AbstractID: 5194 Title: Thresholding of PET Target Volumes for Treatment Planning and Response Monitoring: Measurement and Modelling Approaches

Purpose:
To describe a method to determine the thresholds of different sized objects in PET images for the purpose of target segmentation for radiotherapy treatment planning and response monitoring and compare the measurements to a modelling approach using point spread functions.

Method and Materials:
PET images of the IEC image quality phantom containing 6 spheres of different size containing a known activity concentration of an [F-18] solution were repeatedly imaged at different times in both 2D and 3D PET acquisition modes. Nominal thresholds were found for each sphere and plotted against the mean uptake values in each sphere. The point spread function (PSF) of the PET scanner was measured by imaging a 1 μl drop of high activity concentration. The full-width-at-half-maximum (FWHM) of these PSFs was then used to generate simulated PET images by convolving a binary mask of the 6 spheres with the PSF in 3 dimensions.

Results:
Nominal thresholds and the mean uptake scale linearly with activity concentration for a given sphere size. The slope of these threshold-uptake lines are larger for smaller spheres. The deviation from the slope 0.5 indicates the degree of partial volume effect or non-uniform uptake in the target. Once these lines are quantified the actual threshold for a target of unknown size (approximately spherical in shape) can be found by an iterative procedure. The FWHM of the measured PSFs depends on acquisition mode and PET reconstruction parameters. For the 3D mode, the PSF model excellently predicts the nominal thresholds for all sphere sizes, but not for the 2D mode.

Conclusion:
Segmentation of targets for treatment response monitoring requires an adaptation of the thresholds if the target size is shrinking. The PSF has the potential to be used for pre-processing the PET image before segmentation.