Galician Medical Journal

Scientific and Practical Journal of Ivano-Frankivsk National Medical University

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The Condition of Glutathione Redox System in Cases of Pneumonia in Children Who Often Suffer from Acute Respiratory Diseases

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Abstract

The article is devoted to the study of glutathione redox system condition in cases of pneumonia in children who often suffer from acute respiratory diseases. The study was based on the definition of the enzymes content in blood serum such as glutathione reductases, glutathione S-transferases, glutathione peroxidases, gamma-glutamyl transpeptidases.

Materials and methods. 80 children at the age of 3 to 8 suffering from pneumonia were examined. They included 40 children who often suffered from acute respiratory disease and 40 ones who suffered from the disease not often. Both groups of children received protocol therapy for pneumonia treatment.

The results of the research. Severe disorders of glutathione antioxidant system were observed in children with pneumonia often suffering from acute respiratory diseases in comparison with children who suffered from the disease not often. The levels of glutathione reductase and glutathione S-transferases decreases by 2 and 1.8 times and the levels of glutathione peroxidase and gamma-glutamyl transpeptidase in blood serum increased by 1.4 times.

Conclusions. Glutathione redox system dysfunction was detected in children with pneumonia. It was more severe in children who often suffered from acute respiratory diseases. Functional activity of glutathione redox system did not restore after protocol therapy for pneumonia treatment in children who often suffered from acute respiratory diseases. However, normalization of the enzymes was observed in children who suffered from the disease not often.

Keywords: ***children who often suffer from ARD; pneumonia; glutathione redox system.***

Problem statement and analysis of recent researches

Respiratory diseases occupy a leading place among pathologies of children of all ages. One of the most common diseases in this group is pneumonia which constitutes 3-5% in the structure of child death rate [1]. Children at the age of 1 to 5 constitute 50% and children over 5 comprise 20% among hospitalized with pneumonia. Mortality rates from pneumonia among children in Ukraine constitute 13.1 per 10 000 on the average [2].

The problem of pneumonia in children who often suffer from acute respiratory diseases (ARD) remains unsolved. This group requires special attention as ARD frequent cause immunosuppression, decreased antioxidant protection, the formation of chronic diseases of respiratory and other body systems [7, 5].

Free radical oxidation is important in the development of pneumonia in children who often suffer from ARD. Reactive oxygen species (ROS), hydrogen peroxide, hypochlorite, oxygen radicals (superoxide and hydroxide) are known to be involved in many vital processes in the body, homeostasis, oxidation and detoxification of endogenous and exogenous compounds [5, 6]. Violation of free radical oxidation is early, universal, nonspecific link in the pneumonia pathogenesis which usually precedes the appearance of clinical symptoms [2, 4]. Oxidative stress in which lipid peroxidation products reach high concentrations in blood and tissues, develops in the body as a result of disbalance between prooxidant and antioxidant systems [7, 3]. Antioxidant enzymes of glutathione system provide protection against ROS damaging effect. Glutathione system plays an important role in blocking the pathological processes and severe damage occurs only in cases of the system deficiency or exhaustion. Glutathione system enzymes, namely glutathione peroxidase (GP), glutathione reductase (GR), glutathione S-transferases (GT), gamma-glutamyl transpeptidases (GGTP)

provide regeneration of restored glutathione (RG) from the oxidized form of glutathione. Glutathione supports the functional activity of biological membranes, is involved in the transmission of nerve impulses, amino acids transportation, synthesis of DNA and protein, prostaglandin, modulation of conformational condition of protein molecules, enzyme activity regulation. Its decreased level may indicate the insufficiency of antioxidant system compensatory mechanisms, reduction of the reparative processes rate [3, 5].

The objective of the research was to study the condition of glutathione redox system in cases of pneumonia in children who often suffered from ARD.

