



EVALUATION OF LEAD EXPOSURE IN LEAD ACID BATTERY MANUFACTURING

P. Georeva¹, T. Kuneva², K. Karamfilov³, T. Boeva⁴, Zh. Staikova³

¹Trudova Meditzina” OOD

²St. John of Rila University General Hospital for Active Treatment

³St. Catherine University General Hospital for Active Treatment

⁴Medical University – Plovdiv, Bulgaria

ABSTRACT

Lead is a well-known xenobiotic selectively damaging the haematopoietic system, as well as the peripheral and central nervous system. Despite the efforts to provide safe and healthy conditions at work, the exposure biomarker values are still a significant medicine issue.

The aim of the present study was to evaluate lead exposure in the lead acid battery production.

Contingent and methods. The study involved 187 people working in the basic units of a battery manufacturing plant – Foundry, Pasting, Formation and Assembly.

The lead content in the blood was investigated by atomic absorption spectrophotometry (AAS), as well as a set of paraclinical indicators: complete blood count, haemoglobin content, ESR and urine test by standard clinical laboratory methods. The results were statistically processed by means of SPSS software version 17, at a significance level $p < 0.05$.

Results. The average value of blood lead level ($M \pm SD$) was $478.42 \pm 224.65 \mu\text{g/l}$, which exceeds the WHO criterion for occupational exposure without deviations in the health status. The maximum value observed was $1184.00 \mu\text{g/l}$ - manifestations of lead impact are likely to be found in people whose work involves direct contact with the metal. The highest value of blood lead level was recorded in the people working in the Pasting unit ($M \pm SD - 598.29 \pm 272.61 \mu\text{g/l}$). The analysis of exposure expressed by the most reliable biomarker – blood lead level, showed that the people most severely involved had the following occupations: “pasting workers” from the Pasting Unit, followed by “fitters of lead acid batteries” from the Assembly Unit; “workers manufacturing batteries” from the Formation Unit; “moulders of lead details for batteries” from the Foundry Unit. The biomarker for exposure - blood lead level, was affected by the specialized professional experience, age and smoking.

Conclusion. The analysis of the results obtained showed that measures need to be taken to optimize the conditions at work for some of the workers exposed. The Health Promotion Programme should focus on reduction of smoking because of a dependence we found between this bad habit and lead content in the blood.

Key words: occupational exposure, lead acid battery manufacturing, blood lead level, biological monitoring, smoking.

Lead is a well-known xenobiotic selectively damaging the haematopoietic system, as well as the peripheral and central nervous system. Other factors also exert an influence on lead exposure of workers, e.g. physical activity, smoking, etc. Despite the efforts to provide safe and healthy conditions at work, lead toxicity still remains a significant health issue.

The **aim** of the present study was to evaluate lead exposure in the lead acid battery production process.

Contingent and methods. An exhaustive epidemiological study was conducted involving 197 men engaged in lead acid battery manufacturing, aged between 22 and 70.

The **object of study** was the biomarker level for exposure to lead of the workers in the basic units: Foundry, Assembly, Pasting and Formation.

The following features were used in the study: **independent variables** - age, gender, total

working experience, working experience in lead acid battery manufacturing, harmful habits (smoking); and **dependent variables**- blood lead content (by AAS), and a set of paraclinical indicators: complete blood count, haemoglobin, ESR and urine test.

Questionnaire, instrumental, clinical, toxico-chemical and statistical methods were used in the study.

The **statistical processing** of the results involved parametric and non-parametric methods (Chi-Square Test) at a significance level $p < 0.05$.

RESULTS OF OUR OWN STUDIES

The average age of the people studied was 44.66 ± 9.62 . They were divided into two groups according to age, the first one consisting of those under 40 years of age (32% of all people studied), and the second one including the workers over 40 (68% of the people studied).

The distribution of the people according to their working experience under conditions of lead exposure was as follows:

- up to 1 y - 40.6%; from 2 to 5 y - 23%; from 6 to 10 y - 13.4%; from 11 to 20 y - 16.0%;
- over 20 y - 7% of all people studied.

Distribution of the people studied according to the unit they worked in: Pasting Unit - 26%; Formation Unit - 21%; Assembly Unit - 26%; Foundry Unit - 17%; Administrative unit about 10%.

