therapeutic decisions	Data quality; workflow integration
Pharmacovigilance	NLP; machine learning	Detect adverse drug events and safety signals	Heterogeneous data; signal validation
Drug–drug interactions	Graph/ML models; deep learning	Identify and prioritize potential interactions	Interpretability; incomplete interaction data
Personalized pharmacotherapy	Predictive analytics; ML	Support treatment and dose optimization	Need for high-quality patient-specific data
Medication adherence	Predictive models; digital AI tools	Identify non-adherence risk and support monitoring	Patient engagement; privacy
Antimicrobial stewardship	ML; predictive analytics	Support antimicrobial selection and optimization	Local resistance patterns and validation
Drug information and counselling	Generative AI; NLP	Draft educational and drug-information responses	Hallucinations; need for verification
Pharmacy education	Generative AI; LLMs	Case generation, tutoring and learning support	Accuracy; academic integrity

Legend: AI, artificial intelligence; NLP, natural language processing; ML, machine learning; LLMs, large language models.

Overview of Artificial Intelligence:

AI includes several technologies with different functions. Machine learning enables computer systems to learn patterns from data and generate predictions or classifications. Deep learning, a subset of machine learning, uses multilayered neural networks to identify complex patterns in large datasets. Natural language processing enables computers to process and analyse human language and is particularly relevant to clinical notes, scientific literature, medication records, and pharmacovigilance reports.[2–4]

Generative AI and large language models represent a newer development. These systems can generate text and assist with information retrieval, summarization, education, documentation, and communication. Their increasing availability has generated substantial interest in pharmacy practice, although their clinical reliability remains an important consideration.[11–14]

Current Applications of AI in Clinical Pharmacy:

Medication Safety and Error Prevention:

AI can analyse medication orders, patient characteristics, laboratory results, medication histories, and clinical information to identify potential medication-related problems. Applications include detection of inappropriate prescriptions, dosing problems, contraindications, therapeutic duplication, and potential adverse drug events.[5],[6]

AI may also improve the prioritization of medication alerts. Graafsma et al. identified AI-based approaches for optimizing medication alerts generated by clinical decision support systems. Their review highlighted potential reductions in alert burden and improvements in identification of inappropriate prescriptions, while also emphasizing the limited availability of external validation and real-world implementation studies.[9]

Clinical Decision Support:

Clinical decision support systems provide patient-specific information to support healthcare decisions. AI-enhanced systems can integrate electronic health records, laboratory results, medication histories, and clinical guidelines to support medication review and therapeutic decision-making.[15]

AI-supported clinical decision-making may help pharmacists analyse complex patient information more efficiently. Nevertheless, AI-generated recommendations require clinical verification because performance depends on data quality, model validation, and the clinical context.

Pharmacovigilance and Adverse Drug Reaction Detection:

AI has significant potential in pharmacovigilance because of its ability to analyse large and heterogeneous datasets. Machine learning and NLP can be used to identify adverse drug events, process safety reports, detect safety signals, and identify potential drug–drug interactions.[10]

AI-based pharmacovigilance may increase the efficiency of safety monitoring; however, differences in data sources and model development approaches can affect generalizability. Future studies should therefore evaluate whether AI-supported signal detection produces clinically meaningful improvements in drug safety monitoring.

Drug–Drug Interaction Prediction:

Drug–drug interactions are an important concern in patients receiving multiple medications. AI approaches can analyse drug characteristics, patient information, known interaction datasets, and clinical information to predict potential interactions. Zhang et al. reviewed AI approaches for different DDI prediction tasks and highlighted the potential of AI to support clinical decision-making.[16]

Explainability remains important in DDI prediction because pharmacists need to understand why a particular interaction has been predicted. AI models that provide interpretable evidence may improve clinical confidence and facilitate appropriate intervention.[17]

Medication Therapy Management and Personalized Pharmacotherapy:

AI can assist medication therapy management by integrating patient-specific and medication-related information. A study evaluating ChatGPT in medication therapy management found that the model was able to identify drug interactions and provide general management recommendations in simulated cases, although limitations remained regarding specific dosing recommendations.[18]

AI may also support personalized pharmacotherapy by integrating clinical, demographic, laboratory, genetic, pharmacokinetic, and pharmacodynamic information. Such approaches could assist pharmacists in treatment selection and dose optimization.[19]

Medication Adherence and Patient Monitoring:

