Depleted Uranium Concentration in the Lungs of Allied Forces' Gulf War Veterans at the Time of Exposure

It has been reported that the Allied Forces' Gulf War Veterans exposed to depleted uranium (DU) by the inhalational pathway contained a significant presence of DU in the urine nine years after exposure. The purpose of this work was to determine the body burden of DU at the time of exposure by the use of quantitative gravimetric analysis of DU in the urine and a mathematical model of the biological half-life of ceramic DU oxide particles in simulated interstitial lung fluid.

Thirteen British, Canadian, and United States Gulf War Veterans with a history of inhalational DU exposure and spectrometric evidence of the presence of uranium isotopes in the urine had an estimate of the lung burden of DU at the time of exposure. The mathematic analysis of the estimated DU concentration in the lungs corresponds to the pulmonary fraction of DU that is excreted in urine, representing a minimum lung burden. Integrating the fundamental half-life equation ($dN/dt = -b*N$) gives the traditional decay equation ($N = N_o*e^{-bt}$). Substituting the half-life equation into the decay equation gives an equation relating the initial DU concentration to the rate of excretion, total time, and an unknown decay constant ($N_o = (dN/dt)*e^{bt}/b$). A minimum value for the biological half-life of ceramic DU oxide in the lungs was derived from the Batelle report of minimum dissolution time corresponding to 3.85 years. The minimum concentration of DU at time zero can also be determined by finding the minimum value of the function ($N_o = (dN/dt)*e^{bt}/b$) with respect to the biological half-life constant, thus estimating DU concentration at time zero.

Average total uranium concentration of $2.6x10^{-5}$ mg/24hr had 16.6% fraction of DU. Average total DU amount was $1.49x10^{-5}$ mg/24hr. Using the biological half-life constant derived from the Batelle report of simulated interstitial lung fluid, the estimated lung DU burden at time zero was 0.153 mg for the total lung. The absolute minimum DU concentration in the respiratory system was 0.134 mg.

Quantitative mass spectrometry data of the isotopes of depleted uranium in the Gulf War Veterans was utilized in the mathematical determination of the DU lung burden at the time of inhalational exposure. The results provide conclusive evidence that the pulmonary concentration of DU at the time zero can be reliably obtained as late as nine years after exposure.