AbstractID: 11241 Title: The Estimation of the Uncertainty of Activity Concentrations in PET Images with Filtered-Back-Projection

Purpose: A methodology is proposed to estimate the standard deviation (STD) within lesion voxels for clinical PET images.

Method and Materials: Three series of list-mode dynamic PET images (8x3-minute scans) of a seven chamber phantom (seven one-liter bottles arranged hexagonally, 1120 ml) were acquired in 2D and 3D to estimate the STD of the images voxels. Filtered-Back-Projection (FBP) reconstruction with random, scatter, and attenuation correction is used instead of iterative reconstruction due to its improved signal-to-noise ratio (SNR) in hot lesions and the associated low count convergence issues of iterative reconstruction. In addition, the noise in FBP within each image is spatially invariant, which is not true for iterative reconstruction. The phantom fill ratios were 2x1:1, 2x2:1, 4:1, 8:1, and 16:1 with an initial activity concentration of 5.96 kBq/ml (1.26 mCi). The standard deviations are estimated by comparing the 8 3-minute acquisitions to one another and by examining an ROI drawn within each image. The 3-minute FBP images are compared to the 24-minute image to estimate the standard deviation of the 24-minute frame.

Results:
The following were verified: With FBP the STD of the voxels within a slice is spatially invariant, and FBP has superior SNR to iterative reconstruction for high contrast lesions. In addition, post reconstruction summed FBP images are statistically similar to sinogram summed images with maximum errors of the mean and STD of 0.2%, and 2.1%, in 2D and 2.1%, and 6.1% in 3D respectively. Finally, the STD for the summed image is inversely proportional to the square root of the number of frames.

Conclusion:
In phantom studies a single STD for an entire slice is shown to be representative of the STD of the individual voxels within that slice. Furthermore, in FBP the STD scales with $1/\sqrt{\text{number of frames}}$. This methodology should extend well to patient studies.