Medication adherence is an important determinant of therapeutic outcomes. AI-enabled applications may identify patients at risk of non-adherence, provide personalized reminders, and support communication between patients and healthcare professionals. Recent pharmacy literature has identified medication adherence and personalized medicine as emerging areas of AI application.[6]

Antimicrobial Stewardship:

AI may support antimicrobial stewardship by analysing microbiological data, patient characteristics, previous antimicrobial exposure, resistance patterns, and clinical outcomes. AI-supported systems may assist antimicrobial selection and optimization and potentially contribute to reducing inappropriate antibiotic use. Studies have demonstrated the potential of AI to guide antibiotic selection in recurrent urinary tract infections and support antimicrobial stewardship.[20]

Hospital and Community Pharmacy Practice:

AI can support pharmacy workflow through medication screening, prescription verification, inventory management, prioritization of clinical interventions, and information retrieval. Current pharmacy-practice literature indicates that AI applications are not limited to clinical decision-making but also include operational and workflow optimization.[6],[7]

Pharmacists' perceptions and willingness to use AI are important determinants of implementation. Studies conducted among community pharmacists have identified potential benefits while also reporting barriers related to training, trust, infrastructure, and implementation.[21],[22]

Drug Information and Patient Counselling:

AI-powered conversational systems may assist pharmacists with drug information retrieval and patient education. However, evaluation studies have shown variable performance. Munir et al. reported limited success of ChatGPT in answering pharmacy-based clinical questions, particularly complex patient cases.[13]

Similarly, clinical pharmacy evaluations have shown that ChatGPT may provide useful responses in some domains but may also generate inaccurate or inappropriate information.[11],[14],[23] Therefore, AI-generated drug information should be checked against reliable and authoritative sources before use in patient care.

Generative AI and Pharmacy Education:

Generative AI may support pharmacy education through clinical case discussions, question generation, literature summarization, educational content creation, and simulated patient interactions. Studies of pharmacy students and faculty have demonstrated growing awareness and interest in AI while also highlighting the need for appropriate education and responsible use.[24–26]

AI literacy should therefore become an important component of future pharmacy education. Pharmacists and students should understand both the capabilities and limitations of AI systems.

BENEFITS OF AI IN CLINICAL PHARMACY

AI may provide several benefits to clinical pharmacy practice. First, it can improve the efficiency of analysing large volumes of patient and medication information. This may allow pharmacists to identify high-risk patients and medication-related problems more rapidly.[5–8]

Second, AI can support medication safety by identifying potential errors, drug interactions, inappropriate prescriptions, and adverse drug events. AI-based medication-alert optimization may reduce unnecessary alerts and allow pharmacists to focus on clinically important interventions.[9]

Third, AI may facilitate personalized medication management by integrating multiple patient-specific variables. This may support treatment selection, dose optimization, and therapeutic monitoring.[19]

Fourth, AI can support pharmacovigilance by rapidly processing large quantities of safety information.[10]

Finally, generative AI may improve access to drug information and educational resources, although its outputs require professional verification. [11–14]

Overall, AI has the potential to improve the efficiency, safety, personalization, and accessibility of clinical pharmacy services when appropriately integrated into professional practice.

CHALLENGES AND LIMITATIONS

Data Quality and Availability:

AI systems depend on the quality and representativeness of the data used for training and validation. Missing, inaccurate, incomplete, or biased data may lead to unreliable predictions. Differences between institutions and patient populations may further reduce the generalizability of AI models.[5],[6]

Accuracy and Reliability:

AI systems are not inherently accurate. Performance can vary depending on the clinical question, dataset, model, and context. Generative AI may produce plausible but incorrect responses, making independent verification essential. [13],[14]

Algorithmic Bias:

AI systems can reproduce or amplify biases present in their training data. Bias may result in differences in performance across patient populations and potentially contribute to healthcare inequity.[27]

Explainability and Transparency:

Many advanced AI systems function as complex models whose decision-making processes may be difficult to interpret. Lack of explainability can reduce clinician trust and make it difficult to evaluate AI-generated recommendations. Explainable AI is therefore an important area for future development.[17],[28]

Data Privacy and Cybersecurity:

Clinical pharmacy AI applications may require sensitive patient information, including medication histories, laboratory results, and clinical records. Secure data storage, appropriate access controls, privacy-preserving technologies, and regulatory compliance are essential.

Ethical and Legal Issues:

AI raises important questions regarding accountability, responsibility, informed consent, transparency, and professional decision-making. Clear governance frameworks are needed to define the responsibilities of pharmacists, healthcare institutions, technology developers, and regulators.

