Evaluation of S values for beta–ray emitters in voxel phantoms

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Abstract

Evaluation of the mean absorbed dose per unit cumulated activity (S value) to the urinary bladder wall from uniformly distributed radioactivity within the bladder contents is of importance. S value has been used for dose estimates in radiological protection and diagnostic procedures. In particular, S value to the urinary bladder wall is very convenient for designing patient protocol strategies intended to minimize the dose for a specific radiopharmaceutical. Most S values for beta–ray emitters within the urinary bladder are derived from the simple assumption that the dose at the surface of the contents is approximately half that within their volume. The S values are taken as Eν/2m, where E is the average energy of the beta–ray and ν is a factor representing the degree to which beta–ray penetrate the mucus (ν=1) and m is the mass of the bladder contents of the Medical Internal Radiation Dose (MIRD) Committee of the Society of Nuclear Medicine Pamphlet No.5 type phantoms (MIRD 5 type phantoms) that do not precisely model real human bodies. Hence, S values evaluations for sophisticated models are necessary to estimate internal doses more accurately. For the purpose, the present study was performed to evaluate S values to the urinary bladder wall for several beta–ray emitters such as ^{14}C, ^{18}F, ^{24}Na, ^{32}P, ^{60}Co, ^{89}Sr, ^{90}Sr, ^{90}Y, ^{91}Y, ^{137}Cs, ^{147}Pm and ^{204}Tl for a MIRD 5 type phantom using Monte Carlo simulation instead of the simple assumption. S values were also evaluated on the adult voxel phantoms developed at the Japan Atomic Energy Research Institute (JAERI) and were compared with those for the MIRD 5 type phantom. Furthermore, each of the S values was compared with those derived from the simple assumption. Consequently, it was found that the absorbed dose to the urinary bladder wall for those radionuclides are not one–half of the absorbed dose in bladder content and largely depend on the mass of the urinary bladder wall. S values derived from the simple assumption were found to be conservative for beta–ray emitters within the urinary bladder. It could be stated that S values for beta–ray emitters within the urinary bladder should be estimated for realistic model using Monte Carlo simulation.