iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** VI **Month of publication:** June 2026

DOI: https://doi.org/10.22214/ijraset.2026.83830

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue VI June 2026- Available at www.ijraset.com

Recent Advances in Cancer Immunotherapy: Insights from Emerging Clinical Trials

Nitesh Prasad Sah[1], Neha Kumari[2], Mr. Randhir Kumar Roy[3]
[1, 2]*Fortis Healthcare Research Foundation, Fortis Flt. Lt Rajan Dhall Hospital New Delhi*
[3]*Bharat Institute of Technology, UP*

Abstract: ***Cancer immunotherapy has emerged as a transformative approach in oncology, with multiple clinical trials conducted between 2023 and early 2026 demonstrating significant therapeutic progress. This review provides a comprehensive narrative overview of recent advances in immune checkpoint inhibitors, chimeric antigen receptor T-cell (CAR-T) therapy, tumor-infiltrating lymphocyte (TIL) therapy, and cancer vaccines, with a particular emphasis on evidence from contemporary clinical studies.***

Recent phase II and III trials have reported improved overall survival and progression-free survival in cancers such as melanoma, non-small cell lung cancer, and hematological malignancies, particularly with PD-1/PD-L1 inhibitors and combination immunotherapy strategies (1, 3, 9).

CAR-T therapies targeting CD19 continue to demonstrate high remission rates in B-cell malignancies (4, 12), although toxicity remains a concern (13). Emerging approaches, including mRNA-based vaccines and bispecific antibodies, have shown promising early-phase results (16, 17, 24).

Despite these advances, challenges including immune-related adverse events, therapeutic resistance, and high treatment costs persist (20–22).

Ongoing research is focused on optimizing treatment combinations, identifying predictive biomarkers, and improving accessibility (23). Collectively, these developments highlight the expanding clinical impact of immunotherapy and its potential to redefine cancer treatment paradigms.

Keywords: Cancer immunotherapy, immune checkpoint inhibitors, CAR-T therapy, clinical trials, cancer vaccines, TIL therapy.

I. INTRODUCTION

Cancer remains a leading cause of mortality worldwide. Over the past decade, immunotherapy has fundamentally altered cancer treatment by harnessing the immune system to eliminate malignant cells (1,2).

Between 2023 and early 2026, numerous clinical trials have reinforced the clinical relevance of immunotherapy across both solid and hematological malignancies (5).

Unlike conventional therapies such as chemotherapy and radiotherapy, immunotherapy enhances endogenous immune responses. Immune checkpoint inhibitors targeting PD-1, PD-L1, and CTLA-4 have demonstrated durable responses in multiple tumor types (3,8). Meanwhile, adoptive cell therapies such as CAR-T and TIL therapy have shown remarkable efficacy in selected patient populations (4,14).

II. METHODOLOGY

This review is conducted as a narrative literature review. Relevant studies published between 2023 and early 2026 were identified using databases such as PubMed, Scopus, and Web of Science.

Keywords included cancer immunotherapy, immune checkpoint inhibitors, CAR-T cell therapy, tumor-infiltrating lymphocytes, and cancer vaccines. Studies were selected based on relevance to recent clinical advances, with priority given to phase II and III clinical trials, systematic reviews, and high-impact publications.

Non-English articles and studies lacking clinical relevance were excluded.

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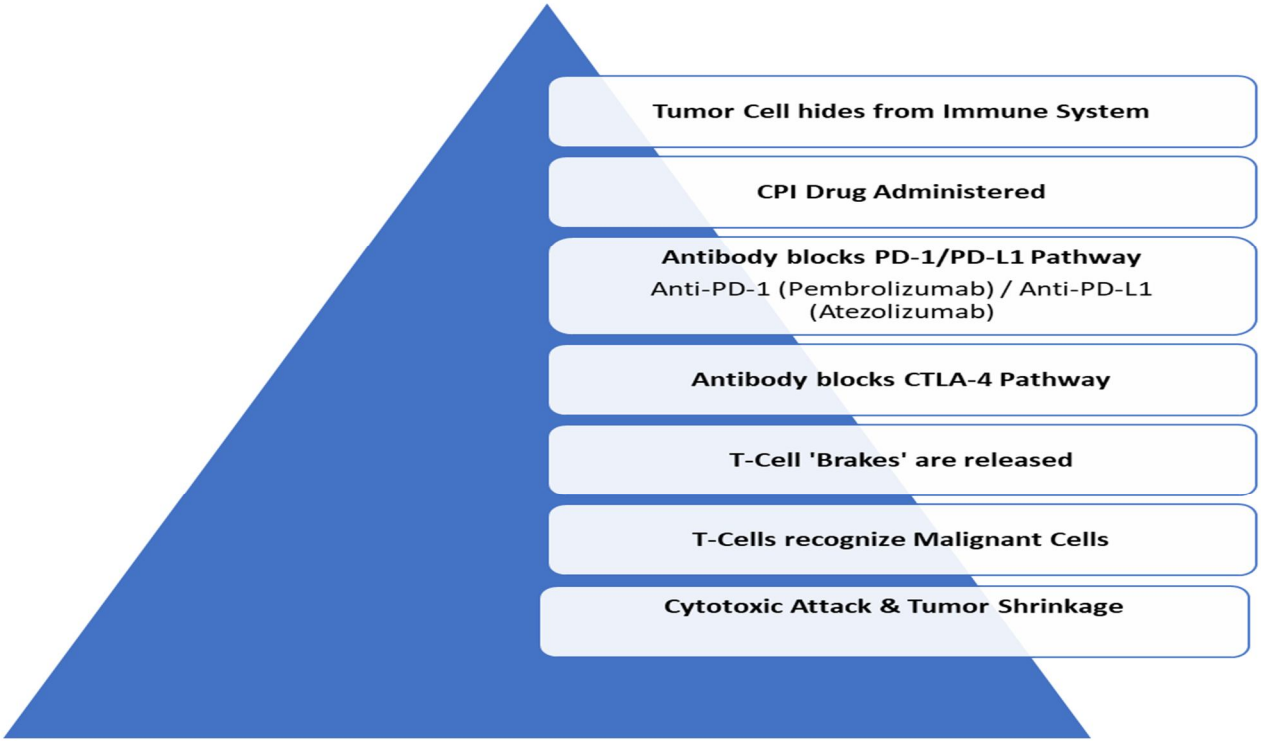


