

Application of Bayesian Inference to the Bioassay Data from Long-term Follow-up of Two Refractory PuO₂ Inhalation Cases.

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The dominant contribution to the uncertainty in internal dose assessment can often be explained by the uncertainty in the biokinetic model structure and parameters. The International Commission on Radiological Protection (ICRP) is currently updating its biokinetic models, including the Human Respiratory Tract Model (HRTM). Gregoratto et al. (2010) proposed a physiologically-based particle transport model that simplifies significantly the representation of particle clearance from the alveolar interstitial region. Bayesian inference using the Weighted Likelihood Monte-Carlo Sampling (WeLMoS) method is applied to the bioassay and autopsy data from the U.S. Transuranium and Uranium Registries' (USTUR) tissue donors 0202 and 0407 exposed to "high fired," refractory PuO₂ aerosols in order to examine the applicability of the revised model and to estimate the uncertainties in model parameters and the lung doses as expressed by the posterior probability distributions. It is demonstrated that, with appropriate adjustments, the Gregoratto et al. particle transport model can describe situations involving exposure to highly insoluble particles. Significant differences are observed in particle clearance pattern characteristics to these two individuals' respiratory systems. The respiratory tract of registrant 0202 was most likely compromised by his prior occupational exposure to coal dust, smoking habit, and chronic obstructive pulmonary disease, while donor 0407 was a non-smoker and had no prior history of lung disorder. However, the central values of the particle transport parameter posterior distributions for both cases are found to be still within the 68% probability range for the inter-subject variability derived by Gregoratto et al. PuO₂ particles produced by the plutonium fire were extremely insoluble, with about 99% absorbed into blood at a rate of approximately $4.8 \times 10^{-6} \text{ d}^{-1}$ (Case 0202).

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