The introduction of inverse treatment planning and IMRT dose delivery has revolutionized the way radiation oncologists, medical physicists, and dosimetrists think about achievable dose distributions. Using this new technology, it is easy to generate plans for complex non-coplanar beam arrangements as well as for treatment of lesions that partially or fully surround critical structures. However, the plans generated with inverse planning are often significantly different than traditional plans, and the steps of plan evaluation and implementation can present problems. For example, relative to past standards, the generally poorer dose homogeneity for inverse planning forces the use lower isodose lines for prescribing dose. Additionally, the intensity maps generated by inverse planning can be complex and, in turn, extend dose delivery times, increase leakage radiation, and complicate treatment verification. Given these difficulties, there is a renewed interest in using forward treatment planning as a possible solution for these problems. There are four major reasons why the forward approach could prove valuable for the treatment planning part of IMRT: First, benchmark plans are needed to illustrate what is possible for complex non-coplanar beam arrangements and for treating targets with invaginations. Second, if these benchmark plans prove to be superior to inverse plans, forward planning may become the method of choice for at least the immediate future. Third, designing new dose optimization techniques that mimic forward methods might lead to improved algorithms that do not show some or all of the limitations of inverse methods. Fourth, the simplicity of the intensity maps produced by forward planning could lead to improved techniques for verification of the delivered dose.

This talk describes two forward treatment planning techniques: one for non-coplanar beam arrangements and another for targets with invaginations surrounding critical structures. Using dose-volume histogram analysis, plans generated with these two methods are compared to plans obtained with inverse planning. Additionally, the problem of increased critical structure dose that results from the practice of prescribing to low isodose levels is discussed. Intensity maps generated with the two forward planning methods are compared to determine their relative complexity. Although a number of methods for checking correct delivery of the intensity distributions for IMRT are available, there is no direct equivalent to imaging the treatment field relative to a patient’s anatomy. It will be argued here that the well-behaved intensity distributions for forward planning allow the use of simple port filming for verification. Finally, an optimization technique that is modeled on the forward planning approach will be discussed, and plans generated using this method will be presented. An advantage of this simple optimization approach as well as the forward treatment planning methods described here is the relative ease with which they can be implemented in small clinics that do not have extensive physics support.

EDUCATION OBJECTIVES: 1) Identify practical limitations for IMRT planning and dose delivery. 2) Offer solutions for these problems. 3) Identify role for forward treatment planning for IMRT. 4) Compare forward and inverse treatment planning.