Cancer Therapy & Oncology
International Journal
ISSN: 2473-554X

Research Article
Volume 32 Issue 3 - July 2026
DOI: 10.19080/CTOIJ.2026.32.556338

Cancer Ther Oncol Int J

Artificial Intelligence in Precision Oncology: A Mini Systematic Review of Diagnostic and Therapeutic Applications

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Submission: June 28, 2026; **Published**: July 10, 2026

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Abstract

Introduction: Artificial Intelligence (AI) reshaping healthcare, and cancer research, defined by immense complexity of data and criticality in diagnosis, has become an important area. It is evident that there is great promise for AI applications in improving early diagnostics, achieving precision oncology, conducting prognoses, and optimizing workflows in oncology. From radiology to robotic surgery, from genomics to pathology, many areas of medicine are now using AI through different methodologies like deep learning, natural language processing, and even generative modeling. Such a scenario marks an important shift in oncology from mass methods to data-driven individualization.

Aim: The aim of this mini systematic review is to provide an overview of current applications of AI in precision oncology, with a focus on diagnostic and therapeutic applications. The review examines how AI is being utilized in cancer detection, diagnosis, treatment planning, therapeutic decision-making, and outcome prediction, and discusses emerging trends, challenges, and future directions for integrating AI into oncology practice.

Objective: The objective of this paper is to evaluate the effectiveness, benefits, and challenges of integrating AI into advanced cancer care with emphasis on its impact on diagnostic accuracy, personalized treatment, and research productivity.

Materials and Methods: A set of pre-defined keywords was used to systematically search for scientific articles in the PubMed database. The search was limited to open-access, full-text publications published in English within the last five years. Animal studies and non–peer-reviewed sources were excluded. The review followed the PRISMA guidelines and data were systematically extracted and analyzed to highlight emerging trends and research gaps in the application of AI to oncology.

Results: Of 32 identified records, the inclusion criteria selected 20 studies, which were grouped into four themes: Clinical Molecular Profiling (8), Personalized Treatment and Cellular Immunotherapy (6), Therapeutic Safety (2), and Cancer Research and Clinical Trials (4). In molecular profiling, AI enhanced genomic interpretation and biomarker discovery. The studies on personalized therapy demonstrated AI's ability to optimize CAR-T and immunotherapy treatments. The safety-focused papers showed AI's ability to predict cytokine release and neurotoxicity risks with high accuracy. Clinical trial studies highlighted its use in adaptive design and patient recruitment. Amidst such heterogeneity of data, problems with interpretability, and ethical issues, AI never failed to further precision, personalization, and efficiency in research and clinical practice across oncology.

Conclusion: AI has a lot of potential to revolutionize the field of oncology through its applications in early diagnosis, precision treatment, and efficient workflows in research. However, issues such as model interpretability, generalizability, and regulation reveal that the use of AI is meant to support the decisions made by healthcare professionals. This paper demonstrates the importance of proper validation, methodology, and regulation to guarantee safety when implementing AI into routine practice.

Keywords: Artificial Intelligence (AI); Cancer Diagnosis; Chimeric Antigen Receptor T-cell (CAR-T); Cancer Treatment; Immuno-Oncology; Machine Learning (ML); Personalized Medicine; Precision Oncology

Abbreviations: AI: Artificial Intelligence; ML: Machine Learning; CAR-T: Chimeric Antigen Receptor T-cell; GPCRs: G-protein-coupled receptors; DLL: Deep Learning; GenAI : Generative AI; CRS: Cytokine Release Syndrome

Introduction

AI can be described as computer systems that can accomplish work tasks that would normally need human intelligence skills, which may include learning from data, pattern identification, making decisions, and interpreting language or imagery [1]. It has had an impactful effect on healthcare, being a revolutionary factor responsible for driving innovation in the processes involved in detecting, diagnosing, and treating diseases. The impact of AI oncology is especially important since the treatment of cancer results in very complicated and huge datasets, which require sophisticated computer processing [2]. Through techniques such as deep learning, natural language processing, and predictive modeling, AI strengthens diagnostic accuracy, supports precision oncology, and accelerates research in personalized and immuno-oncologic therapies.