Clinical Validation:

Many AI models have been evaluated retrospectively or in controlled datasets. External validation and prospective implementation studies remain limited. The medication-alert literature, for example, has identified a lack of external validation and limited real-world implementation.[9]

Pharmacist Training:

The growing use of AI requires pharmacists to develop appropriate AI and digital-health competencies. Surveys among pharmacy students, faculty, and practicing pharmacists indicate interest in AI but also highlight the need for education and training.[21],[22],[24]

Risk of Overdependence:

AI should not replace professional clinical reasoning. Pharmacists must independently evaluate AI-generated information, particularly when recommendations may directly affect medication therapy.

FUTURE PERSPECTIVES

The future of AI in clinical pharmacy is likely to involve increasing human–AI collaboration rather than replacement of pharmacists. AI can perform data-intensive analytical tasks while pharmacists provide clinical interpretation, patient communication, professional judgment, and accountability.[5–8]

Future clinical decision support systems may become more personalized by integrating electronic health records, laboratory data, medication histories, clinical guidelines, and patient-specific characteristics. Improved systems may also reduce alert fatigue by prioritizing clinically meaningful medication alerts.[9]

Generative AI and large language models are likely to expand in pharmacy practice. Potential applications include drug information, clinical documentation, patient counselling, medication education, literature summarization, and pharmacy education. However, reliable source integration, fact verification, and human oversight will be essential.[11–14]

AI may also strengthen pharmacovigilance through continuous analysis of electronic health records, spontaneous reports, scientific literature, and other real-world data.[10] Future DDI systems may incorporate large language models and explainable approaches to improve interaction detection and interpretation.[16],[17],[29]

The development of trustworthy AI will require attention to transparency, fairness, privacy, cybersecurity, validation, and regulatory oversight. Recent work in pharmacovigilance emphasizes the need to move from experimental AI applications toward reliable and scalable drug-safety systems.[30]

RESEARCH GAPS AND RECOMMENDATIONS

Despite substantial progress, several research gaps remain. First, more prospective and multicentre studies are required to evaluate the clinical effectiveness of AI-supported pharmacy services. Second, AI models should undergo external validation across different hospitals, healthcare systems, and patient populations.

Third, future research should focus on patient-centred outcomes rather than relying exclusively on technical performance measures such as accuracy or sensitivity. Outcomes including medication errors, adverse drug events, treatment effectiveness, adherence, patient satisfaction, pharmacist workload, and healthcare costs should be evaluated.

Fourth, standardized frameworks are needed for evaluating AI systems in pharmacy practice. These frameworks should consider clinical validity, usability, safety, explainability, fairness, and economic value.

Fifth, pharmacy education should incorporate AI literacy and competency. Students and practicing pharmacists should understand AI fundamentals, data interpretation, limitations of AI-generated information, ethical issues, and appropriate human oversight.[24–26]

Finally, future studies should investigate the long-term effects of AI implementation in routine clinical pharmacy practice. Particular attention should be given to generative AI, clinical decision support, pharmacovigilance, medication safety, personalized medicine, and drug–drug interaction prediction.

Recommendations:

- Conduct prospective and multicentre clinical studies.
- Perform external validation of AI models.
- Evaluate patient-centred and clinical outcomes.
- Develop explainable and transparent AI systems.
- Address algorithmic bias and health inequities.
- Strengthen patient-data privacy and cybersecurity.
- Establish clear ethical and regulatory frameworks.
- Integrate AI competency into pharmacy education.
- Evaluate cost-effectiveness and implementation feasibility.
- Maintain pharmacist oversight for patient-care decisions.

CONCLUSION

Artificial intelligence is emerging as an important technology in clinical pharmacy with potential applications in medication safety, clinical decision support, pharmacovigilance, drug–drug interaction prediction, medication therapy management, personalized pharmacotherapy, medication adherence, antimicrobial stewardship, drug information, and pharmacy education.

The development of generative AI and large language models has further expanded the potential role of AI in pharmacy practice. However, current evidence also demonstrates important limitations related to accuracy, data quality, bias, explainability, privacy, cybersecurity, clinical validation, ethical responsibility, and professional competency.

The future of AI in clinical pharmacy should therefore emphasize responsible human–AI collaboration. AI should augment pharmacists' analytical capabilities rather than replace their clinical judgment. Robust clinical research, external validation, standardized evaluation, pharmacist education, ethical governance, and patient-centred implementation will be essential to ensure that AI contributes meaningfully to safe and effective pharmaceutical care.

