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Influence of low dose formaldehyde on clinical indices of guinea pigs' organisms

Wpływ niskich dawek formaldehydu na organizm świnek morskich

Formaldehyde is the main pollutant of housing air [1, 3, 8]. The main sources of formaldehyde emission are wooden housing plates, of which furniture is produced, and construction materials. Substance concentrations in this respect stay in the range of 0.001–0.21 mg/m ^{3}.

The general impact of formaldehyde on the organism, studied in acute tests, shows itself in irritation, lesion of central nervous system, liver and kidneys of experimental animals. Teratogenic and mutagenic action of the substance has been proved [4, 9]. Chronic effect of formaldehyde on low levels, which would correspond to its real concentrations in the air, has not been studied thoroughly yet. The data on formaldehyde ability to invoke sensibilization of human organisms, when inhaled through respiratory tract, are contradictory as well. This has served as the aim and goal of our research paper.

The aim of the paper was to study formaldehyde impact on guinea pigs' organisms on the levels which correspond to real concentrations of the substance in the air of housing accommodations.

MATERIAL AND METHODS

The research was conducted on albino guinea pigs. The objects of the research were hematological, biochemical and immunological indices of the animals' organisms. During the experiment the animals were divided into three groups: Screening group (S) and two experimental ones (E1 and E2). Inhalation intoxication with formaldehyde in various concentration was held. With this aim, group E1 was placed in a chamber with formaldehyde concentration of 0.052±0.003 mg/m^3; E2 – 0.13±0.004 mg/m^3; screening group was placed in the chamber with formaldehyde concentration below the sensitivity of estimation method (below 0.001 mg/m^3). Each group consisted of 10 animals. Chamber volume was 200 dm^3, exposure duration lasted 45 days for 6 hours daily.

Hematological tests included determination of indices of peripheral blood of guinea pigs (hemoglobin, red blood cells, white blood cells and leukogram); biochemical tests envisaged determination of aspartate aminotransferase level (AST), alanine aminotransferase (ALT), creatinine, crude protein, urea in blood serum [7]. Immunological indices changes were estimated be means of research on cellular immunity state (due to the content of T-B-O lymphocytes, T-active lymphocytes, T-theophylline resistance cells (helpers), T-theophylline sensitive cells (suppressors). Apart from that, immunoregulatory (Tx/Tc) and immunoeffectory ((E-РУК/Ea-РУК) indices were calculated.

Humoral immunity was studied by the content of immunoglobulins A, M, G (IgA, IgM, IgG) and circulating immune complexes (CIC) [6].

RESULTS

Hematological tests, conducted at the end of the experiment, testified to a significant reduction of hemoglobin level in groups E1 and E2, and a relative number of neutrophils in group E2. The other indices showed no significant changes (Table 1).

Table 1. Changes in general hemogram of guinea pigs under the influence of formaldehyde inhalation intoxication

Index name	Indices values, M±m		
	S group	E1 group	E2 group
Hemoglobin, g/l	137.83±2.00	126.20±1.16*	119.71±2.64*
Red blood cells, T/l	4.37±0.24	3.94±0.21	3.76±0.18
White blood cells, g/l	6.83±0.36	7.72±0.31	7.91±0.52
Basocytes, %	0.67±0.21	1.00±0.32	0.86±0.26
Basocytes, g/l	0.045±0.014	0.076±0.024	0.071±0.022
Eosinocytes, %	3.33±0.76	3.60±0.51	3.86±0.25
Eosinocytes, g/l	0.22±0.04	0.21±0.10	0.31±0.03
Neutrophils, %	25.33±1.22	22.40±1.29	21.86±0.87*
Neutrophils, g/l	1.73±0.10	1.73±0.12	1.71±0.07
Monocytes, %	4.17±0.60	4.40±0.60	4.86±0.33
Monocytes, g/l	0.29±0.04	0.34±0.03	0.38±0.03
Lymphocytes, %	66.50±2.03	68.6±1.80	68.57±0.99
Lymphocytes, g/l	4.60±0.30	5.30±0.28	5.50±0.32

* $p < 0.05$

Biochemical tests showed no significant changes in the levels of AST, ALT, creatinine, crude protein and urea in blood serum, which testified to the probable absence of formaldehyde negative effect on kidneys and liver function in the conditions of the present experiment.

