International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 31, Issue 12, December 2025 ijppr.humanjournals.com ISSN: 2349-7203

A Review on AI Technology is Useful in Cancer Diagnosis and Treatment

Mr. Pavan Doifode[1], Mr. Pramod Mapari[2], Dr. Sunil Jaybhaye[3]

Institute of Pharmacy, (NKSPT) Pathrikar Campus, Badnapur, Jalna. 431202, India.
1 Student of Bachelor in Pharmacy, Dr. Babasaheb Ambedkar Technological University, Raigad, Lonere, India.
2,3 Department of Pharmacy, Faculty of Pharmacy, Dr. Babasaheb Ambedkar Technological University, Raigad, Lonere, India.

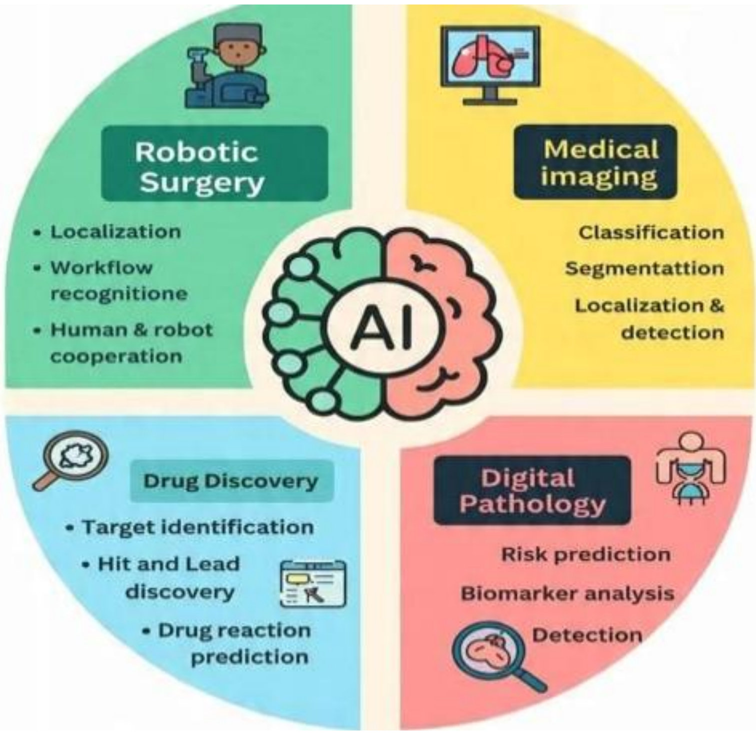
Received: 25 October 2025 Revised: 05 November 2025 Accepted: 26 November 2025

ABSTRACT

Cancer remains a paramount global health challenge, underscoring an urgent need for innovations in early detection, precise diagnosis, and personalized treatment. In response, artificial intelligence (AI) has rapidly emerged as a groundbreaking force in modern oncology. AI is poised to be a powerful ally in this endeavor, particularly as traditional screening programs and diagnostic workforces face challenges in risk stratification, patient selection, and resource constraints. In the diagnostic realm, AI is revolutionizing oncology by handling tedious, time-consuming tasks like lesion detection, thereby reducing human error and improving efficiency in screening programs. Sophisticated algorithms, particularly deep learning models, analyze complex data from a range of modalities including computed tomography, MRI, and digital pathology to identify subtle patterns imperceptible to the human eye. By correlating these imaging phenotypes with genetic and clinical data field known as radiogenomics.

2. Keywords : Artificial intelligence (AI), Machine learning(ML), Cancer diagnosis, Deep learning(DL), Treatment personalization, Pathology, Radiology.

3. GRAPHICAL ABSTRACT



It examines the role of AI in cancer care, focusing on its applications in digital pathology, medical imaging,robotic surgery, and drug discovery.

