LEAD - THE TOXIC METAL TO STAY WITH HUMAN

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ABSTRACT — Lead has been known to be toxic to most living things at high dose. It is found naturally in earth and present in almost all parts of the environment, such as foods, air, water, dust, soil, paint, and tissues of living organisms including human. This metal is being used in various aspects including the manufacturing of storage batteries, production of chemicals, paints and gasoline additives. It is also used to make various metal products, e.g. sheet lead, solder, and pipes.

Human exposure to lead is mainly from foods and other environments. However, it is expected that exposure to environmental lead is normally excessive and produces toxic effects. The well-known and excessive environmental exposures are air of industrial and heavy traffic areas. Use of leaded gasoline has caused the main lead pollution for years in almost every big city. Therefore, city inhabitants normally exposed to lead much more than those who live in the rural area.

The most vulnerable groups at risk to lead exposure are fetuses and preschool age children. Young children in the 2-3 year-old age may be the most at risk for exposure to contaminated soil. Adults are affected when exposure is excessive in the working place and causing lead poisoning. Toxicities are mainly on heme biosynthesis, neurological effects including encephalopathy, peripheral neuropathy, and most importantly on I.Q. deficits. It also affects renal tissues to produce acute and chronic nephropathy and elevated blood pressure. There are studies of lead exposure of various means and the effects on human health, both in children and adults. Lead in environment and human exposure are expected to stay with us for long to come, due to the still required lead use in many fields, particularly the use of lead in storage batteries and others. The magnitude of exposure will depend solely on the control of use by not allowing the contamination of lead in our environment to be excessive.

KEY WORDS: Lead, toxic metal, neuropathy, heme, IQ deficit

INTRODUCTION

Lead, the most useful element among toxic metals, is considered to be one of all essential and non-essential elements that can be found in almost all phases of environment. It also can be found in almost all biological system. In nature, the major ores of lead are mostly galena (PbS), cerussite ($PbCO_3$) and anglesite ($PbSO_4$). Since the production of lead, it has been used extensively in various industries and activities. Therefore, it is expected to spread all over in every phases of our environment. We utilize lead for human activities, sometime without any conscious to its possible serious hazard. The essentiality of lead is uncertained, requires more strong evidence to support. However, it is suggested so, because some laboratory animal raised under conditions that was strictly con-

trolled of lead intake shown to have impaired growth and reproduction (National Research Council). Due to its potential toxicity to human, the major concern will be in the circle of the hazardous circumstances. These can be direct exposure in the working place or by the contact with contaminated environment. Therefore, it is considered to be the substance of serious public health problem. The major concern of the contaminated environment, such as air in heavy traffic condition, lead based paint, house dust, is on the effects on health of fetus and children of very young age, particularly 2-3 years old.

The use of lead is mainly for manufacturing of storage battery which accounts for about one third of lead use. The organic lead, tetraethyllead, has been used as antiknock fuel additives for long time, the use is being reduced to avoid the increasing environmental problem. It is also widely used in pigment manufacture to make lead based paint. The other uses

are grazes and coloring for ceramics, electrical cable, hose and pipe, and stabilizer in plastics.

EFFECT OF LEAD ON HEALTH

The poisoning by lead is considered as one of the most important of all those toxic effects caused by substances. There are reviews on lead available (Ennever, Who, Landirgan, ASTDR). Lead can affects many systems, mainly on the central nervous, hematologic, gastrointestinal, and renal systems. These effects have been characterized clearly and quite extensively and they will be briefly mentioned as follows.

Effect of lead on central nervous system

The most sensitive target of lead poisoning is the nervous system. Children and fetus are the most vulnerable group. Neurologic deficits have been demonstrated. It may cause permanent damage to CNS as a result of lead exposure at age of 2, such as lower IQ scores and cognitive deficits. It can be larger deficits in psychometric intelligence scores, speech and language processing, attention and classroom performance for children with higher blood lead (PbB) level. Besides it can affect class standing, absenteeism, reading disability, fine motor skills, hand-eye coordination, and hearing loss. These effects can be found even at blood lead levels of less than 10 $\mu\text{g/dl}$. Adult with high exposure to lead can develops encephalopathy, fatigue, tremor, hallucination, blind-

ness, and even convulsions. Encephalopathy could be found in adults with PbB level of 100-120 $\mu\text{g/dl}$ and peripheral neuropathy may be observed both in children and adult with blood lead at 40 $\mu\text{g/dl}$ (Goyer).

Effect on hematologic system

Effect on hematologic system is the ability of lead to inhibit the enzymes involved in the synthesis of heme and hemoglobin. The most affected enzymes are δ -aminolevulinic acid dehydratase (δ -ALAD) and ferrochelatase. This will result in anemia of hypochromic normocytic type. Anemia is not an early sign of lead poisoning, it will be evident only when blood lead level is elevated for long time. Basophilic stippling erythroblast, binucleated erythroblast and increased serum iron could also be found. Levels of blood lead that related to hemologic parameters are shown in table 1.

Lead also affects gastrointestinal tract resulted in colic, loss of appetite, nausea, vomiting and constipation. Chronic renal insufficiency may be induced by lead to produce hyperuricemia, nephritis, glycosuria, and hyperaminoaciduria.

