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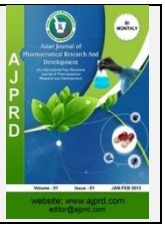

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Review Article

Pharmacogenomics of Anticancer Medicines: Mechanisms, Clinical Applications, and Future Perspectives

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A B S T R A C T

Pharmacogenomics has become a vital tool in oncology, guiding the selection and dosing of anticancer medicines based on genetic makeup. Genetic variations in drug- metabolizing enzymes, transporters, and target genes play a pivotal role in determining therapeutic response and toxicity [1]. This review summarizes current understanding of pharmacogenomics in cancer treatment, highlighting key mechanisms, biomarkers, and clinical applications [2]. It also discusses challenges in implementing pharmacogenomics in routine practice, particularly in developing countries, and suggests future directions for integrating pharmacogenomics into personalized medicine strategies [3].

Keywords: Pharmacogenomics, Anticancer medicines, Genetic Polymorphism, Personalized Medicine, Oncology, Biomarkers

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INTRODUCTION

Cancer remains a major global health burden, and despite therapeutic advances, responses to anticancer agents vary widely [4]. Pharmacogenomics—a field combining pharmacology and genomics—aims to personalize treatment by linking genetic profiles profiles to drug efficacy and safety [5]. Variations in genes encoding metabolic enzymes, transporters, and targets are responsible for inter individual differences in drug response [6]. Advancements in next-generation sequencing (NGS) and bioinformatics have made genomic profiling more accessible in clinical oncology [7].

Mechanisms of Pharmacogenomic influence in Cancer Therapy

Genetic variations can modify pharmacogenomic profiles by altering how drugs are absorbed, distributed, metabolized, and eliminated, as well as how they interact with specific biological receptors or enzymes. [8]. Major metabolic enzymes such as the cytochrome P450 family (CYPs), thiopurine methyltransferase (TPMT), and uridine diphosphate glucuronosyl transferases (UGTs) play crucial roles in determining how drugs are processed within the body. [9]. Variants in CYP2D6 and UGT1A1 notably affect the metabolism of tamoxifen and irinotecan, thereby influencing both therapeutic effectiveness and potential toxicity [10].

Clinical applications of pharmacogenomics

Pharmacogenomic testing helps optimize drug therapy, minimize toxicity, and improve clinical outcomes [11]. FDA-approved pharmacogenomic labels guide the use of drugs such as tamoxifen, irinotecan, and mercaptopurine [12]. In India, initiatives such as the Indian Pharmacogenomics Network (Indi Gen) promote the use of genetic data to enhance personalized medicine [13].Examples of pharmacogenomic biomarkers in cancer therapy include UGT1A1–irinotecan (predicts neutropenia), CYP2D6–tamoxifen (predicts efficacy), TPMT–thiopurines (predicts hematologic toxicity), EGFR–gefitinib/erlotinib (predicts response), and KRAS–cetuximab/panitumumab (predicts resistance) [14].

Challenges and barriers

Challenges in pharmacogenomic implementation include limited awareness, lack of infrastructure, high test in gcosts, and insufficient genomic data from diverse populations [15]. Ethical issues, data privacy concerns, and integration into electronic health systems are additional hurdles [16]. Further research is required to identify population-specific variants affecting anticancer drug response in India [17].

Future perspectives

Integrating pharmacogenomics with artificial intelligence and big data analytics promises to revolutionize oncology [18]. Machine learning models can predict patient-specific drug responses based on genomic profiles [19]. Future strategies include developing low- cost testing platforms and creating region-specific pharmacogenomic data bases to ensure equitable access [20].

CONCLUSION

Pharmacogenomics holds great potential for optimizing anticancer therapy. Understanding genetic variations affecting drug metabolism and target response can minimize toxicity and enhance therapeutic benefit [21].Collaboration between clinicians,

researchers, and policy makers is essential to translate pharmacogenomic knowledge into daily oncology practice [22].

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REFERENCES

1. Singh P,etal. Pharmacogenomics in cancer therapy:current updates and clinical perspectives. Front Pharmacol, 2024; 15(1): 384-765.
2. Huang R, et al. Next-generation sequencing in pharma cogenomics-guided cancer treatment. Cancers (Basel), 2024; 16(4): 914.
3. Patel J,et al. Implementation of pharmacogenomics in oncology practice:barrier sand solutions. J Pers Med, 2023; 13(1): 55.
4. Gupta S,et al. Pharmacogenomic biomarkers in Indian cancer patients .Indian J Med Res, 2023; 158(3): 245-258.
5. Wang J, etal. Pharmacogenomic insights in to targeted cancer therapy. Nat Rev Clin Oncol, 2023; 20(6): 398-412.
6. Kim YJ, et al. Role of ABC transporters in multi drug resistance. Pharmacol Res, 2023;187: 106579.
7. ChenY, et al. Integration of AI in pharmacogenomics: a new frontier in personalized oncology. Front Oncol, 2023; 13: 1120451.
8. Kaur H,et al. Clinical applicability of CYP polymorp hismsin anti cancer therapy. Pharmacogenomics J, 2022; 22(5): 375-388.
9. Zhou X,etal. Global pharmacogenomic trends in oncology. Trends Cancer, 2022;8(10):755- 767.
10. LiJ,et al .KRAS mutations and resistance mechanisms intargeted therapies. Cancer Drug Resist, 2022; 5: 423-437.
11. Das A,et al. Irinote can pharmacogenomics :clinical applications and challenges.J Oncol Pharm Pract, 2022; 28(3): 514-523.
12. Arora V,etal. Population-specific pharmacogenomics in India.Pers Med,2021;18(8):777- 790.
13. Singh R,et al.Cost-effectiveness of pharmacogenomic testing in oncology. Pharmacoeconomics, 2021; 39(6): 681-694.
14. Johnson JA,et al.The role of pharmacogenomics in clinical oncology practice. Nat Rev Cancer, 2021; 21(9): 582-599.
15. Banerjee P,et al. Pharmacogenomics and personalized cancer therapy: current progress. Mol Cancer Ther, 2021; 20(4): 571-585.
16. Almarzouqi A, et al. Ethical and privacy challenges in pharmacogenomics implementation: a global perspective. Pharmacogenomics J, 2023; 23(2): 145–156.
17. Ramesh V, et al. Genetic diversity and population-specific pharmacogenomic variants in Indian patients: implications for precision oncology. Indian J Med Res, 2023; 158(4): 512–520.
18. Chen Y, et al. Artificial intelligence and big data analytics in pharmacogenomics: transforming personalized medicine. Front Oncol, 2023; 13: 1150349.
19. Gupta R, et al. Machine learning approaches to predict drug response in cancer using genomic profiles. Brief Bioinform, 2024; 25(1): bbad429.
20. Patel N, et al. Developing low-cost pharmacogenomic testing platforms for equitable healthcare access. J Pers Med, 2024; 14(2): 231.
21. Johnson JA, et al. The role of pharmacogenomics in clinical oncology practice. Nat Rev Cancer, 2021; 21(9): 582–599.
22. Banerjee P, et al. Translating pharmacogenomics into clinical practice: multidisciplinary collaboration for improved cancer outcomes. Mol Cancer Ther, 2023; 22(5): 481–491.