

*Artificial Intelligence in Polypharmacy: Moving Beyond Drug Alerts Toward Patient-Specific Medication Safety*_____

_____ ***Eneida HOXHA*** _____

Contact Author: eneida_hoxha@yahoo.com

<https://orcid.org/0009-0006-1206-7896>

DEPARTMENT OF INTERNAL MEDICINE

UNIVERSITY HOSPITAL CENTER "MOTHER TERESA", TIRANA, ALBANIA

_____ ***Ledio COLLAKU*** _____

DEPARTMENT OF INTERNAL MEDICINE

UNIVERSITY HOSPITAL CENTER "MOTHER TERESA", TIRANA, ALBANIA

_____ ***Pandush POJANI*** _____

DEPARTMENT OF INTERNAL MEDICINE

UNIVERSITY HOSPITAL CENTER "MOTHER TERESA", TIRANA, ALBANIA

_____ ***Matilda KAMBO*** _____

DEPARTMENT OF TOXICOLOGY

UNIVERSITY HOSPITAL CENTER "MOTHER TERESA", TIRANA, ALBANIA

_____ ***Somida KUKA*** _____

DEPARTMENT OF INTERNAL MEDICINE

UNIVERSITY HOSPITAL CENTER "MOTHER TERESA", TIRANA, ALBANIA

_____ ***Xhesika HABILAJ*** _____

DEPARTMENT OF INTERNAL MEDICINE

UNIVERSITY HOSPITAL CENTER "MOTHER TERESA", TIRANA, ALBANIA

_____ ***Margarita GJATA*** _____

DEPARTMENT OF INTERNAL MEDICINE

UNIVERSITY HOSPITAL CENTER "MOTHER TERESA", TIRANA, ALBANIA

Abstract

Polypharmacy is an increasing challenge in modern clinical practice, particularly among older adults and patients with multimorbidity, chronic kidney disease, heart failure, diabetes, frailty, or cognitive impairment. Its clinical impact extends beyond the number of prescribed medicines and reflects the interaction between therapeutic burden, comorbidities, organ dysfunction, fragmented care, changing physiological reserve, and multiple prescribers.

Traditional medication review remains essential but may be limited by incomplete medication histories, time constraints, fragmented records, and the difficulty of identifying clinically meaningful drug–drug, drug–disease, and drug–patient interactions. Artificial intelligence (AI) may support safer medication management by integrating prescribing data with diagnoses, laboratory values, clinical events, and patterns of healthcare use. Potential applications include medication reconciliation, prioritization of clinically relevant interactions, renal dose adjustment, adverse drug event prediction, recognition of prescribing cascades, and identification of patients most likely to benefit from structured medication review or deprescribing.

However, the value of AI in polypharmacy management should not be measured by the number of alerts generated. Its most useful role may be to help clinicians distinguish theoretical medication-related risks from those that are likely to be clinically important for an individual patient. This requires transparent recommendations, reliable data, local validation, integration into clinical workflow, and clear professional accountability.

This narrative clinical viewpoint discusses the opportunities, limitations, and ethical implications of AI in polypharmacy management. It argues that AI should function as a human-centered clinical decision-support tool that improves prioritization, supports multidisciplinary medication review, and preserves clinician-led and patient-centered prescribing decisions.

Keywords: Artificial Intelligence; Polypharmacy; Medication Safety; Clinical Decision Support; Deprescribing; Patient-Specific Risk Stratification

Introduction

Polypharmacy is an increasingly common challenge in contemporary clinical practice, particularly among older adults and patients with multimorbidity, chronic kidney disease, heart failure, diabetes, frailty, or cognitive impairment. Although it is commonly defined as the concurrent use of five or more medications,

its clinical relevance extends beyond medication count. The central question is whether the overall treatment regimen remains appropriate, coordinated, and safe as the patient's health status, organ function, and therapeutic priorities change [1,2].

Medication-related harm is often difficult to recognize because it may arise from the interaction between multiple drugs, comorbidities, laboratory abnormalities, fragmented prescribing, and transitions of care. Clinicians must simultaneously consider drug–drug and drug–disease interactions, renal and hepatic function, therapeutic duplication, prescribing cascades, adherence, and patient preferences. In routine practice, this process may be limited by incomplete medication histories, time constraints, and information dispersed across different healthcare settings [3,4].