On the other hand, oncology is a branch of medicine that involves studying, diagnosing, treating, and preventing various types of cancers. The term oncology includes more than one hundred diseases characterized by abnormal cell growths, which have the ability to spread into adjacent areas [3,4]. The global statistics on cancer have shown that around 20 million cases and nine million deaths from cancer have been recorded worldwide during the year 2022, and the most common forms of cancer include lung, breast, and colorectal cancer. It is predicted that in the next three decades, the global cancer burden will rise to over 35 million new cases per year owing to aging, lifestyle changes, and risks such as smoking and obesity [5].

Treatment of cancer is still considered to be a very complicated process. Although classical treatment methods including surgery, chemotherapy, and radiation therapy have continued to constitute the core basis for the treatment of cancer, some breakthroughs have been made with new therapies being developed, which can serve as either complements or alternatives to the existing conventional ones. One such revolutionary treatment method is cellular immunotherapy, especially CAR-T therapy, which involves providing customized immune reaction targeting malignant tumors. Other promising treatment techniques include stem cell therapy, targeted therapy, ablation therapy, nanotechnology, natural antioxidants, radionics, chemodynamic therapy, and ferroptosis therapy [6].

However, various hurdles still exist despite these advancements. The potential of cancer immunotherapy has been demonstrated using the immune system to fight off tumors. However, problems have been experienced in ensuring consistency of efficacy and toxicity management such as Cytokine Release Syndrome (CRS) and neurotoxicity. Besides, the expense and complicated process involved in developing cellular immunotherapy, such as the development of CAR-T cell therapy, presents another problem that has to be addressed to make cancer immunotherapy more widely available and affordable [7]. Moreover, cancer diagnosis is hindered by the invasive nature of the procedures utilized [8]. In addition to the emergence of two major therapeutic breakthroughs such as targeted oncology using gene modifications and rise of immune oncology, there remain several major issues which complicate further improvement in cancer treatment.

These include tumor heterogeneity, acquired resistance, and difficulties in interpreting genomic big data which limit the progress made by precision oncology [9]. These issues mirror the previous discussion concerning the complexity of cancer biology, limits of available technology, and problems inherent in advanced treatment methods. The necessity to address these problems suggests that novel solutions are required which would improve upon traditional cancer treatment in terms of their capacity to deal with new demands. Such a possibility may be provided by means of AI which offers the ability to process large volumes of data to provide clinical decision support. Significant advancements have been made over the last few decades with respect to AI, from its use in rule-based expert systems to more advanced technologies like deep learning (DL) and generative AI (GenAI).

This includes the development of multi-omics models for understanding the relationship between mutations and phenotypes as well as deep learning techniques used for tumor grading and prediction of its molecular characteristics. Deep learning and other types of AI also play a vital role in radiology, where they reach a comparable level of accuracy as medical experts in computed tomography and mammography. In addition, predictive modeling is used to develop efficient clinical trials, whereas reinforcement learning is utilized in the process of drug discovery [10]. Furthermore, deep convolutional generative adversarial networks can enhance images, augment the existing data set, and virtually stain pathological tissues. Despite the wide variety of applications, a few problems remain unresolved. Individualized medicine, whereby diagnostics and molecular profiling enable the choice of the best treatment method based on each individual case, is now more than ever depending on artificial intelligence to compensate for the shortcomings associated with manual, inconsistent, and potentially prone to error prognostics and surveillance tools.

In addition, through automation of such tasks and by processing large sets of clinical and molecular information, AI reduces the chances of human error and helps tailor better treatments for patients [11]. All this shows that artificial intelligence serves a more transformative purpose in oncology than assistance one. For purposes of transparency, methodological robustness, and replicability, mini systematic review s and Meta-Analyses (PRISMA) is employed as the reporting methodology for mini systematic review and analysis of the state-of-the-art of AI applications in oncology. The paper is structured as follows: the Materials and Methods section will contain the methodology of search strategy and inclusion/exclusion criteria; the Results section will contain the theme identification process and a summary of findings from selected research; and the Discussion section will evaluate these findings in light of opportunities, challenges, and directions for future research in AI applications in oncology.

