AbstractID: 6734 Title: Evaluation of 3-D Cluster Formation in Inhomogeneous Dose Distributions

Purpose: One shortcoming of using dose volume histogram (DVH) to evaluate a radiotherapy treatment plan is that the spatial distribution of the high dose voxels is not accounted. Cluster models, on the other hand, address not only the volumes but also their spatial location. This study is to evaluate cluster formation in clinical volume or organ at risk (OAR) receiving an inhomogeneous dose distribution.

Method and Materials: In this study, upper five-centimeter esophagus in patients with squamous cell carcinoma of the head and neck was used as the OAR. The patients were treated using IMRT. An in-house program has been developed to analyze the Pinnacle dose grid, and to perform cluster searching. We studied one- and two-connectivity of cluster formation.

Results: The characteristics of cluster formation are very different under different fractional density. The size of the largest cluster shows a distribution with a peak and also some extent of spread. The cluster size can vary in a large range and cannot be accurately predicted. Therefore, the clinical outcome of the same DVH could be potentially different. The relationship between the mean size of the largest cluster (MSLC) and fractional density is non-linear. Above a specific fractional density there is a dramatic increase in the MSLC, which possibly also represents an increase of the chance of percolation. At a certain high fractional density, MSLC increases linearly with fractional density, and additional voxels just increase the size of the existing largest cluster instead of forming new independent short clusters. Comparing one-connectivity with two-connectivity, two-connectivity presents a steeper slope in the exponential increase area on the MSLC v.s. fractional density curve.

Conclusion: Our investigation on the superior section of esophagus disclosed some interesting charasteristics. In the future, it may also be possible to incorporate these new NTCP models in the dose optimization algorithm.