4. INTRODUCTION

Cancer remains one of the most formidable challenges in global healthcare due to its intricate nature. While medical science has advanced, achieving early detection and delivering optimally effective treatments continue to be primary obstacles. Conventional approaches to diagnosis and therapy, though valuable, frequently lack the specificity and customization required to meet the distinct biological profile of an individual's cancer. It is within this landscape that Artificial Intelligence (AI) is arising as a disruptive power, poised to fundamentally reshape the field of oncology [1].

AI technologies, including machine learning and natural language processing, are uniquely equipped to manage the intricate data and variability inherent in cancer[2].These systems thrive on analyzing immense datasets, detecting subtle correlations, and generating predictive insights capabilities that are crucial for contemporary cancer management. By evaluating medical imagery with remarkable precision, forecasting disease progression, and crafting bespoke therapeutic strategies, AI is swiftly establishing itself as a cornerstone of oncological practice.

The incorporation of AI into cancer care presents distinct benefits. It can dramatically improve the precision and efficiency of diagnostics, facilitating the identification of malignancies at earlier, more manageable stages[3].This signals a pivotal evolution from generalized treatment models toward an era of precision medicine, where interventions are meticulously tailored to the individual.

Artificial Intelligence (AI) is transforming cancer care by enhancing diagnosis, treatment, and patient outcomes. AI algorithms analyze vast amounts of medical data, identifying patterns and anomalies that may elude human clinicians. In cancer diagnosis, AI-assisted imaging and machine learning models improve accuracy and speed, enabling early detection and personalized treatment plans.AI also optimizes treatment strategies, predicts patient responses, and streamlines clinical workflow[4].

5. ARTIFICIAL INTELLIGENCE (AI) IN MODERN ONCOLOGY

Artificial Intelligence (AI) is a major branch of computer science focused on creating systems that can simulate human cognitive functions[5].A core component of AI is Machine Learning (ML), which employs statistical methods to enable computers to identify patterns in data and improve their performance on specific tasks without being explicitly programmed for every scenario.

A more advanced subset of ML is Deep Learning (DL), which utilizes multi-layered artificial neural networks. Advances in NLP now allow for the automated extraction and recording of critical clinical information, such as patient outcomes and specific tumor characteristics. This automation is instrumental in building comprehensive cancer databases and registries, which in turn provide the high-quality data needed to train more powerful and accurate AI models[6].

The practical applications of these technologies are vast. NLP and ML/DL models are already being used to match patients with suitable clinical trials and to monitor for potential adverse drug reactions. Furthermore, AI's integration into clinical decision support systems, particularly when analyzing data from high-resolution medical imaging and genomic sequencing, shows great promise for enhancing early disease detection and prognosis. The ability to process these large, complex datasets has also accelerated the discovery of new diagnostic biomarker and is paving the way for the development of highly personalized cancer treatments[7].

6. AI MULTIFACETED IMPACT ON CANCER CARE

Artificial intelligence(AI) is revolutionizing oncology at every stage, including risk assessment, early detection, tailored treatment plans, survivorship care, and the development of new therapeutics. By processing immense and intricate datasets with unprecedented speed and scale, AI improves the precision, efficiency, and reach of healthcare delivery[8].

7. IMPORTANCE OF AI IN CANCER DIAGNOSTIC AND TREATMENT

Extensive research confirms that cancer screening programs are effective for both early disease identification and reducing death rates. Nonetheless, significant challenges persist even in established screening areas such as breast cancer. Key issues involve ongoing debates over optimal participant selection and accurately weighing the benefits against the potential harms. A further criticism is that a standardized screening model is often applied, which is misaligned with the objectives of precision medicine. Moving forward, artificial intelligence (AI) is poised to refine these initiatives. Its capability to evaluate massive, diverse datasets allows it to detect subtle patterns that are typically elusive, thereby offering a path to more sophisticated and individualized screening protocols[9].

8. OBJECTIVES AND SCOPE OF THIS REVIEW

This article offers a comprehensive examination of artificial intelligence's application in contemporary cancer diagnostics, synthesizing various forms of cancer and AI-driven diagnostic methods into a unified perspective. In oncology, AI improves diagnostic accuracy, therapeutic interventions, and patient care through enhanced precision, operational efficiency, and treatment personalization. By utilizing machine learning, deep learning, and natural language processing technologies, AI systems process complex medical information including pathology findings, clinical documentation, genetic profiles, and radiographic images to produce actionable insights for more informed clinical decision-making[10].

