ABSTRACT

Whole-body counting gamma-spectrometry is one of the specialized techniques for monitoring internal exposure to radionuclides. Calibration of these systems is based on the use of linear equation plastic phantoms which contain a known amount of activity of specific radionuclides. Although this technique has broad application, questions about the accuracy of results obtained using in vivo measurement methods are still being asked. These questions might be resolved by developing computational phantoms representing the variation of radionuclide concentrations in the body. These computational phantoms can be incorporated into Monte Carlo code to estimate detector response. In this study, the United States Transuranium and Uranium Registries (USTUR) Case 0102 Americium-241 phantom was modeled using a GEANT4 toolkit. The phantom serves as a realistic standard for comparison of whole-body counting systems at US DOE facilities and other laboratories worldwide. The post mortem radiocolchemical analysis was performed on the USTUR Case 0102 Americium-241 Leg phantom. A method of simulating photon emission from the non-uniformly distributed 241Am requirements of this specific experimental application (de Souza e Silva et al., 2009).

RESULTS

The activity values are scaled based on measured radionuclide distribution in the corresponding energy spectrum is shown in Fig. 1. The external gamma detector geometry is modeled using the Geant4 with detector specific volume and dimensions, as provided by the manufacturer (Fig. 5). The final geometry has been exported to the DICOM-RT format so that it can be incorporated into the Geant4 code. The DICOM-RT data format is similar to the DICOM data format; however, it additionally contains application specific information. In this case, ranges of HU units and positions of the contoured structures are stored in the dataset. This code can be used for further radiation transport and interaction purposes. Electromagnetic interactions of photons and electrons cover energies down to 19 MeV. This feature of the code which allows avoiding all decay products to be modeled individually. DICOM data may alternately be incorporated into the Geant4 code, thus skipping some image processing steps required when building the geometry like normalizing with other Monte Carlo simulation codes. Thus, in demand image manipulation steps can be done within the code. The ability to model radioactive decay is a great feature of the code which allows avoiding all decay products to be modeled individually.

REFERENCES


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