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Original paper

THE BASIC HAEMATOLOGICAL MEASUREMENTS IN PERIPHERAL BLOOD FROM WORKERS EXPOSED TO MERCURY VAPOURS

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Summary: In the present study was assessed the influence of occupational exposure to mercury vapours on the basic haematological parameters (erythrocyte, leukocyte and platelet count, haemoglobin concentration, haematocrit, MCV, MCH and MCHC). Studies were carried out on 138 workers involved in the production of chlorine using the mercuric electrolysis method (divided into three groups: permanently, periodically and earlier exposed to mercury vapours), as well as on 38 healthy workers. The shift time - weighted averages for mercury was determined in the workplace air before research; mean value was significantly over maximum tolerated dose. The mercury content in the blood and urine of exposed workers was determined by atomic absorption spectrophotometry. In all three groups 95th percentile values of mercury in blood and urine are significantly over MTD. Peripheral blood cell parameters were determined using an automatic cell counter. In the group exposed to mercury vapours, was found a statistically significant increase of erythrocyte count with a concomitant decrease in MCV. The mean values of haemoglobin concentration, MCHC and platelet count were higher in the group of workers exposed to mercury vapours, but the difference was not statistically significant. There were no significant differences in haematocrit, MCH and leukocytes between the studied groups. Our results indicate that long-term and permanent exposure to mercury vapours induces changes in the important haematological parameters of the peripheral blood.

Key words: mercury, haematological parameters

Introduction

A large group of workers exposed to mercury vapours may be found in the chlor alkali industry, where chlorine and caustic soda are produced using the electrolysis of brine in mercury cells. A typical mercury cell, 10–20 m^2, may contain up to 3 tons of mercury, and there are often about 100 mercury cells at a plant. Although the process is closed, leakage of mercury occurs as a result of technical faults, and also during repairs and maintenance. The workers of these plants are exposed to mercury mainly in the form of vapour but to some degree also as the dust of mercury salts (1).

It is relatively easy to diagnose mercurialism with an acute or subacute course by such symptoms as metallic taste in the mouth, excessive salivation, gingivitis, stomatitis, diarrhoea and nephritis. CNS symptoms include nervousness, timidity and uncontrolled fierceness. It is much more difficult to detect the initial symptoms of intoxication showing gradual, yet deepening changes in various metabolic processes. At the beginning, they consist of the elimination of the microelements necessary for life (based on competitive interactions) such as Fe, Ca and Zn (2). A recent review of world literature collected by Moszczynsky (3) irrefutable shows the strong, negative influence of mercury on the immune system.

The aim of this investigation was to determinate (on easily accessible material such as the blood of workers exposed to mercury vapours) changes concerning the basic haematological measurements.

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Subjects and Methods

Subjects

The study has been performed on 138 workers involved in the production of chlorine using the mercuric electrolysis method, which were divided into three groups:

Group I, GI – workers (N = 33, average age 36.4 ± 7.21 yrs) permanently exposed to mercury vapours for 8.4 ± 4.7 yrs;

Group II, GII – workers (N = 87, average age 33.9 ± 7.60) periodically exposed to mercury vapours for 7.7 ± 5.3 yrs;

Group III, GIII – workers (N = 18, average age 42.3 ± 5.8 yrs) earlier (minimum 5 years ago) exposed to mercury vapours for 10.3 ± 4.9 yrs.

Control group, CG – (N = 38, average age 31.8 ± 9.4 yrs) consisted of healthy workers, not exposed to mercury vapours.

Methods

The metallic mercury concentrations in workplace air were determined using Analyser of mercury vapour »Jerome instrument corporation S« . The mercury content in the blood and urine of workers was determined by atomic absorption spectrophotometer »Perkin-Elmer«. Blood samples were obtained from fasting subjects together with blood samples for determination complete blood counts. The eight haematological parameters were determined using haematological analyser »Coulter counter«.

The results were subjected to statistical analysis by analysis of variance and Student-t test.

Results

Mercury in blood and urine

The air for the determination of the mercury concentrations was taken in different areas of the workplace on morning and during work time. The shift time – weighted averages determined for mercury in the workplace air before research were 0.045 ± 0.072 mg/m^3 (0.006 to 0.293 mg/m^3); mean value was significantly over maximum tolerated dose, MTD (0.01 mg/m^3).

Maximum tolerated dose for mercury in blood is 0.175 μmol/L and in urine 0.1 μmol/L. Workers in group permanently exposed to mercury vapours have mean value of mercury in blood close to MTD, but mean in urine are significantly over MTD (*Table I*). Mean values in blood in two other groups are bellow MTD, mean value in urine in group periodically exposed is slightly higher than MTD and in group earlier exposed is bellow MTD. In all three groups 95th percentile values of mercury in blood and urine are significantly over MTD.

Mercury concentration in blood and urine of workers significantly correlated with mercury concentration in workplace air: blood: r = 0.415, y = 0.0094 + 0.382x; urine: r = 0.474, y = 0.069 + 0.354x.

