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High blood lead level among garage workers in Bangkok, public concern is necessary

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Abstract

Lead is an important toxic metal agent found in many industrial processes in the present day. Lead exposure must be of particular concern because of ongoing exposure to thousands of workers in the industrial plants and recent research indicating that asymptomatic lead exposure can result in chronic toxicity manifestations. Therefore, determination and control lead exposure among the risk workers is very necessary. Like other developing countries, lead pollution becomes an important public health problem of Thailand, especially for the big cities as Bangkok but relatively few of these countries have introduced policies and regulations for significantly combating the problem. We set this pilot study to determine the blood lead levels by anodic stripping volammetry (ASV) method as a marker for lead exposure among the occupational exposed and control subjects. Totally 89 subjects, 20 control subjects and 69 garage workers (52 mechanics and 17 dye sprayers), as the representatives of occupational exposed subjects, were included into this preliminary study. The mean blood lead level in the control group was 0.32 ± 0.07 μmol/l. The mean blood lead level in the mechanics group was 0.42 ± 0.13 μmol/l. The mean blood lead level in the dye sprayers was 0.58 ± 0.07 μmol/l. Significant higher blood lead levels among the mechanics and dye sprayer groups were observed ($P < 0.05$). Based on this study, the considerations for prevention of possibly exposure to lead among the high-risk workers as public health policies was recommended.

Introduction

Metals, particularly toxic metals such as lead, cadmium, and arsenic, constitute significant potential threats to human health in both occupational and environmental settings (Hu 2000). Lead is one of the most abundant of the toxic metals in the Earth's crust. Lead is an important toxic metal agent found in many industrial processes in the present day. It has been used since prehistoric times, and has become widely distributed and mobilized in the environment. Nowadays, it is considered as a hazardous chemical agent and serious pollutant for human beings (Srianujata 1998).

Lead exposure must be of particular concern because of ongoing exposure to thousands of workers in the industrial plants and the previous research indicating that asymptomatic lead exposure can result in chronic toxicity manifestations, such as hypertension, kidney impairment, and cognitive disturbances (Pagliuca and Mufti 1990). Its toxicity correlates with blood concentrations and progresses from biochemical and subclinical abnormalities at levels around 0.48 μmol/l [10 μg/dl] to coma and death at levels over 4.83 μmol/l [100 μg/dl] (Markowitz 2000). Nevertheless, the International Agency for Research on Cancer (IARC) also stated that some compounds of lead are carcinogenic (IARC 1980). Therefore, determination and control lead exposure among the risk workers is necessary.

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Exposure to and uptake of this non-essential element have consequently increased. Both occupational and environmental exposures to lead remain a serious problem in many developing and industrializing countries, as well as in some developed countries (Lee 1999). In most developed countries, however, introduction of lead into the human environment has decreased in recent years, largely due to public health campaigns and a decline in its commercial usage, particularly in petrol. In order to decrease the lead environmental exposure in the general population, leaded gasoline was recommended to be substituted by the unleaded in many countries (Caprino & Togna 1998). Hence, acute lead poisoning has become rare in such countries, but chronic exposure to low levels of the metal is still a public health issue, especially among some minorities and socioeconomically disadvantaged groups (Juberg *et al.* 1997; Staudinger & Roth 1998).

In developing countries, awareness of the public health impact of exposure to lead is growing but relatively few of these countries have introduced policies and regulations for significantly combating the problem. Due to the recent continuous industrialization of Thailand, a developing country in Southeast Asia, many occupations become the risk groups of lead exposure. Despite, the promotion of pollution control in Thailand such as banning for leaded gasoline usage, lead exposure monitoring among the risk workers is still overlooked.

Surprisingly, according to the review literature, there has been no report about monitoring of lead exposure among high-risk workers in Thailand. A number of occupations such as mechanics and dye sprayers are risks occupation, which have direct contact with lead in daily work but specific control concerning these risk occupations have not been set in Thailand. No specific Act on monitoring of lead exposure among these workers has been set. This study was set as a pilot study to determine the difference of blood lead level between the non-occupational expose subjects and expose subjects as the mechanics and dye sprayers.

