

Artificial Intelligence in Pharmacogenomics: Transforming Personalized Medicine

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Abstract: *Pharmacogenomics (PGx) is a cornerstone of personalized medicine, enabling the optimization of drug therapy based on individual genetic variability. However, the expanding volume and complexity of genomic, clinical, and real-world healthcare data present significant challenges for traditional analytical methods. Artificial intelligence (AI), including machine learning and deep learning approaches, has emerged as a powerful solution for analyzing large, multidimensional datasets and extracting clinically actionable insights. The integration of AI with pharmacogenomics represents a transformative advance in precision therapeutics, with the potential to improve both drug development and patient care. AI-driven pharmacogenomics models enable the identification of genetic variants associated with drug response, toxicity, and therapeutic efficacy by capturing complex, nonlinear relationships between genetic markers and pharmacological outcomes. These capabilities enhance predictions of interindividual variability in drug metabolism and treatment response, facilitating informed drug selection, individualized dose optimization, and early identification of patients at risk of adverse drug reactions. Despite its promise, the clinical implementation of AI-assisted pharmacogenomics faces challenges related to data heterogeneity and quality, limited availability of diverse datasets, model interpretability, validation, and generalizability across populations. Moreover, ethical, legal, and social considerations—including data privacy, algorithmic bias, regulatory oversight, and acceptance by clinicians and patients—must be addressed. This review summarizes current applications of AI in pharmacogenomics, discusses key challenges and ethical considerations, and highlights future directions for advancing reliable and equitable AI-driven personalized medicine*

Keywords: Personalized medicine, Artificial intelligence, Pharmacogenomics, Precision therapeutics, Omics technology