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Materials and Methods

The current study was carried out as a mini systematic review according to the PRISMA guidelines [12]. The main aim of the study was to explore the use of artificial intelligence in oncology, focusing on advanced cancer treatments (e.g., CAR-T cell therapy), treatment planning, and diagnostics. It was decided to use the PubMed database due to its broad scope of studies covering biomedical and cancer-related issues, as well as the presence of indexing through Medical Subject Headings (MeSH). A detailed literature search was conducted based on the above databases. The following inclusion criteria were adopted: peer-reviewed articles written in English and published as full-text open-access works from 2020 to 2025.

Search strategy and Study Selection

The study made use of a mini systematic review that was carried out in three stages. Using the filters and keywords relevant to the concepts of AI and oncology stated above, a thorough search of the PubMed database was carried out in the first stage of the study. From the search process, a total of 32 relevant articles were obtained. All the articles were then extracted and evaluated further in the next stage. In the second stage, the titles and abstracts of all the articles were screened to determine the relevance of the article to AI application in oncology.

In the third stage, the complete texts of the other 24 articles were reviewed using the pre-defined inclusion and exclusion criteria. To maintain transparency and the reproducibility of the article selection process, the PRISMA guidelines were used. Qualitative synthesis included only those studies which met all the inclusion criteria; articles which had little relevance with artificial intelligence were not selected. As a result, twenty articles were selected for a thorough review after the last round of screening. The entire process of identification and selection is schematically presented in Figure 1 below.

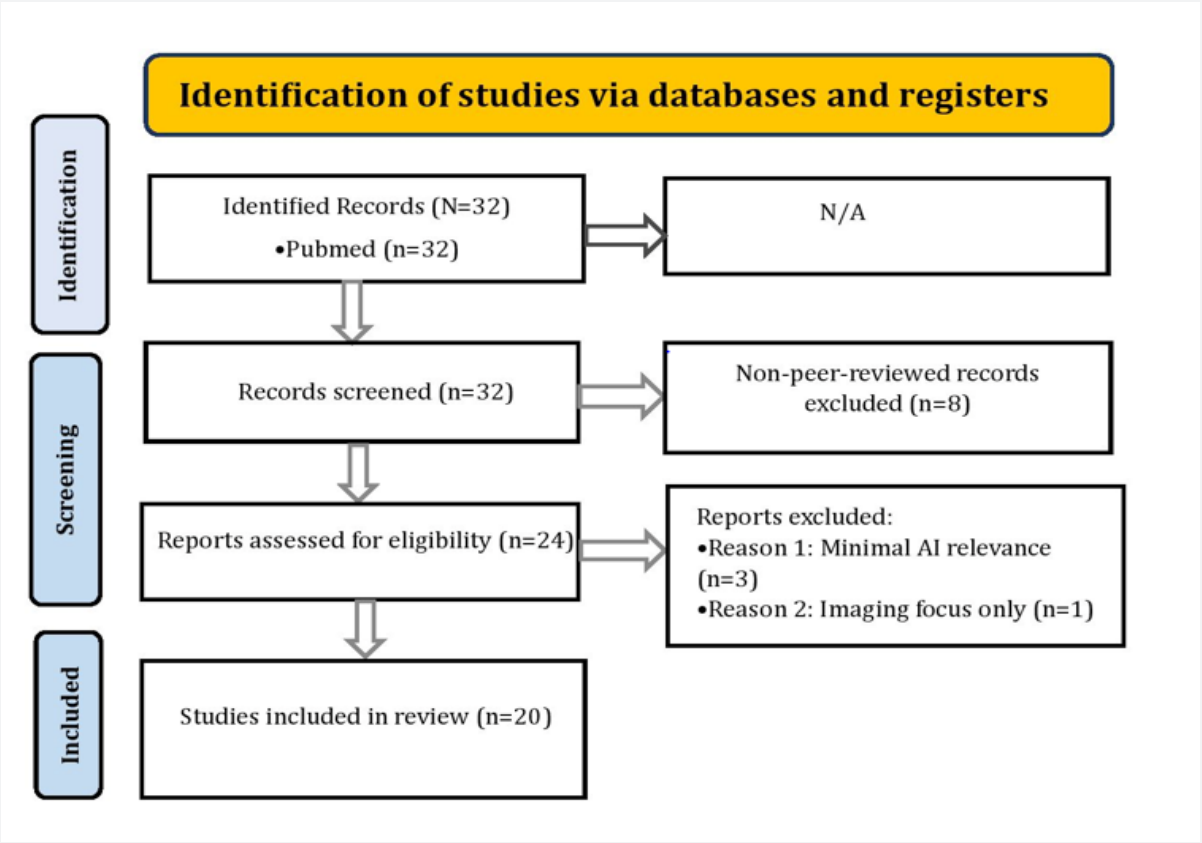

Figure 1: PRISMA flow diagram of study identification, screening and inclusion.