The analysis covers both investigational AI developments and practical clinical implementations, integrating research findings, reference models, commercially available technologies, and regulatory considerations. By positioning AI as a connection between predictive analytics and precision medicine in oncology, this review aids strategic planning and promotes research initiatives that transform Al's potential into tangible clinical benefits[11].

9. ROLE OF AI IN CANCER DIAGNOSIS

While diagnosis seems more complex than basic predictive analytics, the core process is similar. AI models are learning to emulate expert clinicians by recalling vast medical knowledge, comparing scans and data, and forming diagnostic conclusions. This technology promises to enhance healthcare by speeding up diagnoses and reducing the need for invasive procedures. For example, an AI-driven ultrasound system can accurately assess thyroid lumps, potentially preventing unnecessary biopsies[12]. In another case, researchers developed a tool that identifies cancer cells too subtle or invisible to the human eye, analyzing vast datasets with remarkable speed and precision.

Furthermore, AI can be trained to scan MRIs and efficiently flag potential tumors, directing radiologists' attention to areas requiring deeper examination[13].Although widespread adoption in clinics will take time, machine learning is proving its value by performing tasks that are challenging for humans in terms of speed, scale, and sometimes even capability.

International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 31, Issue 12, December 2025 **ijppr.humanjournals.com** ISSN: 2349-7203

A. Imaging-Based AI Diagnostics:

Artificial intelligence (AI), powered by computational models and bioinformatics algorithms, is driving substantial progress in medical imaging technology (MIT).. Its capability to detect biological changes and abnormal cellular growth in the body is a key application. Traditionally, tumor assessment with radiographic imaging has relied on qualitative, or "semantic," traits. These include tumor density, how it enhances with contrast, its internal composition (such as the presence of blood, necrotic tissue, or minerals), the regularity of its margins, and its relationship to surrounding anatomy. While measurements of size and shape can be quantified, the overall profile is descriptive.

A rapidly evolving field called radiomics is shifting this paradigm. It enables the conversion of radiographic images into a wealth of quantitative data, extracting detailed descriptors of size, shape, and textural patterns. The advancement of AI, and particularly a subset known as Deep Learning (DL), has been instrumental in automating the analysis of these complex imaging patterns. A significant strength of DL is its ability to automatically learn feature representations directly from image data, often matching or surpassing human performance in specific tasks. Although it requires large datasets for training, it has also shown a degree of resilience to inaccuracies in its training labels[14].

Imaging-based artificial intelligence (AI) Diagnostics in cancer:

Cancer Type	AI Application & Function	Imaging Modality	Reported Performance / Key Finding
1.Cervical Cancer	Predicting Lymphovascular Space Invasion (LVSI)	MRI, PET/CT	Pooled AUC: 0.87 (internal), 0.84 (external); Deep learning showed higher sensitivity than standard machine learning.
2. Lung Cancer	Automated detection & diagnosis of tumors	CT	AI can improve diagnostic sensitivity for early lung cancer and assist in efficient screening.
3. Prostate Cancer	Outlining cancer suspicious areas	Multiparametric MRI	AI model acts as a "virtual expert," aiding less experienced radiologists in accurate interpretation.
4. Breast Cancer	Detection of abnormalities	Mammography	Deep learning techniques have achieved accuracies exceeding 96%, outperforming conventional methods.
5. Colorectal Cancer	Detecting polyps and adenomas	Colonoscopy	AI-assisted systems demonstrated sensitivity of 97% and specificity of 95% in detecting colorectal polyps.
6. Bladder Cancer	Predicting microscopic spread to lymph nodes	Digital Pathology	A deep learning model using tumor tissue images was more accurate than standard methods for predicting cancer spread.
7. Pancreatic Cancer	Early risk prediction	(Analysis of patient records)	AI models using disease codes can identify high-risk patients, performing as accurately as genetic tests.
8. Liquid Biopsies	Detecting rare cancer cells in blood samples Microscopy	Microscopy (Cell Imaging)	The "RED" algorithm can find 99% of added cancer cells and reduce data review by 1,000 times.

