AbstractID: 6777 Title: Quantification of Uptake Volumes in PET Images for Treatment Response Monitoring: Challenges and Solutions

Purpose:
Monitoring treatment response in PET images by quantifying changes in the spatial distribution of radioactivity concentration over time requires accurate determination of volumes. Thresholding methods are usually based on finding volume-recovering thresholds for known objects, such as spheres, in a discrete voxel grid. Measuring these volumes introduces discretization errors into the threshold calibration process. In addition, thresholds depend strongly on the object-to-background activity ratio which is usually unknown a-priori. In this work, the efficacy of a simple pre-processing step is investigated that makes the thresholds largely independent of the object-to-background activity ratio.

Methods:
PET scans of a standard imaging phantom containing 6 spheres were acquired in 3D mode on a GE Discovery ST scanner for different object-to-background activity ratios including no background. Images were reconstructed using FORE-OSEM with a variable number of iterations. Thresholds in images where the background activity was subtracted were compared to the thresholds in the no-background images. Discretization errors were quantified by placing mathematically accurate contours of the spheres into the voxel grid of the PET dataset. Volumes were computed by the treatment planning software.

Results:
Using a low number of iterations, volumes of all spheres were accurate to within 10% using thresholds derived from the background-corrected images. A higher number of iterations degraded the accuracy significantly. In coarse voxel grids common in PET imaging (2.3 x 2.3 x 3.3 mm), small volumes were consistently overestimated by as much as 30% depending on the position of the spheres with respect to the grid.

Conclusions:
Threshold calibration is sensitive to voxel grid resolution. For images acquired in 3D mode and reconstructed with a low number of iterations, a simple background correction method allows for accurate volume quantification independently of initial background activity and allows for a significant simplification of the threshold calibration process.