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Anatomy-Based Transmission Factors for Technique Optimization in Portable Chest X-ray

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Abstract

Currently, portable x-ray examinations do not employ automatic exposure control (AEC). To aid in the design of a size-specific technique chart, acrylic slabs of various thicknesses are often used to estimate x-ray transmission factors for patients of various body thicknesses. This approach, while simple, does not account for patient anatomy, tissue heterogeneity, and the attenuation properties of the human body. To better account for these factors, in this work, we determined x-ray transmission factors using computational patient models that are anatomically realistic. A Monte Carlo program was developed to model a portable x-ray system. Detailed modeling was done of the x-ray spectrum, detector positioning, collimation, and source-to-detector distance. Simulations were performed using 18 computational patient models from the extended cardiac-torso (XCAT) family (9 males, 9 females; age range: 2-58 years; weight range: 12-117 kg). The ratio of air kerma at the detector with and without a patient model was calculated as the transmission factor. The transmission factor decreased exponentially with increasing patient thickness. For the range of patient thicknesses examined (12-28 cm), the transmission factor ranged from approximately 25% to 2.8% when the air kerma used in the calculation represented an average over the entire imaging field of view. The transmission factor ranged from approximately 25% to 5.2% when the air kerma used in the calculation represented the average signals from two discrete AEC cells. These exponential relationships can be used to optimize imaging techniques for patients of various body thicknesses to aid in the design of clinical technique charts.