Master's Thesis: An Analysis of the Microdistribution and Long-Term Retention of $^{239}Pu(NO_3)_4$ in the Respiratory Tracts of an Exposed Plutonium Worker and Experimental Beagles

Christopher E. Nielsen[1], Xihai Wang[1], Dulaney A. Wilson[1], Gerald E. Dagle[2], Antone L. Brooks[1], Stacey McCord[3], William J. Bair[2], Anthony C. James[3], Sergei Y. Tolmachev[3] and William F. Morgan[1].

[1]Pacific Northwest National Laboratory, Low Dose Project; [2]Retired; [3]United States Transuranium & Uranium Registries, College of Pharmacy, Washington State University, Richland, Washington.

The long-term retention of inhaled soluble forms of plutonium raises concerns as to the potential health effects in persons working in nuclear energy or the nuclear weapons program. The distributions of long-term retained inhaled plutonium-nitrate [$^{239}Pu(NO_3)_4$] deposited in the lungs of an accidentally exposed Hanford worker and in the lungs of experimentally exposed beagle dogs with varying initial lung depositions were determined. Autoradiographs of selected histological lung, lymph node, trachea, and nasal turbinate tissue sections were made to determine the location of plutonium within the tissues. A variety of specific stains were used to detect apoptosis and connective tissue generation. These studies showed that fibrotic scar tissue effectively encapsulated the plutonium and prevented its clearance from the body or translocation to other tissues. Alpha activity from deposited plutonium in the human case was observed primarily along the sub-pleural regions and strongly associated with the deposition of a carbon material, thought to be cigarette residue. No alpha activity was seen in the tracheobronchial lymph nodes of the exposed human. However, high activity levels in the tracheobronchial lymph nodes of the beagle dogs indicated they were more effective in clearing deposited plutonium from the lung tissues to the tracheobronchial lymph nodes. In both the human and beagle dogs, the appearance of bound plutonium was inconsistent with current biokinetic models for soluble forms of plutonium. The presence of sequestered plutonium in the beagle dogs suggested similar retention in the human case may not have been totally from cigarette smoking. The findings presented here provide additional support for a need to revise the lung model and include a bound plutonium fraction occurring after inhalation of plutonium nitrate, qualitatively not unlike that occurring after inhalation of insoluble plutonium oxide particles which also have been reported as being sequestered in pulmonary scar tissue. This bound fraction will have a marked effect on the dose to the lungs and the potential increase in cancer risk. It is suggested that the observation of long term retention of inhaled soluble plutonium nitrate in lungs be reflected in biokinetic models for radiation protection purposes.

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