DECLARATIONS

Ethics Approval:

Not applicable because this manuscript is a narrative literature review based on previously published literature.

Consent for Participation:

Not applicable.

Funding:

No specific funding was received for this work.

Conflict of Interest:

The author declares no conflict of interest.

Author Contributions:

Dr Keerthika R - responsible for the conception, literature search, interpretation of the literature, preparation of the manuscript, and final approval of the manuscript.

Data Availability:

No original datasets were generated or analysed for this review.

REFERENCES

1. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nat Med. 2019;25(1):44-56. doi:10.1038/s41591-018-0300-7.
2. Deo RC. Machine learning in medicine. Circulation. 2015;132(20):1920-1930. doi:10.1161/CIRCULATIONAHA.115.001593.
3. Miotto R, Wang F, Wang S, Jiang X, Dudley JT. Deep learning for healthcare: review, opportunities and challenges. Brief Bioinform. 2018;19(6):1236-1246. doi:10.1093/bib/bbx044.
4. Sutton RT, Pincock D, Baumgart DC, Sadowski DC, Fedorak RN, Kroeker KI. An overview of clinical decision support systems: benefits, risks, and strategies for success. NPJ Digit Med. 2020;3:17. doi:10.1038/s41746-020-0221-y.
5. Alqahtani SS, Menachery SJ, Alshahrani A, Albalkhi B, Alshayban D, Iqbal MZ. Artificial intelligence in clinical pharmacy—A systematic review of current scenario and future perspectives. Digit Health. 2025;11:20552076251388145. doi:10.1177/20552076251388145.
6. Hatzimanolis J, Riley B, El-Den S, Aslani P, Zhou J, Chaar BB. Applications of artificial intelligence in current pharmacy practice: a scoping review. Res Social Adm Pharm. 2025;21(3):134-141. doi:10.1016/j.sapharm.2024.12.007.
7. Chalasani SH, Syed J, Ramesh M, Patil V, Pramod Kumar TM. Artificial intelligence in the field of pharmacy practice: a literature review. Explor Res Clin Soc Pharm. 2023;12:100346. doi:10.1016/j.rcsop.2023.100346.
8. Ranchon F, Chanoine S, Lambert-Lacroix S, Bosson JL, Moreau-Gaudry A, Bedouch P. Development of artificial intelligence powered apps and tools for clinical pharmacy services: a systematic review. Int J Med Inform. 2023;172:104983. doi:10.1016/j.ijmedinf.2022.104983.
9. Graafsma J, Murphy RM, van de Garde EMW, Karapinar-Çarkit F, Derijks HJ, Hoge RHL, et al. The use of artificial intelligence to optimize medication alerts generated by clinical decision support systems: a scoping review. J Am Med Inform Assoc. 2024;31(6):1411-1422. doi:10.1093/jamia/ocae076.
10. Salas M, Petracek J, Yalamanchili P, Aimer O, Kasthuril D, Dhingra S, et al. The use of artificial intelligence in pharmacovigilance: a systematic review of the literature. Drug Saf. 2022;45(10):1073-1087. doi:10.1007/s40264-022-01224-1.
11. Huang X, Estau D, Liu X, Yu Y, Qin J, Li Z. Evaluating the performance of ChatGPT in clinical pharmacy: a comparative study of ChatGPT and clinical pharmacists. Br J Clin Pharmacol. 2024;90(1):232-238. doi:10.1111/bcp.15896.
12. Sallam M. ChatGPT utility in healthcare education, research, and practice: systematic review on the promising perspectives and valid concerns. Healthcare (Basel). 2023;11(6):887. doi:10.3390/healthcare11060887.
13. Munir F, Gehres A, Wai D, Song L. Evaluation of ChatGPT as a tool for answering clinical questions in pharmacy

practice. J Pharm Pract. 2024;37(6):1303-1310. doi:10.1177/08971900241256731.

