AbstractID: 5003 Title: Radiobiologically motivated margin prescriptions

Purpose: The celebrated formula of Van Herck et al. prescribes a target margin of at least 2.5 times systematic standard error plus 0.7 times random standard setup error, in order "to ensure a minimum dose to the CTV of 95% for 90% of the patients" (van Herk et al., IJROBP (2000) 47:1121-1135). However, minimum dose is an imprecise and biased surrogate for local control. The question we address is whether this margin formula is consistent with radiobiological principles.

Method and Materials: To address this issue we make the connection between outcomes and dose distributions using radiobiological modeling and computer simulations of tumor control probability under varying conditions of systematic and random (fraction to fraction) setup errors. We consider an idealized case of a circular cross-section tumor which is shifted systematically and randomly with respect to a fixed dose distribution which falls off rapidly within the plane. Tumor control probability (TCP) is simulated using the Webb-Nahum model. Cohorts of patient treatments were simulated with varying target margins for varying conditions of systematic and random setup shifts. The threshold for a clinically important improvement in TCP was set at 0.01 (absolute).

Results: The radiobiological simulations consistently indicate that the dose-based Van Herk formula produces margins which are unnecessarily large. In our simulations, margins equal to 1.2 times the setup error + 0.7 times the random error consistently produced TCP values which were within 0.01 of the large margin limit.

Conclusion: Although the details of the margin prescription depend on the characteristics of the test cases, radiobiological, as opposed to purely dosimetric principles, support using tighter margins around gross tumor volumes than those indicated by the Van Herk equation

This research was partially supported by NIH grant CA85181