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Determination of Cadmium in Blood of Iranians Zinc Mine Workers

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Toxic metal cadmium is playing the major role in environmental health threats and appear to be seriously affecting the mine workers' health. In the present study, the concentration of toxic heavy element cadmium in zinc mine worker's blood was determined. Flameless atomic absorption spectrometery were used for cadmium measurment. The results indicated that the concentration of cadmium in blood is more than the standard value recommended by WHO found in 100 % of the workers. It causes several diseases in most of the workers. The average concentration of cadmium in the blood samples in this study is found to be 6.2 µg/L.

Key Words: Cadmium, Blood, Iranian zinc worker.

INTRODUCTION

Poisoning caused by industrial exposure or environmental contamination by heavy metals is of great concern[1,2]. Cadmium is probably the most biotoxic element and are therefore regarded as priority pollutant[3,4]. Heavy elements especially the cadmium when absorbed into the body, mainly through food, water intake or inhalation, can injure the renal, pulmonary, skeletal, testicular and nervous systems[4-6]. Because the kidneys accumulate cadmium selectivly, renal failure is often the earliest and most sensitive end-point. Cadmium also impaires normal fetal development and there is an evidence that it causes cancer[7-10]. A significant trend for a risk of lung cancer was found only for exposure to cadmium received in the presence of arsenic-trioxid[8]. Poisoning from inhalation of cadmium vapour or dust is generally limited to occupational settings, which can be fatal. The lethal dose is a product of the exposure duration and concentration. It causes the destruction of the lining cells of the lungs, as a result, pulmonary failure is the ultimate result of cadmium inhalation poisoning. Chronic inhalation also injures liver and kidneys[9-13]. Industries with known occupational exposures like zinc and lead melting are also the source of environmental exposure of cadmium. Acute toxicity from inhalation of this element can produce serious illnesses , particulary in the lungs and GI-tract[14,15]. Unlike other heavy metals such as mercury and lead, cadmium occur in only one valence state +2 and does not form stable alkyl compounds or other organometallic compounds of known toxicologic significance. Thus, it is elemental cadmium that is the toxic agent[6].

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To determine the health effects of this heavy toxic element, the concentration of cadmium was determined in the blood samples of the workers in a zinc and lead mine in Iran.

EXPERIMENTAL

Many procedures for the analysis of blood for individual metals have been reported. All the elements are extracted at the pH of blood with either ammonium pyrrolidine dithiocarbamate (APDC) or sodium diethyl dithiocarbamate since the extractions are reported to be efficient over a broad pH range for most metals[16]. Sodium N,N′-diethyl dithiocarbamate, Triton-X-100 and methyl isobutyl ketone (MIBK) were used for the metal extraction from the blood samples. A flameles atomic absorption spectrophotometer mark Varian GTA, with a recorder readout module and strip chart recorder was used for cadmium measurement. A vortex mixer was used for all stiring. Samples were centrifuged in an international standard centrifuge.

Reagent grade chemicals were used throughout the experiments. Stock metal solutions were prepared by determinate weighing of salts to give a concentration of 1000 ppm of the element. All solutions were made 0.1 % in nitric acid. Standard working were prepared by appropriate dilutions of the stock solutions. Methyl isobutyl ketone was used without further purification. The Triton-X-100 was from Baker. Sodium N,N′-diethyl dithiocarbamate (SDDC) was a 28 % aqueous solution obtained from K & K. Laboratories, Inc. Five mL of whole blood treated with Heparin as anticoagulant are pipetted into a 100 mm. 10 mm test tube. One mL of a solution containing 2 % SDDC and 5 % Triton-X-100 is pipetted into the blood. The solution is mixed on a vortex mixer for 10 s, the left standing for 10 min for complete hemolysis of the blood to occur. Three mL of MIBK are pipetted into the tube which is then stoppered with a polyethylene stopper and shaker gently. The solution is centrifuged at *ca*. 1200 rpm for 5 min. The MIBK layer is aspirated directly into atomic absorption apparature and the absorption percentage recorded. Water saturated MIBK is used to set 0 % absorption[11].

