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AI IN ONCOLOGY: FROM GENOMICS TO CLINICAL APPLICATIONS

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ABSTRACT

AI (Artificial Intelligence) has the potential to revolutionise the diagnosis, treatment, and management of cancer. This paper highlights how AI applications in genomics and clinical contexts have advanced recently, highlighting how they might improve diagnostic precision and tailor treatment plans. This study illustrates the novel techniques AI provides to cancer, such as enhanced genomic data analysis and patient monitoring, by analysing new findings. Examining these developments points to bright potential paths for incorporating AI into oncology procedures to improve patient outcomes.

Keywords: Artificial Intelligence, Convolutional Neural Networks, Perceptron, Machine Learning, Natural Language Processing.

1. INTRODUCTION

Artificial intelligence (AI) is the umbrella term encompassing a variety of technological developments that allow robots to carry out tasks like learning, reasoning, and problem-solving that would normally need human intelligence. Because cancer is a complicated disease with variable patient responses to treatment and varied genetic variants, artificial intelligence (AI) has become increasingly important in oncology (Sebastian et al., 2022). AI can offer creative answers to the complex problems in cancer diagnosis and therapy, including handling the enormous volumes of data produced by genetic sequencing and imaging (Zodwa Dlamini, et. Al., 2020). AI systems can analyse enormous datasets quickly by using machine learning and deep learning techniques. This makes it easier to identify important biomarkers and improves diagnosis accuracy. (Mohamed Khalifa, et al., 2024)

Furthermore, by combining genomic data with clinical information, AI makes it possible to create customised treatment plans, which eventually improves patient outcomes. As research develops, the application of AI to oncology has enormous potential to improve patient outcomes by optimising workflows.

1. Genomic Data Analysis

The study of genomic data has been revolutionised by AI techniques, especially machine learning (ML) and deep learning (DL), which have made it possible to identify important mutations and variations linked to different types of cancer. For instance, a recent study proved the usefulness of deep learning algorithms in predicting breast cancer susceptibility based on genomic profiles, with an accuracy of over 90% (Mostavi, M. et al., 2020). Moreover, multi-omics data may now be integrated into AI models, leading to a more thorough understanding of tumour biology (Cai, Z. et al., 2022).

1.1 AI in Mutation Detection

Large genomic datasets have demonstrated the potential for mutation detection by AI systems. Using a convolutional neural network (CNN) method, whole-genome sequencing data was analysed to find novel mutations in pancreatic cancer that were previously missed by traditional techniques (Ma, H. et al., 2020).

2. Clinical Applications

AI is being incorporated into healthcare workflows more and more to help with patient management, diagnosis, and therapy planning. (T. Davenport and colleagues, 2019)

2.1 Diagnosis

AI algorithms applied to imaging modalities have dramatically improved early cancer detection. According to a meta-analysis, the sensitivity of breast cancer screenings could be increased by up to 15% with AI-enhanced radiological evaluations (Kizildag Yirgin, I. et al., 2022). These systems leverage radiomics to extract quantitative information from imaging data, permitting better discrimination between malignant and benign tumours.

2.2 Treatment Planning

A fundamental component of contemporary oncology is personalised medicine. AI algorithms that examine genomic data in conjunction with clinical characteristics enable oncologists to adapt therapy to specific patients. According to

their genetic profiles, melanoma patients can benefit from personalised immunotherapy combinations recommended by AI, which has been shown in a recent study to increase response rates (Knight, A. et al., 2023).

2.3 Patient Monitoring

Applications with AI capabilities are being created for mobile health and wearable technology to monitor patients in real time. By monitoring side effects and medication compliance, these technologies enable prompt interventions. According to research, AI-driven monitoring can boost treatment outcomes and increase patient involvement (Yelne S. et al., 2023).

3. Drug Discovery and Development

AI is also playing a significant role in drug discovery, notably in finding novel therapeutic targets. A recent study streamlined the process of identifying candidates for clinical trials by using machine learning algorithms to detect drug interactions (Singh, S. et al., 2023). Furthermore, by forecasting patient enrolment and retention rates, AI can improve clinical trial designs and boost the effectiveness of drug development procedures (Stefan Harrer et al., 2024).

4. Ethical and Regulatory Considerations

The application of AI in cancer is posing ethical issues such as algorithmic bias and data privacy. To reduce bias, it is crucial to make sure AI systems are created and verified utilising a variety of datasets (Ueda D, et al., 2024). In order to address these issues and guarantee patient safety while encouraging innovation, regulatory frameworks are also changing (Ciro Mennella et al., 2024).

5. Future Directions

New developments in artificial intelligence (AI), such advanced analytics and natural language processing (NLP), have the potential to improve oncology procedures even more. While big data analytics can spot population health patterns and guide public health initiatives, natural language processing (NLP) can expedite clinical documentation and enhance patient communication (Alanazi, A. et al., 2023).

2. CONCLUSION

Artificial intelligence (AI) has the potential to revolutionise cancer by increasing the precision of diagnoses, individualised treatment plans, and simplifying patient care. To fully realise the promise of AI in oncology, oncologists, data scientists, and AI specialists must continue their research and work together.

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