The purpose of this study was to determine serum zinc, iron, magnesium, copper, potassium, calcium, and sodium levels in acute rotavirus infection and convalescence period in children.

Materials and methods. We examined 86 patients aged from 4 months to 5 years with clinical and laboratory signs of rotavirus infection. The I group – 43 children with RVI in acute period. The II group – 43 children with RVI in convalescence period. The control group included 14 healthy children at the same age. The content of macro- and microelements (zinc, iron, magnesium, copper, potassium, calcium, and sodium) in blood serum was determined by atomic absorption spectrophotometry. Feces samples were used for Cito Test Rota (Pharmasco). Cito test was used for rotavirus antigen detection in feces. Statistical analysis was performed by Excel. Student’s t-test was used to evaluate differences between study groups.

Results. The acute period of the disease in children with rotavirus infection was characterized by a significant increase of copper in blood serum compared with the control group. At the same time, a significant decrease of iron, magnesium, zinc, potassium, calcium, sodium was determined in patients with rotavirus infection, compared with apparently healthy children. After standard treatment only the indicators of magnesium, potassium, and sodium reached the same indices of control group children.

Conclusions. The detected changes in the mineral status of patients with rotavirus infection suggest the need for treatment correction. Correction of micro- and macroelements imbalances in patients with rotavirus infection possibly should be aimed at the metallo-drugs inclusion in complex treatment as well as medicines which improve absorption of the latter in the intestine.

Key words: rotavirus, children, zinc, iron, magnesium, copper, potassium, calcium, sodium.

Original research

Macro- and microelements determination in children with rotavirus infection

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The detection of patients with rotavirus infection was characterized by a significant increase of copper in blood serum compared with the control group. At the same time, a significant decrease of iron, magnesium, zinc, potassium, calcium, sodium was determined in patients with rotavirus infection, compared with apparently healthy children. After standard treatment only the indicators of magnesium, potassium, and sodium reached the same indices of control group children.

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Rotavirus is a member of the family Reoviridae. In all regions of the world rotavirus is the leading cause of hospitalization for gastroenteritis [2]. Rotavirus infection (RVI) is worldwide disseminated disease. Global Enteric Multicenter Study has found that rotavirus is the overall leading cause of moderate to severe diarrhea in children between the ages of 6 month and 2 years old [3,4]. Every year, rotavirus causes approximately 114 million episodes of gastroenteritis requiring only home care, 24 million of clinical visits, and 2.4 million of children aged less than 5 years hospitalizations [2]. Rotavirus is responsible for 5 % of all deaths among children worldwide [5]. Also, RVI is the cause of 453 000 deaths of young children each year, and more than 85 % of these deaths are accounted in low-income countries [6]. Severe rotavirus gastroenteritis occurs at younger age in developing countries and coinfections with other enteric pathogens [3].

Rotavirus can get into the human body mainly with a fecal-oral mechanism of the transmission by means of contaminated hands, environmental surfaces and objects, and occasionally by food and water [7,8]. The clinical manifestation of RVI includes a wide range of symptoms from asymptomatic infection to severe diarrhea with dehydration. Children with RVI have clinical symptoms that vary from mild illness with mild diarrhea of short duration to recurrent profuse diarrhea with high fever and vomiting that can lead to dehydration with electrolyte imbalance and even death. RVI usually starts with severe attack of fever and vomiting that lasts one or two days, followed by watery diarrhea which generally continues for three to seven days [1]. The micro- and macroelements are important because of their essential functions despite the small amount required. Bioelements deficiencies in children of most developing countries are related to their deficit in the common food items. Zinc, iron, magnesium, copper, potassium, calcium, sodium are essential micro- and macronutrients for growth and morbidity development. These elements are regularly needed for protein synthesis, bone mineralization, physical growth, and biological functions such as immunity [9].

Carlson et al. used animal model for study which showed that zinc helps to maintain the integrity of the intestinal mucosa [10]. Yakob et al. reported that reduction of diarrhea mortality in children was due to zinc supplements [11]. Serum zinc levels of the patients admitted to hospital for acute gastroenteritis without any other disease and without moderate or severe malnutrition were not affected by the disease state. Gastroenteritis did not further decrease serum zinc levels in patients with asymptomatic or subclinical zinc deficiency [12]. Zn concentrations in serum significantly increased in remission as compared with admission to hospital in children with viral infections [13].

**Aim**

We conducted a study to determine serum zinc, iron, magnesium, copper, potassium, calcium, and sodium levels in acute rotavirus infection and convalescence period in children.

**Materials and methods**

Our investigation comprised 43 patients aged from 4 months to 5 years with clinical and laboratory signs of rotavirus infection. The I group – 43 children with RVI in acute period, which were patients of St. Zinaida city children clinical hospital, Sumy, Ukraine. The II group – 43 children with RVI in convalescence period. The control group included 14 healthy children at the same age. All children were enrolled in the study after informed consent of their parents or guardians. Ethical approval was obtained from Institutional research ethics committees.

Criteria for inclusion:

- age from 4 months to 5 years;
- rotavirus infection;
- hospitalization in acute phase of the disease;
- informed consent of children’s parents or guardians;
- absence of comorbidities in patients;
- children didn’t take drugs, which contributed to the change in the amount of trace elements;
- absence of comorbidities in children.

