Plutonium Worker Dosimetry

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Abstract – Epidemiological studies of the relationship between risk and internal exposure to plutonium are clearly reliant on the dose estimates used. The International Commission on Radiological Protection (ICRP) is currently reviewing the latest scientific information available on biokinetic models and dosimetry, and it is likely that a number of changes to the existing models will be recommended. The effect of certain changes, particularly to the ICRP model of the respiratory tract, has been investigated for inhaled forms of ^{239}Pu and uncertainties have also been assessed. Notable effects of possible changes to respiratory tract model assumptions are (1) a reduction in the absorbed dose to target cells in the airways, if changes under consideration are made to the slow clearing fraction and (2) a doubling of absorbed dose to the alveolar region for insoluble forms, if evidence of longer retention times is taken into account. An important factor influencing doses for moderately soluble forms of ^{239}Pu is the extent of binding of dissolved plutonium to lung tissues and assumptions regarding the extent of binding in the airways. Uncertainty analyses have been performed with prior distributions chosen for application in epidemiological studies. The resulting distributions for dose per unit intake were lognormal with geometric standard deviations of 2.3 and 2.6 for nitrates and oxides, respectively. The wide ranges were due largely to consideration of results for a range of experimental data for the solubility of different forms of nitrate and oxides. The medians of these distributions were a factor of three times higher than calculated using current default ICRP parameter values. For nitrates, this was due to the assumption of a bound fraction, and for oxides due mainly to the assumption of slower alveolar clearance. This study highlights areas where more research is needed to reduce biokinetic uncertainties, including more accurate determination of particle transport rates and long-term dissolution for plutonium compounds, a re-evaluation of long-term binding of dissolved plutonium, and further consideration of modeling for plutonium absorbed to blood from the lungs.

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