AbstractID: 4701 Title: A Genetic-Stochastic Approach to Volumetric Dose Optimization for Image-Based Brachytherapy: Application to Breast Balloon Brachytherapy

We developed a stochastic algorithm to optimize volumetric dose distributions for image-based brachytherapy. The algorithm was applied for breast balloon brachytherapy of a stepping ^{192}Ir-HDR source. The weights of dwell positions in a balloon catheter define a configuration space. The algorithm consists of (1) determining a pre-optimal domain of the configuration space by a genetic algorithm and (2) searching an optimal configuration in the pre-optimal domain by a stochastic method. A configuration space was divided into five sub-domains, and each of sub-domains was further divided into the same number of weight groups. The genetic algorithm evaluated the weight sets (gene) constructed by the above discretization. A pre-optimal domain (promising gene pull) was determined by ranking the values of objective functions. Random weight sets were stochastically generated within the pre-optimal domain, having intensities uniform in a sub-domain but proportional to the density of promising weight sets. Likewise, the stochastic method evaluated the random weight sets in the pre-optimal domain. Finally, an optimal configuration is determined in terms of the number of dwell positions and weight distribution. The objective functions were to minimize the number of PTV-voxels having more than a given percent difference from the prescription dose (uniformity index), and to minimize the average difference between PTV-doses and the prescription dose (dose index). The PTV coverage can be improved by multiple dwell positions with optimized dwell weights. The optimized PTV coverage can reach above 95%. Such an enhancement is even more significant in axially elongated ellipsoidal balloons than in spherical balloons. Since the optimization shapes ellipsoidal isodoses along the catheter, it spares the part of skin by a few %. The results support the use of the genetic-stochastic algorithm for treatment planning of imaged-based brachytherapy.