Significant advances have been made in the development of external beam conformal therapy techniques to escalate tumor dose for improving local control, without a concomitant escalation in toxicity. Most noteworthy is the use of three-dimensional (3D) information from x-ray computed tomography (CT) and other imaging modalities to better localize the disease. A tighter treatment margin can be prescribed such that a higher dose can be delivered to the tumor without increasing deleterious complications. In practice, the treatment margin must account for the width of the beam penumbra, the daily variation in patient setup, and the variation in organ positions between (i.e. inter-) fractions and during a (i.e. intra-) fraction. The concept of a 3D planning target volume (PTV) introduced by the ICRU has been a very useful guide for prescribing the various components of the treatment margin. So much so that the PTV has become the corner stone in the planning of conformal therapy.

At present, the dimensions of the PTV and treatment margins are mostly based on clinical experience amassed through the evaluation of the treatment of a large patient population. PTVs might be different for different techniques and different institutions. They are meant to accommodate for the broad range of treatment variations that might occur. Unfortunately, such accommodating strategy means that these "population" margins will provide an acceptable solution for most patients, but may not be optimal for the individual patient. Indeed, treatment variation is specific for the individual patient but is unknown until after the initiation of the treatment. It follows that it might be possible to prescribe a more optimal patient-specific PTV by learning more about the nature of the variation of the individual patient.

Several alternative strategies can be considered. A feedback planning scheme is particularly effective when treatment variation is sufficiently stable. Daily portal images and CT scans can be acquired and analyzed early on during the course of treatment. A new PTV can then be prescribed to correct and compensate for the effects of systematic and random setup error. However, for those situations where the component of random variation is large or when organ deformation is variable and significant, one might need to employ the more explicit approach of on-line adjustment based on radiographic or tomographic guidance. Finally, the difficult problem of intra-fraction variation due to breathing motion can be addressed with respiratory gated delivery or with the application of active breathing control where organ motion is temporarily immobilized during treatment.

The wealth of information made available by the recent advent of imaging and computing technologies has created new opportunities for the radiation therapy community to re-evaluate traditional models of treatment planning and delivery. It seems possible to minimize PTV on an individual patient basis. These new treatment strategies will, not only, improve the general quality of radiation therapy, but may play a critical role when considering dose escalation with advanced intensity modulation treatment.

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Objective Lists:

1. Describe the goals of the planning target volume;
2. Introduce the concept that the planning target volume can be optimized individually by analyzing more information about the individual patient.