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Artificial Intelligence-based Advancements in Oncological Studies

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ABSTRACT

Machine learning and artificial intelligence (AI) have greatly impacted the healthcare system in many ways. Technological advancement has made it possible to analyze large datasets quickly and manageably. Artificial intelligence helps in early diagnosis, finding novel therapeutic targets and biomarkers, and evaluating drug resistance. Precision oncology's future has been entirely altered by the advent of next-generation sequencing (NGS) systems, which help in risk assessment, early disease recognition, sequencing-based diagnosis, medical imaging, precise prognosis, identification of biomarkers, and therapeutic targets for new drug discovery. These AI-powered applications advance cancer prognostication and diagnosis using NGS and high-resolution medical imaging. Notwithstanding technological advancements, AI has difficulties and constraints, and the clinical use of NGS needs further validation. Precision oncology and artificial intelligence have a bright future if innovation and technology go further.

Introduction

Artificial intelligence (AI) and machine learning (ML) have significantly impacted humanity during the past ten years. They have applications in various aspects, including manufacturing, communications, engineering, and healthcare (1,2). Although the terms are sometimes used interchangeably, AI and ML are not the same since AI applications enable computers to learn automatically from the data provided by identifying patterns with minimum indoctrination. ML is a subset of AI that mimics or creates human intelligence in machines. Machine learning (ML) methods, such as neural networks, are designed to harness machines' capacity for learning to solve problems and make decisions (3). Neural networks' primary job is to mimic the human brain's ability to detect and comprehend input data, including images, classify it with low error rates, and make decisions. A subset of machine learning called deep learning is further improved to augment AI's accuracy. Robotics, imaging, drug development, diagnostics, and precision therapeutics are just a few of the many fields in which deep learning has important and useful applications. Patients with cancer can receive the appropriate treatment based on their genetic diversity, thanks to precision medicine. Patients can receive tailored therapy through genomic screening procedures according to their genetic variables (4). AI can be beneficial when evaluating large datasets produced by genetic screening for precision medicine. AI is being utilized in the medical field to enhance patient outcomes through novel approaches related to oncology diagnosis and treatment (5).

Precision oncology and artificial intelligence in healthcare

Technology advancements *Viz*; image processing algorithms, next-generation sequencing (NGS), health records of patients, large clinical trial data, and disease prediction, will change healthcare in the future because of large-scale digital data generation. The role of AI in oncology includes prognostications for future events, early detection, and customized or targeted therapy through the acquisition of the patient's genetic information. Pattern recognition and sophisticated algorithmic skills of AI can be used to obtain pertinent clinical data, reducing errors in diagnosis and treatment. Machine learning is a useful technique in precision therapy and oncology. Complex neural networks (CNNs) are useful in genetic analysis data and diagnostic picture generation, which can be used to predict treatment outcomes and the likelihood of disease (6).

Molecular profiling and NGS

Cancer, a complex illness, is characterized by extensive genetic abnormalities. NGS has made finding these abnormalities and mutations in cancer-causing genes possible. With the use of NGS, genomic sequencing is developing quickly for therapeutic applications, and genomic profiling is a viable option for precision oncology in the future. The Sanger sequencing method, a first-generation sequencing technique with expensive expenses and poor data output, was originally started in 1977. The Sanger approach of sequencing requires time-consuming fragment cloning. NGS technology and bioinformatics advanced quickly, and 2nd generation sequencing techniques emerged.

Biomarkers for prognostic prediction, disease initiation, and diagnosis

Molecular biomarker identification is significant for early disease prevention and prognostic prediction for successful treatment; cancer management can be enhanced. By identifying germline mutations in DNA and analyzing the entire transcriptome by RNA sequencing, novel molecular biomarkers for various malignancies can be deciphered (7). Prominent collaborative research initiatives like the Atlas of Cancer Genome (ACG) have demonstrated the potential of RNA-sequencing in identifying biomarkers for diagnosis and serving as a prognostic indicator. The ACG project was started to identify alterations and shifts in the genomic pathways of different forms of cancer (3). With precise knowledge of the genomic landscape of these oncological conditions, including the pathological pathways of cancers, the molecular mutations-based tumor subtypes classification, and the identification of therapeutic aims to guide drug discovery and development, the TCGA project aimed to improve precision oncology. The findings demonstrated that certain cancer forms had similar molecular characteristics despite differences in tumor biology.

