

Epidemiology Bulletin

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Lead Poisoning in A Lead Smelter

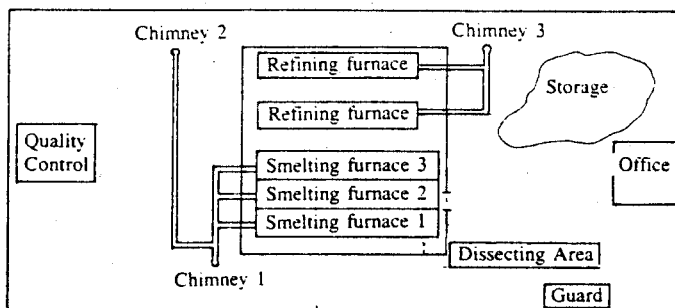
In September 1987, a lead factory worker with symptoms of anemia, wrist drop, and a blood lead level of more than $80 \mu\text{g}/\text{dl}$ was admitted at the National Taiwan University Hospital. He was diagnosed as lead poisoning and hospitalized immediately. To determine whether other workers were also affected, the reporters, with the assistance of the Council of Labor of the Executive Yuan, conducted a field survey in the said factory in November 1987.

The factory retrieves lead from used lead batteries as shown in figures 1 and 2. Of the 110 employees of the factory, 100 work in the factory, of them 15 are female. Only 64 of them accepted the voluntary investigation. The entire recycling process is divided into nine tasks to compare the degree of lead exposure between tasks.

The survey includes a questionnaire, tests of blood lead level and various physiological indices of lead poisoning. The questionnaire administered individually includes personal information, disease history, use of medicine, smoking and drinking, complaints, occupations of family members, work experiences, and use of protecting mask. Heparinized vacuum tube is used to collect whole blood after the skin is rubbed with alcohol several times to avoid lead contamination by skin and air. Atomic absorption spectrophotometry is used for the quantitative analysis of the blood lead level. Physiological indices of lead poisoning such as: complete blood count (CBC), basophilic stippling, GOT, GPT, blood urea nitrogen (BUN), serum creatinine and urine routine examination are tested by the Department of Clinical Pathology of the NTU Hospital. A neurological examination for each worker is conducted by a neurologist from the Neurology Department of the same Hospital.

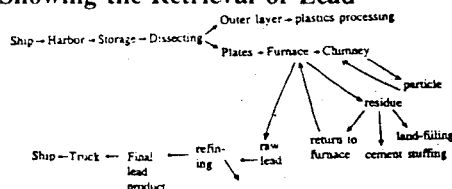
The findings are: No significant difference is found in the sex and age distributions between the 64 examined and the 46 unexamined employees (Table 1). The factory has been established for two years, most employees have worked for less than two years.

Figure 1. Floor Plan of the Factory



Blood lead levels of workers of different tasks differ significantly from each other. The smelting workers ($86.9 \pm 13.6 \mu\text{g/dl}$), maintenance workers ($82.4 \pm 7.5 \mu\text{g/dl}$), and cleaners ($95.4 \pm 35.1 \mu\text{g/dl}$) have the highest levels (Table 2). As most female workers work as cleaners and in places of lower exposure such as the office, it was difficult to detect any effect of sexual difference. Of the 19 workers working in the smelting furnaces, there are 12 smokers and 7 non-smokers. The average age for the smokers is 33 years and their average blood lead level is $89.43 \pm 14.91 \mu\text{g/dl}$. The average age for the non-smokers is 41 years and their average blood lead level $82.57 \pm 9.24 \mu\text{g/dl}$. No smoking effect is noted between them. Multivariate linear regression analysis was made by holding the blood lead level as the dependent variable, and age, smoking habit, drinking, working days, working hours, distance between residence and factory (in km), wearing mask, and kind of task as independent variables. A significant difference is found in the kind of task ($p < 0.05$) only. Only two brothers and a father and a son work in the same factory, the others do not have relatives working in the lead industry.

Figure 2. Flow Chart Showing the Retrieval of Lead



The paralysis of the extensor muscles is the abnormality of the extension of the joint muscles of fingers, wrists, and ankles. The study result shows that when the blood lead level exceeds $60 \mu\text{g/dl}$, the paralysis of the extensor muscles occurs, and when the blood lead level is above $80 \mu\text{g/dl}$, cases always show paralysis of the extensor muscles. One employee in the office is found to have paralysis of the extensor muscles. Further investigation reveals that he has worked at the furnace for eight years. Few employees have subjective symptoms such as: abdominal pain, diarrhea, constipation, weakness of arms, and infertility (Table 2). However, most of those who complain of weakness of arms are workers in the dissecting department (5/8).

