Uncertainties in Radiation Dose Assessment for Internally Deposited Plutonium in Support of Radiation Epidemiology

M. Šefl[1], J.Y. Zhou[2], M. Avtandilashvili[1], S.L. McComish[1], G. Tabatadze[1], S.Y. Tolmachev[1]

[1]U.S. Transuranium and Uranium Registries, Washington State University; [2]U.S. Department of Energy

Since its establishment in 1968, the United States Transuranium and Uranium Registries (USTUR) has received 317 partial- and 47 whole-body donations for scientific research from former nuclear workers who had accidental intakes of actinide radionuclides. These individuals typically have well-documented work history, exposure, bioassay monitoring, and medical records. Among 349 cases with completed radiochemical analysis, 59 cases with recorded ^{239}Pu intake(s) were selected for evaluation of uncertainties in the radiation dose assessment for radiation epidemiology. These individuals were not extensively treated with chelation therapy and had at least five ^{239}Pu urine measurements exceeding the contemporary detection limit, as well as ^{239}Pu concentrations in the skeleton and liver greater than 0.1 Bq kg^{-1} and 1 Bq kg^{-1}, respectively. The objectives were to compare: (i) predicted ^{239}Pu activities in the skeleton and liver, based upon urine bioassays, with measured post-mortem activities in the skeleton and liver; (ii) dose estimates calculated from urine data alone with those based on both urine data and post-mortem radiochemical analyses. Taurus internal dosimetry software was used to model individual cases using default ICRP biokinetic model assumptions. Biases for the predicted and measured post-mortem organ activities and calculated radiation doses were studied as a pilot study of 11 former Manhattan Project workers. Current biokinetic model predictions for the liver+skeleton retention appear to be on average within 5% of the measured organ activities. On the other hand, the use of early urine bioassay data collected during the exposure period in the 1940s overestimated the liver+skeleton activity on average by a factor of 2.5. This demonstrates the importance of a long-term collection of bioassays as a part of follow-up. Analysis of the remaining cases are in progress.

USTUR-0539-20A