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Inclusion criteria and keywords

The search was performed in PubMed using Boolean operators to identify all relevant studies, with "|" representing OR and "&" representing AND. The following structured query was applied:

(Artificial Intelligence and its subfields: Artificial Intelligence | Machine Learning | Deep Learning | Generative AI) & (Oncology terminology: Cancer | Oncology | Tumor) & (Clinical application terms: Diagnosis | Treatment | Precision Oncology | Advanced Cancer Therapy) & (Immunotherapy terms: Cellular Immunotherapy | CAR-T Cell). These terms have been chosen to create a good mix of breadth and specificity to cover all established Artificial Intelligence technologies, as well as some innovative developments in the field.

Exclusion criteria

Criteria for exclusion were determined to ensure the quality and relevancy of the mini systematic review. Those studies including animal models, incomplete randomized controlled trials, and articles without peer review (e.g., conference papers, commentaries, letters, editorials) were excluded. In addition, those articles that were not available in their full text version were also excluded. Moreover, articles that failed to show clear use of AI methods in oncology were further excluded from the review.

Quality Assessment

The articles were qualitatively assessed based on their relevance to applications of AI in oncology, clarity in methodology, peer-reviewing status, recentness, and clinical application. Articles with less relevance to AI applications, studies focusing only on imaging, or unclear methodology were not used in the review.

Results

Once the last set of 20 articles had been selected, they were read through and analyzed for their key themes, with the goal being to achieve the main purpose of this research paper, which is to establish the way in which AI is being used in the field of oncology. The common themes among the articles were considered, and this made it possible to highlight four different themes. This was achieved in relation to the major areas of application of AI in oncology. These four themes have been used to organize the Results section below.

Clinical Molecular Profiling for Precision Oncology

AI-enabled molecular profiling has become one of the key drivers for precision oncology owing to its ability to help make sense of the complex information from genomic and transcriptomic studies. The various molecular characteristics considered in eight studies, ranging from mutation profiles, expression signatures, tumor heterogeneity, to neoantigen detection, can be effectively analyzed using computational techniques due to their high dimensionality. Single cell RNA sequencing offers a better understanding of clonality, stem cell compartments in leukemia, and transcriptional dysregulation leading to drug resistance and relapses in hemopathies [13,14]. Further reviews highlight the increasing importance of genomics in guiding precision medicine and immunotherapy [15-17]. This strategy is well represented by the work carried out by Zhou et al. [18] where multidimensional omics were used to define molecular and immune characteristics of tumors in detail.

The interplay between genomic changes, epigenetics changes, transcriptomics data, proteomics, metabolomics, and microbe interactions were shown to influence the tumor immune microenvironment and impact the response to therapy. With this multi-omics strategy, proper stratification of patients can be facilitated, new target molecules for novel CAR-T cell therapies can be discovered, and tailored cancer treatments can be developed [18]. Figure 2 shows the various molecular and immune characteristics that can be assessed using artificial intelligence technology. The molecular features related to artificial intelligence have shown clinical utility in areas like responsiveness to treatment, chances of relapse, and the potential use of therapies like CAR-T cells and inhibitors [19,20]. Machine learning models improved risk evaluation by incorporating both genetic information and clinical factors; on the other hand, antigen and pathway prediction using computer algorithms made personalized therapy recommendations possible.