Artificial intelligence (AI) offers a potential opportunity to support safer medication management. By integrating prescribing data with diagnoses, laboratory values, clinical events, and patterns of healthcare use, AI-based systems may help identify medication-related risk, prioritize patients for review, detect clinically relevant interactions, support dose adjustment, and highlight opportunities for deprescribing [5,6].

However, AI should not be viewed as a substitute for clinical judgment. Its value depends on reliable data, transparent recommendations, local validation, and integration into real clinical workflows. This narrative clinical viewpoint examines the emerging role of AI in polypharmacy management, with particular focus on medication reconciliation, interaction prioritization, renal dose adjustment, adverse drug event prediction, and deprescribing support. It argues that the principal value of AI is not to generate more medication alerts, but to help clinicians identify which alerts are most likely to be clinically meaningful for the individual patient.

Literature scope and approach

This narrative review and clinical viewpoint was informed by selected literature on polypharmacy, medication safety, medication reconciliation, clinical decision support systems, artificial intelligence, and deprescribing. Priority was given to systematic reviews, scoping reviews, international guidance documents, and recent studies describing clinically relevant applications of artificial intelligence in medication safety. The objective was not to provide a systematic evidence synthesis, but to critically discuss how artificial intelligence may support patient-specific prioritization of medication-related risk in routine clinical practice.

Polypharmacy as a Complex Clinical and Digital Challenge

Polypharmacy is not only a prescribing challenge; it is also a problem of information integration across time, care settings, and clinicians. In patients with multimorbidity, each medicine may be appropriate when assessed in isolation. However, when multiple disease-specific recommendations are applied simultaneously, often by different prescribers, the overall regimen may become difficult to interpret as a whole [2,3].

This complexity is dynamic rather than static. Renal function may decline, acute illness may alter drug tolerance, new medicines may be added during hospitalization, and treatments initiated for short-term indications may remain active after the original clinical context has changed. A regimen that appears appropriate drug by drug may therefore become unsafe when considered in relation to the patient's full therapeutic burden, physiological reserve, and current goals of care [3,4].

Medication-related harm frequently emerges during transitions of care, particularly at hospital admission and discharge. At these points, discrepancies may arise between prescribed, documented, and actually taken medicines, including therapeutic duplication, omitted medicines, unintended continuation of discontinued therapies, and incorrect doses. Structured medication reconciliation, particularly when supported by pharmacists, can help identify and resolve clinically relevant discrepancies during these vulnerable transitions [3,7].

Traditional medication review remains essential, but it is often constrained by incomplete medication histories, fragmented electronic records, limited consultation time, and multiple prescribers. Drug-drug and drug-disease interactions, therapeutic duplications, renal dose issues, and prescribing cascades may therefore be missed, particularly in patients with high medication burden or rapidly changing clinical status [3,5,6].

For this reason, polypharmacy should also be understood as a digital challenge. The problem is not simply that clinicians receive too much information; it is that clinically relevant information is often distributed across different records, institutions, laboratory systems, discharge documents, and patient-reported histories. Digital tools may help organize this information, but their usefulness depends on whether they can distinguish clinically important risk from background noise [8,9].

The central clinical question is therefore not whether an interaction exists in theory, but whether a specific medication combination is likely to cause harm in the current patient, at the current moment, and within the patient's broader therapeutic priorities.

Where Artificial Intelligence Can Add Value in Medication Safety

Artificial intelligence may support medication safety by helping clinicians process and prioritize information that is difficult to review manually in patients with complex therapeutic regimens. Its potential value is not limited to detecting whether a drug interaction exists, but to identifying which medication-related concerns may be most clinically relevant in a specific patient and at a specific moment of care [5,6].

One important application is medication reconciliation. AI-supported systems may compare medication information across outpatient records, hospital admissions, discharge summaries, pharmacy data, and specialist prescriptions. This may help identify duplicated therapies, recent dose changes, discontinued medicines that remain active in the record, and discrepancies between prescribed and actual treatment. More importantly, predictive models may help prioritize patients most likely to have clinically relevant discrepancies, directing pharmacist and clinician time toward those at highest risk rather than applying the same level of review to every patient [10,11].

