Bull. Environ. Contam. Toxicol. (1984) 32: 290–294

Bulletin of Environmental Contamination and Toxicology

Lead Absorption in Cows: Biological Indicators of Ambient Lead Exposure

V. Karačić, D. Prpić-Majić, and Lj. Skender

Department for Occupational Diseases, Institute for Medical Research and Occupational Health, Zagreb, Yugoslavia

In order to determine actual lead exposure from residual amounts of lead in the environmental soil following the introduction of effective engineering emission controls in a lead smeltery, the absorption of lead in cows grazing in the vicinity was investigated. Four groups of cows were examined: two groups of cows exposed to different ambient lead concentration, compared with two normal groups of cows. In each cow δ-aminolevulinic acid dehydratase (ALAD), erythrocyte protoporphyrin (EP) and blood lead (Pb-B) were determined, two years prior to and four years after the technical sanitation of the lead emission source. The results demonstrated normalization of ALAD, EP and Pb-B after the technical sanitation.In spite of normalization, biological indicators ALAD and Pb-B determined four years after the technical sanitation showed increased lead absorption in comparison with the results of the control group. This indirectly indicates lead contamination of the environment from residual amounts of lead in the soil. The biologically active lead deposit from past exposure could be an additional factor in the prolonged effect of lead in the body.

In small village farms about 5000 m away from the lead smeltery, the inhibitants had been exposed for a long time to increased lead concentration. In 1978 new efficient bag filters were introduced for cleaning flue gases in the smeltery, which resulted in an immediate improvement of the air quality (Fugaš et al. 1980). The radical decrease of air lead concentration had an effect on the normalization of biological indicators of lead absorption in humans although these were still different to the corresponding values in the control group (Prpić-Majić et al. 1983). After the technical sanitation of the lead emission source, the soil remains contaminated by lead for a longer period than air. The preliminary data indicate that lead in the first 10 cm of the soil in this area is 6 - 17 times more than in the control area (Fugaš and Hršak - unpublished data). The residual amounts of lead in the soil are

transferred into plants and may enter the food chain. Cows grazing in the vicinity of the lead smeltery could be used as a specific sample when evaluating the residual ambient lead exposure. From this point of view the characteristic biological indicators in cows were investigated before and after the installation of an emission control system in order to evaluate the residual ambiental lead exposure.

MATERIAL AND METHODS

The examinations were carried out in lead exposed and control areas. The cows in the lead exposed areas were from small farms up to 5000 m from the lead smeltery. In the first study (1976), two years prior to bag filter installation, 30 cows from the lead exposed area and 22 cows from the control area were examined. In the second study, four years after the technical sanitation of the lead emission source (1982), 30 cows from the lead exposed area and 15 cows from the control area were studied. For each cow and in each period the following biochemical indicators of lead absorption were determined in blood-ALAD, EP and Pb-B (Karačić et al. 1978). All indicators were analyzed in samples of cow blood with heparin as an anticoagulant. ALAD was determined by the standard European method (Berlin and Schaller 1974) CV = 2%; EP by extraction/spectrofluorometric method (Chisolm and Brown 1975) CV = 3%; Pb-B by ETA - - AAS method (Fernandez 1975) CV = 5%.

The results of the parameters obtained in each group and for each period were presented as median (M) and range values (R). The differences in biological indicators of lead absorption between the two groups in the lead exposed area for each period and corresponding control groups, were tested by median test (Siegel 1956).

RESULTS AND DISCUSSION

Biochemical indicators of lead absorption in cows grazing in lead contaminated pastures are presented in relation with identical indicators for cows from the control area (Table 1.).

All indicators show increased absorption of lead in cows from the contamined pastures. In 1982 a definite trend of normalization of ALAD, EP and Pb-B occurred, after the technical sanitation of the filter system.

The difference in all biochemical indicators in cows from the lead contaminated area, before and after the technical sanitation of the lead emission source, tested by median test, is highly significant ($p<0,001$)

(Table 2.). The results confirm the efficiency of the new filters.

