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MONITORING OF LEAD POISONING IN SIMPLE WORKERS OF A COPYING CENTER BY FLAME ATOMIC ABSORPTION SPECTROSCOPY.

MOHAMMAD ABDOLLAHI, Pharm.D., Ph.D.,
MAASOUMEH EBRAHIMI-MEHR, Pharm.D.,
SHEKOUFEH NIKFAR, Pharm.D., AND
NASER JALALI, M.D.

From the Department of Toxicology and Pharmacology, School of Pharmacy, Tehran University of Medical Sciences, Tehran, Islamic Republic of Iran.

ABSTRACT

Inorganic lead compounds are used most widely in paint and pigment industries. Because of exposure to lead dust in workers in a copying center, we compared blood lead levels in these workers to normal individuals and investigated the relationship between job tenures of the workers and their blood lead levels. This survey was performed on 20 simple workers in a copying center of Tehran University. The ages of the workers were between 27 and 62 years, and job tenures of the workers were between 1 and 27 years. Our results indicated that 94% of the workers had high blood lead concentrations (>49.9 μg/dl) and only 6% showed acceptable (30-49.9 μg/dl) blood lead levels. Blood lead levels of these workers were significantly higher than that of controls ($P<0.01$). Their blood lead levels and job tenures showed a direct but imperfect correlation [coefficient of correlation (r)=0.68] and the confidence interval was between 0.3-1.36 (95% confidence). Clinical manifestations of intoxication in these workers included clumsiness, abdominal pain, lumbar pain and peripheral pain as main symptoms. The results of this study indicate that copying rooms are at high risk for lead poisoning.

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INTRODUCTION

Lead is one of the most ubiquitous of the natural substances which man concentrates in his immediate environment. It is present in food, drinking water and air, and is one of the most insidiously toxic of the heavy metals to which man is exposed, particularly due to its ability to accumulate in the body.[1] The determination of lead in blood is a useful diagnostic test for detecting lead poisoning.[2] Blood lead levels (BLLs) provide probably the best index of recent exposure to this element and have been used for the biological monitoring of populations exposed to occupational lead.[3] Many tests are available for screening workers exposed to lead[4] but BLLs to be used in determining therapy requirements must be determined via venipuncture. Specimens obtained from a finger prick are easily contaminated.[5] Normal BLLs are less than 30 μg/dl, while acceptable BLLs range between 30 and 49.9 μg/dl and high BLLs greater than 49.9 μg/dl.[6] Lead is a human health hazard with a long history of industrial uses. Federal regulators set out to reduce workplace lead exposure in the mid-1970s.[7]

Address for correspondence: Dr. M. Abdollahi, Dept. of Toxicology and Pharmacology, School of Pharmacy, Tehran University of Medical Sciences, Tehran, P.O. Box: 14155/6451, Islamic Republic of Iran.

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Inorganic lead compounds are used most widely in paint and pigment industries.[8] Exposure to lead further occurs in several occupations in which the risk can be classified as moderate or slight; i.e., the incidence of plumbism is usually low or nil and reported lead concentrations in the air or in the workers' blood or urine have, in general, been around or below the safety norms usually employed.[9] Workers in copying centers are at moderate risk for lead intoxication.[10]

Some important symptoms of lead intoxication–a mnemonic by M. Thoman – are: (ABCDE)

Anorexia/apathy/anemia
Behavioral disturbances
Clumsiness
Developmental skill deterioration
Emesis-sporadic vomiting/colic[11]

MATERIALS AND METHODS

Triton^{R} X-100 [Tx; an alkylphenoxy-polyethoxy-ethanol), (Sigma, UK)], 5% by volume in demineralized water; ammonium pyrrolidine dithiocarbamate (APDC) [(1-pyrrolidine-carbodithioic acid ammonium salt), (Sigma, UK)] 2% w/v in demineralized water. This solution, stored in an amber bottle in a refrigerator, remains active for more than a month. It is not necessary to use a fresh solution each day. If desired, APDC can be produced directly in the 5% Tx solution.

Methylisobutylketone (MIBK), water saturated (Sigma, UK). Heparin, sodium salt: 0.2 µg/ml[12] (Leo Pharmaceutical Products, Denmark).

