AbstractID: 2212 Title: The Influence of Linear Accelerator Delivery Errors on IMRT

The introduction of megavoltage (MV) photon-beam intensity modulated radiation therapy (IMRT) achieved through multileaf collimator (MLC) delivery represents a significant advance with great potential for the discipline of radiation therapy. While IMRT may be delivered using many mechanisms including physical attenuators, aftermarket binary collimators, and accelerators designed to allow scanned or binary-modulated beams, the MLC delivery methodology has become prevalent due to its seamless integration into existing delivery systems. MLC-based IMRT has included both dynamic MLC (DMLC) and static MLC (SMLC) IMRT, where the leaves are either in motion or at rest during beam delivery, respectively. This development has allowed the widespread clinical implementation of very complex non-convex dose distributions. Not surprisingly, this complex but promising treatment modality has rapidly proliferated in both academic and community practice settings. In principle, these complex dose distributions will allow escalation of the ionizing radiation dose that can be delivered while lowering or maintaining iatrogenic toxicities caused by radiotherapy. However, these advances do not come without a risk.

MLC based IMRT represents a significant departure from previous conformal therapy practice, where the ability to shape dose distributions relies heavily on the use, and characterization of the penumbra of many irregular MLC fields, which are purposely and necessarily matched over the target. Widely available turnkey clinical dosimetry equipment is not up to the task of accurately validating the 3D high gradient dose distributions delivered with the highly variable beam quality found in IMRT delivery. While current clinical dosimetry methods can assure that there are no gross errors in the normalization or validate the general shape of delivered IMRT dose distributions, more comprehensive dosimetric validation is not currently feasible in a clinical setting. Such high gradient regions are where the “action” is for IMRT, yet, the uncertainty of current dose verification methodologies is high in these regions.

Punctuating the concerns outlined above, recently published reports on the performance of MLC-based IMRT delivery systems indicate that nontrivial IMRT delivery errors exist and are potentially clinically significant. Recent publications have reported that leaf motion and dose delivery errors during both DMLC and SMLC delivery do exist either according to the MLC controller “log files” or film dosimetry performed for simple nonclinical patterns. Attempts to accurately measure both the delivered fluence and field shape simultaneously of DMLC and SMLC deliveries have been performed using electronic portal imaging devices as well.

This lecture will provide an overview of our current understanding of potential sources of linear accelerator delivery error for IMRT and their potential clinical significance. We discuss how IMRT quality assurance programs can ensure that delivery errors are minimized in clinical practice.

Educational Objectives:
1. Understand the potential sources of linear accelerator delivery error for IMRT
2. Review our current understanding of these errors including their significance and frequency
3. Understand the role of IMRT quality assurance in preventing significant delivery errors