

contents of Sb, Cl ($p < 0,001$) was 3–5 times greater than in blood serum, and Rb, Zn, Br, Mg ($p < 0,001$), Hg, Co, Ca, Na ($p < 0,01$), Mg ($p < 0,05$) increased 1,5–2 times. Comparative analysis of most elements in dry remains of lymph has not revealed significant differences ($p > 0,05$) after lyophilic drying.

In group II lymph concentrations of Na, Se ($p < 0,001$), K ($p < 0,01$), Al ($p < 0,05$) had low values in comparison to the same elements of blood serum. Contents of Na, Cl, Al, Co, Br ($p < 0,001$), Ag, Fe, Zn, Hg, Sb ($p < 0,01$), Cu ($p < 0,05$) was increased 2,5–10 times in dry remains of lymph in comparison to elements of dry blood serum mass. Lymph concentrations of Br ($p < 0,001$), Na ($p < 0,01$), Sb ($p < 0,05$) were low, and Mg, Co ($p < 0,001$), Hg, Ag ($p < 0,01$), Zn ($p < 0,05$) – high in comparison to lymph elements of healthy people. Process of lymph drying leads to an increase in Hg, Zn, Co ($p < 0,001$), Ag, Fe ($p < 0,01$), Cr ($p < 0,05$) and decrease in Br ($p < 0,001$), Sb, Na ($p < 0,05$).

Value of index T_1 in blood and lymph serum of group I equaled $2,52 + 0,034 c$ and $1,65 \pm 0,012 c$ ($p < 0,001$) correspondingly. In groups I and II average value of index $*T_1$ in blood serum equals $0,059 \pm 0,0060 c$ and $0,11 + 0,006 c$, lymph – $0,055 \pm 0,010 c$ and $0,19 \pm 0,012 c$ ($p < 0,001$). Via method of the smallest squares we have defined proportional increase in index $*T_1$ of lymph that depended on degree of tumor progression in TNM system. Results of diagnosing sensitivity and efficiency of the methods according to parameter $*T_1$ equaled 81 and 83%, while according to parameter $*T_1$ of blood serum they were equal to 60 and 67% correspondingly. According to contents of Al, Sb, Zn in dry remains of lymph, efficiency of the diagnosing method equaled 93–95%.

Therefore, lymph is more enriched with water and a number of chemical elements among healthy people that blood serum is. Lymph and blood serum of healthy people contains a linked fraction of water that increases in presence of cancer. Progressive increase in hydration degree, number of lymph and hematogenic tissue allow us to develop a number of prior tests in cancer diagnostics. The received results can be interpreted from the position of multilayer polarized structure at the foundation of hydrating lyotropic lines that represent diameter of the ion itself and diameter of water molecules that are able to rest near them. The most hydrated ions contain more molecules of water and energy around them. Linked fraction of water in extracellular space can be represented as an electrically-charged system of colloid ions of lymph and blood that contains ions of multilayer polarized structure of different hydration degree. In such configurations protons are distributed due to induction that is equaled with dissociation constant. Potential energy increases as electron closes up with core. Graphs of low and high limits of ions' polarization register their significant contribution into the general energy capacity of cells (Ling G., 1962, 2008).

Well-hydrated ions can represent a depot of potential induction energy in a multilayer polarized structure. Average- and low-polarized layers, placed in order of directed hydrated ions and hydroxide groups, have a significant mobility and activity with a small resource of own internal energy. Generally, linked fraction of water that has certain specific characteristics of emitting interactive fractions of a solved substance, can play as a link of exchange flow between charged particles, ions, water molecules, have an influence upon tissue structures through electromagnetic energy. Volumetric fraction of water, placed under a weak influence of free energy, coming from the whole volume of linked hydrated layer, possesses unstable characteristics of stabilization, presence of high entropy, phase transitions, fluctuations. Self-organization and formation of biophysical processes of multilayer polarized layers has a non-linear nature.