Lead working standard: 1 mg/ml, prepared from reagent grade lead nitrate and demineralized water. This concentrated standard is stable indefinitely.[13]

In this study male workers of a copying center in Tehran University were chosen. The ages of the workers were between 27 and 62 years, and job tenures of the workers were between 1 and 27 years. Controls were selected from male individuals who had not worked in the copying center but their workplaces were in the university environment. Whole blood samples were obtained via venipuncture. The samples were stored in a refrigerator (4°C) as soon as possible until the analysis. Standards were produced in demineralized water. In each of five 16×130 mm borosilicate test tubes was placed 10 ml of demineralized water. Tubes 2-6 were treated respectively with 2.5, 5, 10,15, and 20 µl of the working standard solution. Then the contents were thoroughly mixed on a vortex mixer. These standards represented 25, 50, 100, 150, and 200 µg/dl of lead in demineralized water. Tube 1 was the reagent blank. In tubes 1-6, all of the blood lead extraction steps were taken. 5 ml of unknown blood was pipetted into other tubes. All of the samples had heparin added in order to prevent coagulation. One ml of Tx 5% solution was also added to each tube. After

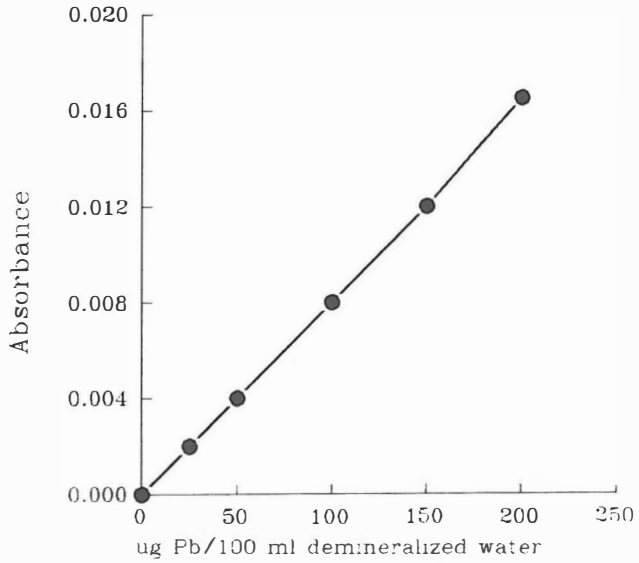


Fig. 1. A typical standard curve for lead.

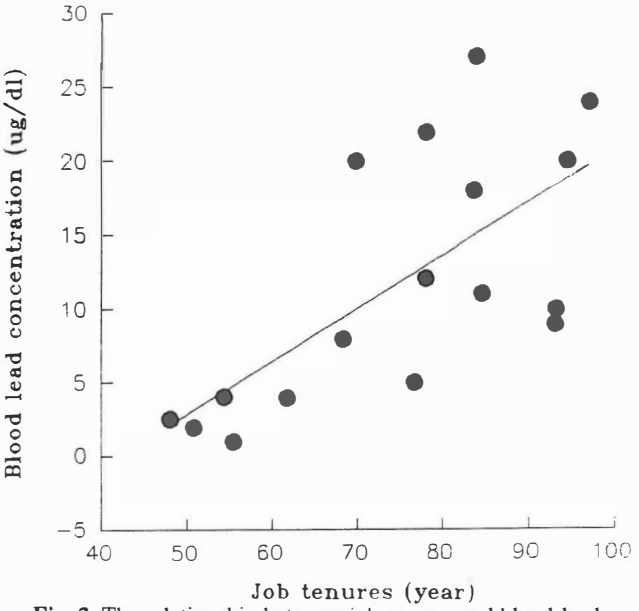


Fig. 2. The relationship between job tenures and blood lead levels (µg/dl) of simple workers of a copying center [correlation coefficient (r=0.68)].

mixing on the vortex mixer (rapid hemolysis), 1 ml of the APDC solution was added to each tube, followed again by vortex mixing. Finally 5.0 ml of water-saturated MIBK was pipetted into each tube. The tubes were sealed with rubber stoppers, shaken vigorously about 60 times,[13] and centrifuged for 15 minutes at 3000 rpm. Phase separation was clean and sharp, and the organic supernatant could be aspirated directly from the tubes.[13]

