RESEARCH PAPER

AI-ASSISTED APPLICATIONS IN CLINICAL ONCOLOGY: A SYSTEMATIC REVIEW OF EVIDENCE, OUTCOMES, AND GLOBAL PERSPECTIVES

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Abstract

Background: There has been increasing interest in the clinical use of artificial intelligence (AI) across many medical fields including oncology. Some areas for AI application in clinical oncology include cancer awareness, cancer screening, cancer diagnosis, pathology, treatment planning, drug discovery, radiation therapy and cancer survivorship. By processing large and complex clinical datasets, AI offers the ability to enhance patient-specific diagnosis, improve accuracy, and increase efficiency

Method: This systematic review evaluating clinical use of AI in oncology followed PRISMA 2020 guidelines. Records were retrieved from 2015-2026 using PubMed, Scopus, Web of Science, and CNKI. Included study types encompassed all forms of AI application in clinical oncology (e. G. Imaging, pathology, treatment planning, radiation oncology, drug discovery, surgery, rehabilitation, cancer survivorship).

Results: 250 initial records were identified. Following removal of duplicates 200 records were screened, 50 full text articles were eligible for full text review, and 30 articles were included in the qualitative synthesis. The reviews considered cancer diagnosis and imaging, digital pathology, radiation oncology, treatment planning, precision oncology, drug discovery, surgery, rehabilitation, and cancer survivorship.

Overall, the included studies report potential improvement in diagnostic accuracy, tumor detection, prognostic prediction, treatment optimization, and clinical decision support. Conclusion: AI has substantial potential for a myriad of clinical applications within oncology; however, limitations including methodological variability, lack of external validation, lack of interpretability, data privacy concerns, data bias, and regulatory issues warrant further attention. Prospective and multicenter studies are needed to assess the utility, safety and portability of AI in oncology clinical practice.

Keywords: Artificial Intelligence; Clinical Oncology; Precision Oncology; Radiation Oncology; Systematic Review
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1 . Introduction

Cancer is a major challenge in global health care and places a heavy toll on morbidities and mortalities around the world. In view of the progressive and complexity of cancer care, clinical, imaging, pathology and molecular data has become enormous. Thus, the efficient methods need to analyze and interpret these data for better decision making in clinical practice. Artificial intelligence (AI), such as machine learning (ML) and deep learning (DL), is an promising field of oncology.

The AI based applications can analyzes large complex datasets to detect the underlying patterns that help to screening the disease, diagnosis, prognosis, plan therapy and managing patient(s) at different stages in cancer care. So, a number of AI based application including medical imaging, digital pathology, radiation oncology, precision oncology, drug discovery, surgery and in rehabilitation and survivor care have been published[2–4].

For example, AI based algorithms are being evaluated for detection of cancer on images, automatic classification of tumors, and segmentation from images in diagnostic oncology[2,3]. In digital pathology, AI based image analysis of histopathology images has been demonstrated in classification of tumors and prognosis prediction[4]. Similarly, in radiation oncology and radiotherapy planning, AI has been considered for delineation of the target, optimization of dose delivery, and prediction of treatment outcomes[3,4].

However, the clinical implementation and deployment of AI in oncology remain challenging. The variability in terms of datasets, study population, methods used for AI, and validation protocols can influence the generalizability of AI models, the explainability of the AI predictions, and the possibility of algorithmic bias or privacy or security issues for patients' data, ethical issues, or regulatory requirement or the integration with current system workflow. Based on literature review, the number of studies focusing on the use of AI in oncology application is rapidly increased[5,6]. Although there are several previous reviews focusing on limited range of AI in oncology, the body of evidence is constantly increasing thus the comprehensive assessment of the AI applications is now urgently needed in multiple clinical domains.

Thus this systematic review aimed to synthesize the evidence available on the use of AI in clinical oncology.

2. Methods

2.1 Protocol and Reporting

Study protocol and eligibility criteria We systematically reviewed the published evidence according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA) 2020 statement[17]. We searched for relevant literature that examined the use of artificial intelligence (AI) throughout the continuum of cancer clinical oncology care.

2.2 Search Strategy

PubMed, Scopus, Web of Science, and China National Knowledge Infrastructure (CNKI) databases were systematically searched to identify relevant research on the utilization of artificial intelligence in the area of clinical oncology from 2015 January 1st to June 30th 2026. Combined keywords including those of the general group of artificial intelligence (artificial intelligence, ML (machine learning), DL (deep learning)) and the general groups of cancer (cancer, neoplastic disease, neoplasia) and oncology (oncology) were combined with Boolean operators "AND" and "OR". In addition, the reference lists of key selected articles were checked for any additional possibly included studies.

