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Pharmacogenomics in Drug Safety: Role in Preventing Adverse Drug Reactions

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Abstract: *Adverse drug reactions (ADRs) are a major challenge in clinical practice, contributing significantly to patient morbidity, mortality, and healthcare costs worldwide. Pharmacogenomics—the study of how genetic variations influence drug response—offers a promising approach to predict, prevent, and manage ADRs through individualized therapy. Genetic polymorphisms in drug-metabolizing enzymes, transporters, receptors, and human leukocyte antigens (HLAs) can alter drug absorption, distribution, metabolism, and elimination, resulting in variable efficacy and toxicity among individuals. This project provides a comprehensive review of the growing role of pharmacogenomics in enhancing drug safety. Key genes linked to ADRs, such as CYP450 isoenzymes (CYP2D6, CYP2C9, CYP2C19), TPMT, UGT1A1, VKORC1, and HLA-B alleles, are discussed with examples of drugs affected by these genetic differences. Clinical implementation strategies, available FDA pharmacogenomic biomarkers, and global guidelines from CPIC and DPWG are summarized. Despite challenges such as high testing costs, lack of clinician awareness, and ethical concerns, pharmacogenomics holds significant promise in transitioning from the traditional "one-size-fits-all" approach to truly personalized medicine. Incorporating pharmacogenomic testing into routine healthcare can minimize ADRs, optimize drug dosing, and improve therapeutic outcomes. This project concludes that pharmacogenomics is a key component of future precision medicine and must be integrated into pharmacy education and clinical decision-making to enhance drug safety.*

Keywords*:* Adverse Drug Reactions", "CYP450", "Drug Safety", "Genomics", "Personalized Medicine, Pharmacogenomics

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