Effect of Health on Systemic Distribution and on Urinary Excretion of Plutonium in Workers Exposed by Inhalation at Radiochemical Plants

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This paper presents the results of a joint Russia-USA investigation of the health impairment effects on distribution of plutonium between the liver and the skeleton and on the urinary excretion rate in workers at the Mayak radiochemical plant (Russia) and USA nuclear industry facilities. The results were obtained by radiochemical analysis of soft tissues and bone sample collected at autopsy of about 400 workers who died suddenly from acute coronary diseases and accidents (relatively healthy workers) and those who died from serious diseases (mainly tumors) of the organs. In Mayak cases the healthy individuals had mean skeleton to liver contents of 50% and 38%, respectively, of systemic plutonium. With the formation of pathological processes in the body, the fraction deposited in the liver decreased and a large portion of the systemic fraction that left the liver entered the skeleton. In individuals with serious diseases of the liver (Cirrhoses and carcinoma of the liver), the relative content in the liver decreases by 25%; almost all the plutonium that was redistributed appeared to go the skeleton, where the relative content increased by 24%. The mean systemic fractions in the skeleton and the liver were 74.0% and 13%, respectively. Systemic plutonium fractions in organs were statistically significantly different between the two groups. In USTUR cases, the systemic plutonium fractions in the liver were higher than in the skeleton for all health groups. In persons of normal health, the relative content in the liver averaged 50% and the relative content in the skeleton was 37%. But with pathological processes in the body, the systemic plutonium fraction in the liver decreased appreciably and a fraction was 31% for individuals who died with a marked liver impairment. The plutonium fraction in the skeleton increased from 37% to 56% with health impairment. In addition to a redistribution of plutonium from the liver to the skeleton, marked liver impairment also results in an increased rate of urinary excretion. In relatively healthy individuals, the urinary excretion factor (daily plutonium excretion divided by systemic plutonium content) was K_e=1.54x10-5 day-1. There was a statistically significantly increase in the value of K_e in persons with serious diseases. The data indicate that using the urinary excretion factor, K_e, without consideration of the health state of an individual can lead to serous overestimation of plutonium body burden and to dose and risk estimates based on the bioassay data.

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