Artificial Intelligence in Clinical Drug Decision-Making: Transforming Personalized Therapeutics

Vivek Jaiswal, *Akanksha Dwivedi and GN Darwhekar

Acropolis Institute of Pharmaceutical Education and Research, Indore, (M.P.) –Indian

ABSTRACT

Artificial Intelligence (AI) has emerged as a transformative technology in clinical medicine, particularly in drug decision-making and personalized therapeutics. Traditional clinical decision-making often relies on clinician experience, standardized treatment guidelines, and population-based evidence, which may not adequately address patient-specific variability. AI-driven systems leverage machine learning, deep learning, and big data analytics to analyze complex clinical datasets, enabling optimized drug selection, dosing, and monitoring. This review explores the role of AI in clinical drug decision-making, highlighting its applications in personalized medicine, adverse drug reaction prediction, clinical workflow optimization, and decision support systems. The paper also discusses ethical challenges, data privacy concerns, regulatory issues, and future prospects of AI-assisted pharmacotherapy in clinical settings.

Keywords: Artificial Intelligence, Clinical Decision Support, Personalized Medicine, Drug Therapy, Machine Learning, Pharmacotherapy

1. Introduction

Clinical drug decision-making is a critical component of healthcare, directly influencing patient safety, therapeutic outcomes, and healthcare costs. Traditionally, clinicians rely on clinical guidelines, empirical evidence, and professional experience. However, increasing disease complexity, polypharmacy, and patient heterogeneity have exposed the limitations of conventional approaches.

Artificial Intelligence (AI) offers a data-driven alternative by integrating patient-specific variables such as genetic makeup, comorbidities, laboratory values, and real-time clinical data. AI-based decision support systems are increasingly being implemented to assist clinicians in selecting appropriate drugs, optimizing dosages, and predicting potential adverse outcomes. The integration of AI into clinical pharmacology represents a paradigm shift toward precision and personalized medicine.

2. Literature Review

Recent studies have demonstrated the effectiveness of AI models in improving clinical drug decisions. Machine learning algorithms such as random forests, support vector machines, and neural networks have been used to predict drug response and treatment outcomes. Deep learning approaches have shown superior performance in analyzing electronic health records (EHRs) and imaging data.

Research by Topol (2019) emphasized that AI can reduce diagnostic and therapeutic errors by augmenting clinician decision-making rather than replacing it. Other studies reported AI-assisted dose optimization in oncology and critical care settings, leading to reduced toxicity and improved efficacy. Furthermore, AI models have been successfully employed to identify drug–drug interactions and predict adverse drug reactions before clinical manifestation.

3. Methodology / Clinical Perspective

This paper adopts a **narrative review methodology**, analyzing peer-reviewed articles published between 2015 and 2024 from databases such as PubMed, Scopus, and Web of Science. Keywords included "AI in clinical pharmacology," "machine learning drug therapy," and "clinical decision support systems."

From a clinical perspective, AI systems are integrated into hospital information systems and EHR platforms. These systems analyze patient data in real time and provide evidence-based drug

recommendations. Clinicians retain final decision authority, ensuring ethical and professional accountability.

4. Applications of AI in Clinical Drug Decision-Making

4.1 Personalized Drug Selection

AI enables patient-specific drug recommendations by analyzing demographic, clinical, and genetic data. This approach minimizes trial-and-error prescribing and enhances therapeutic efficacy.

4.2 Dose Optimization

AI models predict optimal drug dosages based on renal function, age, body weight, and drug metabolism patterns, reducing the risk of toxicity.

4.3 Adverse Drug Reaction (ADR) Prediction

Machine learning algorithms can detect early warning signs of ADRs, allowing clinicians to modify treatment before serious complications occur.

4.4 Clinical Workflow Enhancement

AI-driven tools streamline clinical workflows by automating routine drug checks, improving efficiency and reducing clinician burden.

5. Results and Discussion

Evidence suggests that AI-assisted drug decision systems significantly improve prescribing accuracy and patient safety. Clinical trials and real-world studies have shown reduced medication errors and improved treatment outcomes. However, challenges such as algorithm transparency, data bias, and clinician trust remain barriers to widespread adoption.

Ethical concerns related to data privacy and algorithm accountability must be addressed through robust regulatory frameworks. Continuous validation and clinician training are essential to ensure effective AI integration in clinical practice.

6. Conclusion

Artificial Intelligence is revolutionizing clinical drug decision-making by enabling personalized, precise, and data-driven pharmacotherapy. While AI cannot replace clinical judgment, it serves as a powerful support tool that enhances decision accuracy and patient outcomes. Future advancements in AI algorithms, coupled with ethical governance and regulatory oversight, will further strengthen its role in clinical medicine.

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