Medical imaging with artificial intelligence (AI) for cancer

In the healthcare department, deep learning algorithms have been recognized as an effective medical imaging tool for illness management, diagnosis, and monitoring. Applications of AI are critical in radiology for many modalities with increased quality, including ultrasounds, X-rays, magnetic resonance imaging (MRI), computed tomography (CT/CAT), positron emission tomography (PET), magnetic resonance imaging (MRI), digital pathology, in most oncology-related diagnoses. Highly specialist algorithms are used to examine images more quickly and accurately. Accurate diagnosis depends in large part on the ability to distinguish between normal and aberrant medical images. It is particularly crucial for cancer detection at an early stage because it will improve the prognosis. AI has advanced image quality, computer-aided image interpretation, and radiomics in medical imaging; in the future, AI in medical imaging will concentrate on increasing efficiency and lowering costs (8).

Radiography-based Imaging

The main advances and improvements in AI for healthcare have been extensively implemented for practical usage in medical imaging. Accurate diagnosis and treatment depend on extracting pertinent quantitative data from medical images, which can be time-bound and subject to human error. This quantitative data includes size, symmetry, position, volume, and form. It can present an additional difficulty in the case of complex malignancies. For clinical therapeutics, automated techniques for analyzing medical images are very important. Three strategies, including

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registration, segmentation, and visualization, must be fulfilled to analyze medical images accurately.

Medical imaging has advanced; however, there are still difficulties because of problems with validation, object and data complexity, and intricacy. In contrast to 2D images, which are usually processed slice by slice, 3D image processing adds a spatial dimension and yields additional information, making it more effective than 2D image processing. However, the difficulty in analyzing 3D images lies in the high contrast and resolution needed to block any artefacts and noise. The anatomical features that obstruct the target of interest in examination imaging make the analysis more challenging. These issues are addressed by recent developments in machine learning and deep learning, which provide improved computational techniques that can analyze enhanced image quality and accuracy for optimization of clinical decisions (9).

Digital Pathological Evaluation

Beyond radiology, AI is used in medical imaging. Digital pathology will soon be available, completely changing pathology labs. For many years, the conventional procedure in pathology involved the microscopy of stained cells and tissues. Artificial intelligence (AI) and technological advancements will transform pathology by reducing labour-intensive micro workloads, improving efficiency, and preserving quality for better clinical treatment. By standardizing methods, artificial intelligence (AI) in pathology advances workflow, enables doctors to inspect images for precise interpretation and lowers subjectivity.

Additionally, digital pathology makes larger-scale image viewing and less variable colour information possible. In this manner, it is feasible to successfully find distinct markers linked to disease-specific biomarkers for diagnosis, prognosis, and treatment. Research findings and those required to provide the pathology community with safe and dependable AI are still far apart. The collaborative efforts of various stakeholders, such as scientists, physicians, industrialists, regulatory bodies, and patient support groups, can effectively close this gap. Interestingly, most deep learning algorithms are called "black boxes" because they are accused of being unable to explain their choices despite the fast-expanding benefits of AI algorithms; clinical, legal, and regulatory challenges still need to be clarified. At this stage, AI is unlikely to displace pathologists because the two groups complement rather than compete. Humans are still considered superior to machines or systems in information acquisition, even though AI will continue to make decisions in various domains by considering multiple aspects.

Translational oncology and artificial intelligence
Cancer Therapy

Multidrug resistance is a basic component that presents a significant therapeutic problem and is crucial to managing illness outcomes. Finding new genes and biological mechanisms that cause medication resistance can help. These genes and pathways are usually good for developing and finding new drugs. Several epigenetic changes may also contribute to medication resistance (5). For example, it has been demonstrated that therapeutic resistance develops in ovarian and breast tumours that are positive for the estrogen receptor. Because of the tumour's aggressive biology, the disease's progression and recurrence, and metastasis, ESR1-related cancers typically have a poor prognosis. ESR1 mutations are a crucial biomarker for managing ER + breast tumours since they can predict prognosis and change available therapy options. In a similar vein, mutations or altered gene expressions have been linked to the development of drug resistance to chemotherapy in more than 50% of relapsed patients. Most patients face a recurrence of ovarian cancer within two years due to developed drug resistance, and the standard treatment strategy involves surgery followed by neoadjuvant chemotherapy. In individuals with advanced illness, neoadjuvant therapy is associated with resistance to platinum-based treatment. Apoptosis to avoid drug-induced cytotoxicity tumour migration. P-glycoprotein, the p53 pathway, the mismatched DNA repair process, and multidrug resistance-associated protein are the proposed molecular pathways that cause drug resistance in ovarian cancer. Activation of the ATR-Chk1 pathway causes resistance to treatments based on platinum. The ATR-Chk1 pathway will be hampered by ROS inhibition, which will also reverse acquired drug resistance. This data was collected by RNA-sequencing and quantitative high throughput combinational screening (qHTCS) based on NGS technology. Aberrant RNA splicing signatures can also be found by RNA sequencing using NGS. Drug resistance can be reversed, and new therapeutic approaches can be employed by focusing on the splice variants that increase drug resistance. Sufficient screening to find critical candidate biomarkers that can evade these molecular processes would advance our understanding of medication resistance and enhance the treatment plan for the best possible results.

