Artificial Intelligence in Radiation Oncology Training: Integrating Clinical Skills and Automation

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Artificial Intelligence (AI) is transforming radiation oncology, automating it, and assisting in decision making. This integration poses challenges and opportunities for residents, and the future of radiation oncology will significantly depend on how well these technologies are absorbed into their training. AI can enhance efficiency and optimize patient care but can also raise concerns about skill retention and the evolving role of radiation oncologists. The future of radiation oncology will largely depend on how well residents incorporate AI into their training while maintaining core clinical competencies.

One well-developed application of AI is in auto-segmenting organs at risk and tumor volumes. Historically, contouring was painstakingly labor-intensive, requiring high precision and artistry. Today, AI algorithms carry out this function in a fraction of the time and with accuracy levels commensurate with truly competent radiation oncologists.[1] This allows residents to concentrate on other aspects of patient care, like treatment planning. However, it begs the question of how much practice of manual contouring should be expected of the residents if AI can do it effectively.

Manual contouring remains a fundamental skill for understanding anatomical relationships and ensuring accurate radiation dose delivery. While AI-assisted tools can standardize contours and reduce interobserver variability, over-reliance on automation may erode residents' proficiency in this critical area. AI-generated contours still require validation, and potential errors can have significant clinical consequences. Therefore, training programs must balance the use of AI with the development of strong manual contouring skills to maintain clinical competence.

Machine-learning predictive analytics also improve patient care in several realms, including segmentation. AI may analyze outcomes based on predictive modeling, arriving at toxicity-risk estimates for different radiation dose levels. Examples include the use of machine-learning models to predict acute radiation dermatitis in patients with breast cancer.[2] Another example consists of the RAD-AI trial investigating the use of AI to determine dose recommendations during stereotactic body radiation therapy for lung cancer patients.[3] This phase II trial aims to assess the effectiveness and safety of AI-driven dose planning, potentially leading to more tailored and effective treatment strategies. Such advancements underscore the importance of residents understanding AI applications to effectively interpret and integrate these tools into clinical practice. Though these tools can aid with treatment personalization, residents should rely on their

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sound clinical judgment when interpreting outputs.

Despite these advancements, AI cannot replace the clinical judgment and expertise that radiation oncologists bring to patient care. AI models rely on training data, which may not always reflect the diversity of real-world clinical scenarios. Additionally, AI cannot contextualize unique patient circumstances, such as comorbidities, social determinants of health, and patient preferences, that play a crucial role in treatment decision-making. Radiation oncologists provide the critical thinking, adaptability, and ethical reasoning that AI cannot replicate. Residents must learn to interpret AI-generated recommendations within the broader clinical picture by understanding model limitations and biases.

While AI is helpful and makes things efficient, residents must maintain the power of clinical skills. Integrating AI into training for future radiation oncologists will help establish a practical relationship between technology and sound judgment in patient care. The future of equitable cancer care will depend on striking the right balance between technological innovation and human expertise, ensuring that AI serves as a tool to enhance—not replace—the art and science of radiation oncology.

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