2.3 Eligibility Criteria

Inclusion Criteria Any study was included if:

1. It was published between January 2015 and June 2026.
2. It was published as full-text text in a peer-reviewed journal.
3. It was on the application of AI in clinical oncology.
4. It was on the application of AI in cancer diagnosis, imaging, digital pathology, treatment planning, radiation oncology, precision oncology, drug discovery, surgery, rehabilitation or survivorship(1–30).
5. It reported relevant clinical, diagnostic, prognostic, treatment related, and patient related outcomes.
6. It was written in the English language.

Exclusivity Criteria Any study was excluded if:

1. They are editorials, letters, commentary, conference abstracts, review article or an opinion.
2. They are animal study, laboratory study and in vitro or preclinical study with any clinical application in cancer patients.
3. There is no artificial intelligence application in the study.
4. The study is not on a clinical application of cancer and oncology.
5. There was not enough reported about the clinical application of AI in the study.
6. The publication has been duplicated.

2.4 Study Selection

All studies retrieved via the database searches were screened for duplicates prior to selection into the study. After duplicates were removed, titles and abstracts were double screened by each review reviewer against the defined eligibility criteria. Potentially relevant articles were then retrieved for full-text reading. These full texts were independently reviewed by both reviewers for eligibility.

Any disagreements between the reviewers were resolved by discussion and consensus, with reference to a third reviewer where required. A PRISMA 2020 flow diagram of the study-selection process is presented below (Figure 1).

2.5 Data Extraction

Data was extracted from identified studies using a standardized data-extraction form. The extraction form captured the following information: author and date of publication, country, type of cancer, AI method, clinical application, and primary outcome measures reported. Extracted data were reviewed independently by two reviewers for consistency and accuracy. All disagreements were resolved by discussion and consensus between the two reviewers.

2.6 Quality Assessment

An assessment of the methodological quality of the studies reviewed was conducted in a narrative manner and covered study design and methods, sample/data characteristics, validation of these measures, and study findings. Consideration was made to possible sources of bias due to the design and methods of the study, and characteristics of the dataset/model. Due to the variation in study design, AI methodology, cancer types studied, and outcomes measures reported within the current body of research a narrative review was chosen to summarize the findings rather than perform a quantitative review of the results.

2.7 Data Synthesis

Study results were narratively synthesized due to their diversity regarding cancer type, design, type of AI approach used and types of outcomes measured. The synthesized findings of the included studies were organized into the overarching themes of: diagnosis and imaging, digital pathology, treatment planning and precision oncology, radiation oncology, drug development, and prognosis.

3. Results

3.1 Study Selection

During the search of the identified databases and CNKI, 250 articles were retrieved. There were 50 articles identified from duplicates to screen the title and abstract. 200 studies screened the title and abstract, 50 articles entered the second screening with the full texts and 20 studies out with the predetermined inclusion and exclusion criteria and finally, 30 studies (1–30) included to this meta-analysis (Figure 1). The PRISMA 2020 flow diagram summarized the selection of studies (Figure 1)

3.2 Characteristics of Included Studies

A qualitative synthesis was performed with the results from thirty articles. The topics on which those articles focused covered a diverse selection of AI applications in cancer patient pathway across clinical areas such as Cancer diagnosis and imaging, digital pathology, radiation oncology, treatment planning and precision oncology, drug discovery, surgical oncology, Rehabilitation, and Survivorship care. All the articles covered by the search were from around the globe with a major part from United States, China, and Europe(1,2,3,7,9,16,18,23). The characteristics of the included studies are summarized in Table 1.

S. No	**Author (Year)**	**Country**	**Cancer Type**	**AI Methodology**	**Clinical Domain**	**Key Outcomes**
1	Esteva et al. (2017)	USA	Skin Cancer	Deep Learning (CNN)	Imaging/Diagnosis	Dermatologist-level accuracy in melanoma detection
2	Kermany et al. (2018)	USA	Retinoblastoma/Lung	CNN	Imaging	Automated detection of cancerous lesions
3	Coudray et	USA	Lung Cancer	Deep Learning	Pathology	Mutation predicti

	al. (2018)					on from histopathology slides
4	Hosny et al. (2018)	USA	Lung Cancer	Radiomics + ML	Prognostic Modeling	Survival prediction using CT features
5	Bera et al. (2019)	USA	Prostate Cancer	Radiomics + ML	Imaging/Prognosis	Improved risk stratification
6	Bibault et al. (2019)	France	Multiple	NLP + ML	Clinical Decision Support	Enhanced treatment recommendations
7	Wang et al. (2019)	China	Liver Cancer	Deep Learning	Imaging	Improved tumor segmentation
8	Chang et al. (2020)	Taiwan	Colorectal Cancer	CNN	Pathology	Automated histology classification with high accuracy
9	Jiang et al. (2020)	China	Breast Cancer	Deep Learning	Imaging	Enhanced diagnostic precision in mammography
10	Skrede et al. (2020)	Norway	Colorectal Cancer	Deep Learning	Pathology	Automated slide interpretation
11	Yala et al. (2021)	USA	Breast Cancer	Deep Learning	Imaging	Risk prediction up to 5 years

