



Review

A Review on Artificial Intelligence In cancer Treatment

Arati R. Gavit^{1*}, Rutuja S. Deshmukh¹, Vrushali D. Bhabad¹, Raj P. Chitte¹, Yashoda R. Surywanshi¹

¹Swami Institute of Pharmacy, Abhona, Nashik, Maharashtra, India.

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*Corresponding author:

Arati R. Gavit,

aartigavit546@gmail.com

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Abstract:

Artificial intelligence [AI] applications have transformed healthcare. AI aims to mimic human cognitive functions. It is bringing a paradigm shift to healthcare, powered by increasing availability of healthcare data and rapid progress of analytics techniques. We survey the current status of AI applications in healthcare and discuss its future. AI can be applied to various types of healthcare data [structured and unstructured]. Popular AI techniques include machine learning methods for structured data, such as the classical support vector machine and neural network, and the modern deep learning, as well as natural language processing for unstructured data. Major disease areas that use AI tools include cancer, neurology and cardiology. Over the past decade, artificial intelligence has contributed substantially to the resolution of various medical problems, including cancer. In recent years, Artificial intelligence emerged as transformative forced in healthcare, revolutionizing patient care through smart technology solutions. This paper explores the profound impact of AI in patient care, particularly in the realms of novel approaches to cancer medicine. On the basis of a large quantity of medical data and novel computational technologies, AI has been applied in various aspects of oncology research and has the potential to enhance cancer diagnosis and treatment. In this thorough review, we explore the multifaceted role of AI in cancer medicine, highlighting its potential applications, challenges, and future directions. AI holds enormous promise for revolutionizing patient care and improving outcomes when integrated into various aspects of cancer medicine, including drug discovery and development, early detection and screening, and drug discovery. In this review, we introduced the general principle of AI, summarized major areas of its application for cancer diagnosis and treatment, and discussed.

INTRODUCTION:

Health systems worldwide are at a crossroads and face exponential healthcare cost developments that have far outpaced GDP growth rates to support health system sustainability. This matter was very

straightforward with the emergence of the 2019 coronavirus disease [COVID-19] pandemic and the Ukraine war. There is a combination of tight finances, elderly inhabitants, rising chronic diseases, and the strain on healthcare systems that previously

struggled to cope with increased demand for service accessibility and availability. In addition, the COVID-19 pandemic is leading to health system failure in some countries, e.g., India, Brazil, and Indonesia. There are many industries that are utilizing AI and an area that is witnessing significant attention is healthcare. Artificial intelligence [AI] generally applies to computational technologies that emulate mechanisms assisted by human intelligence, such as thought, deep learning, adaptation, engagement, and sensory understanding. Some devices can execute a role that typically involves human interpretation and decision-making. These techniques have an interdisciplinary approach and can be applied to different fields, such as medicine and health. AI has been involved in medicine since as early as the 1950s, when physicians made the first attempts to improve their diagnoses using computer-aided programs. AI techniques can unlock clinically relevant information hidden in the massive amount of data, which in turn can assist clinical decision making.

The term “cancer” was first used in medicine in the 1600s, which refers to cells that are developing abnormally and have the potential to infiltrate or spread to other parts of the body. Cancer is a complex and multifaceted disorder with thousands of genetic and epigenetic variations, especially in how they grow and divide. In a typical cell

cycle, the cells go through the process of mitosis to reproduce themselves, leading to the cell’s normal growth. Eventually, the programmed cell-death process, known as apoptosis, causes the cells to die in order to ensure controlled growth. Once this process is disordered, the cells lose its balance and grow uncontrollably to form malignant tumours invading the surrounding tissues. The cancer cell may potentially move through the bloodstream or lymphatic system to different organs of the body and continue to spread from there. There are two types of cancer cells, namely benign and malignant. Benign cells do not spread to other parts, while malignant cells metastasize and are considered to be more destructive. There are more than 500 genes known to be connected to different forms of cancer. Cancer is one of the major causes of deaths in the world, especially for adults under 70. One of the world’s most rapidly developing therapeutic fields nowadays is oncology, and there is a need to accurately diagnose cancer at an early stage to enhance patient’s survival rate. The lymphatic system or circulation can transmit these cancerous cells to those other parts of the body. Cancer research has been transformed by the emergence of big data in biomedical research. It’s second nature for scientists to deal with complex biological concerns and collect data from various sources. Research institutions are generally agreed to be incapable of producing enough

data to fit predictive and prognostic models adequately. As a result, data integration is essential for precision oncology. [1-4,14,36,29]