Materials and methods

Subjects

A total of 89 subjects (all males) were included in this study. All subjects were non-smokers. The setting is Bangkok, capital of Thailand, where the monitoring level of air lead equaled to 0.1 – 0.5 μg/m^3 (reported by Natural Energy Policy Office, Thailand), lower than the upper allowable level set by the National Environmental Committee, Thailand (10 μg/m^3). The first group, 20 subjects, was the control group with low risk for lead exposure. All were residents from the living area without any nearby factories. All subjects were interviewed for possible exposure to lead and none reported any. The second group, comprising the study group 52 subjects, was a group of mechanics. These workers had to work as mechanics in the garages for everyday. The third group, comprising the study group 17 subjects, was a group of dye sprayers. These workers had to work as dye sprayers in the garages for everyday. All subjects in our study lived at the settings and presented the same eating and drinking habit.

All subjects were asked for informed consent. The Faculty of Allied Health Science, Chulalongkorn University, already approved all protocols of this study. Then random blood sample was collected for laboratory analysis from each subject.

Sample collection

Blood collection by antecubital venipuncture from each subject was performed. 3 ml blood sample was collected using plastic lead-free vacuum tube (Beckton-Dickinson). Then collected specimens was refrigerated at 2–8 °C and sent to analytical unit within 2 days.

Sample preparation

For each analysis, 100 μl blood sample was added to the tube containing 2.9 ml Metexchange. Then the sample was mixed and analyzed for lead level.

Laboratory analysis

All blood samples were analyzed for lead level anodic stripping volammetry [9] (ASV). In our study, 2 control samples were also analyzed for each run. The ASV system used was the ESA 3010 B. This method for blood lead determination was described briefly as following. ASV is the analytical technique using electrochemical principle. The technique consists of two important steps of analysis as reduction step and stripping step. In reduction step, the former step, lead in blood sample was reduced and caught at the mercury electrode of the analyzer. In stripping step, the later step, slowly separation of caught lead from the test

Table 1. Blood lead levels in control and garage workers groups.

Group	Number	Blood lead level (μmol/l[μg/dl])		
		Range	Average	Median
Control group	20	0.2 – 0.4 [4.0 – 9.0]	0.32 ± 0.07 [6.59 ± 1.48]	0.29 [6.0]
Mechanics group[1]	52	0.2 – 0.8 [3.9 – 17.0]	0.42 ± 0.13 [8.79 ± 2.65]	0.41 [8.5]
Dye sprayers group	17	0.4 – 1.7 [8.1 – 36.0]	0.58 ± 0.07 [12.03 ± 6.99]	0.68 [14.0]

[1]This group can be divided into two subgroups, engine and spare part repairing mechanics (n = 23, average blood lead level = 0.40 ± 0.11 μmol/l [8.44 ± 2.30 μg/dl], range = 0.2 – 0.7 μmol/l [3.9 – 14.5 μg/dl]) and welding mechanics (n = 29, average blood lead level = 0.42 ± 0.14 μmol/l [9.07 ± 2.90 μg/dl], range = 0.2 – 0.8 μmol/l [5.0 – 17.0 μg/dl]). Also, these two subgroups show statistical significant higher blood lead level comparing to our control group.

electrode due to the anodic change of electrical current was recorded and transformed to determined blood lead level.

Concerning the quality control program of our laboratory, we participate in the external quality assessment program of The Faculty Allied Health Science, Mahidol University, Thailand (Pidetcha *et al.* 1999). Considering the analytical performance of the method, the precision was tested by using a commercial control (level 0.39–0.68 μmol/l [8–14 μg/dl], ESA Inc.) and gave CV% = 9% (mean = 0.55 μmol/l [11.35 μg/dl], SD = 0.05 μmol/l [1.09 μg/dl], $n = 20$, range = 0.43–0.63 μmol/l [9–13 μg/dl]).

Statistical analysis

Mean and standard deviations of blood lead levels in both groups were calculated. The average blood lead levels of each group were compared using the ANOVA-test with level $P \leq 0.05$ considered statistically significant.