B. Pathology :

Artificial intelligence is transforming pathology. While pathologists have traditionally diagnosed diseases like cancer by manually examining tissue slides under a microscope a process prone to fatigue and subjectivity—AI now offers powerful support. AI-driven image analysis software can quickly scan samples and flag regions that may indicate disease. This technology can identify subtle cellular patterns and specific biomarkers that are often challenging for the human eye to detect consistently. Furthermore, AI helps create uniform diagnostic standards, minimizing discrepancies between different labs and leading to more reliable and consistent patient outcomes, especially in complicated diagnostic situations[15].

C. Radiology :

The shift from film-based X-rays to digital images in Picture Archiving and Communication Systems (PACS) has greatly advanced imaging research. This progress is largely driven by radiomics, a field that uses quantitative data from medical scans like CT, MRI, and ultrasonic.Radiomic analysis typically uses two methods: traditional machine learning (ML) and deep learning (DL).The traditional ML approach involves extracting specific, measurable features from areas of interest on a scan. These features describe the size, shape, and texture of a lesion and are used to train models for diagnosis and prognosis[16].

10. ROLE OF AI IN CANCER TREATMENT

While surgery, chemotherapy, and radiotherapy remain the cornerstones of cancer treatment, effective care must also consider a tumor's growth rate, potential for spread, and risk of recurrence. Personalized treatment planning is thus becoming crucial for improving patient outcomes. Artificial intelligence contributes to this personalization by optimizing the timing of follow-up tests, determining dosages for drugs and radiation, and informing the selection and sequence of therapies.

These advancements can prolong lives and increase cure rates. A key technical challenge, however, is the use of deep learning to automatically outline tumors for radiation planning, given their vast diversity in shape, location, and internal structure. Despite this difficulty, successful automated contouring significantly speeds up workflow and improves consistency across radiation oncologists[17].

Once cancer is diagnosed, choosing the right treatment is crucial. AI steps in to support doctors in customizing therapy based on: type and stage of cancer, genetic profile of the patient, and previous treatment responses[18].

Personalized treatment plans :

Following a diagnosis, creating an effective treatment plan is the critical next step. Artificial intelligence is poised to revolutionize this process by making personalized medicine a practical reality. Machine learning algorithms can sift through a patient's unique genetic profile, medical history, and other key factors to recommend the most promising treatment strategies. By focusing on the distinct biological characteristics of an individual's cancer, AI empowers clinicians to select therapies with the highest potential for success and the lowest risk of side effects.

Tools like IBM's Watson for Oncology demonstrate this potential. Such systems analyze vast datasets, including medical research, clinical trials, and patient records, to provide evidence-based, individualized treatment recommendations. In certain complex cases, AI has even uncovered viable therapy options that clinicians might have otherwise missed, offering new avenues for patients with challenging cancers[19].

However, the effectiveness of these AI systems depends entirely on the data they are trained on. If the training data lacks diversity, the algorithms can develop biases and may not perform equally well for all patient demographics. This raises a significant concern that without careful oversight, AI could inadvertently worsen healthcare disparities, leading to less accurate diagnoses or suboptimal treatments for certain groups.

Predictive analytics and prognosis :

Artificial intelligence is increasingly used to forecast patient outcomes, providing clinicians with powerful insights to shape treatment strategies. By analyzing vast datasets from historical cases, AI can detect complex patterns that signal a higher probability of positive or negative results. For instance, these algorithms can estimate a patient's likelihood of responding to a specific therapy, their projected survival time, or the potential for the disease to return after treatment. These predictive tools enable healthcare providers to customize treatment plans with greater precision, which can lead to improved patient survival and quality of life, while also optimizing healthcare resources. Furthermore, this technology empowers patients by giving them a more data-driven understanding of their prognosis, allowing them to participate more actively in decisions about their care.

