NEWS & VIEWS

Artificial Intelligence in Cancer Research

Chandra Kishore[1] and Priyanka Bhadra[2]

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The analytical power of artificial intelligence can revolutionize the field of cancer research, diagnosis, and treatment by analyzing the huge raw data available in biomedical science. In this review, we have discussed current challenges, development, and future perspectives of artificial intelligence in cancer research.

Key words: Artificial intelligence, Machine learning, Cancer research

The enormous data generated after the genome sequencing driven human genome project and cancer genome project have accumulated tremendous information that requires powerful computational tools to handle and make sense of it [1]. The enormous potential power harnessed through artificial intelligence can completely transform the way we diagnose and manage cancer. The novel applications of artificial intelligence in preclinical and translational research have drastically increased in recent times leading to unexpected progress in digital pathology and diagnostics and also catalyzing drug discovery research [3]. AI has been applied in multi-omics studies, phenotypic identification, and classification, finding clinical patterns and collecting behavioral data from the wearable devices [4,5]. The expectations from AI for improvement in diagnosis, prognosis, and therapy of cancer are very high but this is limited by the biases in training datasets, heterogeneity of the cancer cells, and availability of external validation cohorts. Multiple molecular dysregulations and defects in complex signaling networks induce the initiation and development of cancer [6]. The omics data which includes the mutational signature, epigenetic alterations, transcriptional output, levels of protein expression, etc includes very heterogenous data and it has a noisy background some time giving a confusing or conflicting result. Sophisticated computational algorithms and programs can perform an integrative analysis of the raw data that can generate a testable hypothesis and link the genetic variations to the ripple effects on the pathways giving rise to cancer. Machine learning is a data-driven method and it is not influenced like researchers with biases of prior knowledge and it provides an unbiased result from the raw data of the experiments. Hence AI complements the low throughput, hypothesis-driven approaches to have a deeper insight into the biological pathways implicated in cancer development. It also helps in a more comprehensive understating of the pathophysiology at the molecular level. Computational prediction of network and pathways had helped in revealing the normal and oncogenic behaviors of the cells. AI can help in the systematic direction of the experiments and in the generation of hypothesis about the signaling pathways, driver gene identification, drug target identification, and provide a system-level and molecular-level understanding of cancer. These approaches can weigh individual datasets and generate a genome-wide functional map from thousands of diverse experiments or it can integrate various signaling molecular pathways to give a holistic view of the processes and generate more targeted and pathway level models [7]. Machine learning is also being used in cancer immunotherapy. From the images which are obtained from CT and MRI as well as from the tissue slides, AI can help in understanding the recognition pattern [8]. In future AI can help in understanding the tumor-immune interaction, resistance to immunotherapy, and mechanistic perspectives of combination therapy [9]. Machine intelligence can also have a wider scope such as: (i) Therapy response can be monitored by longitudinal noninvasive monitoring, (ii). immunogenicity of neoantigens can be predicted, (iii) it

1 Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow-226014, India
2 Medical Device Company, Kolkata, India
E-mail: [1]ckcanres@gmail.com, [2]priyanka.bhadra.2021@gmail.com