Personalized Treatment and Cellular Immunotherapy

The primary role played by AI technology in today's world is becoming crucial for tailoring cancer therapy through optimizing the engineering of cellular immunotherapy and improving the efficacy of CAR-T cells. This has been achieved through genetic signatures profiling, automation of processes, and prediction modeling. Such developments are expected to result in better and personalized therapies in the future. Figure 3 presents a schematic diagram of the personalized cellular immunotherapy process. Epigenetic studies conducted using machine learning have made important contributions in identifying the molecular determinants of CAR-T cell functions. Specifically, several researchers used three algorithms based on ranking of features and their incremental addition in the discrimination of CAR-transduced from untransduced T-cells in patients with leukemia and lymphomas, thereby identifying important methylation signatures that are linked to CAR-T functions and exhaustion dynamics [21].

Such discoveries can serve as an initial premise for enhancing CAR-T cell persistence to avoid recurrence via cellular engineering. Apart from helping in molecular characterization of CAR-T cells, AI can assist in other aspects of the treatment process. For instance, Backel et al. [22] noted that AI was increasingly becoming vital in the analysis of vast amounts of data acquired from automated manufacturing processes of CAR-T cells [22]. According to Ramamurthy et al., AI-driven modeling, non-viral gene editing

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techniques such as CRISPR and transposon-based approaches, and automation of bioreactor-based processes were facilitating the scalability of next generation CAR-T, universal allogeneic CAR-T, and CAR NK/Mac products [23]. Within the field of therapeutic design, new advances in immunotherapy techniques demonstrate the importance of AI in advancing intelligent bioengineering technology.

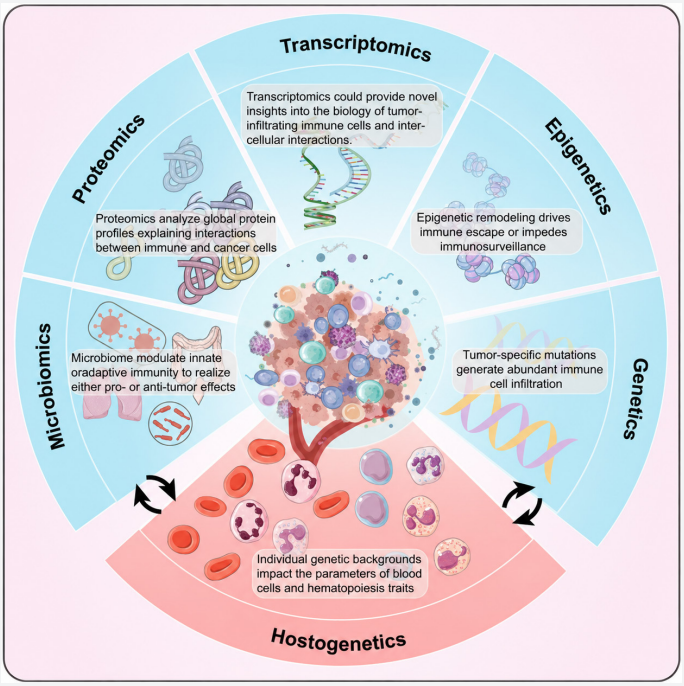

Figure 2: Multi-omics characteristics shape Tumor Immune Microenvironment profiles [18].

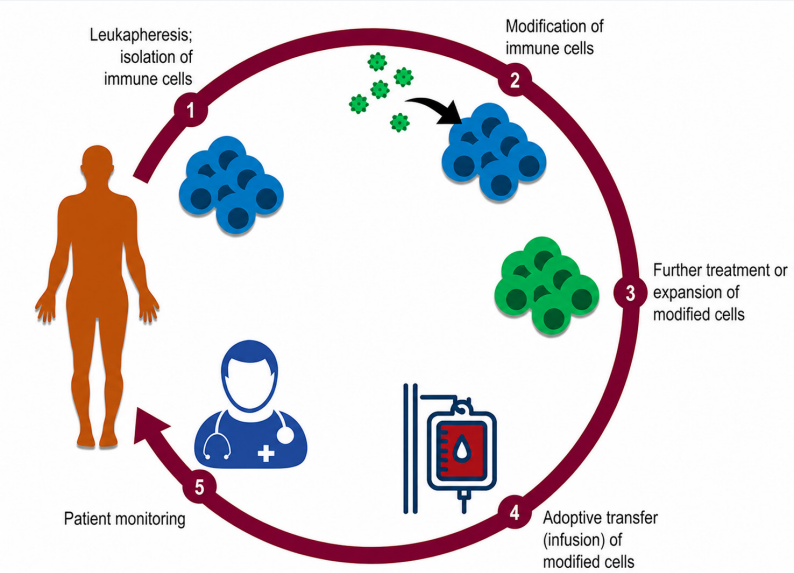

Figure 3: Personalized Cellular Immunotherapy Workflow [26].