SOURCES OF LEAD EXPOSURE

In adult, lead exposure is mostly from workplace and polluted environment as in city with heavy traffic. The blood lead level in battery workers of a factory was study (Kaocharern) during 1991 to 1993 (table 2). There were 40-60% of workers had PbB higher than 40 $\mu\text{g/dl}$, about 10% had in the range 60-79 $\mu\text{g/dl}$. This indicated that the protection is still far from satisfactory. The longitudinal study was done (Pumala) and showed that PbB was rising upto 6 month and gradually leveled off after 1-2 years of exposure. The contribution of lead from exhaust of cars using leaded gasoline is significant. Air lead level in Bangkok was much higher 6 years ago when leaded gasoline was still being used. Until 1994 the unleaded gasoline has been introduced. The lead in the air continues to drop

Table 1. Lowest observed blood lead level ($\mu\text{g/dl}$) on the hematologic effect.

effect	children	adults
Anemia	80-100	80-100
U-ALA	40	40
B-EPP	15	15
ALA inhibition	10	<10

Table 2. Blood lead level in battery workers (1991-1993).

Lead level $\mu\text{g/dl}$	1991		1992		1993	
	No.	%	No.	%	No.	%
< 40	208	57.9	161	36.1	198	39.9
40 - 59	110	30.6	164	36.8	199	40.1
60 - 79	41	11.4	90	20.2	84	16.9
> 80	0	0.0	31	6.9	15	3.0
Total	359		446		496	

yearly. The level was far below the standard level of $1.5 \mu\text{g}/\text{m}^3$ during 1996 both in general areas and roadsides. The leaded gasoline is not allowed to be use in Thailand any more since 1996. The concern was the effect on the children, with the studies in school children indicated that most PbB levels were below $10 \mu\text{g}/\text{dl}$ compared to $15\text{--}20 \mu\text{g}/\text{dl}$ about 10 years earlier. However those who live in Bangkok still had higher PbB than in provincial area (table 3). The exposure from food and water may also contribute to some extent, such as in the area where tin mining is operated. The dietary intake of selected subjects in Bangkok was studied and compared with those in a province of northeast Thailand (Srianujata) during 1988-1989. The results indicated that dietary intake of lead in Bangkok was about double of those in provincial area (table 4). This probably will take some years to lower the intake due to the contaminated of soil from the previous use of leaded gasoline. A study of lead in cord blood and maternal blood was done at Ramathibodi Hospital in Bangkok Phuapradit & Chatura-chinda. The mean concentrations of lead in maternal and cord blood were 6.2 ± 2.0 and $5.2 \pm 2.0 \mu\text{g}/\text{dl}$ respectively. About 5% of maternal blood contained higher than $10 \mu\text{g}/\text{dl}$ of blood lead. It was also found that there was no association between adverse pregnancy outcomes and maternal blood lead levels.

Tin mining was wide spread in the south of Thailand. Some rivers, such as Patani River basin, were found to be contaminated with heavy metals. the blood lead levels in 434 school children living along the river were studied Geater *et al.* The villages adjacent to closed mines and that located close to the

Table 4. Total dietary intake of lead and cadmium of selected subject in Bangkok and Ubol.

area	Weakly intake (mg)	
	Lead	Cadmium
Bangkok	0.56	0.11
Ubol	0.26	0.11
WHO/PTWI	3.00	0.40-0.50

sea, were selected. Those who lived in the area where tin mine was closed recently showed blood lead level higher than $10 \mu\text{g}/\text{dl}$ to be about 73-95% of subjects. While those who lived in the area where tin mine was closed 20 years ago, showed only 23% of subjects who had blood lead levels higher than $10 \mu\text{g}/\text{dl}$.

CONCLUSIONS

From many studies, data available, showed that young children have a great potential for lead exposure and are especially susceptible to its toxic effects. Young children play in dirt and put things in mouth. Together with the fact that lead absorption from gastrointestinal tract in children is greater than adult, and nutritional deficiencies of iron and calcium may facilitate lead absorption. Since blood lead readily crosses the placenta, lead poses the substantial threat to the developing fetus. Also, workers may bring lead dust home on skin and clothes and unknowingly expose family members. These make preschool age children and fetuses are the most vulnerable group. It is important that this group of population should be paid close attention and prevented from lead poisoning.

Table 3. Blood Lead level in children.

Year	No.	PbB	($\mu\text{g}/\text{dl}$)	Authors
1989-1990	?	20.0+7.5 16.2+6.8	(BKK) (Kamchanaburi)	Lueporn P.*
1991	?	18.8+6.2 14.0+3.9	(BKK) (Province)	Oraparn*
1993-1994	71(6 mo.)	5.1+1.7		
	71 (12 mo.)	6.4+2.8		
	512 (4-11 yr)	9.26+3.7	(BKK)	Suwanna R.*
	125 (4-11 yr)	5.73+2.6	(Singburi)	

BKK : 27.4% with PbB > $10 \mu\text{g}/\text{dl}$

Singburi : 5.7% with PbB > $10 \mu\text{g}/\text{dl}$

* from personal communications.

The simple things one can do to prevent childhood lead poisoning may be categorized as follows.

- keep your home as clean and free from dust as possible
- take off your shoes before entering the home
- change out of work cloths
- never sand, burn or scrape paint
- test paint surfaces for lead
- encourage healthy eating habits
- wash children's hands often
- do not use older or handmade dishes
- avoid hobbies that use lead
- keep furniture away from damaged paint
- do not use home remedies or cosmetics that contain lead

Therefore, even though lead will stay with human for very long time to come. It is hope that with the proper utilization of it and with systematic and serious precaution scheme, the lead poisoning and harmful effects should be able to prevent.

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