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PHARMACOGENOMICS: FRONTIER OF PERSONALIZED MEDICINE AND THE ROADBLOCKS AHEAD

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Inter-individual variability in drug response is common and expected to become a more pressing issue globally due to the increasing elderly population needing treatment. This variability can be attributed to genomic factors, which are studied under the field of pharmacogenomics. Gone are the days of "one-size-fits-all" approach to medicine.[1] Pharmacogenomics is revolutionizing personalized medicine by tailoring treatments based on individual genetic profiles. Genetic profiling involves analyzing whether a patient is going to respond to a particular medication or not based on their genetic information. Genetic determinants that affect drug absorption, distribution, metabolism, and clearance are discovered through this process. For example, variants in genes like CYP2D6, CYP2C19, SLCO1B1, and UGT1A6 are known to alter the metabolism of various drugs, including antidepressants, anticoagulants, statins, and antiepileptics.[2,3]

There are many potential benefits of pharmacogenomics. By understanding an individual's genetic makeup, clinicians can tailor therapies to optimize treatment. This approach allows for more precise diagnoses and the selection of medications, thereby enhancing health outcomes. A notable example of pharmacogenomics in action is the use of HER2 status in breast cancer treatment. Trastuzumab, a monoclonal antibody, specifically targets and inhibits the HER2 protein, making it an effective treatment for patients with HER2-positive tumors.[4] Genetic profiling also helps to determine patients who are at risk of adverse drug events. For instance, people possessing specific HLA alleles are known to have an increased susceptibility to severe allergic reactions to drugs such as abacavir and carbamazepine.[5] Avoiding these therapies in genetically predisposed individuals could prevent life-threatening side effects.

Pharmacogenomics can guide dose adjustments based on genetic makeup that influences drug metabolism.[6] This personalized approach could help in achieving optimal drug plasma levels, improving therapeutic response. Moreover, genetic insights can enhance drug discovery and reduce research time by identifying patient subgroups that will most benefit from a novel therapy. This can lead to designing effective clinical trials and developing targeted therapies.[7] Despite a long history and significant potential, there are multiple barriers to translating pharmacogenomics into routine clinical practice. Genetic data is machine learning-based information, its interpretation and reporting require knowledge, resources, and expertise. The existing healthcare system needs significant reforms in infrastructure to store and utilize genetic information. Moreover, clinicians require training and cooperation to integrate genomic information into their clinical decision-making.

The application of genetic data may generate some ethical concerns related to privacy, data security, and the risk of genetic discrimination.[8] Implementation of strict policies and safeguards is crucial to gaining the trust of the public and protecting private information. In addition, genetic testing can be expensive and may not be covered by insurance. Pharmacogenomics will gain widespread acceptance only if these tests become accessible to the general public. The path to personalized medicine is progressing, with pharmacogenomics at the forefront of advancing precision medicine. However, to fully harness its potential and address the associated challenges, meaningful collaboration among the research, clinical, policy, and patient communities will be needed.

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