The study of indices for the cell chain of acquired immunity allows tracking of dose-dependent character of formaldehyde impact. It was determined that E1 group as compared to the screening one showed a substantial reduction in the relative number of T-lymphocytes, T-theophylline resistance cells (helpers) and a substantial rise in relative and absolute number of O-lymphocytes (Table 2). E2 group showed less significant changes, including a reduction in the relative number of T-lymphocytes, B-lymphocytes, the relative and absolute number of T-active lymphocytes, T-theophylline resistance cells (helpers) and a substantial rise in the relative and absolute number of O-lymphocytes. Apart from that, E2 group showed a substantial rise in immunoregulatory index (screening – 1.71± 0.11. experiment – 2.08±0.10), which is related to a lowered quantity of T-helper cells.

The blood serum of animals from both experimental groups showed a substantial reduction of Ig and IgG content (S – 2.40±0.34; E1 – 1.30±0.26; E2 – 0.74±0.17), which correlated with the data in literature and indicated disorders of humoral immunity link [2,5]. IgM level did not change. A slight but significant rise of CIC (S – 84.17±6.52, E2 – 108.86±6.6) can testify to inflammation reaction in animals' organisms.

Table 2. Formaldehyde impact on the state of cell link of acquired immunity of guinea pigs

Index name	Indices values, M±m		
	S group	E1 group	E2 group
T-lymphocytes, %	48.67±1.00	41.6±1.21*	39.14±1.07*
T-lymphocytes, g/l	2.22±0.12	2.22±0.16	2.14±0.16
B-lymphocytes, %	22.83±1.26	20.00±0.84	18.14±0.81*
B-lymphocytes, g/l	1.05±0.13	1.05±0.11	0.99±0.085
O-lymphocytes, %	28.50±1.26	38.40±1.08*	42.71±1.56*
O-lymphocytes, g/l	1.32±0.14	2.03±0.07*	2.34±0.22*
T-active, %	28.83±1.61	26.20±1.28	19.14±1.20*
T-active, g/l	0.64±0.04	0.58±0.04	0.42±0.04*
Tx, %	34.67±1.41	28.60±1.17*	25.71±1.10*
Tx, g/l	0.77±0.06	0.64±0.06	0.55±0.05*
Tc, %	14.00±1.97	13.00±1.80	13.43±1.57
Tc, g/l	0.31±0.04	0.29±0.07	0.29±0.10

* $p < 0.05$

DISCUSSION

The obtained results testify to a potential hazard of adverse impact of formaldehyde on human health in the case of people who stay for rather a long time in the rooms where the substance concentration remains at the level of 0.05 mg/m^3. Along with that, the harmful impact of formaldehyde can include general toxic action and immunosuppressive effect.

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SUMMARY

During the experiment with chronic inhalation intoxication, formaldehyde impact was studied on the organism of guinea pings at the levels of 0.052±0.003 mg/m^3 and 0.13±0.004 mg/m^3. It was determined that the substance can invoke a general toxic and immunosuppressive effect on the animals' organisms, which shows itself in changes of peripheral blood composition, disorders of acquired cell and humoral immunity.

STRESZCZENIE

W trakcie eksperymentu badano wpływ przewlekłej intoksykacji parami formaldehydu w stężeniach 0,052 ± 0,003 mg/m^3 i 0,13 ± 0,004 mg/m^3 na organizm świnek morskich. Wykazano, że długotrwałe narażenie na pary formaldehydu prowadzi do rozwoju ogólnej toksykozy i wywiera efekt immunosupresyjny, co manifestuje się zmianami parametrów biochemicznych i morfologicznych krwi oraz zaburzeniami odporności komórkowej i humoralnej.