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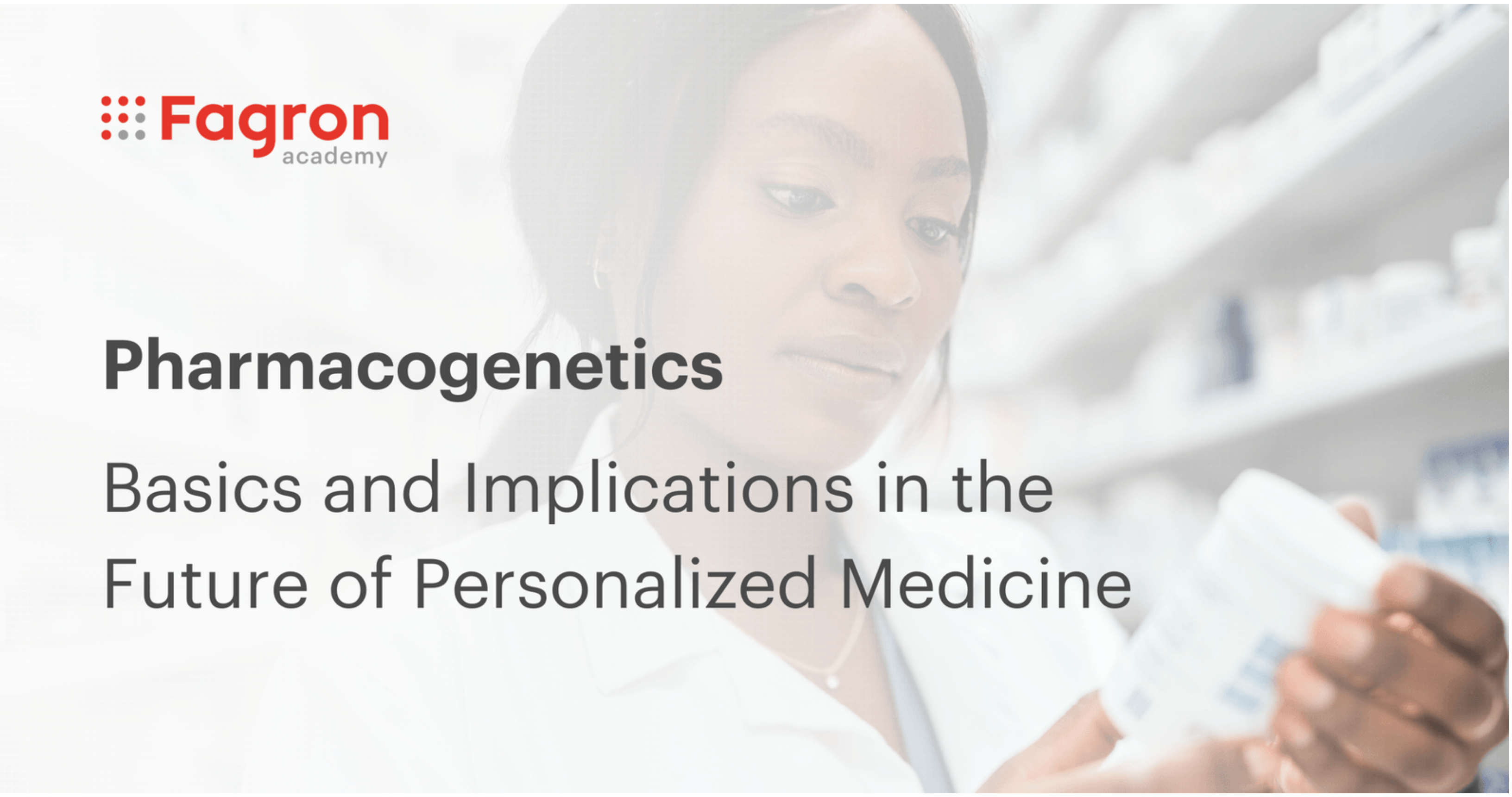

Pharmacogenetics

Basics and Implications in the Future of Personalized Medicine

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Pharmacogenetics is the study of how genetic differences influence individual responses to medications. Originating in the 1950s, this field has grown significantly, evolving alongside advances in genomic research. Pharmacogenetics now plays a crucial role in personalized medicine, allowing healthcare providers to tailor drug therapies to each patient's unique genetic makeup. This approach not only improves the efficacy of treatments but also reduces the risk of adverse drug reactions (ADRs), making pharmacogenetics an essential component of modern healthcare.

