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Environmental health aspects of lead

Die gesundheitlichen Aspekte
der Umweltverschmutzung durch Blei

Les problèmes sanitaires posés par le plomb
présent dans l'environnement

ATMOSPHERIC LEAD IN BUENOS AIRES CITY

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SUMMARY

The present survey has been carried out in order to evidence the effect of leaded gasoline on the population of Buenos Aires city. The aim of the investigation was to establish whether the amount of tetraethyllead or its combustion products present in automobile exhaust gases does effect the normal synthesis of hemoglobin in individuals exposed to unusual amounts of vehicular exhaust. Two main parameters were determined: 1) the blood lead level; 2) the erythrocyte delta-aminolevulinic acid dehydratase activity. The results are given for a few groups of exposed and nonexposed people living and working in the city of Buenos Aires.

INTRODUCTION.

According to the results published by KEHOE (1), the analytical findings with respect to lead in the urine and blood of a group of men working out-of-doors in areas of heavy motor traffic, showed no difference with those obtained in an experiment carried out on a larger scale in Cincinnati and vicinity a few years before.

THOMAS and coworkers (2) carried out an interesting study in California, in order to determine whether exposure to higher concentration of automobile exhaust influences levels of lead in blood. For this purpose, samples of blood from two groups of people living 1) near a freeway, and 2) in a seashore community, were obtained and their content of lead determined. The main finding was that blood lead levels were substantially higher in the population living near the freeway: 22.7 micrograms/100 grams for the first group, and 16.0 micrograms/100 grams for the second one.

However, those blood lead levels were similar to the values reported for other urban populations in the U.S.A.

Various authors have reported different blood lead levels for occupational nonexposed populations in different countries. In an international research program carried out with the participation of 15 different countries (3), the blood lead levels were 15-35 micrograms/100 ml and 95 % of the examined population had values of up to 40 micrograms/100 ml of lead in blood.

The same study gave for Argentina (4) a mean lead level of 21.6 micrograms/100 ml of whole blood with a S.D. = ± 10.3 and a range of 4-48 micrograms/100 ml. The group of people living in urban areas showed a slightly higher average of lead in blood.

The general accepted values for unexposed people lie between 15 and 25 micrograms/100 grams of blood, and it is believed that these levels are without any biological effects.

STOPPS (5) states that this level of lead constitutes a background body burden which is always present and is derived from the soil, water and airborne lead.

The main source of lead in the urban environment is the exhaust from automobiles burning gasoline containing lead antiknock agents, such as tetraethyl- and tetramethyllead.

The fact that the body burden of lead as represented by the blood and urine lead levels has not changed in the past 30-40 years, as demonstrated by various authors, does not prove it is harmless. On the other hand, as HARDY's studies (6) done at the Massachusetts General Hospital in Boston have shown, "the blood lead does not reflect the size or potential threat of the body burden of lead; at any given time the blood lead value reflects a complex balance between the exposure, the amount absorbed from the lung, the gastrointestinal tract, and that already stored".

The inhibitory effect of lead on heme synthesis has shown to be a very sensitive criterion for the purpose of demonstrating whether a small increase in airborne lead may result in some undesirable effect on health. The increase in delta-ALA urine excretion has been reported as an early sign of lead exposure by many authors (7, 8, 9, 10,11) during the last 10-12 years. However, as stated by STOPPS (5), "while a raised delta-ALA excretion is an undoubted result of sufficiently high body burden of lead, the significance of minor degrees of elevation of delta-ALA excretion in terms of human health remains to be demonstrated".

On the other hand, BAUMLER (12) found that delta-ALA excretion in a group of 43 policemen exposed to automotive exhaust was within normal ranges.

According to GOLDSMITH and HEXTER (13) blood lead levels are epidemiologically related to estimated respiratory exposures in areas with high levels of motor vehicle pollution. It is important to remember that the 25-50 % of inhaled lead derived from motor vehicle exhaust is thought to be absorbed by the respiratory tract (14) due to its particle size: 0.5-1.0 micron would be the appropriate diameter, according to KEHOE (15).

