Modeling of a Unique USTUR Dataset: Female Nuclear Worker Treated with Chelation Therapy After Plutonium Inhalation

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

[1]Los Alamos National Laboratory (LANL); [2]U.S. Transuranium and Uranium Registries, Washington State University; [3]Unaffiliated (retired from LANL); [4]U.S. Army

This study shows the modeling of a unique dataset of bioassay measurements from a female former nuclear worker available at the US Transuranium and Uranium Registries (USTUR). 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, 4, and 14 after the intake. A total of 13 fecal and 24 urine samples was collected and analyzed for plutonium (Pu) and americium (Am) immediately after the intake, from day 0 to day 20. Consequently, she was followed-up for bioassay monitoring over 14 years, with 13 additional post-treatment urine samples collected and analyzed for Pu. The uniqueness of this dataset is due to the availability of: (*i*) both early and long-term bioassay data from a female with Pu intake; (*ii*) data on chelation therapy for a female; and (*iii*) fecal measurement results. Chelation therapy with DTPA is known to aid in reducing the internal radiation dose by enhancing the excretion rate of Pu from the body. Such enhancement affects the normal biokinetics of Pu in vivo, posing a challenge to the internal dose assessment. The current dose assessment practice is to exclude the data affected by DTPA from the analysis. Using this standard approach, the worksite's Radiation Protection staff estimated the Pu intake to be 73 Bq, with a Committed Effective Dose (CED) to the whole body of 16 mSv and a Committed Equivalent Dose (CEqD) to the bone surfaces of 340 mSv. The present analysis is the first one to explicitly model the combined biokinetics of Pu and DTPA by using a newly developed chelation model. The Markov Chain Monte Carlo method was used to investigate the model parameter uncertainty, given the bioassay data and assumed prior probability distributions. This work is groundbreaking because the modeling includes the bioassay data collected before, during, and after the DTPA administrations. Preliminary results of this study show that the worker's Pu intake was 22 Bq, with a CED to the whole-body of 1.74 mSv and a CEqD to the bone surfaces of 42.8 mSv, which differ from the original worksite's calculations. The difference in results is expected because this analysis incudes pre- and post-treatment bioassay data and uses a novel model that accounts for the effect of chelation therapy in removing Pu from the body.

USTUR-0644-23A