Use of AI in Cancer Treatment:

The diagnosis of cancer is a crucial point in patient care that affects prognosis, treatment choices, and overall results. Conventional diagnostic approaches mainly rely on imaging modalities, histopathological analysis, and molecular testing, which can take a long time and require specialized knowledge. However, in recent years, artificial intelligence [AI] has revolutionized cancer diagnosis by providing sophisticated tools and techniques to improve accuracy, efficiency, and early detection.[1,6]

Medical Imaging and Image Analysis: Medical imaging is essential for the diagnosis of cancer because it gives doctors important information about the location, size, and morphology of tumours. However, interpreting imaging studies can be difficult and need specific knowledge and training. Artificial intelligence [AI]-driven image analysis algorithms use machine learning techniques to analyze radiological images, including CT, MRI, PET, and X-rays. Moreover, AI-powered image segmentation algorithms can precisely define tumour boundaries and surrounding anatomical structures, enabling treatment planning and surgical navigation. These algorithms can automatically detect and characterize

suspicious lesions, quantify tumour size and growth rate, and evaluate treatment response.[1]

Algorithms for early detection and screening: AI-driven screening algorithms use machine learning and pattern recognition to analyse different kinds of data, such as imaging studies, biomarker measurements, and patient demographics. Early detection is crucial to improving cancer outcomes because it allows for timely intervention and treatment initiation. Artificial intelligence [AI] has demonstrated potential in enhancing the sensitivity and specificity of breast cancer screening systems, thereby decreasing false positives and needless biopsies.[1]

Interpretation of Pathology and Histopathology: Although histopathological analysis is still the gold standard for diagnosing cancer, it can be time-consuming and subjective to manually interpret histopathological slides, which can lead to variations in diagnostic precision. Histopathological analysis provides important information about tumour morphology, grade, and molecular characteristics.[1,9]

AI in Blood Cancer

On average, the human body contains five liters of blood, and your red blood cells are replaced every 120 days. Blood diseases can range from anemia, which is common, to rare disorders that affect only a few. Many different diseases affect blood. Many people

have some form of blood disease, either detected or not. In the United States alone, approximately 72,000 people have sickle cell anemia with about 2,000,000 people carrying the trait. There are 20,000 hemophilia patients in the U.S. Each year, nearly 27,000 adults and more than 2,000 children in the United States learn that they have leukemia.

Lymphomas, which represent a predominant class of lymphoid neoplasms, constitute a diverse group of malignancies resulting from the clonal expansion of lymphocytes.^{1,2} These cancers are classified into two primary types: Hodgkin's lymphoma [HL] and non-Hodgkin's lymphoma [NHL]. Hodgkin's lymphoma is further subdivided into non-classical Hodgkin's lymphoma and classic Hodgkin's lymphoma.^{1,3,4} NHL includes numerous subtypes, with the most prevalent being diffuse large B-cell lymphoma [DLBCL] [25-30%], accounting for over 30% of B-NHL cases.^[5-8] In contrast to Hodgkin's lymphoma, 90% of cases belong to the NHL category, which includes B-cell NHL [B-NHL] expressing markers CD20, CD19, or CD22, T-cell NHL [T-NHL] expressing CD3, CD4, or CD8, and natural killer [NK]/T cell NHL expressing CD56. Lymphomas can originate in any region containing lymphatic tissue, including the spleen,¹⁴ bone marrow,⁹ thymus,¹⁵ tonsils,¹⁶ and lymph nodes.

