OPEN ACCESS Freely available online

Chemotherapy: Open Access

ISSN: 2167-7700

Commentary

Radiotherapy in Oncology Current Practices Innovations and Future Directions

Sophia Williams*

Oncology Department, Royal Marsden Hospital, London, United Kingdom

DESCRIPTION

Adiotherapy remains a cornerstone in the multidisciplinary management of cancer, utilized in approximately 50% of all cancer patients either as a primary treatment or in combination with surgery, chemotherapy, or immunotherapy. Its primary goal is the precise delivery of ionizing radiation to tumor tissues while minimizing damage to surrounding healthy structures. Traditionally, radiotherapy has been guided by anatomical imaging, with conventional techniques such as Two-Dimensional (2D) and Three-Dimensional Conformal Radiotherapy (3D-CRT) forming the foundation of clinical practice. Over the past two decades, advances in imaging, computing and radiation delivery systems have transformed radiotherapy into a highly precise and personalized therapeutic modality. Intensity-Modulated Radiotherapy (IMRT) and Volumetric Modulated Arc Therapy (VMAT) represent key innovations, allowing modulation of radiation intensity across multiple beams to conform closely to the tumor's shape, thereby reducing toxicity to normal tissues. Image-Guided Radiotherapy (IGRT) further enhances precision by integrating real-time imaging during treatment, which ensures accurate tumor targeting despite patient movement or anatomical changes during therapy.

The integration of molecular and functional imaging into radiotherapy planning has expanded the field's ability to personalize treatments. Positron Emission Tomography (PET), Functional Magnetic Resonance Imaging (fMRI) and diffusion-weighted imaging enable clinicians to delineate tumor subvolumes with increased metabolic or proliferative activity, a concept known as biological target volume. This approach supports dose painting strategies, where higher radiation doses are directed to more aggressive tumor regions while sparing normal tissues. In addition, Stereotactic Body Radiotherapy (SBRT) and Stereotactic Radiosurgery (SRS) have emerged as critical tools in managing localized tumors, particularly in the lung, liver and brain. These techniques deliver extremely high doses of radiation in a few fractions, exploiting tumor radiosensitivity and precision delivery to achieve excellent local control with minimal toxicity.

Radiotherapy is also experiencing a paradigm shift through the convergence of technology and biology. Adaptive Radiotherapy (ART) allows treatment plans to be modified during a course of therapy in response to anatomical or physiological changes in the tumor or surrounding tissues. Artificial intelligence (AI) and machine learning are increasingly applied to automate contouring, predict radiation response and optimize treatment plans, reducing planning time and inter-observer variability while improving accuracy. Moreover, proton and heavy ion therapy, collectively referred to as particle therapy, are gaining prominence due to their unique physical properties. Unlike conventional photon-based radiotherapy, particle therapy deposits maximum energy at the tumor site (the Bragg peak) with minimal exit dose, offering superior sparing of healthy tissue. This is particularly beneficial for pediatric tumors and cancers located near critical structures such as the spinal cord or brainstem.

The future of radiotherapy in oncology is poised to be defined by the integration of immunotherapy and radiotherapy, an approach known as radio-immunotherapy. Radiation can modulate the tumor microenvironment, enhance antigen presentation and promote systemic anti-tumor immune responses. Clinical trials are investigating combinations of checkpoint inhibitors and radiotherapy to potentiate systemic disease control, including the abscopal effect, where localized radiation triggers regression of distant metastatic lesions. In addition, research into radiogenomics is exploring how genetic profiles influence tumor radiosensitivity, enabling individualized dose prescriptions and minimizing adverse effects. Nanotechnology also offers potential for next-generation radiotherapy, including the use of radiosensitizing nanoparticles to enhance tumor-specific radiation damage while protecting normal tissues.

CONCLUSION

Despite these advances, challenges remain. Radiotherapy access is uneven globally and high costs of advanced technologies such as proton therapy limit widespread availability. Additionally, understanding long-term toxicities, secondary malignancies and optimizing combination therapies are ongoing areas of investigation. Nevertheless, the convergence of technological innovation, biological insights and precision medicine promises

Correspondence to: Sophia Williams, Oncology Department, Royal Marsden Hospital, London, United Kingdom, E-mail: sophia.williams@rmh.nhs.uk

Received: 30-Jun -2025, Manuscript No. CMT-25-40400; **Editor assigned:** 03-Jul-2025, PreQC No. CMT-25-40400 (PQ); **Reviewed:** 17-Jul -2025, QC No. CMT-25-40400; **Revised:** 25-Jul-2025, Manuscript No. CMT-25-40400 (R); **Published:** 02-Aug-2025, DOI: 10.35248/2167-770.25.12.223

Citation: Williams S (2025) Radiotherapy in Oncology Current Practices Innovations and Future Directions. Chemo Open Access. 12:223.

a future in which radiotherapy becomes even more effective, personalized and less burdensome for patients. In summary, radiotherapy continues to evolve from a primarily anatomical approach to a sophisticated, highly individualized treatment modality that integrates advanced imaging, molecular targeting, adaptive strategies and emerging systemic therapies. Its role in oncology is expanding and ongoing research ensures that it will remain a pivotal component of cancer care, offering hope for improved outcomes and quality of life for patients worldwide.