Thus, innovative technologies allow us to estimate linked fraction of water in lymph and blood that can be represented as electrically-charged heterogeneous system that contains multilayer polarized structure of extracellular space. In normal state internal energy of thermodynamic tissue system is concentrated in well-hydrated layers and spread unevenly into average- and low-hydrated layers as free energy along with an increase in entropy in free layers where processes have dynamic and easily-reversed nature. In terms of cancer stable increase in internal energy of polarized hydrated layers will go along with an expressed flow of particles, heterogeneous hydration degree, elevation of certain elements due to redistribution of free ions and water molecules from blood to lymph.

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**PATHOGENETIC FACTORS
CAUSING FORMATION OF CHRONIC
GASTRODUODENITIS IN CHILDREN,
CONSUMING DRINKING WATER WITH
HIGH CONCENTRATION OF MANGANESE
AND HYPERCHLORINATION PRODUCTS**

Zaitseva N.V., Ustinova O.Y.,
Luzhetsky K.P., Maklakova O.A.

*Federal Budget Scientific Institution “Federal Scientific
Center for Medical and Preventive Health Risk
Management Technologies”, Perm,
e-mail: ustanova@fcrisk.ru*

Introduction. Contamination of drinking water with chemicals of man-made origin generates negative trends in prevalence of digestive system diseases and, above all, chronic inflammatory diseases of the upper gastrointestinal tract [1, 3]. The presence of residual hyperchlorination products and heavy metals in drinking water causes

the occurrence of additional cases of gastroduodenal disease at the level of 18% annually, increases the number of children with abnormal and complicated forms of gastroduodenal diseases, including hypotrophic and atrophic chronic gastroduodenitis (CGD) [1, 2, 4]. The likelihood of hypotrophic and atrophic damages developing of the mucous membranes of the stomach and duodenal ulcer (DU), the causes of their genesis remain the most debated issues of pediatric gastroenterology [2, 4]. Some researchers see the correlation between the CGD and adverse effects of chemicals of man-made origin [2, 5]. However, pathogenetic factors for CGD development, associated with exposure to chemicals of man-made origin, remain under-investigated.

The **aim** of this study was to investigate the pathogenesis of CGD Hp (-) in children consuming drinking water with high concentration of manganese and hyperchlorination products (chloroform).

Materials and methods. The study group comprised 116 children with CGD Hp (-) aged 7–10 years ($8,6 \pm 1,2$ years), living on the territory with unsatisfactory quality of drinking water in terms of sanitary-chemical parameters (content of chloroform – to 2,7 MAC, manganese – to 3,3 MAC). The comparison group consisted of 56 children with CGD Hp (-) of the same age ($8,4 \pm 1,4$ years, $p \geq 0,05$), living in the area where drinking water quality complies the hygienic standards. The air quality in the living territories of the children from both groups corresponded to hygienic requirements. The groups have been matched by gender. All children had negative results of “Helika test” and ELISA blood test for antibodies to *Helicobacter pylori*.

Chemical-analysis study of manganese in blood has been performed by atomic absorption spectrophotometry method on the spectrophotometer AAnalyst produced by PERKIN-ELMER (USA); detection of chloroform – by gas chromatography on the chromatograph “Chromatec-Crystal-5000” with the halogen-selective detector.

The clinical examination of children included: socio-medical questionnaires, analysis of outpatient-card of development, examination by pediatrician, gastroenterologist, neurologist. Autonomic nervous system status assessment has been carried out with the use of cardiorythmographic programme “Poly-Spectrum”. The assessment was based on the cardiac rhythm mathematical analysis. Ultrasound scan of liver, gallbladder, biliary tract, stomach and duodenum has been performed according to standard procedures on the unit “Toshiba VIAMO” (Japan) using convex (1,9–6,0 MHz) and linear (7,0–14,0 MHz) multi-frequency sensors. Fibrogastroduodenoscopy has been carried out according to standard procedures with mucosal biopsy of 2 sites. Analysis of the information has been performed with the use of statistical methods (Statistica 6.0) and with the help of specially designed software, coupled with MS-Office applications.

