

Modeling Am-241 Distribution in Bones of the USTUR Case 0102 Human Leg Phantom

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Whole-body-counting gamma-spectrometry is one of the specialized techniques for monitoring internal exposure to various radionuclides. Calibration of these systems is based on the use of tissue equivalent plastic phantoms which contain a known amount of activity of specific radionuclides. Although this technique has broad application, questions arise about the accuracy of results obtained using in vivo measurement methods and techniques. These questions might be resolved by developing computational phantoms representing the variation of radionuclide concentration in the human skeleton. These voxel geometries can be incorporated into a Monte Carlo code to estimate detector response. In this study, the United States Transuranium and Uranium Registries' (USTUR) Case 0102 Am-241 Leg phantom was created using a real human skeleton. The phantom serves as a realistic standard for intercomparisons of whole body counting systems at US DOE facilities and other laboratories worldwide. The post mortem radiochemical analysis of the Case 0102 skeleton showed a significant variation of Am-241 concentration within and between different bones. This study describes an approach of modeling the radionuclide concentration distribution for use in a Monte Carlo simulation. A 3D voxel model of the phantom has been developed. DICOM (Digital Imaging and Communications in Medicine) images of the phantom have been segmented using Eclipse[®] radiotherapy planning software. Each Dicom image was segmented into multiple regions of interest. Additionally, all bones of the voxel phantom were divided into multiple sections to represent samples used in the radiochemical analysis. A method of simulating photon emission from the non-uniformly distributed Am-241 source is presented. Once the voxel representation of the phantom is imported into the Geant4 Monte Carlo code, experimental response of external planar germanium detectors can be simulated for various distributions of Am-241 concentration in the human bones of the phantom.

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