Purpose:
To investigate the performance improvement of a novel region growing (SRG) and "segmentation-by-consensus" (SBC) technique for delineation of lesions in FDG-PET. Further, the improvement in lesion segmentation using time-of-flight (TOF) PET was investigated.

Methods:
The NEMA image quality phantom was filled to give 3:1 and 7:1 contrast ratios between spheres (0.44 - 27.13 cc) and background. Contrast added to the sphere volumes and a hi-resolution CT allowed segmentation of the true activity distribution. Ten minute list-mode scans were acquired on a GE Discovery 690 PET/CT system. Images were reconstructed representing 1, 2 and 5 minute acquisitions using TOF and NTF methods. Four commonly used segmentation methods, 40%max 50%max, K-means, fuzzy C-means, and the SRG technique, were used to segment the six spheres. The SBC approach creates volumes from voxels segmented by a majority of the techniques. Absolute volume differences and volume overlap were metrics for evaluating each algorithm's performance.

Results:
All techniques performed poorly for the small (0.44 & 1.08 cc) spheres with mean volume errors between 10-30 cc (3:1 contrast), and 5.5-12 cc (7:1). SRG consistently had lower average volume errors (4.25-6.30 cc) but 40%max had the highest absolute volume overlap for the largest sphere (0.7795-0.8090). However, SRG dramatically outperformed 40%max for the 1.08 cc sphere (0.4338-0.4952 vs. 0.0124-0.0173). For the high (7:1) contrast, k-means consistently gave lower average volume errors (0.09-6.95 cc) and higher average volume overlap (0.4741-0.5765) than SRG (8.57-10.15 cc and 0.3543-0.3967). No noticeable difference with TOF was observed. SBC gave results within the above ranges for both 3:1 and 7:1 with less variation and was close to the highest performing technique in each scenario.

Conclusions:
TOF offers comparable results to NTF PET for the volumes segmented. The SRG technique provided lower mean volume errors and good volume overlap in low contrast situations.