AbstractID: 10515 Title: Mechanistic formulation of a lineal-quadratic-linear (LQL) model: split-dose experiments and exponentially decaying sources

Purpose: In recent years, several models were proposed that modify the standard linear-quadratic (LQ) model to make the predicted survival curve linear at high doses. Most of these models are purely phenomenological and can only be applied in the particular case of acute doses per fraction. We consider a mechanistic formulation of a LQL model in the case of split-dose experiments and exponentially decaying sources. This model provides a comprehensive description of radiation response for arbitrary dose-rate and fractionation with only one additional parameter.

Method and Materials: We use a compartmental formulation of the LQL model from the literature. We analytically solve the model's differential equations for the case of a split-dose experiment and for an exponentially decaying source. We compare the solutions of the survival fraction with the standard LQ equations and with the Lethal-Potentially Lethal (LPL) model.

Results: In the case of the split-dose experiment, the LQL model predicts a recovery ratio (RR) as a function of dose per fraction that deviates from the square law of the standard LQ. The survival fraction as a function of time between fractions follows a similar exponential law as the LQ but adds a multiplicative factor to the LQ parameter β. The LQL solution for the split-dose experiment is very close to the LPL prediction. For the decaying source, the differences between the LQL and the LQ solutions are negligible when the half-life of the source is much larger than the characteristic repair time, which is the clinically relevant case.

Conclusion: The compartmental formulation of the LQL model can be used for arbitrary dose-rates and provides a comprehensive description of dose response. When the survival fraction for acute doses is linear for high dose, a deviation of the square law formula of the recovery ratio for split-doses is also predicted.