The number of hematologists are limited and in most small towns and clinics, there is not any physician. This method, therefore can be very beneficial and can be used in any general hospital, clinic and even in laboratories for primary diagnosis which can be sent to haematologists. [24,28,32,35]

Method

1. Neural Network

Neural networks are composed of simple, interconnected processing elements, called neurons, which operate in parallel. These elements are triggered by biological nervous systems. As in nature, the network function is determined largely by the connections between elements. We can program a neural network to perform a particular function by adjusting the values of the connections [weights] between elements. An artificial neuron is a simplistic representation that emulates a signal integration and threshold firing behaviour of biological neurons by means of mathematical equations. Like their biological counterparts, artificial neurons can be bound together by connections that determine the flow of information between peer neurons. Stimuli were transmitted from one processing element to another via synapses or interconnections, which can be excitatory or inhibitory. If the input to a neuron is excitatory, it is more likely that this neuron will transmit an excitatory signal to the other neurons connected to it. Whereas, an inhibitory input will most likely be

propagated as inhibitory. Commonly neural networks are adjusted, or programmed, so that a particular input leads to a specific target output. There, the network is adjusted, based on a comparison of the output and the target, until the network output matches the target. Typically, many such input/target pairs are needed to program a network. complex functions in various fields, including Neural networks have been programmed to perform pattern recognition, identification, classification, speech, vision, and control systems. Today, neural networks can be programmed to solve problems that are difficult for conventional computers or human beings. A neural network is superior at fitting functions and recognizing patterns. In fact, there is proof that a fairly simple neural network can fit any practical function. [35]

2. Conventional method

In order to show the ability, accuracy and capability of ANN applications in predicting diseases, we compared the ANN method with one of the conventional methods which can similarly do this task.[23, 24] One of these conventional methods is using statistical solutions. The statistic method that we used is the multivariable nonlinear regression method to find a relation between each disease and input data to analyze cases, as well as predicting diseases for new cases, based on the

relationships. [35]

CAR T-Cell Therapy in Blood Cancer

Immunotherapy, a therapeutic approach that aims to enhance the functionality of immune cells to eliminate neoplastic cells, has made significant advancements in oncological treatment and yielded clinically meaningful outcomes. Various immunotherapy approaches have rapidly developed, including oncolytic virus therapy, tumour-specific antigens as cancer vaccines, dendritic cell-based cancer vaccination, genetic modification of autologous tumour cells to evoke tumour-specific immune responses, the application of cytokines in cancer treatment, adoptive cell transfer [ACT], and immune checkpoint inhibitors. Advances in genetic engineering have led to numerous innovations in cancer immunotherapy, emphasizing the importance of immunotherapy in clinical applications for cancer treatment. Immunotherapy primarily focuses on activating T cells due to their potent tumour-killing capability.[32,9] Two primary categories of genetically engineered T cells exist: T-cell receptor [TCR]-engineered T cells and chimeric antigen receptor [CAR]-T cells. CAR-T cells represent one of the most cutting edge immunotherapeutic approaches for relapsed or chemotherapy-refractory B-cell NHL, particularly for patients who have shown no resolution following multiple courses of chemotherapy. Lymphoma, one of the cancer

types requiring increased attention in its treatment, still faces limitations in available medications on a global scale. As an immunotherapy tool, CAR-T cell therapy holds the promise of a significant breakthrough in the treatment of lymphoma cancer. To gain a comprehensive understanding of cancer treatment using CAR-T cell therapy technology, one must delve into detailed information and consider which types of cancer treatments should be explored and developed in future manufacturing.[32,11,35]

AI in Pancreatic Cancer:

Pancreatic cancer [PC] is the deadliest form of all cancer. The five-year relative survival rate for PC is only 11% in the USA, which is the lowest among all cancers. There were 495773 new cases and 466003 deaths from PC worldwide in 2020, accounting for 2.6% of all new cancer diagnoses and 4.7% of all cancer deaths, respectively. Most patients have non-specific first symptoms, such as jaundice, fatigue, change in bowel habits, and indigestion, that make it difficult to distinguish from non-cancer diseases. In the recent meeting of The Alliance of Pancreatic Cancer Consortia, the discussion focused on imaging methods and the use of AI for the early detection of PC.[33,34]

AI in Tumour Diagnosis in pancreatic cancer

Process Reading medical images to make judgments is essentially a problem of

recognizing complex patterns, which computers can be trained using ML models to achieve efficient and repeatable recognition. AI can play a role in several steps in medical image-based PC diagnosis, including image reconstruction, segmentation, and detection, characterization, grading of pancreatic disease based on image features. Using similar techniques, AI can also identify digitized histopathology slides. It can potentially improve the accuracy, reproducibility, and efficiency of diagnosis using histological sections. In addition, the computer can analyse biomarker information with high throughput and accuracy, thus identifying tumour-related biomarkers more efficiently and using this information for diagnosis.[33,35]

