Internal Dosimetry of Plutonium: From Biokinetics to Dose Estimates

Martin Šefl[1], Maia Avtandilashvili[1], Sergei Y. Tolmachev[1]

[1]United States Uranium and Transuranium Registries, College of Pharmacy and Pharmaceutical Sciences, Washington State University, Richland, WA, USA

A system of biokinetic models developed by the International Commission on Radiological Protection, including human respiratory tract, human alimentary tract, and plutonium systemic models, describes the biokinetic behavior of inhaled plutonium in the human body. The integral of activity in a biokinetic compartment at a given time results in the number of disintegrations which occurred in this compartment. The number of disintegrations can be converted to energy released and, using specific absorbed fractions (SAF), to energy deposited in a target organ. SAF is the fraction of particle energy emitted in a source region deposited in a target region per mass of the target tissue. For ^{239}Pu, alpha particles are the dominant radiation contributing to absorbed dose; therefore, calculation of the dose seems fairly simple: multiply the number of disintegrations in a source region, the total alpha energy emitted per one disintegration, and SAF for each combination of source-target region and energy. However, associating the compartments of the biokinetic models with source regions defined for SAF may be confusing. For some organs, like the liver, the process is straightforward; for others, it is more complicated. For example, 59 compartments are needed to model plutonium inhalation, and there are 79 source regions (tissues) for which the SAFs are defined. The associations depend on the biokinetic model, and, unfortunately, the biokinetic models are not always accompanied by explicit instructions on how to link the biokinetic model compartments with the corresponding dosimetric source regions. A step-by-step guide on the dosimetry of plutonium inhalation is presented including instructions on how to assign biokinetic compartments to dosimetric source regions.

USTUR-0594-21A