

Evaluation of Bayesian modeling of uncertainty in plutonium organ doses using post-mortem measurements

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Monitoring bioassay data, such as urinary excretion and in-vivo chest counts, is the primary source of information for radiation epidemiological studies of nuclear workers. Bayesian analysis provides a distribution of dose estimates rather than a single value that is commonly used in radiation epidemiology. Using distributions allows for more sophisticated uncertainty estimates of organ activities and associated doses. The United States Transuranium and Uranium Registries (USTUR) stores monitoring data with post-mortem radiochemical analyses of tissues. Uncertainties in organ activities and radiation dose estimates from internally deposited ²³⁹Pu were evaluated using a group of 20 former nuclear workers. These individuals voluntarily donated their tissues to the USTUR. Ten workers were exposed to soluble Pu-nitrate and ten workers to 'high-fired' PuO₂ aerosols. Plutonium bioassay data for everyone included at least five positive urine measurements. The measured ²³⁹Pu activities ranged from 9.6 to 920 Bq in the liver, from 9.2 to 774 Bq in the skeleton, and from 7.2 to 6,550 Bq in the lungs. Latin hypercube sampling was employed to create priors of main absorption parameters (rapidly dissolved fraction and slow dissolution rate) and selected particle transport rates. Distributions of ²³⁹Pu organ doses were generated. The distributions of doses based on ²³⁹Pu bioassay measurements were compared to the point estimates based on the measured post-mortem ²³⁹Pu activities in the lungs and liver+skeleton. Furthermore, the extent of distribution coverage of the post-mortem point estimate was evaluated.

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