AI in Breast Cancer

Breast cancer is the second leading cause of death from cancer in women .Consequently, many governments and pharmaceutical companies have implemented large-scale interventional clinical trials to investigate both new therapeutic strategies and experimental compounds. As a result, current breast cancer guidelines generally rely on evidence from large, randomized phase III clinical trials. However, oncologists are well aware of the pitfalls associated with applying population-based data to individual patients, including challenges in predicting treatment response and prognosis at the individual

level when drawing upon trial data. Indeed, the ultimate goal of the field of personalized medicine is to match the best possible anticancer treatments to each patient, based on individual patient and disease characteristics. Of note, it is increasingly clear that response to treatment depends not only on tumour characteristics, but also on factors such as the so-called tumour microenvironment [TME] and, more broadly, on the patient's socio demographic characteristics. These features are complex and deeply intertwined; posing a challenge to clinicians' ability to predict outcomes. Breast cancer is a significant public health concern and is the leading cause of cancer-related deaths among women. Previous work has demonstrated the potential of combining the strengths of radiologists and machine learning models using ensemble learning methods, consolidating predictions from radiologists and models. [6,9,12,13,16,21,27]

AI in Lung cancer

Lung cancer is the leading cause of malignancy-related mortality worldwide due to its heterogeneous features and diagnosis at a late stage. Artificial intelligence [AI] is good at handling a large volume of computational and repeated labour work and is suitable for assisting doctors in analysing image-dominant diseases like lung cancer. Scientists have shown long-standing efforts to apply AI in lung cancer screening via CXR and chest CT since the 1960s. Several

grand challenges were held to find the best AI model. Currently, the FDA have approved several AI programs in CXR and chest CT reading, which enables AI systems to take part in lung cancer detection. The majority of the patients diagnosed with lung cancer are in the late-stage, and therefore have a poor prognosis. The future of AI applications in lung cancer could focus on integration and applications. First, because AI is a data-driven technology, scientist can integrate small datasets to create large data sets for training. However, regulations regarding data sharing are a huge obstacle for researchers. Federated learning, a method that shares the trained parameters rather than sharing the data, is a simple solution. In federated learning, the models were trained at each different hospitals separately and only the trained models were sent to the main server, so that the main server does not touch the raw data directly. The final model was then reported back to individual hospitals. Apart from improvement in model accuracy by increasing the training sample size and multidisciplinary integration, another issue is the application of AI programs. Although the studies above all showed the promising results of applying AI in lung cancer and some products were approved by the FDA.[31,29,25]

AI in Prostate Cancer

Prostate cancer [PC] is the second most commonly diagnosed cancer in the male

population and it is the most common cancer type in the United States. In 2020, WHO provided cancer statistics, which showed 1,414,259 cases of PC in the complete dataset. It was also noted that PC is the most common disease among the Afro-American races. As per the National Institute of Health [NIH] data, 268,490 new cases of PC were reported in 2022, with there being 34,500 deaths worldwide. It was found that the size of the prostate gland increases with age, which is termed prostatic hyperplasia [BPH]. BPH causes symptoms such as frequent urination which is caused by the compression of the bladder due to an enlarged prostate. It affects 33% of men over 60 and 50% of men that are over 80 years old. An earlier study indicated BPH as a precursor for PC, but could not establish a clear association. This study collected articles on the applications of basic and advanced machine learning algorithms that were used for the active surveillance of, the disease staging of, the diagnosis of, and the effective treatment of prostate cancer. An artificial intelligence [AI] algorithm created by Australian researchers can detect the early symptoms of prostate cancer by analysing normal computed tomography [CT] images. The FDA has authorized the use of AI in detecting prostate cancer.[36,23]

AI in Colorectal Cancer

Colorectal cancer [CRC] is a common disease that threatens the public health. the