can help in the integration of multimodal data. AI can also help in understanding sequencing data and understanding the spatial information of distribution and infiltration of immune cells in the tumor. The transfer learning of data integration can help in transferring data from one data type to another data type. Development of novel deep learning methods can help in data integration and sufficient learning and testing data can be generated. Machine learning efforts in computer vision for biomedicine is hugely going to impact cancer research [10]. It can match and even go beyond the human eyes and assessment for pathological investigations. Machine learning-based diagnostic systems can assist the expert or even can replace humans in the future. These techniques will increase the efficiency of the pathologist and help them with repeated boring jobs and allow them to focus on more serious tests. It will also decrease the time for diagnosis and giving results. Computer vision systems are developed not only to assist but directly to get engaged in the diagnosis and prognosis of the diseases [11]. Mutation status has been shown to get detected in pathology images by machine learning [12]. Advanced computer vision will help identify rich heterogeneity in similar-looking cancer tissues and help in personalized targeted therapy for the tumor. Deep learning models can also help extracting differences in response to drug-treated and untreated cancer cells [13]. It can also help extract information from the unstained cells which might help save economic resources and exposure to harmful chemicals. Diagnostic machine learning can be combined with demography and genomics data in the coming years to improve the treatment and outcome of the diseases. Accurate diagnosis and early detection as well as the study of response in patients can decrease the mortality of the patients. Machine learning has been applied in pathology, gynecology, radiology, urology, and dermatology for assisting the technicians and helping improve the lives of patients. The malignant and benign tumors are used to train deep neural networks using the images of MRI and CT scans to detect patterns in the data for comparison and diagnosis. Recently neural network was trained to detect skin cancer and it was shown to compete with the physicians [14]. Successful convergence of artificial intelligence and digital pathology is also shown by furcating patient survival, improving Gleason scoring, predicting driver mutations [15]. So, it helps doctors in diagnosing and patients for better survival. It will help in early detection. It will help with new solutions for early detection and accurate diagnostics. In the future for skin cancer, a smartphone with deep learning can help detect early signs of mole getting converted into cancer. Home-based diagnostic tools can be developed which will help in spotting cancer at the early stages. Health care footprints of millions of individuals store in electronic health records when combined with machine learning can improve understanding of cancer onset and recurrence. Machine learning can replace current imperfect screening guidelines with more intelligent, personalized recommendations for health monitoring. It can also help avoid false-negative and false-positive cases. Blood parameters, BMI, pain and digestion, infection, and other factors can be combined with machine learning to generate non-imaging signatures of different cancers and combine them with radiological examinations. Counterfactual interference can be applied for malignancies where many possible treatments are available and there is a lot of variation between clinicians and patients' outcomes [16]. Machine learning can help in improving screening, diagnosis, and management of cancer from patients of different ethnic backgrounds and diverse genetic backgrounds. Environmental factors, social circumstances, behavior, and other phenotypic factors play a very important role in cancer development and these can be integrated into mobile and other wearable and implanted devices by machine learning to properly monitor the different aspects of human physiology and its relation to the disease. Connected devices and sensors in cities can capture another parameter like pollution and noise and these ever-growing data can be monitored and managed by machine learning. Mobile phones are very widely gadgets now and skin and pancreatic cancer that can be screened by phone cameras give hope that machine learning algorithms along with cameras can be further used in the future for preliminary screening and monitoring of disease and especially in countries with poor resources and health infrastructure. Machine learning can also act as a personal assistant for patients to guide them for taking medicines on time, suggesting the required changes in lifestyle, advising on symptoms management, and when to contact the doctor.

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Author's biography

Dr. Chandra Kishore was born at Madhubani district of Bihar, India in the year 1987. He

earned his MSc in Zoology and Epigenetics from Hindu College, New Delhi and Department of Zoology, University of Delhi. He did his PhD in Cancer Biology from Department of Biotechnology, Indian Institute of Technology Madras in 2020. Currently, he is working as Research Associate at Sanjay Gandhi Postgraduate Institute of Medical Sciences, Lucknow, Uttar Pradesh. During PhD tenure, his work was focused on Wnt signaling pathway in colorectal cancer and screening of anticancer drugs and their molecular mechanism. His major research interests are cell signaling, anticancer drugs, stem cells, organoids, epigenetics and immunotherapy, majorly focused on colon cancer and pancreatic cancer. He has cleared joint UGC-CSIR-NET-JRF in Life Sciences, GATE in Life Sciences, and received UGC CAS Scholarship. He has published many international journal papers .

Dr. Priyanka Bhadra did her MSc in Biotech-

nology, with specialized in Recombinant DNA Technology. After finishing her MSc, she pursued a Master of Technology in Bioinformatics, with a specialization in Drug Designing, Genomics, Proteomics, Pharmacogenomics, Cheminformatics, and Computer-based structural biology from DOEACC society, Jadavpur University, West Bengal. She had qualified for a n ational level exam for entrance into Ph.D. programs, CSIR-UGC-NET-JRF (Life sciences), and joined in Jadavpur University, Department of Metallurgical Engineering for pursuing her research on Nanotechnology. She had developed a unique nanostructure name as "Vitrabid" to study the Vitamin encapsulation in natural polymer and control release. She did her four years and three months Post Doctorate Fellowship program at IIT Madras, Department of Electrical Engineering and Biotechnology, and continued her research work on NEMS and MEMS study and biosensing application. During this period she learned Surface Engineering, VLSI, Cantilever Fabrication, and Nanopore Fabrication. Additionally she had done another Post Doctoral Fellowship program at University of Tokyo for six months. She had honored with Young Scientist Award 2015, Woman in Science conducted by CEFIPRA (Indo French Centre for The Promotion of Advance Research) held at IISC Bangalore. She has published 28 international journal papers and presented her research work in various national and international conferences and write a book on Covid-19. Currently she has engaged in freelance scientific article writing and on the other hand she is a co-founder and chief scientific officer of a medical device company.