AI may also improve the detection and prioritization of drug–drug and drug–disease interactions by incorporating patient-specific factors such as age, kidney function, liver function, laboratory abnormalities, frailty, recent acute illness, and concurrent medication burden. This may be more clinically useful than conventional rule-based alerts, which often identify theoretical interactions without distinguishing between low-risk warnings and situations likely to cause clinically meaningful harm [6,8].

Another promising area is dynamic monitoring of renal dose adjustment and adverse drug event risk. By integrating estimated glomerular filtration rate trends, creatinine values, potassium levels, glucose measurements, blood pressure, and medication exposure, AI-based tools may help identify patients at increased risk of drug accumulation, hyperkalemia, bleeding, hypoglycemia, hypotension, sedation, or acute kidney injury. However, these models should be viewed as risk-stratification tools rather than diagnostic systems: a prediction of increased risk does not establish causality, nor does it replace clinical assessment of volume status, acute illness, competing diagnoses, or treatment urgency [6,12].

AI may also assist in recognizing prescribing cascades and prioritizing deprescribing. Patients with recurrent falls, cognitive impairment, high anticholinergic burden, repeated hospitalizations, chronic kidney disease, or multiple prescribers may benefit from targeted medication review. In this context, AI may help identify patients or medication combinations that warrant closer attention, while the final decision regarding continuation, dose reduction,

substitution, or discontinuation remains clinician-led and based on expected benefit, prognosis, symptom burden, and patient preferences [5,13].

The practical value of AI will therefore depend on whether its recommendations are understandable, actionable, and integrated into clinical workflow. Systems that merely generate additional warnings may increase workload and alert fatigue. Systems that help clinicians prioritize meaningful risks, identify patients most likely to benefit from review, and explain why action may be needed are more likely to contribute to safer medication management.

TABLE 1. Potential applications of artificial intelligence in polypharmacy management.

Clinical task	Potential AI-supported function	Potential clinical value	Key limitation	Clinician role
Medication reconciliation	Compare medication lists across hospital, outpatient, pharmacy, and specialist records	Detect discrepancies, duplicated therapies, omitted medicines, and recent changes	Incomplete or inaccurate records may produce misleading results	Confirm the actual medication regimen with the patient, caregivers, and available documentation
Drug–drug and drug–disease interactions	Identify and prioritize interactions using patient-specific data	Focus attention on interactions most likely to cause harm	Risk of false-positive alerts and alert fatigue	Assess clinical relevance, indication, severity, and alternatives
Renal dose adjustment	Integrate eGFR trends, creatinine, potassium, and medication exposure	Identify possible accumulation, hyperkalemia, hypotension, or nephrotoxicity	Laboratory values may not reflect rapidly changing clinical status	Interpret results alongside volume status, acute illness, and treatment urgency
Adverse drug event prediction	Recognize patterns associated with bleeding, falls, hypoglycemia, delirium, acute kidney injury, or sedation	Prioritize high-risk patients for medication review	Prediction does not establish causality	Evaluate competing diagnoses and confirm medication-related contribution
Prescribing cascades and therapeutic duplication	Detect temporal links between medication initiation, symptoms, diagnoses, and additional prescriptions	Identify potentially avoidable medication burden	Requires accurate longitudinal prescribing data	Decide whether symptoms represent an adverse effect, new disease, or both
Deprescribing prioritization	Identify patients with high medication burden, frailty, recurrent admissions, CKD, or high-risk medication combinations	Direct structured review toward patients most likely to benefit	Algorithms cannot determine patient goals or acceptable trade-offs	Lead shared decision-making and determine whether deprescribing is appropriate

Note. AI, artificial intelligence; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

From Alerts to Human-Centered Clinical Decision Support

Early digital medication-safety systems were largely based on rule-based alerts for drug interactions, duplicate therapies, contraindications, or dose-related concerns. Although these systems may improve awareness, their usefulness is often limited by insufficient clinical context. A technically correct alert may have little relevance for a specific patient, while an important medication-related risk may be missed when it depends on the combined effect of frailty, laboratory trends, acute illness, medication timing, organ dysfunction, and multiple comorbidities [8,14].

