Abstract ID: 15340 Title: Monte Carlo Simulation of Arbitrary Geometries and Heterogeneous Optical Properties for Treatment Planning in PDT

Purpose:
An important aspect of Photodynamic Therapy (PDT) treatment efficacy is uniformity of light dose. An analytic solution of fluence in a spherical cavity originally presented by Willem Star was further developed to calculate fluence in cavities of arbitrary geometries. To verify our analytic solution in conjunction with a Finite Element Model (FEM) developed in COMSOL, we compare the fluence results for a cavity of arbitrary geometry and heterogeneous optical properties to a Monte Carlo (MC) simulation developed in the MATLAB platform. This verified analytic solution will be applied to a real-time Infrared (IR) Camera device used as a treatment planning tool for pleural PDT.

Methods:
The CT scans and IR camera data from four patients enrolled in a Phase I study for HPPH-mediated Photodynamic Therapy (PDT) are used as the arbitrary cavity geometries which build the framework for the FEM and MC models of fluence. The cavity walls are assigned optical properties measured using a diffuse reflectance spectroscopic system during treatment both before and after the patient receives light dose. Once this cavity environment has been established, and isotropic light source is placed both at a central and off central location in the cavity. The resulting fluence rate calculated from the MC simulation is compared to the results from the FEM simulation.

Results:
Preliminary results show there is good agreement for spherical cavities of heterogeneous optical properties in the presence of attenuation and multiple scattering. The results of simulations for arbitrary geometries are currently being developed and analyzed.

Conclusions:
The verification of our FEM model allows us to apply this solution in the clinic with an IR camera which tracks the clinician’s treatment in real time. By coupling our fluence model with this new tool we can implement a real-time fluence monitoring device which may improve uniformity of treatment.