

Purpose: In the framework of stereotactic body radiation therapy (SBRT), dose per fraction larger than 2Gy have become more common, challenging the applicability of the linear-quadratic (LQ) model. Several authors have proposed ways to modify the LQ model to make it linear at large doses per fraction. Qualitatively, the modification implies a reduction of biological effect with respect of the standard LQ model for large doses. The purpose of this work is to quantitatively study the effect of the survival curve linearization at high doses for BED calculation relevant to prostate and lung SBRT.

Method: We use a previously published linear-quadratic-linear model (LQL) to calculate BEDLQL and the equivalent dose in 2Gy fractions EQD2 for several clinically used fractionation schemes of prostate and lung cancer. The LQL model adds a parameter δ that makes the survival curve linear at high doses and is estimated to be 0.05-0.2Gy⁻¹. We compare BED and EQD2 for the LQ and LQL models.

Results: For prostate cancer if $\alpha/\beta=1.5-3\text{Gy}$ the difference in EQD2 between the LQ and LQL is 5 to 10% for cases with $\delta=0.2\text{Gy}^{-1}$ and moderate dose per fraction $d=3-4.3\text{Gy}$. For extreme hypofractionation the effect is more pronounced with differences of up to 35% in EQD2. For the lung cancer SBRT, the BEDLQL for doses of 10-12Gy is 3-25% smaller than BEDLQ with $\alpha/\beta=10\text{Gy}$ while even bigger differences ranging from 10 to 40% are possible for normal tissues $\alpha/\beta=3\text{Gy}$.

Conclusions: There is a clear interplay of the α/β ratio and the parameter δ in terms of BED and EQD2 calculations for different fractionations. The impact of the parameter δ is significantly higher for low α/β ratios. This is particularly important for the case of prostate cancer where a large value of δ (0.2Gy⁻¹ or so) could bring EQD2 below acceptable therapeutic.