Table 1. Backgrounds and Working Statuses of Persons Examined and Unexamined

Tasks	Persons unexamined				Persons examined			
	No.		Age	Duration of Work	No.		Age	Duration of Work
	M	F			M	F		
Furnace	14	0	36 ± 5	554 days	19	0	36 ± 10	346 days
Dissecting	14	0	36 ± 9	327	10	0	34 ± 7	450
Maintenance	3	0	39 ± 4	633	3	0	29 ± 3	289
Cleaner	0	0	-	-	0	6	49 ± 2	539
Refining	3	0	29 ± 1	679	6	0	30 ± 4	549
Cleaner of working area	2	0	49 ± 1	133	4	0	42 ± 1	684
Office*	4	4	43 ± 19	453	4	1	52 ± 11	960
Crane operator	2	0	38 ± 0	526	6	0	43 ± 4	530
Other**	0	0	-	-	1	4	26 ± 5	111

* including staff and janitors

** sales representatives or staff recently employed.

Not many employees show abnormalities of hemoglobin (male less than 12 g/dl , and female less than 10 g/dl) or hematocrit (male Hct less than 40% and female less than 35%). Nor are abnormalities of average MCH (male MCH $< 28.6 \text{ pg}$, female MCH $< 27.8 \text{ pg}$), average MCV (male MCV $< 91 \text{ fl}$, female MCV $< 90.1 \text{ fl}$), and average MCHC (male MCHC $30.1 < \text{g/dl}$, female MCHC $< 29.5 \text{ g/dl}$) found among workers of different tasks. When multivariate linear regression analysis is made by holding the basophilic stippling as the dependent variable, and sex, age, duration of employment, and blood lead level as independent variables, a significant positive correlation ($p < 0.05$) is found between the amount of basophilia stippling and the blood lead level. No significant relation is found among other variables. No abnormality is found in the routine urine examination, serum creatinine, blood uria nitrogen, GOT and GPT. This fact may indicate that lead poisoning may not have any significant impacts on the kidney and liver functions in a short duration.

Table 2. Distribution of Various Variables Among Workers by Task

Task	Blood lead level ($\mu\text{g}/\text{dl}$)		No. of persons		
	$\bar{X} \pm \text{SD}$	< 40	40-80	> 80	
Furnace	86.9 \pm 13.6	0	7	12	
Dissecting	69.4 \pm 16.1	1	7	2	
Maintenance	82.4 \pm 7.5	0	1	2	
Cleaner	48.0 \pm 5.2	0	6	0	
Refining	64.2 \pm 16.1	0	5	1	
Cleaner of working area	95.4 \pm 35.1	0	2	2	
Office	37.8 \pm 4.2	4	1	0	
Crane operator	63.9 \pm 11.1	0	5	1	
Other	7.9 \pm 5.8	5	0	0	

(Cont'd)

Paralysis of extensor muscle N(%)	Abdominal pain N(%)	Diarrhea N(%)	Constipation N(%)	Weakness of arms N(%)
11 (58)	3 (16)	3 (16)	0	2 (11)
4 (40)	2 (20)	1 (10)	0	5 (50)
1 (33)	1 (33)	1 (33)	1 (33)	1 (33)
0	0	0	0	1 (17)
0	0	1 (17)	1 (17)	0
1 (25)	0	0	0	0
1 (20)	0	0	0	0
1 (17)	1 (17)	1 (17)	1 (17)	1 (17)
0	0	0	0	0

(Cont'd)

Infertility	Abnormalities of				
	Hemoglobin N(%)	Hematocrit N(%)	Average MCH N(%)	Average MCV N(%)	Average MCHC N(%)
0	2 (11)	5 (26)	7 (37)	10 (53)	0
0	1 (10)	3 (30)	2 (20)	4 (40)	0
0	0	0	0	1 (33)	0
0	0	0	1 (17)	4 (67)	0
0	0	2 (33)	3 (50)	3 (50)	0
0	0	0	1 (25)	1 (25)	0
0	0	0	0	0	0
0	0	0	3 (50)	4 (67)	1 (17)
0	0	0	2 (40)	2 (40)	0

Note: % stands for percentage of abnormal cases to the number of workers in that group.

The survey shows that at least one-third of those according to the regulations promulgated by the council of labors, examined are identified as lead poisoning requiring third-grade care! Some workers said that some of their colleagues had been diagnosed of similar abnormalities by other hospitals and they did not come for the examination for fear that they might be dismissed because of the third-grade care. Thus, the 1/3 estimate of the lead poisoning prevalence of this factory is most likely an underestimate. Reports from other countries show that children living within a radius of 1.6 km from a smelting factory seem to have increased absorption of lead and their IQ's are also affected. To further understand whether the environment around the factory has been polluted, more studies of the lead level and IQ's of school children in the neighborhood will be conducted to protect the health and safety of the residents around the area.

Reported by CS Chang, JD Wang, and YH Huang of the Graduate Institute of Public Health, National Taiwan University Medical College, and WY Yeh of the Council of Labor, the Executive Yuan.

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