AbstractID: 7130 Title: Compounding errors: time delay in gated radiotherapy

Purpose: When commissioning any component in an integrated radiotherapy system, it is imperative to consider possible compounding of errors through the entire system. Gated imaging and radiotherapy provides a useful example of this.

Method and Materials: In gated radiotherapy, the accuracy of treatment delivery is determined by the accuracy with which both the imaging and treatment beams are gated. If the time delays (the time between the IR markers entering/leaving the gated region and the first/last image acquired or treatment beam on/off) for the imaging and treatment systems are not consistent, the required ITV margin may increase above that deduced from the tolerance for either system measured individually. We measured one gating system's time delay on 2 fluoroscopy systems, and two linear accelerator, using a motion phantom of known geometry, varying gating type (amplitude vs. phase), beam energy, dose rate, and period.

Results: In the worst case scenario, beam-off for amplitude-based gating (3-5s period), the last fluoroscopic image in the gated region was acquired 0.15 ± 0.08 s (1SD) before the IR markers left the amplitude-gated window, while the treatment beam cut off 0.06 ± 0.02 s after the IR markers had left the same region. For a patient with 1 cm amplitude, 4 s period sine wave breathing, this time delay mismatch increases the ITV margin by 3.7mm. For beam-on times, the fluoroscopy system was also early, while the linear accelerator beam-on was late. The images indicate a larger region is treated than is in truth, decreasing the duty cycle and increasing overall treatment time. Dose rate and treatment beam energy had negligible effects. In less-predictable, physiological breathing motion, these time delays may vary.

Conclusion: By following patient flow from simulation through treatment, physicists may more accurately assess accumulated errors in systems including gated radiotherapy.