Further research explored novel methods such as logic-gated CAR structures, multi-antigen targeting mechanisms, adaptor-based CAR molecules, and gene-engineered immune cells. The significance of AI in facilitating the selection process of antigens, optimizing their structure, and creating targeted, multi-antigen therapies that address issues such as antigen escape and complexity

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associated with solid tumors was highlighted [24]. Other research explains the contribution made by AI and CRISPR technologies to the advancement of CAR-T therapy, especially Boolean-gated designs and specific antigen recognition [25]. Such experiments have shown that using AI, cellular immunotherapy benefits from improved molecular pattern recognition, manufacturing process optimization, cell engineering techniques, and safety measures. With the application of AI in processes ranging from cell design to handling adverse events, the utilization of CAR-T therapy and similar immunotherapy techniques becomes much more accurate and effective.

Therapeutic Safety in Cancer Patient Management

The use of AI tools to solve one of the critical issues in the field of immuno-oncology – the problem associated with the control of the adverse effects caused by the therapy, such as CRS and neurotoxicity, is becoming more widespread. Existing studies have been focused on predictive models for the identification of such effects using AI approaches. As for safety issues, Jones et al. focused on developing an EEG scale to classify the Cell Associated Neurotoxicity Syndrome based on machine-learning techniques. The visual EEG grade showed high correlations with the extent of neurotoxicity, providing a marker for predicting adverse effects in a patient-specific way [27]. Some researchers introduced meta-analysis informed ML techniques designed to support early CRS detection by integrating statistical knowledge from prior clinical studies with real-world cytokine data.

This hybrid approach, termed M2-CRS, overcomes data scarcity, a common limitation in rare immune-related conditions, by combining cytokine concentration measurements from patients with literature-derived evidence of cytokine peak values. Using biomarkers such as IL-2, IL-6, IL-8, IL-10, TNF-α, IFN-γ, and GM-CSF, the model achieved over 90% accuracy in identifying cytokine storm onset [28]. Importantly, the model emphasized explainability, incorporating abductive reasoning and probabilistic scaling to trace predictions back to known clinical evidence. This transparency bridges the gap between machine predictions and clinical interpretability, enabling oncologists to assess the likelihood of CRS onset based on specific cytokine profiles and compare them against validated thresholds from multiple studies. The study demonstrated that combining knowledge-based modeling with ML can significantly increase safety and provide actionable insights for timely prophylactic interventions [28].

Speth et al. created a classification model that is based on machine learning algorithms and uses clinical trial data from a sample of 390 patients who were diagnosed with large B-cell lymphoma and underwent CAR-T therapy in several trials. The goal of the study was to find markers that would help detect patients who are at low risk of developing early CRS and NE within the first three days after CAR-T infusion. As a result of performing logistic regression analysis and selecting features, the researchers concluded that there are six pre-treatment factors that are most important for predicting low early toxicity – namely age, tumor burden, C-reactive protein, aspartate transaminase, hemoglobin, and the number of previous treatment lines. After building a model, Speth et al. reported that its positive predictive value is equal to 0.71, which means that this classifier shows high accuracy of distinguishing between patients with low and high risks [29]. model can contribute to improved risk stratification and outpatient care of patients. In terms of applicability, the method described in the paper can be successfully used because it relies only on clinical data that does not require any biomarkers.

Cancer Research and Oncology Clinical Trials

AI contributes to oncology research and clinical trials through effective data management, efficient patient stratification, adaptive clinical trial design, and predictive approaches to treatment response. Being used at different levels of cancer research, AI shows how computational technologies advance the precision oncology field and make individualized medicine available. Developers created an innovative data management solution combining patient care, research, and data science functions for precision medicine support via real-time compliant analysis across several research centers.