For the comparison of quantitative characters two-sample Student t-test has been used; evaluation of dependencies between the characters has been performed by the method of regression analysis.

Results of the study. All children, included in the study group, were born from 1–3 pregnancies, had no congenital abnormalities of the gastrointestinal tract, carried to full-time (95% – study group and 94,1% – comparison group; $p = 0,34$), had close weighty growth parameters at birth ($3241,3 \pm 154,6$ g and $51,2 \pm 0,6$ cm – study group; $3132,4 \pm 162,4$ g and $50,37 \pm 1,56$ cm – comparison group; $p = 0,43–0,48$) and Apgar score ($8,12 \pm 0,20$ scores vs. $8,58 \pm 0,10$ scores; $p = 0,20$). The frequency of recording in the history of acute intestinal infections in the two groups did not differ (10,3 and 12,5% respectively, $p = 0,67$). Most children (79,3% and 73,2% respectively, $p = 0,37$) were raised in families with middle-income (12–14 thousand rubles per family member), lived in comfortable housing and used tap water without further purification (95 and 87,5%, respectively, $p = 0,24$). Violations of the nutritional status of children was noted by 32,8% of parents of children in the study group and 25% – in the comparison group ($p = 0,29$). Duration of the disease in children of the study groups was $2,1 \pm 1,1$ and $1,9 \pm 1,2$, respectively ($p = 0,72$).

During the chemical-analysis studies of blood it was found: manganese concentration in children of the study group was $0,0283 \pm 0,0042$ mkg/cm³ (reference concentration – mkg/cm³ 0,011, $p < 0,01$); chloroform – $0,019891 \pm 0,006675$ mkg/cm³ (reference concentration – mkg/cm³ 0,0, $p < 0,01$). In the comparison group the manganese concentration was $0,011389 \pm 0,001434$ mkg/cm³ ($p < 0,01$ to the study group), chloroform – $0,002009 \pm 0,000701$ mkg/cm³ ($p < 0,01$ to the study group). In general, the concentration of manganese in children of the study group exceeded the rate in the comparison group by 2,6 times ($p < 0,01$), chloroform – by 10 times ($p < 0,001$).

The comparative analysis of the incidence of complaints of gastrointestinal character showed that children in the study group noted more frequently decreased appetite (91,4 and 61%, respectively, $p = 0,04$), gaseous eructation (45,5% vs. 25,4%, $p = 0,03$), abdominal pain (58,6% vs. 37,2%, $p = 0,03$), localized in the epigastrium (58,2% vs. 23,2%, $p \leq 0,001$) or right upper quadrant (61,2% vs. 32,1%, $p \leq 0,001$), disorders of intestinal habits (78,5% vs. 57,1%, $p = 0,004$). Among the complaints of astheno-vegetative character the most frequently mentioned included: sweating (37,1% vs. 10,9%, $p = 0,02$), fatigue (16,4 and 8,6%, respectively, $p = 0,04$), transport intolerance (6,9 and 5,4%, $p = 0,82$). In children of the study group the hepatobiliary dysfunction symptoms were recorded 1,4 times more likely (87,9 and 64,3%, respectively, $p = 0,001$). The significant causal relationship of probability of the development of biliary

tract disease with the elevated blood levels of chloroform ($R^2 = 0,29$; $F = 36,92$; $p = 0,001$) and diseases of the nervous system of functional nature – with the high concentration of manganese and chloroform ($R^2 = 0,50-0,77$; $F = 93,67-109,62$; $p = 0,01-0,001$) has been determined.