Figure 1. Mechanism of immune checkpoint inhibition illustrating PD-1/PD-L1 interaction and T-cell reactivation in the tumor microenvironment.

III. MECHANISTIC BASIS OF CANCER IMMUNOTHERAPY

The immune system plays a critical role in tumor surveillance; however, cancer cells evade immune detection through inhibitory checkpoint pathways (5). Proteins such as PD-1 and CTLA-4 regulate immune responses but are often exploited by tumor cells to suppress T-cell activity (6).

Checkpoint blockade therapies restore anti-tumor immunity by reactivating T cells, enabling effective tumor cell elimination (7). This mechanism underlies the success of immune checkpoint inhibitors in multiple malignancies.

IV. CLINICAL ADVANCES IN IMMUNOTHERAPY (2023–2026)

A. Immune Checkpoint Inhibitors

The KEYNOTE-942 trial demonstrated significant improvements in recurrence-free survival (hazard ratio 0.56; 95% CI, 0.38–0.84), corresponding to a 44% reduction in the risk of recurrence in melanoma patients receiving pembrolizumab in combination with mRNA-4157 (17,25). However, the study was limited by relatively short follow-up duration, which may impact long-term outcome assessment. Similarly, nivolumab plus ipilimumab has demonstrated improved overall survival in advanced melanoma, although higher rates of grade 3–4 toxicities have been reported, highlighting the need for careful patient selection (19).

B. CAR-T Cell Therapy

CAR-T cell therapy has demonstrated substantial success in hematological malignancies, particularly B-cell acute lymphoblastic leukemia and lymphoma (4,11). Clinical studies report remission rates exceeding 80%, supported by pivotal trials such as those evaluating tisagenlecleucel in B-cell acute lymphoblastic leukemia (12,27).

Despite high efficacy, variability in patient response and long-term safety concerns remain areas of ongoing investigation.

However, adverse events such as cytokine release syndrome and neurotoxicity remain significant challenges (13).

C. Tumor-Infiltrating Lymphocyte (TIL) Therapy

TIL therapy has shown promising results, particularly in advanced melanoma (15). This approach involves isolating and expanding tumor-reactive lymphocytes, which are then reinfused into the patient to enhance anti-tumor immunity (14).

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D. *Cancer Vaccines*

Cancer vaccines, particularly mRNA-based platforms, have demonstrated encouraging results in recent clinical trials, especially when combined with checkpoint inhibitors such as pembrolizumab (17,18).

Combination approaches involving vaccines and checkpoint inhibitors have resulted in significant improvement in therapeutic efficacy (18).

V. SUMMARY OF KEY CLINICAL TRIALS (2023–2026)

Therapy Type	Cancer Type	Trial Phase	Key Findings
PD-1/PD-L1 inhibitors	NSCLC, melanoma	Phase III	Significant improvement in OS and PFS (HR <1.0 vs chemotherapy) (9)
Nivolumab + Ipilimumab	Melanoma	Phase III	Durable survival benefit with increased grade 3–4 toxicity (19)
CAR-T (CD19)	B-cell ALL	Phase II/III	>80% remission rates with risk of cytokine release syndrome and neurotoxicity (12,13)
Lifileucel (TIL)	Melanoma	Phase II	Clinically meaningful responses in refractory patients (15)
mRNA vaccine + pembrolizumab	Melanoma	Phase II	Improved recurrence-free survival (HR 0.56) (17,25)

VI. CHALLENGES IN CANCER IMMUNOTHERAPY

A. *Immune-Related Toxicity*

Immunotherapies can cause adverse effects involving multiple organs due to immune overactivation (20).