This limitation contributes to alert fatigue. When clinicians receive frequent, non-specific, or low-priority warnings, important alerts may be ignored, overridden, or delayed. The challenge is therefore not simply to generate more notifications, but to improve their relevance, timing, interpretability, and capacity to support a practical clinical response [15,16].

AI may help shift medication safety from generic alert generation toward patient-specific risk stratification. Rather than only identifying that two medicines may interact, an AI-supported system may help estimate whether that interaction is likely to be clinically important in the current patient. For example, the relevance of a potential interaction may depend on age, renal function, electrolyte disturbances, blood pressure, recent hospitalization, history of falls, frailty, or cumulative exposure to high-risk medicines [8,13].

A clinically useful system should also distinguish between different levels of urgency. Some situations may require immediate action, such as a high-risk medication combination in the setting of acute kidney injury, severe hyperkalemia, active bleeding, recurrent hypoglycemia, bradycardia, or excessive sedation. Other situations may require closer monitoring, dose adjustment, pharmacist review, medication reconciliation, or discussion at a subsequent outpatient visit. AI should support this prioritization, not replace the clinical evaluation needed to determine urgency and appropriate action [17].

However, AI-supported medication review should not be confused with automated prescribing. Algorithms may identify patterns, estimate risk, and highlight medication-related concerns, but clinicians must still assess indication, expected benefit, prognosis, functional status, symptom burden, treatment alternatives, and patient priorities. A recommendation to stop, reduce, or substitute a medicine may be technically reasonable yet clinically inappropriate if it disregards the patient's therapeutic goals or the risks of changing treatment.

The most valuable role of AI is therefore to make medication review more structured, selective, and clinically meaningful. It should reduce cognitive overload by helping clinicians identify which patients require urgent attention, which medication-related questions deserve closer review, and why a particular risk may matter for that individual patient [18].

Risks, Ethics, and Human Oversight

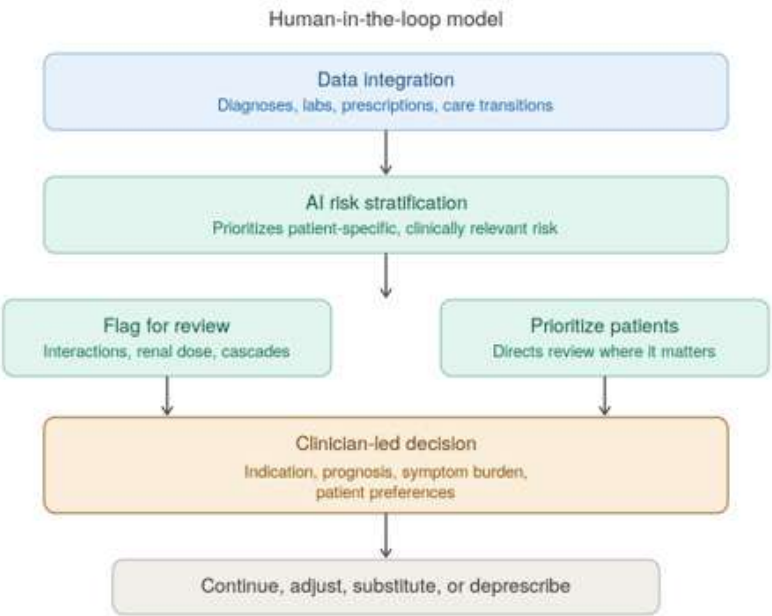
Despite its potential benefits, AI in polypharmacy management should be introduced cautiously. Algorithms depend on the quality, completeness, and timeliness of the data they receive. Missing information about over-the-counter medications, herbal products, adherence, recent dose changes, functional status, or patient preferences may substantially reduce the reliability of automated recommendations [3,5].