Drug discovery

While the market's available NGS technologies have improved healthcare utility, recent advancements in AI have led to the creation of new devices that improve time and cost efficiency and the delivery of high-throughput data. Recent research on glioblastoma in humans has shown that molecular events are exclusive to certain regions. This investigation found that the pseudo-palisading cells had higher levels of growth factor signalling pathways than the tumour. The overexpressed genes are linked to the advancement of the disease, making them prospective targets for glioblastoma treatment (8). The LCM-RNAseq has shown some encouraging results, but its clinical applicability is still limited and needs more validation.

TCGA, the biggest genome program, used the therapeutic advantages of NGS to contribute significantly to drug development. The investigation's two outcomes were the discovery of novel targets for upcoming drug development and the identification of particular genetic abnormalities as targets of presently marketed medicines. As a result of these findings, the National Cancer Institute (NCI)-USA launched the Lung-MAP clinical study, which offers patients with lung squamous cell carcinoma a changeable treatment regimen based on their genetic variations.

Artificial intelligence and precision oncology's therapeutic benefits

The benefits of AI in healthcare are now widely known, and new advancements are happening quickly. AI implementation must be on par with or significantly superior to human intervention through well-integrated AI systems in clinical practice. NGS offers numerous advantages for identifying prognostic or predictive biomarkers in a clinical context. Over the last ten years, NGS has seen significant changes that have improved sequencing throughput, quality, cost, and turnaround time. NGS has combined platforms for both lengthy and short reads. The short readings are useful in precision medicine for population screening and identifying variations with clinical benefits. On the other hand, lengthy reads are used to accomplish full-length isoform sequencing. New possibilities for precision cancer targeting therapeutics will become clearer thanks to advanced algorithms and their capacity to evaluate extremely complicated datasets. Furthermore, digital pathology and medical imaging are effective technologies that provide accurate, timely, and exact diagnostic and predictive outcomes.

References

[1] Ahmad A, Tariq A, Hussain HK, ... Equity and Artificial Intelligence in Surgical Care: A Comprehensive Review of Current Challenges and Promising Solutions. BULLET J … [Internet]. 2023;02(02):443–55. Available from: https://journal.mediapublikasi.id/index.php/bullet/article/view/2723%0Ahttps://journal.mediapublikasi.id/index.php/bullet/article/download/2723/1180

[2] Ahmad A, Hussain HK, Tanveer H, Kiruthiga T, Gupta K. The Intelligent Heart Rate Monitoring Model for Survivability Prediction of Cardiac Arrest Patients Using Deep Cardiac Learning Model. In: 2023 International Conference on Intelligent Systems for Communication, IoT and Security (ICISCoIS). 2023. p. 376–81.

[3] Habehh H, Gohel S. Machine learning in healthcare. Curr Genomics. 2021;22(4):291.

[4] Ahmad A, Tariq A, Hussain HK, Yousaf Gill A. Revolutionizing Healthcare: How Deep Learning is poised to Change the Landscape of Medical Diagnosis and Treatment. J Comput Networks, Archit High Perform Comput. 2023;5(2):458–71.

[5] Khan M, Shiwlani A, Qayyum MU, Mannan A, Sherani K, Hussain K, et al. AI-POWERED HEALTHCARE REVOLUTION : AN EXTENSIVE EXAMINATION OF INNOVATIVE METHODS IN CANCER. 2024;03(01):87–98.

[6] Dias R, Torkamani A. Artificial intelligence in clinical and genomic diagnostics. Genome Med. 2019;11(1):70.

[7] Khan M, Mannan A, Sherani K, Qayyum MU. ISSN 3025-7409 (Media Online) REVOLUTIONIZING HEALTHCARE : THE IMPACT OF ARTIFICIAL INTELLIGENCE ON PATIENT CARE , DIAGNOSIS , AND TREATMENT ISSN 3025-7409 (Media Online). 2024;1(5):779–90.

[8] Hussain HK, Tariq A, Gill AY, ... Transforming Healthcare: The Rapid Rise of Artificial Intelligence Revolutionizing Healthcare Applications. BULLET J … [Internet]. 2022;01(02):171–80. Available from: https://journal.mediapublikasi.id/index.php/bullet/article/view/3063%0Ahttps://journal.mediapublikasi.id/index.php/bullet/article/download/3063/1449

[9] Hardy M, Harvey H. Artificial intelligence in diagnostic imaging: impact on the radiography profession. Br J Radiol. 2020;93(1108):20190840.