14. Perrottet N, et al. Assessing the applicability and appropriateness of ChatGPT in answering clinical pharmacy questions. Pharmaceutics? 2023. doi:10.1016/j.pharma.2023.11.001.
15. Sutton RT, et al. An overview of clinical decision support systems: benefits, risks, and strategies for success. NPJ Digit Med. 2020;3:17. doi:10.1038/s41746-020-0221-y.
16. Zhang Y, Deng Z, Xu X, Feng Y, Shang J. Application of artificial intelligence in drug-drug interactions prediction: a review. J Chem Inf Model. 2024;64(7):2158-2173. doi:10.1021/acs.jcim.3c00582.
17. Vo TH, et al. On the road to explainable AI in drug-drug interactions prediction: a systematic review. Comput Struct Biotechnol J. 2022;20:2112-2123. doi:10.1016/j.csbj.2022.04.021.
18. Roosan D, Padua P, Khan R, Khan H, Verzosa C, Wu Y. Effectiveness of ChatGPT in clinical pharmacy and the role of artificial intelligence in medication therapy management. J Am Pharm Assoc (2003). 2024;64(2):422-428.e8. doi:10.1016/j.japh.2023.11.023.
19. Johnson KB, Wei WQ, Weeraratne D, Frisse ME, Misulis K, Rhee K, et al. Precision medicine, AI, and the future of personalized health care. Clin Transl Sci. 2021;14(1):86-93. doi:10.1111/cts.12884.
20. Cai T, Anceschi U, Prata F, Collini L, Brugnolli A, Migno S, et al. Artificial intelligence can guide antibiotic choice in recurrent UTIs and become an important aid to improve antimicrobial stewardship. Antibiotics (Basel). 2023;12(2):375. doi:10.3390/antibiotics12020375.
21. Jarab AS, Al-Qerem W, Alzoubi KH, Obeidat H, Abu Heshmeh S, Mukattash TL, et al. Artificial intelligence in pharmacy practice: attitude and willingness of the community pharmacists and the barriers for its implementation. Saudi Pharm J. 2023;31(8):101700. doi:10.1016/j.jsps.2023.101700.
22. Sendekie AK, Limenh LW, Abate BB, Chanie GS, Kassaw AT, Tamene FB, et al. Artificial intelligence in community pharmacy practice: pharmacists' perceptions, willingness to utilize, and barriers to implementation. Explor Res Clin Soc Pharm. 2024;16:100542. doi:10.1016/j.rcsop.2024.100542.
23. Huang X, Estau D, Liu X, Yu Y, Qin J, Li Z. Evaluating the performance of ChatGPT in clinical pharmacy: a comparative study of ChatGPT and clinical pharmacists. Br J Clin Pharmacol. 2024;90(1):232-238. doi:10.1111/bcp.15896.
24. Hasan HE, Jaber D, Al Tabbah S, Lawand N, Habib HA, Farahat NM. Knowledge, attitude and practice among pharmacy students and faculty members towards artificial intelligence in pharmacy practice: a multinational cross-sectional study. PLoS One. 2024;19(3):e0296884. doi:10.1371/journal.pone.0296884.
25. Zhang X, Tsang CCS, Ford DD, Wang J. Student pharmacists' perceptions of artificial intelligence and machine learning in pharmacy practice and pharmacy education. Am J Pharm Educ. 2024;88(12):101309. doi:10.1016/j.ajpe.2024.101309.
26. Weidmann AE. Artificial intelligence in academic writing and clinical pharmacy education: consequences and opportunities. Int J Clin Pharm. 2024;46(3):751-754. doi:10.1007/s11096-024-01705-1.
27. Obermeyer Z, Powers B, Vogeli C, Mullainathan S. Dissecting racial bias in an algorithm used to manage the health of populations. Science. 2019;366(6464):447-453. doi:10.1126/science.aax2342.
28. Ghassemi M, Oakden-Rayner L, Beam AL. The false promise of current approaches to explainable artificial intelligence in healthcare. Lancet Digit Health. 2021;3(11):e745-e750. doi:10.1016/S2589-7500(21)00208-9.
29. Al Meslamani AZ, Abou Hajal A. Language models for drug-drug interactions: current applications, pitfalls, and future directions. Expert Opin Drug Metab Toxicol.

2025;21(9):1083-1102. doi:10.1080/17425255.2025.2551724.

30. Gomase VS, Vairachilai S, Sharma R, Dhamane SP, Sardana S, Marakarkandy B, et al. Explainable artificial intelligence in pharmacovigilance and drug safety: a systematic review of enhancing transparency and regulatory acceptance. Curr Drug Saf. 2026. doi:10.2174/011574886346720826052909481 1.

HOW TO CITE: Dr. Keerthika R, Artificial Intelligence in Clinical Pharmacy: Current Applications, Challenges, and Future Perspectives – A Narrative Literature Review, Int. J. of Pharm. Sci., 2026, Vol 4, Issue 8, 3085-3096. https://doi.org/10.5281/zenodo.22030982