Feces samples were collected in a sterile container at admission to the hospital. These samples were used for Cito Test Rota (Pharmasco). Cito test was used for rotavirus antigen detection in feces.

In the morning fasting venous blood samples were obtained from children with rotavirus into sterile tubes for trace elements analysis. After two hours keeping and centrifugation at 3500 rpm for 10 minutes, blood serum was separated. The serum samples were put in closed plastic laboratory tubes and stored at -18 °C until trace elements were analyzed.

The content of trace elements of zinc, iron, magnesium, copper, potassium, calcium, and sodium in blood serum was determined by atomic absorption spectrophotometry (AAS) on a spectrophotometer C-115MI (JSC “Selmi”, Ukraine) [14,15]. All results of trace elements analysis in patients were compared with healthy controls. The content
of trace elements in blood serum in comparison group was determined by AAS.

Statistical analysis was performed by Excel (Microsoft Corporation, Redmond, WA). Student’s t-test was used to evaluate differences between study groups. Statistically significant differences were indicated by p values <0.05.

Results and discussion

For determination of trace element provision in children with rotavirus infection, we have determined the content of copper, iron, zinc, magnesium, potassium, calcium, and sodium in the acute phase of the disease (1–3 days) and convalescence period (7–10 days) (Table 1).

The acute period of the disease in children with rotavirus infection was characterized by a significant increase of copper in blood serum to 20.15 ± 0.34 mcg/mL compared to the same period of the control group (12.36 ± 0.33 mcg/mL (P < 0.001)). At the same time, a significant reduction of iron was determined in patients of group 1, it was 6.45 ± 0.21 mcg/mL compared with apparently healthy children who had 11.42 ± 0.48 mcg/mL (P < 0.001). Similar changes were related to the content of zinc which was 6.15 ± 0.31 mcg/mL, lower than that of children in the control group (13.56 ± 0.37 mcg/mL (P < 0.001)). Patients with RVI were characterized by a significant decrease of magnesium in blood plasma to 0.66 ± 0.03 mcg/mL, compared to the same index in the control group children (0.97 ± 0.05 mcg/mL (P < 0.001)).

In acute phase of the disease patients of the group 1 had potassium and calcium content of 4.07 ± 0.15 mcg/mL and 1.67 ± 0.05 mcg/mL, respectively, which was lower than the level of the same elements in healthy children (5.12 ± 0.13 mcg/mL and 2.76 ± 0.05 mcg/mL, respectively, (P < 0.001)). In addition, the reduction of sodium in blood plasma to 147.32 ± 1.62 mcg/mL was determined in the given group of patients compared to the same index in children of the control group (152.43 ± 1.87 mcg/mL (P < 0.001)).

After standard treatment there was no complete normalization of micro- and macroelements content of the studied parameters in children of the group 1. In the period of convalescence magnesium level increased significantly to 1.02 ± 0.05 mcg/mL (P < 0.001) in patients with RVI. In addition, potassium and calcium concentration in blood serum increased in children of the group 1, it was 4.78 ± 0.16 mcg/mL and 2.15 ± 0.06 mcg/mL, respectively, (P < 0.01). At the same time, in children of this group copper index tended to decrease, and iron, zinc and sodium – to increase (P > 0.5).

It is known that zinc is the main component that regulates the activity of immune system; it is the factor of nonspecific immune protection that is required for the maturation of specific immune cells and cytokine production. Reducing its number in children with RVI may indirectly constitute the immune system dysfunction and organism resistance impairment. Since copper is a part of oxidative enzymes, and the processes of free radical oxidation increase in acute phase of the disease, the need for these enzymes also increases. All these facts may contribute to copper release from the depot and its active participation in metabolic processes. According to scientific references, iron exchange in the body has a close relationship with the immunologic reactivity. Therefore, the reduction of iron in blood serum may possibly be due to its significant demand in the body for normalization of immunoreactivity impaired function in patients under investigation.

Thus, this study has shown a significant decrease in iron, magnesium, zinc, potassium, calcium, sodium, and copper increase in blood serum in early phase of the disease in children with rotavirus infection. After standard treatment only the indicators of magnesium, potassium and sodium reached the same indices of the control children group. The detected changes in the mineral status of patients with rotavirus infection suggest the need for treatment correction.

Conclusions

1. The acute phase of the disease in patients with rotavirus infection is characterized by micro- and macroelements imbalances in blood serum when compared with those of healthy children, which are determined by a significant decrease in iron, magnesium, zinc, potassium, calcium, sodium, and increase in copper.

2. After standard treatment only the indicators of magnesium, potassium and sodium reached the same indices of control children group.

Prospects of further scientific research. A promising study will be the correction of micro- and macroelements imbalances in patients with rotavirus infection. Correction possibly should be aimed at the metallo-drugs inclusion in complex treatment as well as medicines which improve absorption of the latter in the intestine.

Conflicts of Interest: authors have no conflict of interest to declare.

Конфлікт інтересів: відсутній.
Оригинальные исследования

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