Application for Round-6 QIBA Project Funding

Title of Proposal: SUV Quantification with Point Spread Function PET Reconstruction		
QIBA Biomarker Committee/Task Force: FDG PET/CT Biomarker Committee		
NIBIB Contract Objective(s) which this project addresses: Objective 3 is specifically addressed in this proposal; Objectives 2, 4 & 5 are also partially addressed		
PI (Project Coordinator or Lead Investigator Information) Note, this is a co-PI collaboration with Ronald Boellaard, PhD (U Groningen)		
Last Name: Lodge	First Name: Martin	Degree(s): PhD
e-mail:		Tel #:
Institution/Company: Johns Hopkins University (JHU)		
Total Amount Requested:		

Project Description

Advanced image reconstruction algorithms that incorporate resolution recovery (also known as point spread function modeling or PSF) are available on most modern PET systems. Improvements in lesion detection have been reported with PSF due to a better trade-off between spatial resolution and image noise. Despite these advantages, the current version of the QIBA FDG PET/CT oncology profile specifically excludes PSF from our claim statement. Concerns have been raised about the quantitative accuracy and reproducibility of PSF images and it was felt that insufficient data existed on this topic. Nevertheless, PSF reconstruction is being used in clinical practice and there is a need for clearer guidance regarding SUV quantification with PSF.

PSF reconstruction is commonly associated with an artifact at the interface between regions of different activity concentrations. Unintended overestimation of the local image signal can occur at the edges between organs and this artifact, while not always obvious in small potentially heterogeneous masses, is known to affect tumor quantification. The highest pixel in a tumor may be amplified by the artifact so when SUV_{max} is used to quantify tumor uptake, a substantial and unreliable positive bias can result. Phantom data illustrate this bias and also indicate that the magnitude of the bias is dependent on the size of the sphere. At a particular sphere size, the edge artifacts appear to combine unfavorably to produce a pronounced increase in SUV that could further complicate quantitative response assessment.

In this application we propose a co-PI, collaborative, international, multi-center effort, aimed at evaluating and optimizing SUV quantification in conjunction with PSF image reconstruction. We propose to measure the bias (accuracy) and repeatability (precision) of SUV measurements derived from PSF images. Specifically, we will assess whether volumetric regions-of-interest have advantages over the current standard, SUV_{max}, when reconstructing with PSF. Our evaluation will employ phantom experiments that will allow for assessment of both bias and repeatability under various conditions. Unlike in-patient studies, the activity concentration in phantoms can be independently measured and the accuracy of different SUV approaches can be assessed. Phantoms also allow for the acquisition of multiple statistically independent images, from which the repeatability and (multicenter/multivendor) reproducibility of different SUVs can be measured. It is noted that this phantom based repeatability assessment includes only a component of the overall repeatability of

the method but should not be a limitation in this case because the additional variability associated with clinical variables is expected to be similar for each SUV measure.

Careful consideration will be given to the implications of our work on standardization of data collection between scanner systems. The intention of PSF reconstruction is to alter (improve) image characteristics but it's possible that VOI-based tumor segmentation can be used to produce SUVs that are not as sensitive as SUV_{max} to variations in image characteristics (spatial resolution, noise, edge artifacts, etc.). If volumetric regions-of-interest can maintain PSF-derived SUV in a similar range to the one currently expected for SUV_{max}, and their repeatability is superior to the current approach (no-PSF & SUV_{max}), it would provide support for the use of PSF in a way that is consistent with the QIBA Profile claim. In this way we hope to fill a gap in the current QIBA Profile and hopefully contribute to improved accuracy and repeatability of quantitative tumor imaging.