Since the inhibition of erythrocyte delta-ALA dehydratase is one of the first effects of lead at molecular level, it seemed to us very reasonable to think of a test based on the determination of this enzyme activity as a means of providing a more sensitive index for the early detection of lead effect at low levels.

Our previous studies on the inhibition of erythrocyte delta-ALA dehydratase by lead (16, 17, 18) have shown a good correlation with extremely low exposures.

HERNBERG and NIKKANEN (19) have very recently measured blood-lead levels and erythrocyte delta-ALA dehydratase activity in 26 healthy medical students with no occupational exposure to lead, and found that an inhibition of the enzyme appears "even for people representing normal urban exposure to lead". The authors mentioned above present their finding as "an example of how the border between effect and no effect can be shifted by the introduction of more sensitive methods", and in a further publication (20) they state the usefulness of this parameter in indicating biochemical effects on the general population.

We agree with them is asking whether this interference of lead with normal metabolism may or not be harmful.

With this idea in mind the present survey was planned in order to investigate how does the current lead level in the common environment affect the hemoglobin synthesis in different groups of adult city dwellers, such as employees working in indoor offices, policemen, garage and service station operatives, street newspaper-sellers and flower-sellers, etc.

A questionnaire card was completed for each individual to provide information about name, age, alcoholic and smoking habits, varying intensities of urban air pollution according to residence, traffic density, working place, and occupation during the past ten years. All the participating individuals were in apparently good health.

We would like to stress, however, that the most susceptible groups of the population should be evaluated as well, since community exposures affect not only the healthy but the sick. Other segments of the population will be submitted to a careful evaluation as a part of a project to be developed in the near future.

The first results obtained with a few small groups of people living and working in Buenos Aires city are given.

MATERIAL.

Four groups of people were selected according to their occupation:

1.- Indoor office employees and laboratory technicians (n = 25)

2.- Garage workers and gas-station attendants (n = 29)

3.- Street newspaper-sellers (n = 20)

4.- Street flower-sellers (n = 20)

Groups 3 and 4 worked at busy streets with heavy traffic.

METHODS.

Only two parameters were determined for each group: blood lead level and delta-ALA dehydratase activity. Urinary lead, coproporphyrins and delta-ALA excretion have not been studied because of the difficulty in obtaining the urine specimens correctly collected.

Lead in blood was determined by a dithizone technique (21) and delta-ALA dehydratase activity by an adaptation of BONSIGNORE et al's method (22).

RESULTS.

The values obtained for the above mentioned groups of people are depicted in Table 1.

When groups 2, 3 and 4 are compared with group 1, the p values (Student test) for lead in blood and for delta-aminolevulinic acid dehydratase activity are showing differences statistically significant, as can be seen in Table 2.

However, group 1 is not considered to be strictly taken as "normal", since it is composed by people living in a polluted urban area. Group 1 should be, in turn, compared with some other groups living either in rural areas or in the high mountains.

A comparison has also been possible* a group of 14 people working in an ethylating plant and two smaller groups of 6 people each, working at the control laboratory and at the offices of the same industrial plant, respectively.

The mean values for lead in blood levels and for delta-aminolevulinic acid dehydratase activity were not very different in groups a, b, and c, as shown in Table 3. However, when butirylcholinesterase was studied, a decrease in the mean values for the total enzyme activity in groups a and b, as well as the inhibition of anodic fractions was found, with respect to group c.

It has to be remarked that the ethylating process was carried out in a closed system resulting in a minimal atmospheric pollution.

A study carried out on a group of 144 printing shop workers, in which the degree of lead absorption is fairly low, allowed us to establish an interesting comparison with groups 2, 3 and 4. The results are shown in Table 4.

* between

DISCUSSION.

