Purpose: To examine the impact of 4D-PET on target volume delineation of upper-abdominal tumors, versus conventional un-gated PET.

Methods: Four patients with upper-abdominal tumors underwent respiratory-correlated FDG PET/CT scanning (4D-PET) as part of a continuing IRB-approved research protocol. Internal target volumes of FDG-avid tumors were contoured on the 4D-PET and conventional un-gated PET by a radiation oncologist who is a specialist in gastro-intestinal tumors. To create the 4D-PET ITV, the end-inhale and end-exhale 4D-PET phases were used. The relative volumes and volumetric overlaps of the 4D and un-gated target volumes were examined. Additionally, 4D-PET was used to measure the motion of the tumors.

Results: Of the four patients who were imaged, one showed minimal motion (< 3 mm in any direction) and one showed minimal FDG avidity; these were removed from further analysis. Of the two tumors which showed significant motion and FDG uptake, 4D-PET volumes were 28% and 21% larger than un-gated PET volumes. The un-gated PET volumes were almost entirely contained within the 4D-PET volumes (95% and 93% for the two tumors). Tumors appeared to deform as well as translate with breathing, although this could be due to varying intra-gate motion rather than actual physiological deformation. The superior-inferior borders of the tumors exhibited the most motion, with displacements of 5.6 mm and 6.4 mm.

Conclusions: 4D-PET can be used to estimate the motion of FDG-avid upper-abdominal tumors. Use of 4D-PET increases the size of target volumes compared to un-gated PET in a subset of upper-abdominal cancer patients. Direct measurement of tumor motion and deformation by 4D-PET imaging could allow the use of patient-specific margins rather than population-based margins, potentially leading to increased target coverage and reduced normal tissue irradiation.