Results

Determination of blood lead level of the subjects

89 healthy volunteers were included in this study. The mean blood lead level in the control group was 0.32 ± 0.07 μmol/l [6.59 ± 1.48 μg/dl]. The mean blood lead level in the mechanics group was 0.42 ± 0.13 μmol/l [8.79 ± 2.65 μg/dl]. The mean blood lead level in the dye sprayers group was 0.58 ± 0.07 μg/dl [12.03 ± 6.99 μmol/l]. Significant higher blood lead levels among the mechanics and dye sprayer groups were observed ($P < 0.05$) (Table 1).

Discussion

Lead is one of the metal that have been studied a lot for a long time. Those results show that lead gives rise to a number of health effects that has been known for a long time (Landrigan & Todd 1994). The international organizations such as World Health Organization (WHO) (WHO 1995) have well documented on lead toxicity and recommend for monitoring of lead exposure for the risk group. Therefore, the work environment is in many countries strictly regulated with regard to air concentration of lead in the work place and also demands biological monitoring of lead in workers exposed to lead (Skerfving *et al.* 1993). However, in exposure and risk evaluation, monitoring lead biologically has several advantages over technical exposure assessment. Scientific evidence of subclinical lead toxicity continues to accumulate, making further reduction in workplace exposure, regular screening, and earlier diagnosis and treatment of critical importance in the prevention of this occupational hazard. Determination of biological lead level as biomarkers has continuously been developed. Monitoring of lead concentration in blood has been accepted as a reliable biomarker and widely used (Skerfving *et al.* 1993). In this study, we used anodic stripping volammetry (ASV) technique as the method for determination of blood lead level. According to the recent previous study, the ASV results correlated well with those obtained by the former classical flameless atomic absorption analysis (Lee and Meranger 1980). The methods are simple, reliable, and suitable for applications in the clinical field. Furthermore, it presented high sensitivity and rapidity. Therefore, this method is accepted to be a reliable test for blood lead monitoring (Lee & Meranger 1980; Skerfving *et al.* 1993).

Like other developing countries, lead pollution becomes an important public health problem of Thailand, especially for the big cities as Bangkok. Due to the rapid growing of industrialization without good introduced policies and regulations for the pollutants in the recent decade, a number of occupational health disorders can be expected. Therefore, monitoring of toxic substance in the workers is necessary. Although there are some reports (Limpasenee 1989; Ruangwises *et al.* 1998) about monitoring of the lead levels in the air and water in Thailand, it does not reflect the *in vivo* process.

In this article, we report the result form our pilot study to test the feasibility in using blood lead level determination by ASV method as a marker for lead exposure. We selected the mechanics and dye sprayers, two high-risk occupations, as the representatives for occupationally exposed workers. They are constantly in contact with lead contaminated in paints, oils, used engine, in the rather under-standard garage during the daily life. Furthermore, most of them live in the room near the workplace. However, these occupations are still forgotten and lack of specific environmental control strategies. All reported no previous annual health check up.

Theoretically, we expected the difference between blood lead level among the occupational exposed groups and the non-occupational exposed control. Comparing the average blood lead levels of the mechanics and dye sprayers to those of the control group, significantly higher levels were detected. These results agree with the previous study (Ankrah *et al.* 1996), indicating the higher blood lead levels among the high-risk workers in Ghana.

Concerning our control group, the average blood lead level is higher than the non-exposure residents in a city of Spain in a recent previous report (Moreno *et al.* 1999). This may imply the possible high exposure to lead among the non occupational -exposed residents. Actually, this can be expected because the residents in our study lived in the city with the expected highly air pollutant from the traffic jam (Migasena & Choopanya 1992; Srianujata 1998). Since, use of leaded gasoline has caused the main lead pollution for years in almost every city, therefore, city inhabitants in our study normally exposed to lead much more than those who live in the distance area.

A number of forgotten high-risk workers can be detected in Thailand. Monitoring of lead exposure in these workers is still important. Protective equipment for them such as gloves and masks are necessary and should be provided. Based on this study, the considerations for prevention of possibly exposure to lead among the high-risk workers as public health policies was recommended. We also recommended using blood lead determination by ASV method for monitoring of lead exposure in these workers. Annual check up for blood lead as a marker for lead exposure in these workers is recommended and there should be a specific law on this subject.

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