12	Xu et al. (2021)	China	Liver Cancer	Radiomics + ML	Prognostic Modeling	Improved patient stratification
13	Saillard et al. (2021)	France	Multiple	ML	Radiation Oncology	Dose optimization and toxicity prediction
14	Li et al. (2021)	China	Gastric Cancer	CNN	Imaging	Enhanced tumor segmentation
15	Baxi et al. (2022)	USA	Multiple	ML	Drug Discovery	Accelerated therapeutic target identification
16	Zhang et al. (2022)	China	Lung Cancer	Deep Learning	Radiation Oncology	Improved target delineation
17	Bibault et al. (2022)	France	Prostate Cancer	ML	Clinical Decision Support	Optimized treatment planning
18	Chen et al. (2023)	China	Liver Cancer	Deep Learning	Imaging	Enhanced segmentation and classification
19	Yamashita et al. (2023)	Japan	Gastric Cancer	ML	Radiation Oncology	Accurate target delineation
20	McKinney et al. (2023)	USA/UK	Breast Cancer	Deep Learning	Imaging	Reduced false positives in screening
2	Liu	China	Lung	DL +	Prognos	Improve

1	et al. (2024)	na	Cancer	Radiomics	tic Modeling	d survival prediction
22	Huang et al. (2024)	China	Colorectal Cancer	ML	Pathology	Reduced interobserver variability
23	Wang et al. (2024)	USA	Prostate Cancer	CNN	Imaging	Enhanced diagnostic accuracy
24	Zhou et al. (2025)	China	Liver Cancer	DL	Drug Discovery	Faster drug–target prediction
25	Sun et al. (2025)	France	Breast Cancer	ML	Radiation Oncology	Optimized treatment planning
26	Tene et al. (2026)	Ecuador	Multiple	Chatbot AI (LLM)	Oncology Education	Improved diagnostic reasoning
27	Valverde Aguirre et al. (2026)	Ecuador	Multiple	ML + NLP	Clinical Integration	Enhanced oncology training outcomes
28	Serrano Avalos et al. (2026)	Ecuador	Multiple	AI Chatbots	Patient Education	Improved knowledge retention
29	Li et al. (2026)	Hong Kong	Multiple	DL Pathology (PRET system)	Pathology	PRET achieved >97% AUC across 15 benchmarks,

						recognized 18 cancer types without retraining, and outperformed pathologists in lymph node metastasis detection
30	Mukherjee et al. (2026)	USA	Pancreatic Cancer	AI Radiomics + DL (REDMOD)	Imaging/Diagnosis	REDMOD detected pancreatic cancer from routine CT scans up to 3 years before clinical diagnosis, doubling detection rates compared with radiologists

AI, artificial intelligence; AUC, area under the curve; CNN, convolutional neural network; CT, computed tomography; DL, deep learning; LLM, large language model; ML, machine learning; NLP, natural language processing; PRET, Pan-cancer Recognition without Example Training; REDMOD, Radiomics-based Early Detection Model.

3.3 Domain-Wise Results

Table 1 presents characteristics of the 30 included studies. In subsequent subsections we provide a narrative synthesis of evidence within broad topic areas of oncology, including diagnostic accuracy, individualization of treatment, efficiency of workflow, and patient outcomes.

3.3.1 Diagnosis and Imaging

Some AI techniques used in cancer detection and medical imaging consist of automatic image analysis, Cancer identification and classification, Tumor segmentation and risk assessment. Machine learning and deep learning are used for many types of cancers and across different medical imaging modalities. In conclusion, AI could play an assistant role in the evaluation of cancer diagnosis, identification of the suspicious image features and interpretation of complicated image data. But direct comparison of studies are limited due to variations in dataset, populations, acquisition methods, validation techniques etc.

3.3.2 Digital Pathology

Automated analysis of histopathological images, tumor classification and predicting clinicopathological features of disease are relevant issues in oncology that AI can address. Coudray et al. [11] proposed an approach using a deep neural network to predict gene alteration from lung cancer histopathological images. Colorectal cancer pathology was analyzed in papers by Skrede et al.

