Lung cancer patient feasibility study for emission guided radiation therapy

**Innovation/Impact:** This is the first feasibility study involving PET data from a lung cancer patient for emission guided radiation therapy (EGRT), a new modality that uses PET tracer emissions in real-time to guide radiation delivery.

The proposed EGRT geometry is depicted in Figure 1. Positron annihilation photon emissions from the subject are used in real-time to guide radiation delivery. The EGRT algorithm involves switching a binary multi-leaf collimator so that beamlets of radiation are directed along detected emission lines of response (LOR’s). A static planning target volume (PTV) is used as a filter to reject LOR’s that do not intersect this volume. The timestamp of each LOR is also used to reject past events (e.g. LOR’s detected more than 500 ms in the past are rejected).

Raw list-mode data from a lung cancer patient’s PET-CT scan was used as input into a simulation framework that runs the EGRT algorithm for a 1 Hz rotation system, and simulates the EGRT dose delivered using a Monte Carlo software package (VMC++). The list-mode data were not normalized, or corrected for scatter, randoms, or attenuation. Although physiologic motion of the patient was ignored due to the tumor exhibiting < 2 mm of motion, the 500 ms LOR cutoff was still used to determine feasibility of EGRT based on a clinical data set.

Figure 2 shows the PET and CT reconstructions for this patient, with the FDG-avid tumor plainly visible in the upper left lung. The dose simulation results are depicted in Figure 3. In the IMRT scheme, a PTV was uniformly irradiated using a helical delivery. In the EGRT approach, the same PTV was used a filter as described above. Both approaches were normalized so that the same integral dose to the chest wall was delivered (Figure 4).

The feasibility of EGRT with respect to a real clinical data set has been demonstrated. Future work will be to estimate performance benefits for cases with significant respiratory motion.