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Objective Tolerances in Clinical Radiation Therapy and Treatment Planning

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Abstract

Radiation therapy is the clinical use of ionizing radiation for the treatment primarily of cancer. The complexity of the treatment process requires comprehensive quality control and quality assurance programs to prevent errors and to provide confidence that patients will receive the intended treatment with high accuracy. The advent of more conformal treatment techniques has the potential of improving the clinical outcome but poses higher demand on the quality assurance programs. Thus, innovative approaches are needed to balance patient safety and treatment quality with available resources. This thesis presents a methodology for the critical assessment of tolerances in quality control for radiation delivery based on the dosimetric outcome. The study evaluates inaccuracies in 3 important steps in radiation therapy (planning, verification and delivery) and defines objective tolerances based on a surrogate of the clinical outcome: the Equivalent Uniform Dose (EUD). The EUD is a physical quantity that is quickly gaining acceptance as a tool to report, analyse and optimize treatments due to its biological basis, robustness of a dose-domain model, dependence of only one radiobiological parameter and ease of use. The current study provides a basis for the efficient allocation of resources within a quality assurance program for modern radiation therapy encompassing both Three-Dimensional Conformal and Intensity Modulated Radiation Therapy.