AbstractID: 5911 Title: Assessing the impact of radiotherapy dose uncertainties on tumour control probability: application of equivalent stochastic dose (ESD)

Purpose: To demonstrate a method of TCP evaluation that intrinsically accounts for the dose uncertainties.

Method and Materials: The dose uncertainty is taken into account through the concept of an equivalent stochastic dose (ESD) defined as the dose to a voxel that results in the mean expected survival fraction from a process randomly depositing a dose D. Applying ESD to a non-uniform dose distribution yields the concept of equivalent uniform stochastic dose (EUSD). TCP was calculated to include dose uncertainty and dose inhomogeneity as TCP(EUSD). We show that Webb-Nahum and Niemierko-Goitein TCP models both converge to TCP(EUSD) when dose uncertainty is taken into account. Voxel control probabilities (VCPs) were modeled for a single voxel irradiated with a uniform prescribed dose of 60 and 70 Gy at 2 Gy per fraction. Effect of the dose fractionation on TCP in the presence of the dose uncertainty was also investigated using our TCP(EUSD) model. *Tolerance uncertainty* on the dose resulting in *tolerance TCP loss* (assumed as 5%) was calculated for a range of radiobiological parameters.

Results: TCP degradation due to the treatment dose uncertainty in the whole tumour, as well as in its fraction was evaluated and shown that degradation of the TCP was controlled by the voxels where the dose is not known exactly. It is shown that cell radiosensitivity, the α/β ratio and the cell density each influence the TCP degradation due to the dose uncertainty. For a modeled tumour (α=0.3, α/β=10, $N_0=10^8$) irradiated with 60 Gy, 10 % dose uncertainty reduced the TCP from 95% to 45%.

Conclusion: Presented TCP(EUSD) model demonstrated capability to robustly evaluate the loss of TCP due to the dose uncertainties. It is shown that the *tolerance uncertainty* reduces with decreased number of fractions indicating that hypo-fractionated treatments may require more accurate dose delivery.