AbstractID: 3010 Title: On the relationship between risk management and IMRT treatment plan optimization

Purpose:
We assess the suitability of using biological and voxel-based penalty criteria vs. different types of dose-volume histogram (DVH) constraints that have been proposed for fluence map optimization (FMO) in IMRT by developing a rigorous relationship between treatment plan evaluation criteria based on the DVH and voxel-based penalty criteria.

Method and Materials:
Viewing the IMRT FMO problem as the problem of shaping the dose distributions in structures, an analogy was established with risk management problems from the area of financial engineering.

Results:
On the one hand, traditional DVH constraints (bounding the dose received by a pre-specified proportion of a structure) and CVaR constraints (bounding the tail mean dose received by a pre-specified proportion of the structure) can be viewed as dominance constraints of the dose distribution in a structure with respect to some reference dose distribution. On the other hand, most commonly used biological criteria (tumor control probability (TCP), generalized equivalent uniform dose (gEUD), normal tissue complication probability (NTCP)) are equivalent to voxel-based penalty functions, which can be viewed as utility functions that measure the desirability of dose received by voxels. We demonstrated that dominance based on traditional DVH constraints is equivalent to dominance with respect to all non-decreasing voxel-based penalty functions, while dominance based on CVaR constraints is equivalent to dominance with respect to all non-decreasing *convex* voxel-based penalty functions.

Conclusion:
If measures based on and including TCP, NTCP, and gEUD (with $a \notin (0,1)$) are deemed sufficient to describe the effect of a dose distribution on a structure, traditional DVH constraints should *not* be imposed on these dose distributions. However, if traditional DVH constraints are deemed necessary to describe the effect of a dose distribution on a structure, particularly in the case of parallel structures, *e.g.*, the liver, the abovementioned biological criteria cannot be used as alternatives to DVH constraints.