In the Foundry Unit the lead grids and other lead-coated parts are cast. The people working there are exposed to lead aerosols. In the Pasting Unit the active pastes are applied to lead grids. In the Formation Unit the active masses are formed into positive and negative grids. In the Assembly Unit the batteries are assembled, where apart from the exposure to lead aerosols, carrying the various parts requires from moderate to heavy physical activity.

The specialized working experience ranged from 6 months to 28 years at a mean value of ($M \pm SD$) 5.48 ± 7.03 y. The level of the lead exposure biomarker varied from $76 \mu\text{g/l}$ to $1184.65 \mu\text{g/l}$, at a mean value of blood lead level $478.42 \pm 224.65 \mu\text{g/l}$, exceeding the WHO criterion for occupational exposure - $400 \mu\text{g/l}$.

The analysis of blood lead levels according to working place showed highest mean value ($598.29 \pm 272.61 \mu\text{g/l}$) in the men working in the Pasting Unit; the lowest mean value ($377.24 \pm 149.73 \mu\text{g/l}$) was found in the workers from the Foundry Unit. The mean value of lead concentration in the blood of the workers from the Pasting Unit was significantly higher, as compared to that of the workers from the Formation Unit ($454.73 \pm 176.67 \mu\text{g/l}$), the Foundry Unit, and the Administrative Unit ($318.67 \pm 172.71 \mu\text{g/l}$).

Applying correlation analysis to the above-mentioned variables, we found the following reliable dependencies:

- negative dependence between the specialized working experience under conditions of lead exposure and the haemoglobin values in the blood of the people studied $- 0.182$;
- moderate dependence between the specialized working experience and the blood lead level of the people studied.

The analysis of the influence of smoking habits on the values of the lead exposure biomarker revealed a statistically significant ($P=0,005$) difference between the two groups of workers – smokers and non-smokers.

DISCUSSION

The results of the present study show that the specialized working experience under conditions of lead exposure, age and smoking exert an influence on blood lead level. Other factors of the labour process, such as moderate to heavy physical activity at work, are also implicated. Such a synergistic action of two factors – lead aerosols in the working environment, around or slightly over the threshold limit values, and moderate to heavy physical activity resulting in the inhalation of a greater amount of aerosols – was observed in the Assembly Unit.

A third factor was observed in the workers who smoked, influencing the likelihood of lead ingestion. Apart from being inhaled, lead was ingested perorally by the smokers, in cases of at risk behavior on their part or non-compliance with the regulations on personal hygiene (eating and smoking at the working place with or without gloves) (4, 6).

The analysis of exposure according to the position held showed that the “pasting workers” from the Pasting Unit were involved to a greatest

extent, followed by “fitters of lead acid batteries” from the Assembly Unit; “workers manufacturing batteries” from the Formation Unit; “moulders of lead battery parts” from the Foundry Unit.

The mean blood lead level found in the exposed workers involved in battery production ($M \pm SD$) $478.42 \pm 224.65 \mu\text{g/l}$ exceeds the WHO criterion for occupational exposure, the lowest value of the lead exposure biomarker being $76 \mu\text{g/l}$, and the maximum value found being $1184.00 \mu\text{g/l}$, which shows that people with obvious signs of

health impairment are likely to be found among the lead-exposed workers.

Health-impairing effects are known to be manifested at different blood lead levels. The lowest value registered by us in the blood of workers was below the WHO criterion for population ($150 \mu\text{g/l}$). However, the highest value observed exceeds considerably the criterion for occupationally exposed people ($400 \mu\text{g/l}$). The clinical manifestations vary among individuals, although in general they are in agreement with the below-mentioned dependencies (1, 2,3):

Blood lead level	Possible health-impairing effects
Over $300 \mu\text{g/l}$	Raise in the systolic arterial pressure
About $400 \mu\text{g/l}$	Peripheral neuropathy, nephropathy, sterility in men
About $500 \mu\text{g/l}$	heme damage of hemoglobine
Over $650 \mu\text{g/l}$	lead colic
About $800 - 850 \mu\text{g/l}$	Development of anemia, encephalopathy, nephropathy
About $1000 \mu\text{g/l}$	CNS involvement and development of encephalopathy

CONCLUSION

The analysis of the results from the study proved that in spite of the fact that lead content in the air of the working environment was at the level of the admissible hygiene norm (the threshold limit value), the blood lead level of the workers was above the admissible value. Thus, measures have to be taken with view to optimizing labour conditions and changing the workers' behavior. The programme of health promotion should focus on reduction of smoking, keeping proper personal hygiene and adequate personal protection.

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