USTUR Case 0785: Modeling Pu decorporation Following Complex Exposure

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High levels of exposure to actinides can cause severe health effects. Individuals with significant internal contamination typically undergo treatment with chelating agents to accelerate urinary excretion and thus reduce radiation dose to sensitive tissues. The US Transuranium and Uranium Registries (USTUR) studies actinide biokinetics and tissue dosimetry by following up occupationally exposed workers. These studies are fundamental to improving the reliability of, and confidence in, radiation dose and risk assessment methods. By linking radiation exposure history, bioassay results, and medical data with post-mortem measurements of actinides in the human body, we aim to develop and parameterize a biokinetic model for plutonium decorporation therapy. USTUR Case 0785 was selected for this study. This individual was exposed to plutonium via inhalation and wounds due to an explosion at the defense nuclear facility, and underwent chelation treatment. Worksite personnel estimated his systemic deposition at 7.4 kBq. The ^{239}Pu whole-body activity at the time of death, estimated from tissue radiochemical analysis, was 2.8 kBq. Of these, 69.7% was deposited in the skeleton, 21.7% in the liver, and 6.5% in the respiratory tract. The results confirmed that internal deposition of plutonium was caused by inhalation and wound intake, and provided additional information on material solubility type. In this preliminary study, IMBA Professional Plus® software was applied to fit post-mortem plutonium activities measured in the lungs, liver and skeleton. The ICRP 130 human respiratory tract model, NCRP 156 wound model, and Leggett plutonium systemic model were used with default assumptions of material type. As small particles are typically generated due to explosion, 1 μm particle size was used instead of ICRP 130's default value of 5 μm. Inhalation and wound intake regimes were fitted simultaneously. Results of calculations were consistent with the ICRP 68 Type S material. The residual fraction of total intake, not removed by chelation treatment, was estimated at approximately 24 kBq with 89% contributed by inhalation. This information will be used for modeling plutonium decorporation therapy.

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