The predominant type of vegetative tonus in children of the study group was eutonia (50%), but in 37,5% vagotonic option was revealed, which is 1.9 times higher than in the comparison group (20%, $p = 0,02$). In the study group the sympathicotonic type of autonomic reactivity was observed in only 25%, which is 1,2 times less frequently than in the comparison group (30%, $OR = 1,2$, $CI = 1,1-1,7$, $p = 0,04$), the predominant type was hypersympathicotonic (62,5%); in the comparison group this option was met 1,5 times less frequently – 43,3% ($OR = 1,45$, $CI = 1,16-3,11$). The direct significant correlations of elevated blood manganese and initial development of vagotonia ($R^2 = 0,41$; $F = 98,72$; $p = 0,01$) have been established; elevated blood manganese and hypersympathicotonic type of autonomic reactivity ($R^2 = 0,37$; $F = 87,54$; $p = 0,01$). During the ultrasound scan of hepatobiliary area the reactive changes of the liver in the study group were recorded 7 times more frequently (31,7% vs. 4,5%, $p = 0,01$), in addition, 1,6–1,7 times more frequently the biliary dysfunction of hypokinetic type took place (80,2% vs. 50%, $p = 0,001$) and an increase in the linear dimensions of the liver (12,2 and 7,0%, respectively, $OR = 1,74$, $CI = 1,32-3,76$, $p = 0,05$). There was a significant correlation between the elevated chloroform concentration in children's blood and the development of reactive changes of the liver ($R^2 = 0,39$; $F = 76,83$; $p = 0,01$), higher concentration of manganese in blood and presence of biliary dysfunction of hypokinetic type ($R^2 = 0,41$; $F = 99,23$; $p = 0,01$).

During the ultrasound scan of the gastroduodenal area a moderate amount of fluid in the stomach was determined in children of the study group 3 times more frequently than in the comparison group (33 and 11%, respectively, $p = 0,003$). Physiological variant of motor function of the stomach and duodenum in children of the study group was met 2 times rarer (14% versus 28%, $p = 0,03$). Duodeno-gastric, duodeno-bulbar, bulbo-gastric reflux was detected in the study group 1,4–1,5 times more frequently ($OR = 1,41-1,52$; $CI = 1,12-3,87$, $p = 0,01-0,03$). The causal link of the high concentration of manganese in blood and the impaired motor function of the stomach and duodenum ($R^2 = 0,25-0,52$; $F = 46,5-119,18$; $p = 0,01-0,001$) was found.

During the endoscopy the incidence of atrophic and hypotrophic changes of antral gastric mucosa in the study group was 3,4 times higher than the comparison group (18,1% versus 5,4%, $p = 0,01$). The causal link of the high concentration of manganese in blood and the atrophic and hypotrophic changes of the gastric mucosa ($R^2 = 0,21-0,36$; $F = 58,11-94,32$; $p = 0,01$) has been established.

Discussion. The results of the performed study suggest that in children consuming water of inadequate quality (concentration of hyperchlorination and manganese products $> 1MAC$), the chloroform and manganese concentration in blood substantially exceeds the reference level. It has been found that the elevated concentration of chloroform and manganese in blood contributes to the development of autonomic parasympathetic dysfunction by parasympathetic type, reactive changes of the liver, biliary dysfunction of hypokinetic type and dysmotility of the stomach and duodenum by the hyperkinetic type. The effect on the gastric mucosa of bile acids results in solubilization of the lipid surface of epithelial layers' membrane. According to the literature [2, 4] the lecithin contained in the bile by the action of pancreatic juice phospholipase is biotransformed in lysolecithin, which in case of contact with the stomach has a strong cytotoxic effect on the epithelium and the subsequent development of hypotrophic processes. The biliary dysfunction by the hypokinetic type initiated by chemical toxicants combined with hyperkinetic disorders of gastroduodenal sphere underlie the development of the sub- and atrophic changes in the mucosa of the stomach and duodenum. The emerging technologies of prevention should be aimed not only at increasing the activity of the processes of biotransformation of chemicals and their elimination, but also at the correction of autonomic dysfunction, gastroduodenal and biliary motility.

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