11. ROBOTIC SURGERY

Artificial intelligence is now being integrated into surgical settings, significantly improving capabilities in medical imaging, surgical navigation, and robotics[20]. This advancement is set to transform surgical practice by merging real-time data from sensors with robotic systems, thereby enabling different levels of autonomy during operations.

12. HISTORY OF ROBOTIC SURGERY

Robotic systems represent a transformative advancement in surgery, with a history spanning more than two decades. The integration of sophisticated hardware and artificial intelligence has enabled these systems to assist in highly complex operations, leading to improved surgical precision and better patient outcomes[21].

Platforms like the da Vinci system have moved beyond the limitations of traditional surgery. They offer surgeons enhanced control, flexibility, and access to confined anatomical structures through robotic arms that manipulate specialized instruments. The da Vinci robot was a historic pioneer, becoming the first surgical robot to receive FDA approval in 1997. Since then, it has been used in millions of procedures worldwide. Ongoing research continues to optimize these systems; for instance, algorithms have been developed to autonomously control the da Vinci's camera for optimal visualization and zoom during operations[22].

The field continues to evolve with new entrants like Medtronic's HUGO™ RAS System, launched in 2021 as a modular alternative to existing platforms[23]. The HUGO system features an open console with a 3D display and uses independent, modular arm carts. Each robotic arm is highly flexible, featuring multiple joints, and can be vertically adjusted. The instruments are controlled via specialized motors, allowing for adaptable and versatile movement during surgery.

13. AI ROLES IN ROBOTIC SURGERY

Artificial intelligence for robotic and autonomous surgical systems can be divided into four key functional areas: perception, localization and mapping, surgical workflow recognition, and human robot interaction[24].

In the area of perception, a primary challenge is teaching AI to differentiate between natural tissue and surgical instruments. Research teams have made significant progress using deep learning. Beyond visual identification, other research has focused on providing tactile information, such as developing a wearable fabric that creates stiffness models to give surgeons haptic feedback when palpating tissues during robotic procedures[25].

Localization and mapping are crucial in cancer surgery for ensuring complete tumor removal while preserving healthy tissue. AI models are being used with fluorescence imaging to create precise heatmaps that guide surgeons to cancerous areas, as demonstrated in oral and throat surgeries. Another team created an AI model that can instantly remove visual smoke from electrocautery tools in real-time video, clearing the surgeon's view[26].

Finally, surgical workflow recognition (SWR) provides real-time operational feedback to help prevent errors and assist in training. Using a dataset of 300 surgical videos, one AI model learned to classify different phases of a complex procedure with over 80% accuracy and could distinguish between dissection and exposure actions with 83.2% accuracy. Other approaches use the tools visible in the video to recognize the surgical phase, and methods like active learning are being employed to streamline the labor-intensive data labeling process for these systems[27].

14. DISCUSSION

The integration of artificial intelligence into oncology holds immense potential, yet its successful implementation demands a balanced approach that addresses both its technical capabilities and its ethical implications. To realize this potential, sustained collaboration among AI researchers, healthcare providers, and ethics experts is paramount. This partnership is vital for creating AI tools that are not only effective but also responsible and equitable. As these technologies are adopted, continuous evaluation of their effects on patient health, treatment accessibility, and systemic costs will be essential. By confronting these issues proactively, the medical community can leverage AI to achieve transformative advances in cancer care.

15. CONCLUSION

The integration of Artificial Intelligence (AI) in cancer diagnosis and treatment has revolutionized the field of oncology, offering unparalleled opportunities for improving patient outcomes. By leveraging advanced machine learning algorithms, deep learning techniques, and natural language processing, AI is transforming every aspect of cancer care, from early detection and diagnosis to personalized treatment planning and predictive analytics. The impact of AI in cancer care is profound, enabling clinicians to make more accurate diagnoses, develop targeted treatment strategies, and improve patient survival rates. As highlighted in a seminal study by Rajpurkar et al. (2020), AI-powered deep learning models have demonstrated exceptional accuracy in detecting cancer from medical images, paving the way for the widespread adoption of AI in clinical practice and redefining the future of cancer care.

