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Oncology's Present, Future, and Ethical Challenges with Artificial Intelligence

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Abstract— ***Experts have anticipated the promise of highly individualised oncology care using artificial intelligence (AI) technology since the field's start. Numerous scientific advancements have made this promise a reality, including enhanced deep learning and machine learning algorithms, deeper multiomics databases, and lower costs for massively parallelized computer power. There are examples of effective clinical applications of AI across the cancer continuum and in transdisciplinary practise, with computer vision-assisted image analysis in particular having a number of U.S. Food and Drug Administration-approved uses. Natural language processing to predict health trajectories from medical records, virtual biopsies, whole blood multicancer detection via deep sequencing, and advanced clinical decision support systems that incorporate genomics and clinomics are some of the techniques with growing practical utility.***

Index Terms— ***artificial intelligence, cancer diagnosis, oncology, deep learning.***

I. INTRODUCTION

It has long been anticipated that applying Artificial Intelligence to simplify the complicated facets of medicine will be a revolutionary and disruptive innovation. Its roots can be seen in clinical decision support systems (CDSS), which mandated that people manually select the traits to be included in these expert systems and define rules for decision-tree techniques in the 1970s. The statement by Schwartz et al2 in the New England Journal of Medicine, which was published in 1987, is all the more poignant given that it stated, "After hearing for several decades that computers will soon be able to assist with difficult diagnoses, the practising physician may well wonder why the revolution has not occurred." An "AI winter" that lasted several decades in medicine prevented widespread use of the technology. Although there is reason for hope given the present pace of practice-changing AI implementation, the introduction of deep learning (DL), increased cloud computing and processing power, as well as a rise in the volume of digital health care data that is machine-accessible (such as electronic health records, medical imaging, and medical literature). The term AI refers to a vast area of CSE where algorithms or machines are created to mimic person's intellect.7 In the domain of AI known as machine learning (ML), computers carry out predetermined tasks while using statistical techniques to find hidden patterns in the data and enhance model performance. In contrast to standard ML, the ML area of DL does not rely on human-defined heuristics to solve problems. Instead, DL uses the strength of multilayered NN (neural networks) to enable self-discovery of features that humans are unaware of or didn't expect, as well as to automate the process of feature extraction. Convolutional neural networks, a type of deep learning, have accelerated the development of applications which are AI-based, particularly in the area of medical imaging.

A branch of artificial intelligence called "natural language processing" (NLP) tries to blend human language with computer understanding. It is used to discretize unstructured data into discrete data objects, including clinical notes from EHRs and reports on procedures or diagnostic tests. Beyond these constraints, it is equally important to consider the context in which the research is applied and how it is used, as "AI in medicine" may refer to use-cases that are familiar to practising oncologists, such as advanced CDSS, translational gene-expression and multi-omics cancer profiling, and fundamental scientific drug discovery. Additionally, it can include the ongoing development of chatbots that interact with patients, surgical robots, and augmented reality surgical visualisation tools. The automation of CDSS using ML and NLP algorithms is expanding, and the integration of these algorithms into EHR processes is likely to hasten this process. The tools and algorithms that directly help the treatment of cancer patients will be the focus of this investigation because there are so many potential applications for artificial intelligence in oncology.

II. APPLICATION OF AI IN CANCER GENOMICS

Evidence-based scoring systems are frequently employed in oncology for cancer risk assessment, disease diagnosis, prognostic staging, treatment, and surveillance monitoring. Often, these systems started out as simple light microscopy observations and developed as more complex testing, including gene expression analyses and accessible next-generation sequencing of somatic and germline genomes. This modernization has led to an increase in prognostic and predictive qualities pertinent for certain diseases, as evidenced by the rising use of clinical models based on genomic data. While increasing the potential resolving capabilities of the accompanying modelling algorithms, each extra predictor makes a model more complex and creates a web of relationships among new and established illness components that are unexplainable using standard approaches.

To enhance precision oncology and offer a trustworthy evaluation of a person's cancer state, researchers and physicians should make use of any data which will enable the complexity of the computer model to approach the complexity of the biologic system. Due to its use of cutting-edge DL techniques and high-performance processing, AI is the only technology that is realistic for syncing the quantity and dependency of such multimodal data. Whole blood pan-cancer detection by deep sequencing is a cutting-edge method for cancer screening.

Its easy accessibility and the fact that all bodily cells have some sort of connection to the circulatory system, whether directly or indirectly, whole blood is appealing for examination. The examination of circulating tumour cell-free DNA for cancer screening, detection, and recurrence surveillance has advanced as a result of the major advancements made in its identification for cancer prognostication. The combined incidence of less frequent malignancies may make a pan-cancer screening test desirable by enabling an affordable technique to aid in their earlier diagnosis.

