AbstractID: 2971 Title: Evaluation of the limits of accuracy of the high heterogeneity TCP model

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Purpose: To determine the limits of accuracy of a TCP model that assumes high heterogeneity, such as the Roberts and Hendry (*IJROBP* **41** 689-699 1998) model.

Method and Materials: A TCP model that incorporates heterogeneity in radiosensitivity, clonogen number and growth rate is reduced to a two parameter model by grouping variables using a method previously introduced by Carlone et al (Carlone et al *Med Phys* **30** 2832-2848 2003). The model is then approximated in the high heterogeneity limit by approximating the TCP function as a Heaviside step function with a step at 0.577. The high heterogeneity approximation, when plotted in the reduced parameter space has iso-TCP lines that are linear, and cross at a common point. This suggests a further variable reduction such that TCP depends on a single variable, δ: TCP = ½ *erfc*(δ/sqrt(2)). A similar variable substitution can be inserted into the exact TCP model; the result is a function of two variables, however the TCP function depends much more strongly on the variable δ than on the second variable. The limits of accuracy of the approximation are determined by calculating the difference between the two solutions.

Results: When only heterogeneity in α is considered, the high heterogeneity TCP approximation is accurate (< 5%) when $\sigma_\alpha D$ is larger than 1.6. When $\sigma_\alpha D$ is large as compared to 0.577, the TCP function can be accurately evaluated using only parameter ratios (Roberts and Hendry closed formula), however it does depend on the value of σ_α when $\sigma_\alpha D \approx 0.577$. When σ_α is small, maximum errors on the order of 30% to 50% can occur.

Conclusion: When the quantity $\sigma_\alpha D$ is significantly larger than 1, the heterogeneous TCP function can be accurately modeled using only parameter ratios, and the high heterogeneity approximation.