Haematological parameters

There were no significant differences in haematocrit, MCH and leukocytes between the studied groups (*Table II*).

Erythrocytes count was significantly higher in the group permanently exposed to mercury vapours, 4.74 × 10^{12}/L vs. 4.47 × 10^{12}/L in the control group (t = 2.09, p = 0.04). The other two groups of workers were not statistically different from the control group (*Figure 1*).

There was substantial drop in the mean corpuscular volume (MCV) value from 102.0 fL in the control group to 97.4 fL in the group permanently exposed to mercury vapours (t = 2.044, p = 0.044). The values in the group of workers periodically exposed to mercury vapours were slightly higher than the values in the other groups with extremely high 95th percentile value (*Figure 2*).

The mean values of haemoglobin concentration, MCHC and platelet count were higher in the group of workers permanently exposed to mercury vapours, but the difference was not statistically significant.

Table I Mercury concentrations in blood and urine of control group and workers exposed to mercury vapours

Group	Blood (μmol/L)		Urine (μmol/L)	
	mean ± SD	5th–95th P	mean ± SD	5th–95th P
CG	0.009 ± 0.0080	0–0.022	0.015 ± 0.033	0–0.078
GI	0.172 ± 0.123	0.055–0.457	0.379 ± 0.388	0.069–1.017
GII	0.102 ± 0.087	0–0.237	0.103 ± 0.098	0.006–0.280
GIII	0.087 ± 0.093	0–0.202	0.045 ± 0.053	0.006–0.132

Table II The values of haematological parameters in the studied groups

Group	Haemoglobin (g/L)		Erythrocytes count ($\times 10^{12}$)	
	mean ± SD	5th – 95th P	mean ± SD	5th – 95th P
CG	141.6 ± 15.86	111.9 – 160.1	4.47 ± 0.61	3.58 – 5.40
GI	148.0 ± 12.05	124.0 – 160.0	4.74 ± 0.46	3.97 – 5.50
GII	144.7 ± 11.98	125.7 – 160.0	4.54 ± 0.49	3.84 – 5.37
GIII	145.0 ± 15.79	125.6 – 160.0	4.68 ± 0.60	3.63 – 5.41
Group	Haematocrit (L/L)		MCV (fL)	
	mean ± SD	5th – 95th P	mean ± SD	5th – 95th P
CG	0.45 ± 0.045	0.39 – 0.50	102.0 ± 9.91	88.9 – 116.7
GI	0.46 ± 0.029	0.40 – 0.49	97.4 ± 9.27	85.7 – 112.3
GII	0.46 ± 0.029	0.41 – 0.50	103.0 ± 11.99	89.3 – 122.2
GIII	0.46 ± 0.042	0.39 – 0.50	100.2 ± 9.76	87.2 – 114.4
Group	MCH (pg)		MCHC (g/L)	
	mean ± SD	5th–95th P	mean ± SD	5th – 95th P
CG	31.8 ± 1.49	28.4 – 35.4	313.2 ± 22.07	275.5 – 350.0
GI	31.3 ± 2.45	28.0 – 36.0	323.0 ± 22.38	293.1 – 351.2
GII	32.1 ± 3.74	27.6 – 37.8	311.9 ± 23.14	278.9 – 354.5
GIII	31.2 ± 2.90	27.7 – 35.4	311.6 ± 18.33	281.4 – 340.4
Group	Leukocytes ($\times 10^9$)		Platelet ($\times 10^9$)	
	mean ± SD	5th – 95th P	mean ± SD	5th – 95th P
CG	7.50 ± 1.96	4.8 – 11.1	219.4 ± 33.0	169.7 – 281.0
GI	7.58 ± 1.57	4.8 – 9.8	240.3 ± 43.5	171.8 – 300.0
GII	7.52 ± 1.98	5.0 – 10.3	236.6 ± 42.4	166.3 – 296.8
GIII	7.60 ± 2.00	5.0 – 10.9	234.3 ± 39.9	178.5 – 290.0

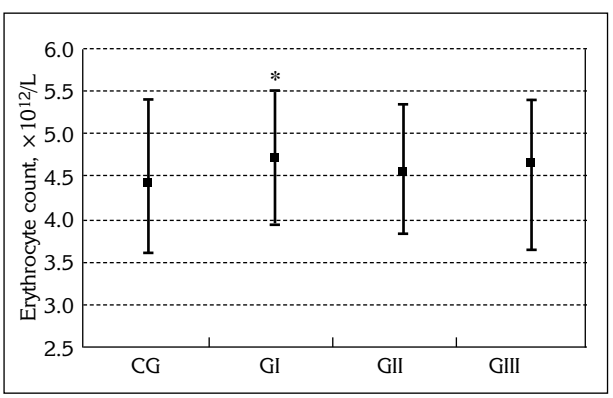

Figure 1. Mean value and 5th and 95th percentile values of erythrocyte count in control group and in groups of workers exposed to mercury vapours; * $p < 0.05$

