Quality Assurance and Treatment Verification for Intensity Modulated Radiation Therapy

Susan Richardson

Under the supervision of Professors Bhudatt Paliwal and Wolfgang Tome
At the University of Wisconsin-Madison

May 18, 2003

Inverse planning utilized in Intensity Modulation Radiation Therapy (IMRT) results in steep dose gradients near edges of tumors and critical structures. It is imperative for both tumor control and quality of life that the prescribed treatment dose is delivered accurately. Dose verification for IMRT is more complicated than conventional treatment verification due to many irregular field sizes and multiple portals per gantry angle. It also involves continuously changing fields called sliding windows. New types of quality assurance processes are required for these patient treatments. In this work, a film/phantom system is used to verify treatment delivery.

There are three major steps in a patient treatment quality assurance process: verification of the patient positioning, validation of the treatment planning software, and confirmation of the delivered dose with measurements. At our institution, the first step is performed using an optical guidance system that yields reproducible positioning to 0.1 mm and 0.1°. The latter two are carried out by using a phantom with film placed in a spiral groove inside the phantom. Together, the system allows accurate prediction, three-dimensional sampling, and measurement of the intended intensity modulated dose distribution. In conjunction with a semi-absolute dose measurement, it also verifies the treatment planning system dose calculation. A discussion of other commercially available methods to verify intensity-modulated treatments, including other quality assurance phantoms and tools is also presented.

Case studies involving the spiral film phantom and a semi-absolute dosimetry measurement using TLDs are included in this thesis. Film analyses have been conducted using isodose distributions and dose area histograms provided by RIT film scanning software and pass/fail maps using PTW's VeriSoft. A new formalism for the evaluation of dose distributions will be given, and a statistical analysis will be presented of the spiral film system.

The system described has been utilized to verify intensity modulated fields produced on a linac. It can also be used in either static collimator or sliding window techniques of intensity-modulated delivery as well as on tomotherapy

machines. Though used here exclusively for intensity-modulated beams, it also can be employed to verify conventional treatments. Additionally, it does not require the use of optical guidance, though the best localization procedure should be used. The phantom is both robust and versatile, resulting in quick and accurate treatment plan verification.