

AbstractID: 11054 Title: Stylized MIRD Phantoms Should be Replaced by Anatomically Realistic Phantoms: Discrepancies In Red Bone Marrow Doses From CT Scans

Purpose: To test the hypothesis that the stylized MIRD phantoms would cause significant error in the estimated red bone marrow (RBM) dose from CT scans in comparison with anatomically realistic phantoms.

Method and Materials: The MC model of the CT scanner include the source geometry, movement, source energy spectrum, bow-tie filter, as well and the beam shape. MCNPX 2.5.0 was used to simulate the RBM dose from various CT scanning procedures. To calculate the absorbed dose to the RBM as a function of photon fluence in the spongiosa and the photon energy, an F4 tally together with a set of DE/DF cards in MCNPX were used to score the photon fluence in MCNPX. The stylized MIRD phantom and the anatomically realistic RPI Adult Male and Adult Female phantoms were implemented in the MCNPX to determine organ doses using the same dose algorithm.

Results: For all the cases studied, the RBM doses calculated using RPI adult phantoms were greater than those obtained from MIRD-ORNL phantoms. For the chest CT scan, the RBM dose ratio (RPI-AM to MIRD-ORNL) is about 1.50 (1.48-1.51), and RBM dose ratio of female phantoms is about 1.28 (1.24-1.32). For the abdominal-pelvis CT scan, the RBM dose ratios are 1.30 (1.28-1.31) and 1.32 (1.28-1.38) for male and female phantom, respectively. These differences are mainly from the anatomical differences in the phantoms.

Conclusion: As the RBM is not uniformly distributed in the human body, the homogeneous bone mixtures definition by MIRD phantoms underestimated the dose by as much as 50% in certain cases. This test concludes that the simplified MIRD phantoms used in existing CT dose software should and can be replaced by realistic phantoms. This is an opportunity to improve the anatomical realism and therefore the associated dose and risk assessments for patients who undergo CT examinations.