Table 1. Median (M) and range (R) values of biochemical indicators of lead absorption in cows from the lead contaminated and control area, before and after bag filter installation

Year		Statistical parameter	Biochemical indicator		
			ALAD U/L E	EP µmol/L	Pb-B µmol/L
1976	Exposed group	M	0,6	14,55	3,09
		R	0,0-1,8	3,88-58,82	1,21-5,45
	Control group	M	4,3	1,45	0,29
		R	0,9-14,0	1,14-2,15	0,24-0,53
1978	Bag filter installation				
1982	Exposed group	M	1,5	3,47	1,44
		R	0,6-5,9	1,68-12,38	0,82-3,40
	Control group	M	5,0	2,22	0,27
		R	1,6-8,8	1,70-3,27	0,09-0,60

Table 2. Statistical significance of the difference in biochemical indicators in cows from the lead contaminated area, before and after the bag filter installation

Years compared	Statistical parameter	Biochemical Indicator		
		ALAD U/L E	EP µmol/L	Pb-B µmol/L
1982-	x^2	17,066	26,666	13,066
-1976	p	<0,001	<0,001	<0,001

In spite of the evident normalization in 1982 in comparison with 1976, the biological indicators ALAD and Pb-B showed increased lead absorption in 1982 in relation to the results of comparable control group ($p < 0,001$) (Table 3.). The increased lead absorption demonstrated through lowered ALAD activity and increased Pb-B concentration, in comparison with the control group, could be explained by contaminated grass from the residual amounts of lead in the soil. An additional factor is probably a biologically active lead deposit

from past exposure.

Table 3. Statistical significance of the difference in biochemical indicators in cows from the lead contaminated and control area, before and after bag filter installation

Year of examination	Statistical parameter	Biochemical indicator		
		ALAD U/L E	EP µmol/L	Pb-B µmol/L
1976	χ^2	25,527	38,133	38,133
	p	<0,001	<0,001	<0,001
1978		Bag filter installation		
1982	χ^2	16,899	3,600	22,500
	p	<0,001	>0,05	<0,001

It is pointed out that the Pb-concentration in air has been within the limits allowed since 1979. Thus the biological indicators of increased lead absorption in cows reflect soil contamination by lead for a longer period than air.

The biological monitoring of ALAD, EP and Pb-B in cows grazing in the vicinity of a lead smeltery could be a useful approach in the establishment of the elapsed time, after the reduction of lead emissions, before lead contaminated soil could be proclaimed as safe for humans and domestic animals. Thus, the chosen biological indicators of increased lead absorption in cows could be applied in evaluating residual ambient lead exposure.

Acknowledgement: The authors wish to thank Mrs. Antonija Keršanc, who performed ALAD analyses, Mrs. Jadranka Pongračić, who performed Pb-B analyses and Mr. Rudi Čretnik for collection of the blood samples.

REFERENCES

Berlin A, Schaller KH (1974) European standardized method for the determination of δ-aminolevulinic acid dehydratase activity in blood. Z Klin Chem Klin Biochem 12:389-390

Chisolm JJ, Brown DH (1975) Micro-scale photofluorometric determination of "free" erythrocyte porphyrin (protoporphyrin IX). Clin Chem 21:1669-1682

Fernandez FJ (1975) Micro-method for lead determination in whole blood by atomic absorption, with use of the

graphite furnace. Clin Chem 21:558-561

Fugaš M, Hršak J, Souvent P (1980) The effect of a new emission control system on lead, zinc and cadmium concentrations in the environment of a lead smeltery. A paper presented at the Fifth International Clean Air Congress, Buenos Aires

Karačić V, Keršanc A, Pongračić J (1978) Abnormal lead absorption in cows in the vicinity of a lead smeltery. In: Proceedings of the International Seminar on Problems of Lead and Fluorine Air Pollution from Industrial Source, Centro Ceramico, Bologna, p 129

Prpić-Majić D, Mecner J, Telišman S, Keršanc A (1983) Biochemical follow-up of an environmental lead problem after engineering pollution controls of the emission source. In: Proceedings of theVIth World Congress on Air Quality, Vol. 2, Paris, p 99

Siegel S (1956) Nonparametric statistics for the behavioural sciences. The extension of the median test. McGraw-Hill, New York Toronto London
Received August 12, 1983; accepted September 22, 1983