World Health Organization [WHO], the number of new cases of CRC in China is estimated to reach 590 thousand in 2022, more than any other countries in the world. Currently, the main diagnostic methods for CRC include laboratory tests, endoscopy, imaging and histopathology examination, etc. Traditional ways of treating CRC entail surgery, radiotherapy, and post-metastasis therapy, among others. The application of AI in CRC screening can improve the early screening rate and thus significantly reduce the incidence and mortality of CRC patients. The bioinformatics tools embedded in AI can help screen and identify more CRC biomarkers. AI assisted pathology recognition technology can help pathologists improve efficiency, reduce workload, and lower the rate of misdiagnosis and missed diagnosis. Colonoscopy has long been regarded as the gold standard procedure for diagnosing colorectal diseases, and it is strongly recommended as an early screening criterion by national associations. The treatments for CRC include surgical therapy, chemotherapy, targeted therapy, and other combined therapies. The application of AI in the treatment of CRC can design appropriate therapeutic plans for patients, providing patients with more personalized and precise medical decisions, and improving the prognosis. The prognosis evaluation of CRC patients is an important part for clinical doctors to choose appropriate treatment

plans. DL-based assisted MRI can predict the metastasis of LARC patients receiving NCRT, which is a hot topic of current research. Targeted therapy is one of the effective methods for the treatment of CRC. Abnormal mutations in genes and chromosomes can also cause drug resistance, which brings many obstacles to the treatment of CRC. AI will develop rapidly in medicine. AI-based on various algorithms that combine with multiple medical imaging big data help to improve the early detection rate and diagnosis of CRC, conducting the early and systematic evaluation of patients.[11,30,9,29]

CURRENT SCENARIO

In October 2023, India's counterpart to the US food and Drug administration the central drugs & Standard Control Organization, made NexCAR19 India's first approved CAR-T cell therapy .The approval was based on the result of two Small clinical trials conducted in India in 64 people with advanced lymphoma or leukaemia.

The pharmaceutical sector, a crucible where scientific inquiry meets humanitarian aspirations, stands at the precipice of a profound transformation propelled by AI.

Possibilities of AI in pharma are accelerated drug discovery, personalized medicine, optimized clinical trials, drug repurposing, regulatory compliance and drug safety. WHO recognizes that AI holds great promise for pharmaceutical development and delivery. However, AI also presents risks and

ethical challenges that must be addressed if societies, health systems and individuals are to fully reap its benefits.

Total number of AI-based biotechnology and pharmaceutical companies are 600.

PROSPECTS FOR THE FUTURE AND POSSIBLE CONSEQUENCES

Anticipating a bright future for transformative innovation and improvements in patient care, AI-driven cancer medicine is ripe with opportunities. Trends like multi-omics integration, explainable AI, federated learning, and patient-centric AI are likely to influence the next wave of AI-driven healthcare technologies, which will allow for more accurate, individualized, and patient-centred approaches to cancer diagnosis and treatment. Realizing the full potential of AI in oncology also requires addressing outstanding problems and obstacles like data quality, algorithmic bias, regulatory harmonization, and patient engagement. By encouraging interdisciplinary collaboration, ethical AI development, and patient participation in healthcare decision-making, we can harness the transformative power of AI to transform cancer care and enhance the lives of patients everywhere.[1]

As soon as obstacles are resolved and “AI algorithms” are confirmed by future research, AI-based models will be integrated into all aspects of healthcare. In the coming years, “oncology AI applications” will be

realized through “data intelligence”, a better knowledge of tumours, more accurate therapy alternatives, and enhanced “decision-making processes.” The field of Oncology will become a more specialized field, and individuals will receive treatment more frequently than ever.[37]

CONCLUSION:

The Path from theoretical development to particle application in the dynamic Nexus of Artificial Intelligence [AI] and healthcare represent a Paradigm shift with both Enormous promises and difficulties. The future of AI in pharmacy holds immense promise in transforming healthcare delivery and elevating patient care to unprecedented levels, Provided that challenges are effectively manage, and human touch is preserve.in summary, AI has shown great potential in revolutionizing the detection, diagnosis, and Treatment of Breast cancer, prostate cancer, lung cancer, etc. by analysing vast amount of data, AI algorithms and anomalies that may not be apparent to human Observers. These can lead to early detection of cancer, more accurate diagnosis; personalize treatment plans tailored to each individual patient. The application of AI in cancer has the potential to significantly improve outcomes and save lives.

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