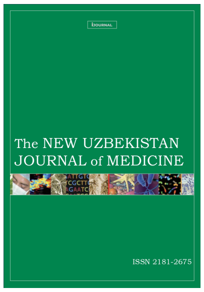


The New Uzbekistan Journal of Medicine (NUJM)

Available online at: https://ijournal.uz/index.php/nujm/index
Volume I, Issue II, 2025
ISSN: 2181-2675

AI-BASED SELECTION OF PERSONALIZED CANCER THERAPY

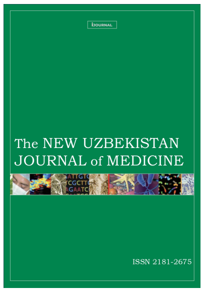
Fazliddin Arziqulov, Sayfullayeva Dilbar Izzatillayevna, Maxsudov Valijon Gafurjonovich

Assistant, Department of Biomedical Engineering, Informatics, and Biophysics,
Tashkent State Medical University, Tashkent Uzbekistan

Abstract

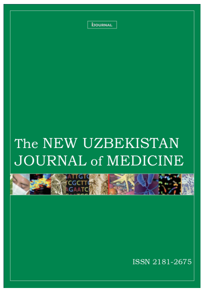
Cancer therapy has evolved from standard, one-size-fits-all regimens to personalized approaches tailored to individual patient profiles. Despite advances in genomics and precision medicine, selecting the optimal therapy remains challenging due to tumor heterogeneity, complex molecular interactions, and patient-specific factors. Artificial Intelligence (AI) provides a transformative solution by integrating multi-dimensional biomedical data—including genomics, transcriptomics, proteomics, imaging, and clinical history—to guide personalized treatment selection. This thesis examines AI-based systems for cancer therapy selection, highlighting computational methodologies, clinical applications, advantages, challenges, and future directions. AI-driven approaches have demonstrated improved accuracy in therapy prediction, enhanced patient outcomes, and reduced treatment-related toxicity, representing a paradigm shift in precision oncology.

Keywords: Cancer Therapy, Artificial Intelligence, Precision Oncology, Personalized Medicine, Genomics, Machine Learning, Predictive Modeling.



Introduction. Cancer remains a leading global health challenge, accounting for millions of deaths annually and presenting a highly heterogeneous disease landscape. Traditional treatment strategies often involve standard chemotherapy, radiotherapy, or immunotherapy regimens, which may not account for the unique molecular, genetic, and clinical characteristics of individual patients (Sullivan & Breen, 2017). The concept of precision oncology aims to tailor therapies to patient-specific tumor profiles; however, the integration of diverse datasets to inform therapy selection is complex and often exceeds human analytical capacity (Esteva et al., 2019). Artificial Intelligence offers advanced computational tools capable of analyzing large-scale, multi-dimensional biomedical datasets to identify optimal therapeutic strategies. This thesis explores the role of AI in personalized cancer therapy selection, emphasizing machine learning (ML) and deep learning (DL) methods, clinical applications, and the challenges of implementation.

Main Body. AI-based selection of personalized cancer therapy relies on the integration of heterogeneous datasets encompassing genomic, transcriptomic, proteomic, metabolomic, imaging, and clinical information. Machine learning algorithms, including supervised, unsupervised, and reinforcement learning models, can identify complex patterns and correlations between molecular features and therapy response (Kourou et al., 2015). Deep learning architectures, such as convolutional neural networks (CNNs) and recurrent neural networks (RNNs), enable the analysis of high-dimensional data, including radiomic features from imaging modalities such as MRI, CT, and PET scans. Natural language processing (NLP) techniques are employed to extract critical information from unstructured clinical notes, pathology reports, and research literature, enhancing the comprehensiveness of AI models. Supervised ML models are commonly trained on annotated datasets in which therapy responses are known, allowing the identification of predictive biomarkers and therapy-specific response signatures. Random forests, support vector machines, and gradient boosting methods have been successfully applied to predict responses to targeted therapies, immunotherapies, and chemotherapeutic regimens (Zhang et al., 2020). Deep learning models can capture nonlinear interactions among genes, proteins, and clinical variables, improving predictive accuracy for complex treatment outcomes (Miotto et al., 2016). Reinforcement learning frameworks have also been explored to simulate sequential therapy decisions, optimizing treatment plans based on predicted patient outcomes over time. In clinical practice, AI-based therapy selection has demonstrated significant potential. In breast cancer, AI models integrating genomic, transcriptomic, and clinical features have accurately predicted responsiveness to hormonal therapies, targeted inhibitors, and combination regimens, enabling clinicians to avoid ineffective treatments and reduce toxicity (Kourou et al., 2015). In lung cancer, AI algorithms have analyzed multi-omics data and imaging features to guide the selection of targeted therapies and immunotherapy agents, achieving higher response rates and improved survival outcomes compared to conventional approaches (Esteva et al., 2019). AI-driven systems can also identify novel therapy combinations, uncover resistance mechanisms, and prioritize patients for clinical trials, advancing translational research and personalized oncology. The advantages of AI-based therapy selection include increased accuracy in predicting treatment outcomes, minimization of adverse effects, and acceleration of clinical decision-making. Automated AI systems reduce the cognitive burden on clinicians,