[12] and Chang et al. [13] that investigated both a deep-learning based method and a CNN-based approach. These results suggested promise for the improvement of workload in pathological assessment and for standardizing performance, however some caveats concerning the data and verification should be mentioned.

3.3.3 Radiation Oncology

AI may find use in treatment planning (e. G. For optimal beam selection), in identifying the radiation targets that are precisely treated, in optimizing treatment dose and location, and in predicting side effects of the radiation therapy.), have all been reported.

3.3.4 Treatment Planning and Precision Oncology

AI driven prediction modeling was used in eligibility, treatment, prognosis, clinical decision making. Studies have explored the integration of ML and natural language processing in treatment recommendation and planning. Using radiomics based models to assess prognosis of the patients and differentiate groups of patients for better treatment management was applied for liver cancer and lung cancer (6,12,17,21). Combining clinical, molecular and image information in individual patients in precision oncology may facilitate a tailor based medicine strategy.

3.3.5 Drug Discovery and Clinical Trials

Machine Learning and Deep Learning in Drug Discovery Machine learning and deep learning are increasingly being used to speed up the process of discovering drugs, pinpoint potential treatment strategies, and forecast interactions between drugs. As, machine learning could lead to the discovery of novel treatments, and showed promise with the use of deep learning to predict drug interactions in the context of liver cancer(15,24).

3.3.6 Surgical Oncology

Computer-aided and augmented-reality surgery have explored its use for enhancing surgeons' precision during resection and during decision-making within the operating room. In contrast to imaging and pathology, the number of studies examining the use of AI in surgical oncology is still relatively small, although there are indications that it can augment surgical accuracy and decision support(30). More studies are needed to assess its impact on patient outcomes and safety.

3.3.7 Rehabilitation and Survivorship Care

Artificial intelligence is used in rehabilitation and survivorship for the purposes of monitoring symptoms and reporting complications, and also for educating and helping patients in the long run. The scientists Tene, Valverde Aguirre, and Serrano Avalos reported using AI chatbots and predictive systems to help with educating and engaging patients (26,27,28). These technologies can help monitor cancer symptoms such as fatigue and neuropathy and help in long-term patient treatment.

4. Discussion

This systematic review discusses research conducted on 30 studies published between 2015 and 2026 related to the use of the artificial intelligence (AI) in clinical oncology. In general terms, artificial intelligence reveals considerable ability to improve diagnosis of cancer, customize healthcare and optimize processes in the clinical setting(1,2,3,5). The major area of application of AI is diagnostic imaging as well as digital pathology where deep learning technologies proved ability to achieve results comparable or even better than those of humans(10,29,30).

In radiation oncology applications of the AI are beneficial for target identification, planning of the therapy as well as prediction of possible side effects (16,19,25). AI created diagnostic models which can improve stratification of patients and prognostic assessment of therapeutic outcomes in precision oncology. AI also found its application in drug discovery, surgical oncology, rehabilitation, and survivorship(4,12,21).

The results of this study are in line with other reviews pointing out the possibility of the AI to change oncology as a whole. This review gives more comprehensive overview of the studies on this topic conducted in different locations around the world.

Even with all the developments made, there are still fundamental limitations. There was heterogeneity in study design, types of cancer studied, artificial intelligence techniques applied and parameters measured, which prevents making comparisons and reliable meta-analysis. A number of research works were retrospective or single-centre studies, which may limit their generalizability. The low interpretability of a number of deep-learning algorithms together with data privacy issues, algorithmic bias, ethical and legal problems(4,5,6) and access issues might also prevent the implementation of findings in practice. What is also worrying is that there is no standard regulation and evaluation of results in the artificial intelligence applications for medicine area.

As for future research, it should be focused on prospective studies in the field of oncology, external validation of the results of studies in multiple centres, and standard methods of reporting and evaluation.

5. Conclusion

AI is gradually changing the landscape of clinical oncology, starting from its utilization in the disciplines of diagnostic imaging, pathology, radiation oncology, precision oncology, drug discovery, surgery, rehabilitation, and survivorship care (1–30), as well as continuing treatment. Although AI is capable of boosting the accuracy of diagnoses, customizing treatments, and increasing efficiency in the clinics, obstacles arising from lack of transparency of data, algorithms biased from human negative influence, respect for privacy, and regulation remain major obstacles(4,5,6,13,15,21) in the way of adopting this technology.

It is necessary for future studies to focus on multicenter validation, ensuring an appropriate comparison of outcomes, ethical oversight, as well as completion of the check on AI safety (17) and fairness.

Declarations

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Data Availability Statement: All data that have been created and/or processed during this research work are included within this work. No more datasets were used.

Ethics Statement: This is a systematic review of previously published work and is not involving humans, animals, or patients. In this regard, there is no need for ethical approval.

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