Algorithmic bias is another important concern. AI systems are often developed using data from specific populations and healthcare settings. If older adults, patients with frailty, chronic kidney disease, multimorbidity, or limited access to care are underrepresented, algorithmic recommendations may be less reliable precisely in the populations most vulnerable to medication-related harm. Local validation across relevant clinical settings is therefore essential before widespread implementation [19,20].

Explainability is equally important. Clinicians need to understand why a patient has been identified as high risk: for example, because of declining kidney function, cumulative sedative burden, laboratory abnormalities, therapeutic duplication, or a recent hospitalization, or a combination of these factors. Systems that provide transparent and clinically interpretable explanations are more likely to support safe decisions than opaque tools that generate unexplained recommendations [21,22].

AI must therefore operate within a human-in-the-loop model. It may identify patterns, estimate risk, and prioritize patients for review, but it cannot determine treatment goals or replace professional judgment. Decisions about deprescribing, dose reduction, treatment continuation, or therapeutic substitution require consideration of prognosis, symptom burden, expected benefit, patient preferences, family support, and the potential risk of therapeutic change [23,24].

FIGURE 1. The human-in-the-loop model of artificial intelligence in polypharmacy management. AI integrates clinical data and performs risk stratification to flag and prioritize patients for review, but the final therapeutic decision remains clinician-led and patient-centered.



Privacy and accountability must also be addressed. AI-supported medication review requires access to sensitive information, including diagnoses, laboratory data, prescribing history, care transitions, and sometimes patient-reported information. Health systems need secure data governance, clear standards for validation and monitoring, and explicit professional responsibility for decisions influenced by algorithmic recommendations [20,24].

The goal is not automated prescribing. It is intelligent clinical support that helps clinicians identify who needs closer medication review, which medication-related risks deserve attention first, and when a recommendation should be reconsidered in light of individual patient's circumstances.

Implications for Clinical Practice and Health Systems

The successful integration of AI into polypharmacy management will require more than new software. Its usefulness depends on accurate medication lists, interoperable electronic health records, timely laboratory data, reliable documentation of care transitions, and clear communication between primary care, hospitals, pharmacies, and specialist services [6,25].

AI tools should be integrated into the clinical moments when medication decisions are already made: hospital admission, discharge, emergency assessment, chronic disease follow-up, pharmacy review, and multidisciplinary case discussions. Systems that require clinicians to open separate platforms, manually re-enter data, or interpret poorly explained risk scores are unlikely to be used consistently in routine practice [25,26].

Implementation should be gradual and clinically driven. In settings with limited digital infrastructure, the first priority is not advanced predictive modelling but the creation of reliable foundations for medication safety: structured medication reconciliation, accurate electronic medication lists, basic interaction screening, standardized monitoring of high-risk therapies, and clear documentation of renal function and other clinically relevant laboratory values. These steps may provide immediate safety benefits and create the data quality needed for more advanced AI-supported tools in the future [3,6].

A practical AI-supported medication-safety pathway should focus on identifying patients who require closer review rather than replacing routine clinical judgment. Patients with chronic kidney disease, recurrent falls, frailty, cognitive impairment, repeated hospital admissions, high anticholinergic burden, multiple prescribers, or high-risk medication combinations may be prioritized for multidisciplinary review. The final assessment should involve physicians, pharmacists, nurses, and, whenever possible, patients and caregivers.

Healthcare professionals also need training in the interpretation of AI-generated recommendations. Physicians, nurses, pharmacists, and clinical pharmacologists should understand what information an algorithm uses, how a risk score is generated, when a recommendation may be unreliable, and when clinical judgment should override an automated suggestion. Training should include communication with patients, especially when a medication is reduced, stopped, or changed on the basis of a structured medication review [27].

The relevant question is therefore not whether an algorithm can identify a theoretical interaction. It is whether AI can help prevent avoidable harm, reduce unnecessary medication burden, improve coordination across care settings, and support prescribing that remains aligned with the needs and priorities of the individual patient.

Conclusion

Polypharmacy is a complex medication-safety challenge that cannot be addressed by medication count alone. It reflects the interaction between multimorbidity, changing physiological reserve, organ dysfunction, fragmented care, therapeutic burden, and the growing volume of clinical information that must be interpreted across different settings.