RESULTS AND DISCUSSION

To determine the effects of heavy toxic element cadmium on the health of a zinc mine workers, the applicability of this analytical procedure to determination of element cadmium was investigated. Five hundred and fifty blood samples were taken from the workers of a zinc and lead mines, in the western part of Iran. Table-1 shows the concentration of cadmium in the blood sample of some workers. Cadmium concentrations determined in 550 blood samples were relatively high, ranging from 1.3 to 15 µg/L. As many as 50 % of the participants had a blood cadmium concentration lower than 6.1 µg/L, whereas in 38 % of participant it was between 6 to 12 µg/L and also in 2 % it was up to 12 µg/L. The median concentration of blood cadmium was 6.1 µg/L (interquartile range, 1.3-2.6; 10th-90th percentile, 4.2-8.7). The average concentration of cadmium in the blood samples of the zinc workers is 6.2 µg/L, which

TABLE-1
CONCENTRATION OF CADMIUM IN THE BLOOD SAMPLE OF SOME IRANIAN ZINC MINE WORKERS' BLOOD

Code	Cd µg/dl	Code	Cd µg/dl	Code	Cd µg/dl	Code	Cd µg/dl	Code	Cd µg/dl
1	0.53	11	0.39	21	0.45	31	1.20	41	0.42
2	0.45	12	0.66	22	0.51	32	0.69	42	0.87
3	0.72	13	0.66	23	0.45	33	0.60	43	0.72
4	0.62	14	0.45	24	0.39	34	0.66	44	0.96
5	0.84	15	0.45	25	0.42	35	1.20	45	0.66
6	0.42	16	0.54	26	0.60	36	0.87	46	0.57
7	0.66	17	0.51	27	0.45	37	0.45	47	0.72
8	0.72	18	0.69	28	0.36	38	0.13	48	0.69
9	1.10	19	0.84	29	0.60	39	0.72	49	0.72
10	0.45	20	0.54	30	1.50	40	0.87	50	0.60

is 5 folds than the reference value[12]. This reference value is 1.2 µg/L. Fig. 1 shows the comparison of cadmium concentration in the blood sample of some workers with standards value[12]. The results of this study indicate the higher concentration of cadmium in blood sample of zinc mine workers, than standard level in western Iran. Most of the worker with higher exposure to these elements has bone, kidney, liver and GI-illnesses. It is highly recommended, that the worker in this facility use personal protective measures to avoied contamination of toxic elements in the body. Health and safety measures in the facility by the regulated health care of the workers and installation of control equipments for the air and water control is also recommended.

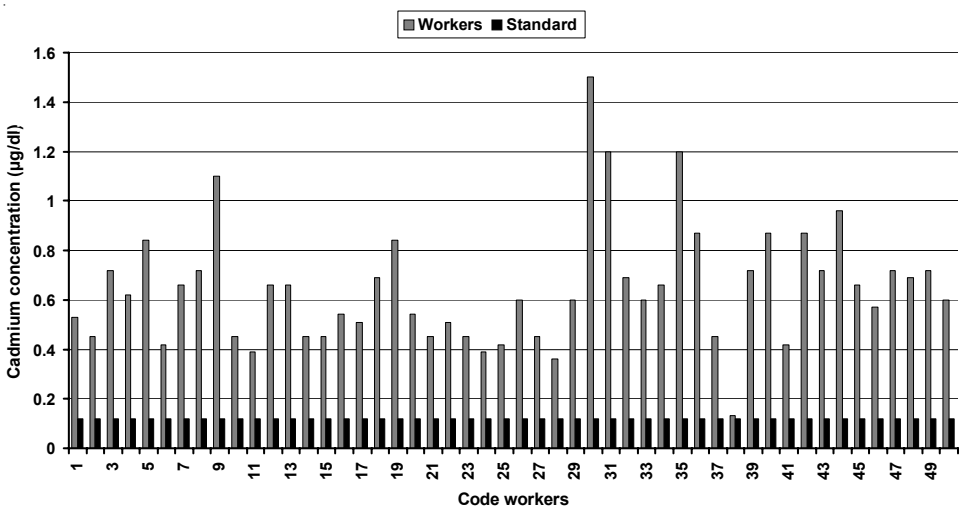

Fig. 1. Comparison of cadmium concentration with OSHA standard for some of the workers

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