Quantification of Bone Lead and Toenail Manganese and Mercury in vivo with X-ray Fluorescence Technology

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Abstract:

Lead (Pb), manganese (Mn) and mercury (Hg) exposures have been related to many chronic health effects. Bone and toenail are advantageous biomarkers to assess cumulative exposures to these metals. In this project, we have explored and validated a practical and convenient technology – portable x-ray florescence (pXRF) – for the non-invasive in vivo exposure assessment of Pb in tibia bone (PbBn), and Mn and Hg in toenail (MnTn & HgTn). We recruited 60 subjects from the general population in Indiana and measured their PbBn level in vivo with both pXRF and the KXRF systems. In addition, we measured their MnTn and HgTn level in vivo with the pXRF system, and analyzed the clipped nails with ICP-MS. The detection limit (DL) for in vivo PbBn measurement was estimated to range from 4 to 12.5 µg/g with skin thickness of 2 to 6 mm, and the results confirmed that the uncertainty increases significantly with the increase of the soft tissue thickness for pXRF. A promising correlation of the PbBn concentrations from both systems was found to be 0.79 for skin thickness of 6 mm or less (N=40). The correlation decreases when the results from the subjects with higher skin thicknesses were added to the analysis. The DL of the pXRF system for MnTn and HgTn were estimated to be 3.65 and 0.55 µg/g. The average MnTn and HgTn level were found to be 0.33 ± 0.05 and 0.1 ± 0.02 µg/g in the population with ICP-MS. The whole-body effective dose of the pXRF system was estimated to be less than 0.3 μSv.

Host: Dr. Linda Nie