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"How much complexity is necessary for IMRT?

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IMRT treatment planning and delivery systems have developed rapidly over the past 5 years. Every manufacturer of linear accelerators now offers IMRT delivery systems using multileaf collimators and some sort of automated delivery scheme. Most treatment planning systems now offer "inverse" planning algorithms that optimize fluence and dose distributions given a set of dose constraints for tumors and normal tissues. For some accelerator manufacturers, the output of the planning system is a set of multileaf shapes, or "segments" with associated intensities, which combine to give a variable intensity distribution for each beam angle. This delivery system is referred to as static multileaf IMRT (or SMLC). For others, the intensity distribution is continuous and the leaves move with variable speed across the field with the beam remaining on. This is called dynamic multileaf IMRT, or DMLC. SMLC tends to be somewhat time consuming relative to conventional delivery, as there is overhead due to communication between the MLC controller and the accelerator. For DMLC, very little time is lost relative to conventional beam delivery times.

Most IMRT planning systems have a mechanism for controlling the complexity of the resulting plan, which is determined by the number of beam angles and the number of intensity levels specified in the plan. Highly complex plans are those that end up with large numbers of beam segments and small monitor units per segment, translating into rapid dose gradients within the patient. These are presumably desirable when a tumor is immediately adjacent to a very sensitive normal tissue and the dose falloff must be rapid outside the tumor border. On the other hand, dose delivery errors are expected to be greater with highly complex plans, since the dosimetry of small fields and the linearity of the dose at small numbers of monitor units, are rather uncertain. This fact drives us to limit the complexity as much as reasonably possible. Since DMLC does not have a significant time penalty for high complexity, there is a tendency to plan highly complex IMRT for these delivery systems. For SMLC, the constraints of treatment time tend to drive the planner to choose less complex solutions. The question to be addressed in this Symposium is how much complexity is necessary for IMRT. Clearly, the answer is site-dependent, but even at a given site, the answer is not clear. Today's speakers will describe the incentives for simplicity (time and dose accuracy), methods of controlling the complexity and the tradeoffs between complexity and conformality.