This system combines care, research, and data science modules, enabling electronic case reporting forms, pseudonymized CAR-T manufacturing process management, and AI-powered algorithms generation for prognostic modeling in oncology [30]. It provides capabilities for carrying out multicenter research that uses real-world and clinical data to stratify patients and bridges the care and research environment. Such architecture allows demonstrating the ability of AI to ensure regulated exchange of data and cooperation among different sites, which are crucial components of comprehensive cancer trials. Researchers applied multiple machine learning models including Non-Negative Matrix Factorization, Random Forest, and Support Vector Machines to classify head and neck squamous cell carcinoma patients into prognostic subtypes based on G-protein–coupled receptors (GPCRs) expression profiles [31].

The results showed that one subtype was positively correlated with the activity of $CD8^+$ T cells and had better survival rate. Further functional experiments confirmed that the S1PR4 upregulation enhances CAR-T cytotoxicity, showing how AI-supported molecular research is used to identify novel treatment targets and increase the efficacy of existing therapies. Recent studies proposed the Smart CAR-T Nanosymbionts approaches, integrating nanotechnology, AI, and CAR-T therapy to improve manufacturing efficiency, patient selection, and safety monitoring [32]. By using ML and DL algorithms such as convolutional and graph neural networks, researchers can predict CRS, neurotoxicity, and optimize nanoparticle formulations for mRNA transfer.

This approach represents a paradigm shift in AI-guided adaptive trials, allowing real-time optimization of therapeutic

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design and toxicity prediction before and during clinical application. Other studies examined sonodynamic therapy as an emerging modality using ultrasound-activated sensitizers for solid tumors, emphasizing how ML can enhance sonosensitizer optimization and preclinical trial translation [33]. The study proposes ML models to identify ideal acoustic and pharmacological parameters across 3D tumor models, improving efficacy predictions for ongoing trials. This approach exemplifies AI's contribution to experimental oncology and bridging in vitro screening and clinical validation. Therefore, AI, combining genomics, imaging, and clinical data, is capable of enhancing patient stratification and predicting treatment efficacy in oncology. Moreover, AI-based solutions increase the efficiency of patient recruitment, streamline regulatory compliance processes, and improve safety by facilitating the identification of adverse events.

Discussion

With rapid advancements in big data analytics, machine learning, and deep learning, AI has recently become an integral component of many medical domains, including cancer diagnosis, personalized treatment selection, drug development, and clinical research. This mini-review highlights key AI-based innovations and trends in oncology with emphasis on applications in precision medicine, personalized therapy and immunotherapy, prediction of therapy-induced toxicities, clinical oncology trials, and data-driven translational cancer research. Based on the collected literature, the following conclusion can be made. Despite a range of remaining challenges, AI appears to play a pivotal role in the evolution of modern oncology with great potential for improving patient outcomes and optimizing workflows and clinical decision-making in this domain. Machine learning and deep learning tools offer an array of benefits for the analysis of multi-scale omics data that cannot be handled using conventional analytical techniques.

By virtue of their abilities to integrate various types of molecular and clinical data, AI tools may assist in the identification of molecular subtypes, the prediction of therapeutic responses, the search for biomarkers and molecular drivers of diseases, and the characterization of the tumor microenvironment. These benefits are especially relevant for precision oncology. As the field continues to evolve, treatment regimens become increasingly tailored to the specific features of each patient's molecular profile. In turn, AI-assisted molecular interpretation may become crucial for accurate stratification and personalized treatment in the future. However, many AI tools currently being used in this setting have been developed based on relatively small or specialized training datasets and require additional validation studies. Alongside the growing interest in using AI to improve therapeutic effectiveness and select optimal treatment options, recent years have seen an increased number of applications focusing on the prediction of treatment-related toxicities and the prevention of adverse effects.

A particular focus is placed on the prediction of adverse reactions and complications associated with CAR-T therapies. Among such toxicities, two of the most frequent ones – cytokine release syndrome (CRS) and neurotoxicity – have been studied by several recent publications. It appears that compared to other applications, AI systems designed for predicting therapy-related toxicities and adverse reactions are relatively easily transferrable to the clinical environment since they usually use explainable models and routinely collected clinical data. Hybrid approaches combining domain expertise with statistical data processing have proven effective for predicting toxicities in this field. However, the vast majority of studies conducted to date have focused only on the acute phase of treatment and complications occurring within the period of the controlled trials. Little is known about long-term toxicities in these patients, so further studies may be needed.

