AbstractID: 7222 Title: Verification Measurements for IMRT

Intensity Modulated Radiation Therapy can provide highly-conformal dose distributions that simultaneously treat tumor to high doses while avoiding complex, nearly-surrounding critical structures. This comes at the cost of increased complexity of treatment planning and delivery. IMRT is typically delivered using a temporal sequence of complex, often small, portals, the dosimetry of which is prone to error. For conventional treatment-planning systems, monitor units (MUs) can often be verified to within a few percent using manual estimations of the field sizes and the known portal depths. The complex nature of IMRT makes manual verification impossible. This simultaneous juxtaposition of complex dose distributions, delivery sequences, and a loss of manual MU verification is unfortunate. Until independent leaf-sequence and monitor-unit verification systems are widely available, physical dose-distribution measurements will be the primary verification method.

The verification of IMRT dose distributions is more complex than the verification of typical conformal-therapy beams. The selection of dosimeters is limited by the temporal delivery sequence. An ionization chamber in a scanning water phantom can rapidly measure the dose distribution of a static beam. Interpolation over large distances is possible due to the predictable nature of the dose distribution. With IMRT, the dose distribution is a complex three-dimensional structure, so interpolation is less useful. The temporal delivery leads to the greatest constraint because the entire dose delivery sequence must be delivered to provide each point measurement. Given that the delivery sequence can take as long as 10-20 minutes, large-scale scanning is impractical. Selected points can, however, be measured with high accuracy and this talk will describe the selection criteria for ionization chamber point measurements.

The complex nature of IMRT dose distribution demands a multidimensional detector. The most common, and likely the most used, is radiographic film. Techniques for using radiographic film will be discussed.

As important as the detector selection is the selection and design of the phantom. While anthropomorphic phantoms provide realistic-looking treatment plans, they have some significant drawbacks relative to geometrically regular phantoms. Anthropomorphic phantoms are often more difficult to align to the beam, increasing the measurement spatial uncertainty. The preparation of film is also usually more difficult, and the presence of internal heterogeneities may make the source of differences between measurement and calculation difficult.

Methods for evaluating the measured and calculated dose distributions will also be discussed. Steep dose gradients make some dose comparison tools oversensitive. A summary of dose comparison tools will be provided.

Accurate dose-distribution measurements will identify and quantify regions where the dose calculation disagrees with the delivered dose but they do not indicate why the differences appear. Interpretations of differences between measurement and calculation will be presented.

Educational Objectives:

1) Describe the need for direct measurement-based verification of IMRT

2) Describe the use and limitations of ionization chambers for IMRT dose measurements

3) Describe the proper use of radiographic film for IMRT dose measurements

4) Outline the tradeoffs between anthropomorphic and geometrically regular phantoms

5) Present methods for dose distribution evaluation

6) Describe potential sources of error in IMRT