AbstractID: 9502 Title: Nanoparticle transport study for drug delivery in diagnostic & therapeutic oncology

Purpose: To study the fundamental transport properties (diffusion) of nanoparticles in tumor and surrounding normal tissue for several geometries and several volumetric nanoparticles.

Method and Materials: Diffusion is the dominant mode of interstitial transport for small solutes, and when the driving force for convection is diminished, it may be the dominant or at least a significant mechanism for the transport of macromolecules. Computation of transport of nanoparticles using the Fluid Dynamics program Fluent® 6.2 with the use of user defined functions made it possible to study diffusion in arbitrary geometries. Fluent computations for time dependent particle distribution for four different cases of volumetric nanoparticle sources were performed for model geometries, and tissue/tumor properties and results for arbitrary scalar (ϕ) value (e.g. mass concentration, particle concentration, etc.) were analyzed. Different volumetric sources that we have considered are (1) constant, (2) no source, (3) an arbitrary function of space and time, and (4) as an arbitrary function of space. For the several model cases, we have also verified Fluent results against analytical results.

Results: The computations are carried over a 6 hour diffusion time period in the tissue-tumor geometry. Computational results for particle distributions in the model are sampled for every 30 minutes and volume integral of ϕ are plotted for tissue and tumor volumes. Volume integrals of ϕ in normal tissue volumes and tumors for the four cases of sources gave an estimate of the amount of ϕ absorbed in the tumor volumes.

Conclusions: These results appear consistent with expectations, and the computational model thus appears appropriate for future explorations/verifications. The study of transport property of the nanoparticles using Fluent has provided insight into the distribution of the nanoparticles. This would allow us to explore variety of different nanoparticles like gold, gadolinium, tungsten etc for diagnostic and therapeutic oncology.