

## Lead exposure and nuclear medicine

**To the Editor:** May we refer to the importance of stable lead in the environment and to the radionuclides of lead-plumbum (Pb). The two radionuclides of Pb often mentioned in the literature are  $^{210}\text{Pb}$  and  $^{212}\text{Pb}$  with half lives 21 yr and 10.6 h respectively [1].  $^{212}\text{Pb}$  is a b-rays emitter and decays to bismuth-212 ( $^{212}\text{Bi}$ ) which is an a-rays emitter with a half life of 1.1 h [1a, 2]. These a-rays have energy of 5.3 MeV and a range 21.4  $\mu\text{m}$  [1b]. They may thus be suitable for radiation treatment of cancer and immunotherapy studies [2,3].  $^{212}\text{Pb}$  is used in various chemical applications of radionuclides such as chemical radioanalysis of sulfates or chromates by precipitation [1c].  $^{212}\text{Pb}$  as having suitable decay products such as  $^{212}\text{Bi}$ , has been used in immunotherapy studies [2, 3]. Furthermore,  $^{212}\text{Pb}$  may be of value in specific conditions, including treatment of leukaemia, inter-cavity treatment or strategies that target vascular or endothelial tumours [3].  $^{210}\text{Pb}$  has been used for equilibrium-self diffusion studies in solids [1d].

The relative abundance in nature of Pb is variable. Comparing the relative abundance of stable Pb in the environment with blood lead levels (BLL), we may identify the cause of Pb poisoning [4]. Occupational exposure and toxicity of stable Pb has been recognised as a health hazard for more than 2,000 years by Hippocrates and Nikander and remains an important public health problem. Lead is mainly found in mineral deposits, in paints, in industrial products and by-products and may enter the body by ingestion through the intestine, by inhalation through the lungs and through the skin [5]. Lead toxicity causes central and peripheral nervous system dysfunction, and also renal, haematopoietic, gastrointestinal and reproductive dysfunction [5, 6]. BLL often underestimate total body burden because most of Pb is stored in the bones [5].

Stressful circumstances induce Pb bone release and may elevate BLL [5]. Individual susceptibility should also be considered. Table 1 summarises advisory standards and enforceable regulations for Pb concentrations in blood or in air, issued by health agencies [5-7]. According to the Greek Presidential Decree 94/1987, subjects with erythrocyte glucose-6-phosphate dehydrogenase (G6PD) deficiency, thalassaemia and acquired anaemia must be excluded from Pb exposed jobs [7]. Subjects expressing G6PD deficiency may be hyper-susceptible to lead haemo-toxicity because of significant reduction of erythrocyte glutathione (GSH) concentration [8] although recent epidemiologic studies do not support this view [8, 9]. BLL above 50mg/dl for long periods of time can induce anaemia with basophilic stippling of erythrocytes, haemolytic anaemia or diminished red cells survival as tested by  $\text{Na}_2^{51}\text{CrO}_4$  [5, 10]. Nutritional supplements or reduced-fat diets must be encouraged [11, 12], as drinking about 700g of milk per day might protect from lead peripheral neurotoxicity [12].

The above underline the possible toxic effects of stable Pb in the environment and of radioactive Pb in radiochemistry and in cancer treatment.

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**Table 1.** Summary of standards and regulations for lead in the environment

Agency	Media	Lead level	Action to be taken
Centers for Disease Control and Prevention (CDC)	Blood	10 $\mu\text{g}/\text{dL}$	Advise
Occupational Safety and Health Administration (OSHA)	Blood	40 $\mu\text{g}/\text{dL}$	Written notification and medical examinations. Removal from the area. Permissible exposure limit for an average of 8h in general industry
	Air (workplace)	50 $\mu\text{g}/\text{m}^3$	
National Institute for Occupational Safety and Health (NIOSH)	Air (workplace)	50 $\mu\text{g}/\text{m}^3$	Recommended exposure limit (non-enforceable)
		100 $\mu\text{g}/\text{m}^3$	Immediately dangerous to life and health
American Conference of Governmental Industrial Hygienists (ACGIH)	Blood	30 $\mu\text{g}/\text{dL}$	Biological exposure index
	Air (workplace)	150 $\mu\text{g}/\text{m}^3$	TLV/TWA guideline for lead arsenate
		50 $\mu\text{g}/\text{m}^3$	TLV/TWA guideline for other forms of lead
Kosnett et al. 2007	Blood	$\geq 30\mu\text{g}/\text{dL}$	Remove from exposure
Greek Presidential Decrees (94/1987 & 338/2001)	Blood	$\geq 40\mu\text{g}/\text{dL}$	Action level (intervention)
		70 $\mu\text{g}/\text{dL}$	Maximum acceptable BLL
	Air (workplace)	> 75 $\mu\text{g}/\text{m}^3$ (8-hr average)	Action level (intervention)

TLV/TWA: threshold limit value/time-weighted average; BLL: blood lead level

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Published online: 19-11-2007