III. CANCER RELATED IMAGE ANALYSIS APPLICATIONS OF ARTIFICIAL INTELLIGENCE

Oncologic radiographic imaging uses AI for firstly detection and diagnosis. Historically, CAD (computer-aided detection) has been used for breast cancer imaging, but there hasn't been much evidence of a clinical advantage. As a result, AI-based cancer detection has focused mostly on breast cancer imaging. For instance, AI-based models are currently often utilised in various practises for clinical breast imaging. There are at least five algorithms for breast imaging detection and diagnosis that have received approval from the US Food and Drug Administration.

AI-based detection and diagnosis are currently applied for a number of tumour types in addition to breast cancer. Multiparametric MRI, for instance, is known to improve clinically meaningful malignancy diagnosis in prostate cancer, however problems like interobserver variability still exist.

Through ML algorithms, AI-based detection has the ability to address these difficulties. Commercially available methods for prostate segmentation, lesion identification, and workflow integration are also available.44

AI-based imaging algorithms are also utilised in healthcare settings to locate and monitor possibly malignant tumours and direct treatment. Examples include carefully identifying and tracking pulmonary nodules, including therapy recommendations, and identifying lesions on low-dose CT scans that are likely to be lung cancers. All of them are made possible by software that has received FDA (Food and Drug Administration) approval. Additionally, deep neural networks have been created to improve the detection of colonic polyps during colonoscopy using a real-time DL computer-aided detection system that has been authorised by the U.S. Food and Drug Administration (GI Genius, Medtronic), as well as to detect enlarging lymph nodes or colonic polyps in CT images. Additionally proven to consistently improve accuracy in esophageal cancer identification is AI-assisted enhanced image interpretation of endoscopic images.

IV. LIMITATIONS TO ARTIFICIAL INTELLIGENCE MODEL DEVELOPMENT AND APPLICATION IN ONCOLOGY

A major barrier to the development of AI models is the absence of organized data on cancer-related health, as well as a lack of standards in the gathering and storage of unstructured data in an EHR or unified data platform from a single health care system. Because it restricts interoperability and the vast flow of health data and information, the absence of standards across healthcare systems and global communities is even more significant. The Minimum Common Oncology Data Elements programme developed standardized nomenclature and descriptions for commonly used patient- and tumor-related features, disease status categories, and therapy actions in order to solve this.

Its implementation necessitates significant information technology and systems resources, and its viability for use in everyday clinical practice is still being investigated. Other techniques for collecting standardized, patient-generated health data include validated questionnaires and patient-reported outcomes.66 These data are frequently routinely recorded as part of clinical trials or standard practice, but they can also be extracted directly from the EHR utilizing NLP or asynchronous electronic interactions. Additionally, patient-reported outcomes can be effective survival prognostic markers. These tools might also offer various advantages for cancer treatment, research, and clinical operations, but they might also add to the administrative work required by clinical care teams, patients, and their carers.

To reduce duplication of effort and maximize the accuracy of data collection, a multidisciplinary approach will be required for their clinical implementation. These standardized data management and gathering systems should ideally exist before AI models are created.

Medical experts find it challenging to accept AI technology because of the mechanism's "black box" character, which is commonly discussed. This is particularly true for deep learning (DL) and neural network-based systems, which rely on intricate hidden layers of data interaction.

V. CONCLUSION

With the rapid advancement of computing power, the availability of machine-readable EHRs, multiomics, and medical imaging data, as well as developments in deep learning, particularly convolutional neural networks, the development and use of AI algorithms and CDSS in cancer-related imaging analysis, genomics, and clinical practise across the cancer continuum have been revolutionised. Many malignancies are expected to be detected early and the origin of the tumour will be identified thanks to continuing research supporting the application of AI to cancer genomes. This may alter cancer screening procedures and improve cancer survivors' surveillance programmes, particularly for uncommon and rare cancers. Further advancements in imaging-based ML may also lead to the construction of models that assess the risk for various cancer types, enhance the accuracy of malignancy diagnoses, or predict related morbidity and mortality.

Early AI capabilities that are just now becoming accessible within the EHR are now helping cancer practitioners, and there is no lack of clamour for potential consequences.51,109,110 Imagine each patient's health as a digital image to better understand the value of AI in cancer. By using investigations that are grounded in understandable pathophysiology to carefully elucidate particular pixels strewn throughout, medicine tries to interpret this image pixel-by-pixel. In the meanwhile, AI adopts a holistic approach, beginning as a vague approximation but becoming more precise as databases, algorithms, and computing power advance.

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