In addition to practical applications in patient treatment and safety prediction, many of the recently developed AI technologies have found application in cancer clinical trials. Such applications include improved multicenter data collection, enhanced patient selection, and stratification for enrolment in trials; identification of novel biomarkers and therapeutic targets; and adaptive design of clinical trials based on AI-driven results. New approaches, including AI-based nanotechnology platforms, smart CAR-T systems, and sonodynamic therapy models, illustrate the role that computational tools may play in the future of cancer research. On the one hand, these applications promise to accelerate drug development processes and streamline clinical research workflows. On the other hand, they are likely to present unique challenges related to the interpretability and auditability of AI systems; regulatory aspects, including bias against groups in the training data; and ethical and governance concerns regarding the use of AI in clinical trials.

Alongside issues that are specific to the selected area, certain problems related to the implementation of AI in cancer care have been discussed across all of the analyzed publications. For example, most of the current studies emphasize the importance of having high-quality and consistent datasets to obtain reliable results from machine learning and deep learning models. Moreover, the representativeness of these datasets may become an additional concern since the availability of the necessary data is often uneven between countries and different health-care systems. Another problem that may prevent AI tools from achieving their full potential is the lack of transparent governance frameworks. In recent years, the importance of ethical issues such as obtaining informed consent and maintaining patient anonymity during data sharing have become widely acknowledged.

At the same time, few publications consider the questions of cross-border data sharing, ownership of patient data, interpretability and audibility of AI-based decisions, and equitable access to cutting-edge AI-enabled therapeutics. Some limitations need to be considered when interpreting the results. Firstly, the search strategy employed in the present mini-review was limited to a single database and covered only English-language, open-access studies. Moreover, the search string was optimized

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towards therapeutic applications of AI rather than the field as a whole. Overall, the trend observed throughout the literature search suggests that AI is becoming a transformational part of modern oncology. Although many challenges remain unresolved, the progress of recent years shows that AI is set to play an increasingly important role in cancer medicine and data-driven oncology.

Conclusion

This mini systematic review demonstrates that artificial intelligence has already been embedded into the main steps of contemporary oncology, namely molecular profiling, personalized cellular immunotherapy, therapeutic safety, and cancer clinical trial design and conduct. Among the 20 selected studies, AI invariably enhanced interpretation of complex omics data, informed engineering and optimization of CAR-T and related therapies, empowered early detection of serious toxicities such as cytokine release syndrome and neurotoxicity, and enhanced data management and patient stratification in clinical research. Finally, these applications give reason to believe that AI has great potential for enhancing precision, personalization, and efficiency in cancer care.

In general, AI systems in use today are in the very nascent stage of development and suffer from the same limitations related to inadequate data, lack of external validation, poor methodology, and reporting. Many hurdles still exist around interpretability of the models, generalizability, data management issues, and regulation. As such, AI should be seen as a decision support tool that can assist clinicians but not replace them. Future studies should focus on evaluation and standardization efforts as well as on the implementation of AI technologies as an integral part of patient care and research, bearing in mind the ethical dimension. If these requirements are met, then AI will be able to operate as an assistant and a crucial facilitator of effective and personalized oncologic treatment.

Acknowledgement

This research was supported by an Australian Government Research Training Program (RTP) Scholarship [DOI: https://doi.org/10.82133/C42F-K220] Brazilian CTC PROGRAM (CNPq-No.16/2014), 170233/2023-5) from INCT in Stem Cells Research and Cellular Therapy in Cancer.

The authors declare that AI technologies, including Grammarly and ChatGPT, were used responsibly for editing texts and images, summarizing source articles, and making the text easier to understand. The sources were reviewed manually to ensure accuracy, reliability, and academic integrity.

Conflicts of Interest

The authors declare no conflicts of interest.

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How to cite this article: Vahedian V, Ranjbar Motlagh R. Artificial Intelligence in Precision Oncology: A Mini Systematic Review of Diagnostic and Therapeutic Applications. Canc Therapy & Oncol Int J. 2026; 32(3): 556338. DOI: 10.19080/CTOIJ.2026.32.556338

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DOI: 10.19080/CTOIJ.2026.32.556338

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