Use of a convolution/superposition-based treatment planning system for dose calculations in the kilovoltage energy range

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A number of procedures in diagnostic radiology and cardiology make use of long exposures to x-rays from fluoroscopy units. Although numerous studies have been performed to measure or calculate skin dose from these procedures, there have only been a handful of studies to determine the dose to the other organs. This thesis was focused on devising a method to calculate the absorbed dose to underlying tissues and organs. The work was performed in several stages. First, a commercial convolution/superposition-based treatment planning system used in radiation oncology was modified and complemented to make it usable with the low energies of x-rays used in diagnostic radiology. This required generation of energy deposition kernels in the kilovoltage energy range. The kernels were generated using the EGS4 Monte Carlo system of codes and added to the treatment planning system. The treatment planning system was then evaluated for its accuracy of calculations at low energies within homogeneous and heterogeneous materials. Next, the system was used to determine the dose distribution and lung dose in a humanoid phantom and to determine the lung dose from a sample cardiac procedure. The results were subsequently compared to other methods and studies. These dose distributions can also be used to create dose-volume histograms for internal organs irradiated by low energy beams. Using these data and the concept of normal tissue complication probability developed for radiation therapy, the risk of future complications in a particular organ can be estimated.

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