providing evidence-based recommendations derived from complex datasets that are otherwise difficult to analyze manually. By continuously learning from new patient data, AI models can adapt and refine therapy recommendations, supporting dynamic and responsive clinical management. Integration with electronic health records (EHRs) and clinical decision support systems facilitates seamless adoption in hospital and research settings (Rajkomar et al., 2019). Despite its promise, AI implementation in personalized cancer therapy faces challenges. Data quality, completeness, and standardization are essential to prevent biased or inaccurate predictions (Char et al., 2018). Privacy and regulatory concerns arise when handling sensitive genomic and clinical data, requiring compliance with HIPAA, GDPR, and other international standards. Algorithmic transparency and interpretability are critical to clinician trust and patient acceptance, particularly for high-stakes treatment decisions. Additionally, disparities in healthcare access and representation within datasets may exacerbate inequities if not carefully addressed in model development and deployment (Topol, 2019). Future developments in AI-driven personalized therapy include integration of multi-omics, wearable sensor, and real-world clinical data to improve predictive accuracy. Federated learning approaches can enable cross-institutional collaborations without compromising patient privacy, enhancing dataset diversity and generalizability. Explainable AI frameworks will further enhance model interpretability, supporting informed clinical decision-making and increasing confidence in AI-guided therapy selection. Continued research in this domain has the potential to revolutionize oncology by making personalized, data-driven therapy selection a standard of care.

Conclusion. AI-based selection of personalized cancer therapy represents a transformative advancement in precision oncology, integrating genomic, clinical, and imaging data to inform individualized treatment strategies. By accurately predicting therapy responses and optimizing treatment plans, AI improves patient outcomes, reduces adverse effects, and supports evidence-based clinical decision-making. Challenges related to data quality, privacy, algorithmic transparency, and equitable access must be addressed to ensure ethical and effective implementation. Ongoing research and technological innovation promise to expand the scope of AI-guided therapy selection, ushering in a new era of personalized cancer care and improved patient survival.

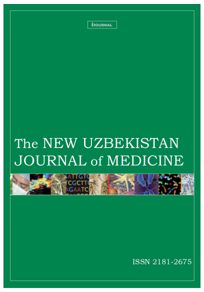
References

Char, D.S., Shah, N.H. and Magnus, D. (2018) ‘Implementing Machine Learning in Health Care — Addressing Ethical Challenges,’ New England Journal of Medicine, 378(11), pp. 981–983.

Esteva, A. et al. (2019) ‘A Guide to Deep Learning in Healthcare,’ Nature Medicine, 25, pp. 24–29.

Kourou, K., Exarchos, T.P., Exarchos, K.P., Karamouzis, M.V. and Fotiadis, D.I. (2015) ‘Machine Learning Applications in Cancer Prognosis and Prediction,’ Computational and Structural Biotechnology Journal, 13, pp. 8–17.

Miotto, R., Li, L., Kidd, B.A. and Dudley, J.T. (2016) ‘Deep Patient: An Unsupervised Representation to Predict the Future of Patients from the Electronic Health Records,’ Scientific Reports, 6, 26094.



Rajkomar, A., Dean, J. and Kohane, I. (2019) ‘Machine Learning in Medicine,’ New England Journal of Medicine, 380, pp. 1347–1358.

Sullivan, R. and Breen, R. (2017) Cancer: A Comprehensive Overview. London: Academic Press.

Topol, E.J. (2019) Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again. Basic Books.

Zhang, Y., Jiang, J., Chen, Z. and Zhang, Y. (2020) ‘Machine Learning Approaches for Predicting Chemotherapy Response in Cancer Patients,’ Frontiers in Oncology, 10, 550.