The results obtained for the groups of people under study show a significant inhibition of the delta-aminolevulinic acid dehydratase activity in red blood cells, which means a disturbance in the biosynthesis of hemoglobin. It is not yet known whether this finding has to be considered as evidence of a harmful effect of lead, but there is no doubt that a biochemical injury is present at cellular level.

From the analysis of figures given in Table 1 and Table 3 it may be concluded that the people working at the ethylating plant are apparently not affected, and this is due to the efficiency of the working systems.

On the other hand, the groups 2, 3 and 4 under examination may be fairly well compared to the group of printing shop workers, according to the figures shown in Table 1 and Table 4. Although it is stated that the risk of lead poisoning is minimal at the printing work (23), those workers have to be considered as to be exposed. It would therefore be reasonable to apply a similar concept to those sectors of population such as the ones submitted to the present survey. It is interesting to point out the fact that HAEGER-ARONSEN et al (24) have not find significant changes in the enzymatic activity of red cells in a group of 35 people (16 traffic policemen, 10 car park inspectors, and 9 taxi drivers) exposed to town traffic in the city of Lund (250.000 inhabitants). It must be stressed that Buenos Aires city has about 4.5 million inhabitants and a total amount of cars between 450.000 and 500.000.

Another important point we would like to stress concerns the susceptibility of children to lead. Although systematic studies have not been carried out, some cases of children with low erythrocyte enzymatic activity have been carefully studied in order to find out whether unusual environmental conditions were responsible for this abnormality. In most cases the source of exposure was unknown. It is interesting to mention the case of a five-year-old girl showing a very low delta-aminolevulinic acid dehydratase activity (36 U/ml RBC), who was investigated in order to find the probable source of exposure. The house-located in a suburban residential area - was just in front of a bus stop for four different lines of buses, and the average lead level in air around the house was found to be 21 micrograms/cubic meter, which is fairly high if we consider that according to STOPPS (5) the general environment may give average air lead concentrations ranging from 0.3 to 2.5 $\mu g/m^3$.

CONCLUSIONS.

The results of the survey carried out on various groups of apparently healthy people are given as a contribution to a very early detection of lead exposure. Attention is called about the danger invloved in the use of tetraethyllead as a gasoline additive for the general population of urban areas.

The most susceptible groups of people should be examined, since community exposures affect not only the healthy but the sick. Children are particulary susceptible to environmental lead. Other segments of the population will be submitted to a careful evaluation in the near future.

REFERENCES

1.- KEHOE R.A. The hygienic aspects of the production and use of lead antiknock compounds. 55th Annual Meeting of the APCA, Chicago, Ill. May 1962.

2.- THOMAS H.V., MILMORE B.K., HEIDBREDER G.A., KOGAN B.A. Arch. Environ. Health. 15. 695. 1967.

3.- Meeting of investigators for the International Study of Normal Values for Toxic Substances in the Human Body. WHO. Geneva. October 1965.

4.- SINGERMAN A. Unpublished data.

5.- STOPPS G.J. Proc. of the Symp. on Air Quality Criteria. New York, N.Y. June 1968.

6.- HARDY H.L. J. of Air Pollution Control Assoc. 19. 701.1969.

7.- HAEGER-ARONSEN B. Scand. J. Clin. Lab. Invest. 12. Suppl. 47. 1960.

8.- DE KRETSER A.J., WALDRON H.A. Brit. J. Ind. Med. 20. 35.1963.

9.- GATTNER H., SCHRANTZ G. Dtsch. Med. Wschr. 89. 1027. 1964.

10.- CHISOLM J.J., KAPLAN E. J. of Pediatrics. 73. 942. 1968.

11.- SINGERMAN A. Arch. Environ. Health. 9. 464. 1964.

12.- BAUMLER J. Zt. für Präventivmed. 11. 265. 1966.

13.- GOLDSMITH J.R., HEXTER A. Science. 158. 132. 1967.

14.- GOLDSMITH J.R. J. Air Pollution Control Assoc. 19. 714.1969.

15.- KEHOE R.A. Ind. Med. Surg. 28. 156. 1959.

