Regional retention of plutonium in the respiratory tract of four acutely-exposed workers can be described using scar-tissue compartments

Poudel, Deepesh[1], Maia Avtandilashvili[2], John A. Klumpp[1], Luiz Bertelli[1], Sergei Y. Tolmachev[2]

[1]Los Alamos National Laboratory, Los Alamos, NM, USA; [2]United States Uranium and Transuranium Registries, College of Pharmacy and Pharmaceutical Sciences, Washington State University, Richland, WA, USA

Certain parameters of the Human Respiratory Tract Model such as the bound fraction have a significant impact on retention of plutonium in the lung tissues and the radiation doses imparted to different parts of the respiratory tract. Confidence in these parameters is important to ensure confidence in the biokinetic models, and consequently, the epidemiological and dose response models. To properly evaluate – and quantify – critical parameters such as binding, one would need information on long-term retention of plutonium in individual compartments of the respiratory tract. Such data on regional retention in the respiratory tract of four workers – who had inhaled materials ranging from very soluble nitrate to insoluble high-fired oxide – were obtained at the United States Transuranium and Uranium Registries. An assumption of bound fraction alone was found to be inconsistent with this dataset and also with a review of the literature. Several studies show evidence of retention of a large amount of activity in the scar tissues of humans and experimental animals, and accordingly, a model structure with scar-tissue compartments was proposed. The transfer rates to these compartments were determined using Markov Chain Monte Carlo analysis of the bioassay and post-mortem tissue radiochemical analysis data, taking into account the uncertainties associated with deposition, dissolution, and particle clearance parameters. The models predicted that a significant amount – between 20-100% for the cases analyzed – of plutonium retained in the respiratory tract was sequestered in the scar tissues. Retention of plutonium in the scar tissues has a dose consequence that would be different from that in the bound compartments.

USTUR-0597-21A