International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 31, Issue 12, December 2025 ijppr.humanjournals.com ISSN: 2349-7203

16. REFERENCES

1. Tiwari, S., et al. (2025). Artificial intelligence in cancer diagnostics and precision oncology. Molecular Cancer, 24, 159. https://doi.org/10.1186/s12943-025-02369-9
2. Esteva A, et al. Dermatologist-level classification of skin cancer with deep neural networks. Nature. 2017.
3. Jiang F, et al. Artificial intelligence in healthcare: past, present and future. Journal of Medical Systems. 2017..
4. Rajkomar A, et al. Machine learning in medicine. New England Journal of medicine. 2019.
5. Russell S, Norvig P. Artificial Intelligence: A Modern Approach. 4th ed. Pearson; 2021.
6. Savova GK, et al. Natural language processing in clinical research. Journal of the American Medical Informatics Association. 2010.
7. Kourou K, et al. Machine learning applications in cancer prognosis and prediction. Computational and Structural Biotechnology Journal. 2015.
8. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nature Medicine. 2019.
9. Majumder A, Sen D. Artificial Intelligence in Cancer Diagnostics and Therapy: Current Perspectives. Indian J Cancer 2021;58:481-92.
10. LeCun Y, Bengio Y, Hinton G. Deep learning. Nature. 2015.
11. Gupta A. The Role of AI in Cancer Diagnosis and Treatment. Eur J ClinOncol., 2024, 6(2), 001-002.
12. Song J, et al. Deep learning for classification of thyroid nodules on ultrasound images. Thyroid. 2019.
13. Litjens G, et al. A survey on deep learning in medical image analysis. Medical Image Analysis. 2017.
14. Anu Acharya ,The Role of AI in Cancer Diagnosis and Treatment. April 25, 2025.
15. Bera K, et al. Artificial intelligence in digital pathology—new tools for diagnosis and precision oncology. Nature Reviews Clinical Oncology. 2019.
16. Gillies RJ, Kinahan PE, Hricak H. Radiomics: Images are more than pictures, they are data. Radiology. 2016.
17. Cardenas CE, et al. Deep learning for automatic contouring of radiotherapy structures: a systematic review. Radiotherapy and Oncology. 2019.
18. Sebastian AM, ; Peter, D. Artificial Intelligence in Cancer Research: Trends, Challenges and Future Directions. Life 2022, 12, 1991.https://doi.org/10.3390/ life12121991.
19. Patel NM, et al. The role of artificial intelligence in precision oncology. CA: A Cancer Journal for Clinicians. 2021.
20. Yang GZ, et al. Medical robotics—Regulatory, ethical, and technical challenges. Science Robotics. 2017.
21. Lanfranco AR, et al. Robotic surgery: A current perspective. Annals of Surgery. 2004.
22. Kranzfelder M, et al. Toward increased autonomy in robot-assisted surgery. Surgical Endoscopy. 2019.
23. Medtronic. HUGO™ Robotic-Assisted Surgery (RAS) System launch. 2021.
24. Maier-Hein L, et al. Surgical data science for next-generation interventions. Nature Biomedical Engineering. 2017.
25. Hughes J, et al. Haptic feedback systems for robotic surgery. IEEE Transactions on Haptics. 2018.
26. Shademan A, et al. Autonomous suturing in robotic surgery. Science Translational Medicine. 2016.
27. Twinanda AP, et al. EndoNet: A deep architecture for recognition of surgical workflow. IEEE Transactions on Medical Imaging. 2017.

How to cite this article:
Mr. Pavan Doifode et al. Ijppr.Human, 2025; Vol. 31 (12): 249-255.
Conflict of Interest Statement: All authors have nothing else to disclose.