B. *Therapeutic Resistance*

Resistance to immunotherapy, either primary or acquired, remains a major limitation (21).

C. *Economic Barriers*

High treatment costs, particularly for CAR-T therapy, restrict accessibility (22).

These challenges highlight the need for biomarker-driven patient selection and optimized combination strategies to improve therapeutic outcomes.

VII. FUTURE DIRECTIONS

Emerging strategies, including bispecific antibodies and next-generation immunotherapies, are under active investigation (24).

Advances in genomics are expected to facilitate personalized immunotherapy approaches (23).

VIII. CONCLUSION

Clinical trials conducted between 2023 and early 2026 have demonstrated substantial progress in cancer immunotherapy. Approaches such as checkpoint inhibitors, CAR-T therapy, and cancer vaccines have significantly improved clinical outcomes (1,4,16).

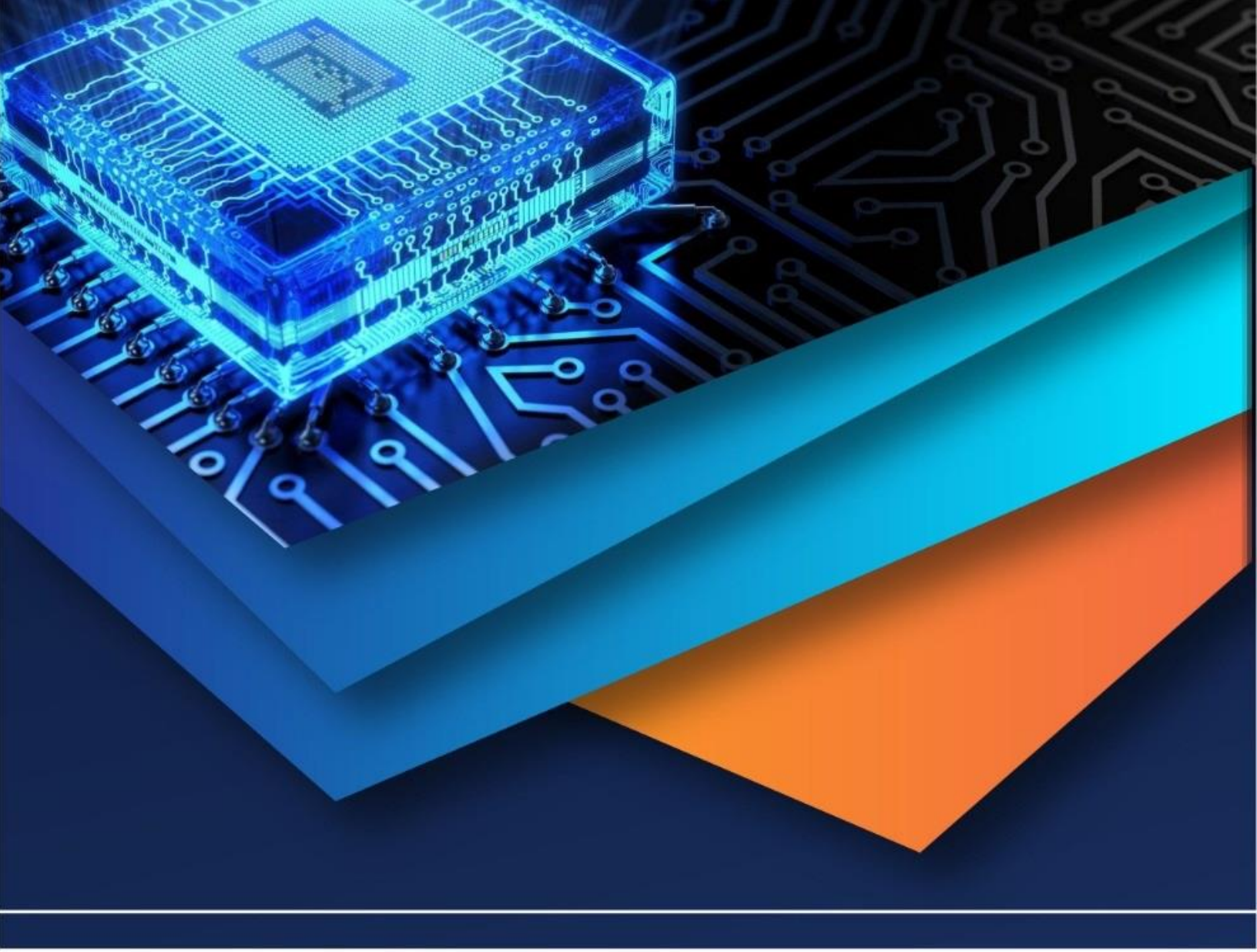
Ongoing research aims to address current limitations and expand the applicability of these therapies, reinforcing their role as a cornerstone of modern oncology.

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