16.- SINGERMAN A. Rev. Asoc. Bioq. Arg. 33. 162. 1968.

17.- SINGERMAN A. Rev. Asoc. Bioq. Arg. 35. 78. 1970.

18.- GIMENEZ E.R., VALLEJO N.E., IZURIETA E.M., SINGERMAN A. Rev. Asoc. Bioq. Arg. 35. 185. 1970.

19.- HERNBERG S., NIKKANEN J. The Lancet. 1. 63. 1970.

20.- HERNBERG S., NIKKANEN J., MELLIN G., LILIUS H. Arch. Environ. Health. 21. 140. 1970.

21.- CHO[illegible] J., [illegible] D.M., BURKEY R.E. Anal. Chem. 20,671. 1948.

22.- BONSIGNORE D., CALISSANO P., CARTASEGNA C. Med. Lavoro. 56, 199. 1965.

23.- HERNBERG S., LILIUS H., MELLIN G., NIKKANEN J. Work-Environ-ment-Health. 6, 5. 1969.

24.- HAEGER-ARONSEN B., ABDULLA M., FRISTEDT B.I. Arch. Environ. Health. 23, 440. 1971.

TABLE 1 - Blood lead level and erythrocyte ΔALA-D activity in four groups of people living and working in Buenos Aires city.

GROUP	n	AGE (range)	SMOKING HABITS	ALCOHOLIC HABITS	LEAD IN BLOOD µg/100 gm		ΔALA-D units/ml RBC	
					MEAN VALUES	S.D.	MEAN VALUES	S.D.
1	25	22-65	non smokers light smok.	no alcoholics	24.0	10.0	90.0	20.9
2	28	18-61	moderate smokers	moderate alcoholics	33.3	21.9	46.6	16.5
3	20	26-62	moderate smokers	moderate alcoholics	32.4	6.8	69.4	28.7
4	20	18-62	moderate smokers	moderate alcoholics	34.9	7.5	48.0	19.2

TABLE 2 - p values (Student test) for lead in blood and erythrocyte ΔALA-D. Group 1 = Control.

LEAD IN BLOOD µg/100 ml	GROUP 1	GROUP 2	GROUP 3	GROUP 4	ΔALA-D units/ml RBC	GROUP 1	GROUP 2	GROUP 3	GROUP 4
MEAN VALUES	24.0	33.3	32.4	34.0	MEAN VALUES	90.0	46.6	69.0	48.0
S.D.	10.0	21.9	6.8	7.5	S.D.	20.0	16.5	28.7	19.2
p	-	< 0.05	< 0.01	< 0.001	p	-	< 0.001	< 0.02	< 0.001

TABLE 4 - Blood lead level and erythrocyte ΔALA-D activity in 144 printing shop workers.

	LEAD IN BLOOD µg/100 ml	ΔALA-D units/ml
MEAN VALUES	48.4	49.0
S.D.	8.3	23.0

TABLE 3 - Blood lead level, erythrocytes ΔALA-D activity, and plasma cholinesterase in groups a (14 workers, ethylating plant), b (6 technicians, control laboratory), and c (6 employees, offices).

GROUP a	LEAD IN BLOOD µg/100 ml	ΔALA-D units/ml RBC	CHOLINESTERASE ImU/ml
MEAN VALUES	18.5	116.7	2574
S.D.	3.43	18.8	623
RANGE	11-23	96-168	1522-3857
GROUP b	LEAD IN BLOOD µg/100 ml	ΔALA-D units/ml RBC	CHOLINESTERASE ImU/ml
MEAN VALUES	18.6	111.0	2549
S.D.	3.00	8.3	495
RANGE	16-23	99-119	2110-3280
GROUP c	LEAD IN BLOOD µg/100 ml	ΔALA-D units/ml RBC	CHOLINESTERASE ImU/ml
MEAN VALUES	15.5	114.1	2994
S.D.	2.78	10.5	650
RANGE	11-19	94-121	2157-3810