AbstractID: 12007 Title: Promise and Challenges of PET for Target Definition and Treatment Response Evaluation

Positron Emission Tomography (PET) images show physiological and biological information through the in vivo distribution of radioactive, positron-emitting agents. PET imaging shows focal and distributed regions of cancer and its metastases. Initial PET uses in oncology include diagnosis and staging, which are important for determining treatment decisions. Current PET uses now include target definition for radiation planning followed by PET-based assessment of treatment. Hybrid PET-CT devices are becoming attractive radiation treatment simulators.

PET imaging has coarse spatial resolution compared to CT and MR. PET's clinical use is valued because of its great sensitivity for cancer detection. While F-18-labled Fluoro-deoxyglucose (FDG) remains the most promising agent for tumor diagnosis and staging, other, biologically more specific agents (e.g., FMISO, CuATSM for hypoxia imaging or FLT for cell proliferation imaging) might be more appropriate for target definition and treatment assessment.

Although PET brings to radiation therapy of cancer the critical advantage of defining the tumor based on its molecular properties, delineating the gross tumor volume (GTV) with PET is problematic due to the uncertainties in the biological and physiological processes governing the tracer uptake and due to physical limitations for the accuracy of PET images. The main PET image degrading factors, including limited resolution, photon scatter and attenuation will be described and some of the current correction strategies will be introduced. A brief summary of the PET image segmentation methods will be presented.

This course reviews PET-CT hybrid scanning devices, uses of FDG and non-FDG PET for oncology imaging, and quantitative aspects for PET-based radiation target definition and treatment assessment. Example images demonstrate the potential contributions and limitations of FDG and non-FDG PET oncology imaging. This review course is intended for both imaging and radiation oncology physicists.

Learning Objectives

1. Understand the principle and the current physical limitations of PET
2. Become familiar with the types of PET-based tumor segmentation methods
3. Discuss quantitative aspects of PET imaging for treatment assessment