Artificial intelligence may support safer medication management by helping reconcile medication lists, identify clinically relevant interactions, recognize high-risk patterns, support renal dose adjustment, and prioritize patients for structured medication review or deprescribing. Its greatest value is unlikely to come from generating a greater number of alerts, but from improving the prioritization, timing, and clinical interpretation of medication-related risk.

However, AI is not a substitute for clinical judgment. Safe implementation requires accurate and complete data, transparent and explainable recommendations, local validation, secure data governance, and integration into real clinical workflows. Decisions about prescribing, deprescribing, and therapeutic priorities must remain clinician-led, multidisciplinary, and aligned with the patient's goals, preferences, and expected benefit.

When used within a human-in-the-loop model, artificial intelligence may help transform polypharmacy management into a more proactive, individualized, and safer component of modern clinical care. The aim is not automated prescribing, but better-informed clinical decisions for the patients most vulnerable to medication-related harm.

The future of AI in polypharmacy should not be judged by how many drug alerts it can generate, but by whether it helps clinicians recognize the right medication-related risk, in the right patient, at the right time.

Conflict of Interest

The authors declare no conflict of interest.

Funding

This research received no external funding.

References

1. Masnoon N, Shakib S, Kalisch-Ellett L, Caughey GE. What is polypharmacy? A systematic review of definitions. *BMC Geriatr*. 2017;17(1):230. <https://doi.org/10.1186/s12877-017-0621-2>
2. Pazan F, Wehling M. Polypharmacy in older adults: a narrative review of definitions, epidemiology and consequences. *Eur Geriatr Med*. 2021;12(3):443-452. <https://doi.org/10.1007/s41999-021-00479-3>
3. World Health Organization. Medication safety in polypharmacy: technical report. Geneva: World Health Organization; 2019.
4. Zazzara MB, Palmer K, Vetrano DL, Carfi A, Onder G. Adverse drug reactions in older adults: a narrative review of the literature. *Eur Geriatr Med*. 2021;12(3):463-473. <https://doi.org/10.1007/s41999-021-00481-9>
5. Bringhurst K, Jones T, Runko G, Jabbari M, Zipparro N, Nghi Vo G, et al. Artificial intelligence in the management of polypharmacy among older adults: a scoping review. *Cureus*. 2025;17(8):e90867. <https://doi.org/10.7759/cureus.90867>