In this work a Shimadzo AA-680 atomic absorption/flame emission spectrophotometer was used. The hollow cathode lead lamp was operated at the recommended level of 5 mA. Analyses were performed at 283.3 nm, primarily

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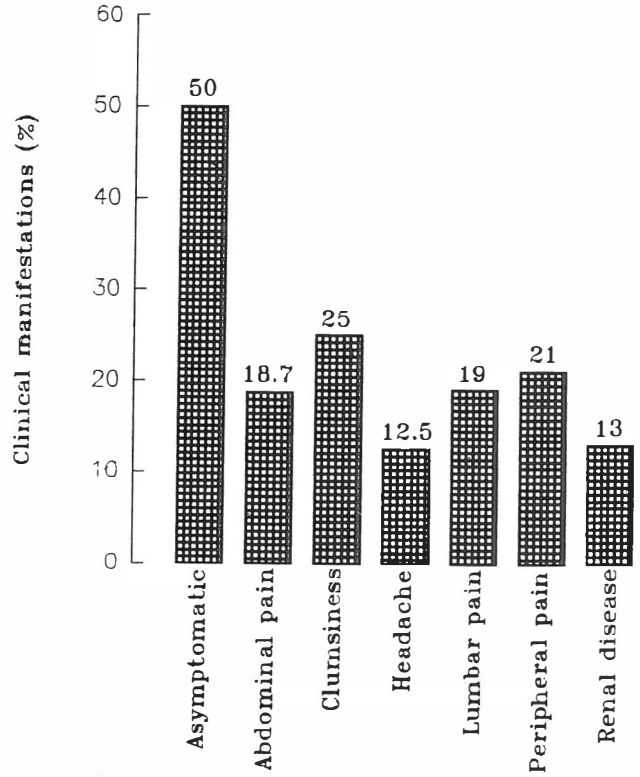


Fig. 3. Percentage of complaints relative to some symptoms of lead poisoning in workers of a copying center.

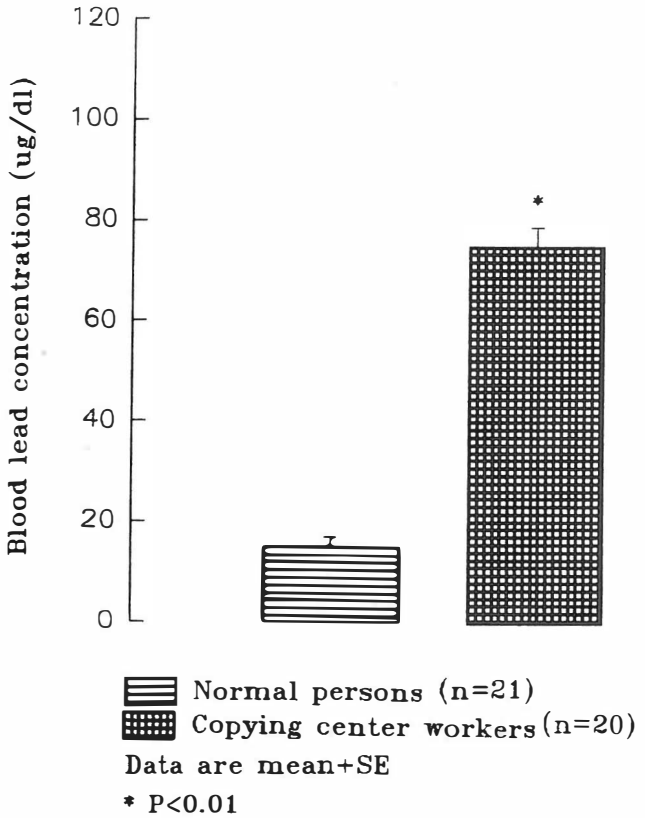


Fig. 4. Comparison of blood lead levels between copying center workers and normal individuals.

because of the favorable signal to noise ratio, as compared to the 217 nm line. Other settings were as follows: slit 1, scale expansion 1, chart speed 1, flame (air-C_2H_2), fuel 2.7 L/min, and oxidant (8 L/min). Lifting of the flame from the burner head during the adjustments can be remedied by aspirating air for a few seconds.[13]

