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Personalized Treatment Planning for Targeted Radionuclide Therapy: A Monte Carlo Model

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Patients who receive targeted radionuclide therapy (TRT) for cancer treatment suffer from damaging unwanted healthy body tissues and may receive unexpected dose to healthy organs as an inadvertent consequence of their treatment. In particular, they risk significant dose to critical and secondary organs, e.g. bone marrow, gonads, uterus etc., which may cause long- or short- term damage for entire life. The unintended dose to organs varies widely depending on the types and energy of the emitted radiation and their decay scheme. Royal University Hospital at University of Saskatchewan recently started Yitrium-90 (Yt-90) treatment available for the liver patients in a drug name TheraSphere. Several other radionuclide treatments, e.g. Radium-223, Strontium-89 will be available in coming months. Till now, MIRD principle is the only methodology that is being widely used for TRT dosimetry and there is no commercial program available that can be fitted over wide varieties of radionuclide treatments. Medical Imaging team at Royal hospital is currently building a customized virtual treatment planning system that is capable to combine personalized CT images to advanced particle transport framework. This presentation showcases design features and initial results of this planning system.

The proposed virtual planning system consists of series of 2-D DICOM images of the patient captured by CT scanner. The 2-D data set are transformed to 3-D object (composed of thousands of voxels (volume of the pixels) that is readable to a particle transport framework. This framework is capable for dose modeling to specific organs. Initially, this system will be used in planning Yt-90 for liver-treatment and Strontium-90 for treatment of bone. In the long run, the system will be upgraded for treatment of alpha emitters with substantial improvements in particle transport data framework. This customized user friendly tool can be used by the clinicians in parallel to existing commercial planning system in order to cross-validate diagnosis and treatment plan for individual patient.
The initial design is completed and been tested for several radionuclides. The presentation will include the results and future challenges.

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