Estimation of Actinide Skeletal Content from a Single Bone Analysis

Sergei Y. Tolmachev[1] and Ronald L. Kathren[1]

[1]*United States Transuranium and Uranium Registries, College of Pharmacy, Washington State University, Richland, WA*

Estimation of the total skeletal actinide content (A_{sk}) is important to support biokinetic modeling of actinides. A_{sk} is calculated as a product of radionuclide activity concentration (C_{rad}) and skeletal weight (W_{sk}), $A_{sk} = C_{rad} \times W_{sk}$. The large uncertainties are typically associated with the estimated activity, as generally only few bones are analyzed and ICRP reference weight of 10.5 kg or height-weight equation are used to estimate the skeleton weight. Several approaches are published for plutonium and americium activities estimation in a human skeleton based on the analyses of limited number of bones collected at autopsy and various assumptions on skeleton weight. Alternatively, A_{sk} can be estimated from a single bone analysis if a fraction of total skeleton activity (deposition coefficient, K_{dep}) is known for this particular bone. The use of $K_{dep} = A_{bone}/A_{sk}$, allows simple straightforward calculation of total skeleton activity from a single bone analysis with reduced uncertainties. In addition, a linear regression equation, $A_{sk} = a \times A_{bone} + b$, can be used. In this study, K_{dep} values were calculated for patella bone using data from 16 whole body donors to the United States Transuranium and Uranium Registries (USTUR) with known exposure to ^{238}Pu, ^{239}Pu, and ^{241}Am. Total ^{238}Pu, ^{239}Pu, and ^{241}Am skeletal activities were calculated using a standardized methodology. The average K_{dep} values (±standard deviation) for ^{238}Pu, ^{239}Pu, and ^{241}Am were calculated as 0.0037±0.0015, 0.0033±0.0012, and 0.0040±0.0013, respectively. With repeated ANOVA test, no significant difference was found among K_{dep} for ^{238}Pu, ^{239}Pu, and ^{241}Am (p=0.126) resulting in the average K_{dep} = 0.0037±0.0013 (n=48) for the actinides. Thus, the measured activity of plutonium or americium in patella can be reliably used to estimate the total skeletal content. Actinide total skeletal content can be simply obtained by multiplying the measured activity in the patella by $1/K_{dep}$ = 273±98. Using linear regression analysis for log-transformed data (n=48), the excellent correlation, with a slope of 0.957±0.023, and 2.411±0.036 intercept, was found between activity in patella and that in the skeleton (r^2=0.973).

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