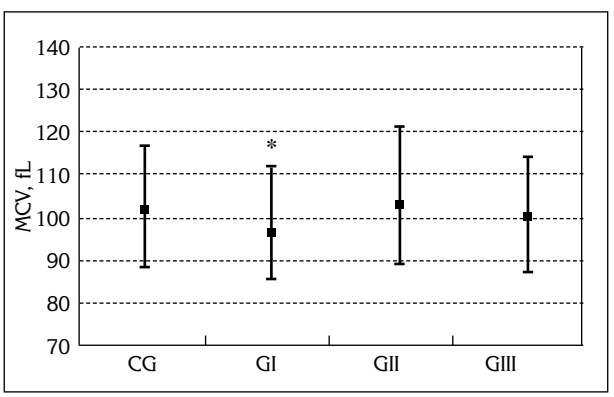

Figure 2. Mean value and 5th and 95th percentile values of MCV in control group and in groups of workers exposed to mercury vapours; * $p < 0.05$

Discussion

Elemental mercury has been detected in the urine of workers exposed to mercury vapour. The occurrence of trace amounts of elemental mercury is considered to be due to reduction of mercuric ion by certain types microorganisms present in the urine and direct urinary excretion following glomerular filtration of elemental mercury persisting in the blood. But determinations of the inorganic species of mercury in urine samples can provide information on both recent exposure and the body borden resulting from chronic exposure to mercury vapour (4). Our results support this assertion. Almost all workers have had increase values of mercury in urine.

Data collected for all studied groups, i.e. groups exposed to mercury vapours and control subjects are generally contained within normal range. However, when we compared group of workers permanently exposed to mercury vapours with control subjects, the mean value of erythrocyte count was significantly higher and mean value of MCV was significantly lower in the group permanently exposed to mercury. The

quantitative health status results obtained after treatment with toxic compounds or heavy metals where studied parameters fall below the physiological values are relatively easy to explain. It is not easy to comment results obtained in the present study. One possible explanation is that concerning differences in the level of physical exercise, which is higher in the group permanently exposed to mercury than the control group consisting of not physically hardworking people. It is known that physical exercise (6–8 h) increases loss of water from the body, which entails a »thickening« of the peripheral blood (5, 6). The blood »thickening« is accompanied by increased water reapsorption in the renal tubules and increased oxygen consumption by the renal tissue, resulting in local hypoxia which increases the erythropoietin synthesis. That effect is revealed by the increased number of erythrocytes (7).

The decrease of MCV in the group permanently exposed to mercury vapour may result from the diminished iron incorporation into erythrocytic cell lineage, as indicated by increased values of serum ferritin, transferrin and TIBC (8, 9). However, in further studies on cases of mercury intoxication, the level of Cu as well as cerulloplasmin activity in the serum should be taken into account. Copper deficiency is frequently the cause of decrease in MCV and MCHC (10).

Our results indicate that long-term and permanent exposure to mercury vapours induces changes in the important haematological parameters of the peripheral blood, but explanation that phenomenon requires further, broader research.

VREDNOSTI OSNOVNIH HEMATOLOŠKIH PARAMETARA U PERIFERNOJ KRVI RADNIKA IZLOŽENIH UTICAJU PARA ŽIVE

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Kratak sadržaj: U radu je ispitivan uticaj izloženosti parama žive iz radne sredine na osnovne hematološke parametre (broj eritrocita, leukocita i trombocita, koncentraciju hemoglobina, hematokrit, MCV, MCH i MCHC). U studiju je uključeno 138 radnika koji rade u proizvodnji hlora procesom elektrolize (podeljeni su u tri grupe: stalno izloženi, povremeno izloženi i ranije izloženi uticajima para žive), kao 38 zdravih radnika. Pre studije su određene koncentracije žive u vazduhu radne sredine; srednje vrednosti su bile znatno iznad maksimalne doze tolerancije (MTD). Koncentracije žive u krvi i urinu radnika koji su izloženi živi određena je atomskom apsorpcionom spektrometrijom. U sve tri grupe je vrednost 95-tog percentila bila znatno iznad MTD. Hematološki parametri su određeni uz pomoć automatskog brojača. U grupi koja je stalno izložena parama žive, dobijeno je značajno povećanje srednje vrednosti broja eritrocita, kao i značajno smanjenje vrednosti MCV. Srednje vrednosti koncentracije hemoglobina, MCHC i broja trombocita u grupi radnika koji su stalno izloženi uticaju žive bile su viće nego u kontrolnoj grupi, ali ta razlika nije statistički značajna. Između posmatranih grupa nije bilo značajne razlike u vrednostima hematokrita, MCH i broja leukocita. Dobijeni rezultati pokazuju da dugotrajna i stalna izloženost parama žive može da dovede do promena u vrednostima važnih hematoloških parametara.

Ključne reči: živa, hematološki parametri

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