RESULTS

In Table I absorbances of lead standards with the coefficient of variation (CV) of each absorbance are shown. The highest limit of CV was 10, therefore data greater than 10 for all of the examinations were eliminated. In Fig. 1 a typical standard curve is shown. Known amounts of lead were added to whole blood samples and the recovery was determined for each sample. The average of recovery was 96.31% (Table II). Our data indicated that 6% of the workers had acceptable BLLs and 94% of them had high BLLs. In Fig. 2 the relationship between BLLs and job tenures of workers is shown. There is a direct but imperfect correlation (r=0.68) between BLLs and job tenures of the workers; the confidence interval of this r was between 0.3-1.36 (95% confidence).

Clinical manifestations in these workers are shown in Fig. 3. As depicted, 50% of the workers are asymptomatic. In the remaining 50% clumsiness, lumbar, abdominal and peripheral pain were the most prevalent symptoms (one case with an acceptable BLL was disregarded in this evaluation). In Fig. 4 the BLLs of controls are shown and, as can be seen BLLs of the test group employees are significantly higher than those of controls (P<0.01).

DISCUSSION

The above mentioned method of lead determination produces a sensitive, practically noise-free measurement with a working curve that is linear up to at least 250 µg/dl blood or demineralized water.[13] Blood and aqueous standards (diluted with water) assayed by the flame emission atomic absorption method demonstrate similar results.[14] In this study aqueous standards were used and we found the obtained working curve very linear and thus suitable for sensitive quantitation of lead.

Lead toxicity in adults results primarily from workplace exposure.[15] The most probable route of lead exposure in such areas may be the inhalation of lead dust. The results of this study indicated significant differences between the BLLs of these workers and those of controls. 94% of the workers had high BLLs and many of them symptoms of lead toxicity. We know that symptomatic workers and those with BLLs above 60 µg/dl must be removed from the workplace until levels fall below 40 µg/dl; patients with

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Table I. Absorbance of lead standards and coefficient of variation of each absorbance.

Concentration	Absorption	Coefficient of variation
25	0.002	4.163
50	0.004	5.336
100	0.008	2.064
150	0.012	3.522
200	0.016	5.722

Each figure is the mean of 6 standard samples.

Table II. Recovery (%) of lead added to whole blood examined by flame atomic absorption spectrophotometry.

Lead added (µg/100 ml)	Lead recovery (µg/100ml)	
	Result	Recovery (%)
10	9.5	95
20	19	95
30	30	100
35	34.5	98.6
40	38	95
45	44.6	99.1
50	47	94
60	56	93.3
75	74	98.7
90	85	94.4
		Av=96.31

BLLs above 70 µg/dl should be admitted and chelated with both EDTA and BAL; patients with BLLs between 55-69 µg/dl should be admitted and chelated with EDTA alone, and patients who present with BLLs between 40 and 55 µg/dl may be treated with penicillamine.[5] Workers must be protected by protective work clothing and equipment, such as:

1. Coveralls, or similar full-body work clothing.
2. Gloves, hats, and shoes or disposable shoe coverlets.
3. Face shields, vented goggles, or other appropriate protective equipment.

No significant relationship was found between BLLs and job tenures of the workers. This can be due to the existence of abundant ways of lead pollution which prevent an exact survey. There are many interactions between the factors of influence, for instance, and that it is sometimes impossible to detect the main relevant factor. Moreover, nonconsumers of dairy products may be significantly over-exposed to lead. On the other hand, constituents of food may have significant influence on lead absorption or excretion.[16]

Some symptoms of lead intoxication in these employees are indicated in Fig. 3. Other symptoms of lead poisoning such as anorexia, apathy, emesis and sporadic vomiting were not observed. Anemia, behavioral disturbances and developmental skill deteriorations were not examined.

We suggest the undertaking of further precautions and designing programs for controlling lead toxicity in persons working in copying centers, as this group are at high lead exposure and the cumulative effects of lead in their body organs may lead to clinical signs and symptoms similar to those of other pathological disease. Physicians must be informed regarding different routes of lead exposure and toxicity, especially lead inhalation in copying centers.

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