6. Mouazer A, Tsopra R, Sedki K, Letord C, Lamy JB. Decision-support systems for managing polypharmacy in the elderly: a scoping review. *J Biomed Inform.* 2022;130:104074. <https://doi.org/10.1016/j.jbi.2022.104074>
7. Mekonnen AB, McLachlan AJ, Brien JA. Effectiveness of pharmacist-led medication reconciliation programmes on clinical outcomes at hospital transitions: a systematic review and meta-analysis. *BMJ Open.* 2016;6(2):e010003. <https://doi.org/10.1136/bmjopen-2015-010003>
8. 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. <https://doi.org/10.1093/jamia/ocae076>
9. Fabricius PK, Andersen O, Steffensen KD, Kirk JW. The challenge of involving old patients with polypharmacy in their medication during hospitalization in a medical emergency department: an ethnographic study. *PLoS One.* 2021;16(12):e0261525. <https://doi.org/10.1371/journal.pone.0261525>
10. Abdo A, Galla L, Vallecillo T, Clarenne J, Quillet P, Vuiblet V, et al. A machine learning-based clinical predictive tool to identify patients at high risk of medication errors. *Sci Rep.* 2024;14(1):32022. <https://doi.org/10.1038/s41598-024-83631-w>
11. Van De Sijpe G, Schrooten T, De Winter S, Van der Linden L, Vanbrabant P, Dompas A, et al. Development and temporal validation of machine learning models for predicting clinically relevant medication reconciliation discrepancies at the emergency department: a single-center retrospective study. *Int J Med Inform.* 2026;211:106309. <https://doi.org/10.1016/j.ijmedinf.2026.106309>
12. Wong A, Plasek JM, Montecalvo SP, Zhou L. Natural language processing and its implications for the future of medication safety: a narrative review of recent advances and challenges. *Pharmacotherapy.* 2018;38(8):822-841. <https://doi.org/10.1002/phar.2151>
13. Al Meslamani AZ. Management of polypharmacy through deprescribing in older patients: a review of the role of AI tools. *Expert Rev Clin Pharmacol.* 2025;18(6):333-345. <https://doi.org/10.1080/17512433.2025.2519648>
14. Syrowatka A, Motala A, Lawson E, Shekelle P. Computerized clinical decision support to prevent medication errors and adverse drug events: rapid review. In: *Making Healthcare Safer IV: A Continuous Updating of Patient Safety Harms and Practices.* Rockville (MD): Agency for Healthcare Research and Quality (US); 2024.
15. Van Dort BA, Zheng WY, Sundar V, Baysari MT. Optimizing clinical decision support alerts in electronic medical records: a systematic review of reported strategies adopted by hospitals. *J Am Med Inform Assoc.* 2021;28(1):177-183. <https://doi.org/10.1093/jamia/ocaa279>
16. Ng Y, Hsu JTY, Ng NNE, Ong JZE, Hsu JLJ, Sulaimi F, et al. Evaluating the role of clinical decision support systems in medication safety for older people: a systematic review. *Age Ageing.* 2025;54(7):afaf206. <https://doi.org/10.1093/ageing/afaf206>
17. Khosravi M, Zare Z, Mojtabaiean SM, Izadi R. Artificial intelligence and decision-making in healthcare: a thematic analysis of a systematic review of reviews. *Health Serv Res Manag Epidemiol.* 2024;11:23333928241234863. <https://doi.org/10.1177/23333928241234863>
18. Fahim YA, Hasani IW, Kabba S, Ragab WM. Artificial intelligence in healthcare and medicine: clinical applications, therapeutic advances, and future perspectives. *Eur J Med Res.* 2025;30(1):848. <https://doi.org/10.1186/s40001-025-03196-w>
19. Cross JL, Choma MA, Onofrey JA. Bias in medical AI: implications for clinical decision-making. *PLOS Digit Health.* 2024;3(11):e0000651. <https://doi.org/10.1371/journal.pdig.0000651>

20. Morley J, Machado CCV, Burr C, Cowls J, Joshi I, Taddeo M, et al. The ethics of AI in health care: a mapping review. *Soc Sci Med.* 2020;260:113172. <https://doi.org/10.1016/j.socscimed.2020.113172>
21. Amann J, Blasimme A, Vayena E, Frey D, Madai VI; Precise4Q Consortium. Explainability for artificial intelligence in healthcare: a multidisciplinary perspective. *BMC Med Inform Decis Mak.* 2020;20(1):310. <https://doi.org/10.1186/s12911-020-01332-6>
22. Freyer N, Groß D, Lipprandt M. The ethical requirement of explainability for AI-DSS in healthcare: a systematic review of reasons. *BMC Med Ethics.* 2024;25(1):104. <https://doi.org/10.1186/s12910-024-01103-2>
23. Tun HM, Rahman HA, Naing L, Malik OA. Trust in artificial intelligence-based clinical decision support systems among health care workers: systematic review. *J Med Internet Res.* 2025;27:e69678. <https://doi.org/10.2196/69678>
24. Pham T. Ethical and legal considerations in healthcare AI: innovation and policy for safe and fair use. *R Soc Open Sci.* 2025;12(5):241873. <https://doi.org/10.1098/rsos.241873>
25. Murthi S, Martini N, Falconer N, Scahill S. Evaluating EHR-integrated digital technologies for medication-related outcomes and health equity in hospitalised adults: a scoping review. *J Med Syst.* 2024;48(1):79. <https://doi.org/10.1007/s10916-024-02097-5>
26. 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. <https://doi.org/10.1016/j.ijmedinf.2022.104983>
27. Vo V, Chen G, Aquino YSJ, Carter SM, Do QN, Woode ME. Multi-stakeholder preferences for the use of artificial intelligence in healthcare: a systematic review and thematic analysis. *Soc Sci Med.* 2023;338:116357. <https://doi.org/10.1016/j.socscimed.2023.116357>