Modeling plutonium decorporation in a female nuclear worker treated with Ca-DTPA after inhalation intake

Sara Dumit[1]; Maia Avtandilashvili[2]; Stacey L. McComish[2]; Guthrie Miller[3]; Jasen Swanson[4]; and Sergey Y. Tolmachev[2]

[1]Los Alamos National Laboratory, Los Alamos, NM; [2]United States Transuranium and Uranium Registries, Washington State University, Richland, WA; [3]Retired, Santa Fe, NM; and [4]US Army, Tacoma, WA

The present work models plutonium (Pu) biokinetics in a female former nuclear worker. Her bioassay measurements are available at the US Transuranium and Uranium Registries. The worker was internally exposed to a plutonium-americium mixture via acute inhalation at a nuclear weapons facility. She was medically treated with injections of 1 g Ca-DTPA on days 0, 5, and 14 after the intake. Between days 0 and 20, fecal and urine samples were collected and analyzed for ^{239}Pu and ^{241}Am. Subsequently, she was followed up for bioassay monitoring over 14 y, with additional post-treatment urine samples collected and analyzed for ^{239}Pu. The uniqueness of this dataset is due to the availability of: (1) both early and long-term bioassay data from a female with plutonium intake; (2) data on chelation therapy for a female; and (3) fecal measurement results. Chelation therapy with Ca- and/or Zn-salts of DTPA is known to aid in reducing the internal radiation dose by enhancing the excretion of plutonium and americium from the body. Such enhancement affects plutonium biokinetics in the human body, posing a challenge to the internal dose assessment. The current radiation dose assessment practice is to exclude the data affected by Ca-DTPA from the analysis. The present analysis is the first to explicitly model the chelation-affected bioassay data in a female by using a newly developed chelation model. Thus, the bioassay data collected during and after the Ca-DTPA administrations were used for biokinetic modeling and dose assessment. The Markov Chain Monte Carlo method was used to investigate model parameter uncertainty, based on the bioassay data and assumed prior probability distributions. A χ^2/nData (number of data points) ≈ 1 was observed in this study, which indicates self-consistency of the data with the model. Results of this study show that the worker's ^{239}Pu intake was 12 Bq, with a committed effective dose to the whole-body of 1.2 mSv and a committed equivalent dose to the bone surfaces, liver, and lungs of 37.8, 9.1, and 0.8 mSv, respectively. This study also discusses the worker's dose reduction due to chelation treatment.

USTUR-0710-25A