The importance of pharmacogenetics lies in its ability to predict how patients metabolize drugs and determine the most appropriate dosage for each individual. By accounting for genetic variations, particularly in drug-metabolizing enzymes such as CYP2D6and CYP2C19, healthcare providers can adjust drug doses to ensure optimal therapeutic outcomes. For example, certain patients may require lower doses of warfarin due to variations in the VKORC1 gene, which influences their sensitivity to the drug. Without this adjustment, such patients might experience an increased risk of bleeding. In this way, pharmacogenetics helps improve pharmacotherapy by minimizing trial-and-error dosing and reducing the likelihood of under dosing or overdosing.

Pharmacogenetics is also crucial in avoiding side effects, which are often caused by an individual's genetic makeup affecting how they process medications. Variants in genes such as CYP2D6 can lead to either rapid or poor metabolism of drugs like codeine, resulting in either insufficient pain relief or dangerous toxicity levels. Similarly, pharmacogenetic testing helps prevent severe ADRs, e.g.: hyper sensitivity reactions. For instance, patients carrying the HLA-B57:01* allele are at high risk for a life-threatening reaction to abacavir, an HIV drug. Testing for this genetic marker ensures that only safe and effective treatments are prescribed. Key genetic markers play a significant role in pharmacogenetics, particularly those involved in drug metabolism and immune response. The CYP450 family, including enzymes such as CYP2D6, CYP2C9, and CYP2C19, is one of the most studied groups in this field, affecting the metabolism of a wide range of drugs, from antidepressants to cardiovascular medications.

In clinical practice, pharmacogenetic testing is increasingly used to optimize prescriptions, particularly in areas like oncology, cardiology, and psychiatry. By determining the right drug and dose for each patient based on their genetic profile, clinicians can avoid harmful side effects while improving treatment efficacy. In psychiatry, pharmacogenetic testing is applied to guide antipsychotic prescriptions, where genetic differences in metabolism can lead to significant variability in drug response. Despite its benefits, widespread implementation of pharmacogenetics still faces challenges, including cost, regulation, and the need for healthcare infrastructure to support genetic testing on a larger scale.

Looking ahead, the future of pharmacogenetics promises even broader applications. As genetic testing becomes more accessible, it is expected that pharmacogenetic data will be integrated into electronic health records, allowing for real-time guidance on medication choices. Research continues to expand our understanding of gene-drug interactions, offering the potential for more comprehensive genetic panels that cover a wider range of medications. Ultimately, pharmacogenetics holds the potential to make healthcare more precise, efficient, and patient-specific, leading to better outcomes and reduced healthcare costs.

References

1. Roden, D. M., McLeod, H. L., Relling, M. V., Williams, M. S., Mensah, G. A., Peterson, J. F., & Van Driest, S. L. (2019). Pharmacogenomics. The Lancet. doi:10.1016/S0140-6736(19)31276-0.
2. Saadullah Khani, N., Hudson, G., Mills, G., et al. (2024). A systematic review of pharmacogenetic testing to guide antipsychotic treatment. Nature Mental Health, 2, 616–626. https://doi.org/10.1038/s44220-024-00240-2
3. Kabbani, D., Akika, R., Wahid, A., Daly, A. K., Cascorbi, I., & Zgheib, N. K. (2023). Pharmacogenomics in practice: A review and implementation guide. Frontiers in Pharmacology, 14:1189976. https://doi.org/10.3389/fphar.2023.1189976.
4. Verbelen, M., Weale, M. E., & Lewis, C. M. (2017). Cost-effectiveness of pharmacogenetic-guided treatment: Are we there yet? The Pharmacogenomics Journal, 17, 395–402. https://doi.org/10.1038/tpj.2017.2
5. Chang, W.-C., Tanoshima, R., Ross, C. J. D., & Carleton, B. C. (2021). Challenges and opportunities in implementing pharmacogenetic testing in clinical settings. Annual Review of Pharmacology and Toxicology, 61:65-84. https://doi.org/10.1146/annurev-pharmtox-030920-025745.
6. Daly, A. K. (2017). Pharmacogenetics: A general review on progress to date. British Medical Bulletin, 124(1), 65–79. https://doi.org/10.1093/bmb/ldx035.

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