Materials and methods of the research

80 children at the age of 3 to 8 who suffered from pneumonia were examined. The main group consisted of 40 children who often suffered from ARD (the number of cases during the year was 6 and more), experimental group included 40 children who suffered from the disease no often. Both groups of children received protocol therapy for pneumonia treatment (the order of MOH Ukraine №18 dated 13.01.2005). The control group consisted of 20 healthy children of the same age. The content of glutathione antioxidant redox system enzymes in blood serum was determined in all examined patients. GR was determined by the method of S.N. Vlasova, GP and DT were defined according to the method of M.I. Prokhorova as well as GGTP in the laboratory of the Department of Biological and Medicinal Chemistry with Physcolloid and Bioinorganic Chemistry Course at Ivano-Frankivsk National Medical University. The research was conducted on the first-second and twelfth-fourteenth days of inpatient treatment for pneumonia.

Results of the research and their discussion

Analysis of GR content in blood serum established that its concentration before treatment was decreased in children of the main group in comparison with healthy children and constituted 0.03 ± 0.01 and 0.06 ± 0.01 versus 0.15 ± 0.01 nM per minute ($p<0.001$). Moreover, GR level in children of the main group was 2 times lower than in children of the experimental group and comprised 0.03 ± 0.01 nM per minute versus 0.06 ± 0.01 nM per minute ($p<0.05$). After treatment GR level in the main group did not improve despite its significant increase, namely from 0.03 ± 0.01 to 0.06 ± 0.01 versus 0.15 ± 0.01 nM per minute ($p<0.001$). It increased to normal values in the experimental group, namely from 0.06 ± 0.01 to 0.13 ± 0.01 versus 0.15 ± 0.01 nM per minute ($p>0.1$).

Table 1

Indicators of Glutathione Redox System in Serum in Children Who Suffered from Pneumonia (M ± m)

Indicators of glutathione redox system	Control group (n= 20)	Main group (n=40)		Experimental group (n=40)	
		before the treatment	after the treatment	before the treatment	after the treatment
Glutathione reductase nM per minute protein	0.15 ± 0.01	0.03 ± 0.01 *	0.06 ± 0.01 $^{*,\circ,\Delta}$	0.06 ± 0.01 $^{*,\circ}$	0.13 ± 0.01 $^{\circ,\triangle}$
Glutathione peroxidase, mcM /mg	0.19 ± 0.03	0.55 ± 0.03 *	0.34 ± 0.04 $^{*,\circ,\Delta}$	0.40 ± 0.05 $^{*,\circ}$	0.23 ± 0.02 $^{\circ,\triangle}$
Glutathione S-transferase,u/l	18.65 ± 1.61	5.20 ± 0.84 *	9.57 ± 2.31 $^{*,\circ,\Delta}$	9.22 ± 0.93 $^{*,\circ}$	16.10 ± 2.2 $^{\circ,\triangle}$
gamma-glutamyl transpeptidase, nM/l	18.90 ± 0.77	34.05 ± 1.24 *	27.61 ± 0.38 $^{*,\Delta}$	25.75 ± 0.88	20.40 ± 0.40 $^{\circ,\triangle}$

Notes: differences are significant concerning the index: * – in children of the control group ($p<0.05$-0.001); º – in children of the main and experimental groups ($p<0.05$-0.001); Δ – in children of the main group before and after the treatment ($p<0.05$-0.001); ⌂ – in children of the experimental group before and after the treatment ($p<0.05$-0.001).

At the same time, the indices of GP level in the examined groups of children were significantly higher than those in the control group. Thus, GP level in children of the main group exceeded its content in healthy children and constituted 0.55 ± 0.03 versus 0.19 ± 0.03 mcM /mg, ($p<0.001$). It also exceeded its level in the experimental group, 0.40 ± 0.05 versus 0.19 ± 0.03 mcM /mg respectively, ($p<0.001$). GP content in children of the main group was higher by 1.4 times than in the experimental group ($p<0.01$). After the treatment GP level remained high in the children of the main group

(0.34 ± 0.04 versus 0.19 ± 0.03 mcM /mg, ($p<0.001$)). It decreased to normal values in the experimental group and constituted 0.23 ± 0.02 versus 0.19 ± 0.03 mcM/mg, ($p>0.1$).

The research of GT levels in children of both groups detected its decrease in comparison with healthy children by 3.3 and 1.9 times (5.20 ± 0.84 and 9.22 ± 0.93 u/l versus 18.65 ± 1.61 u/l, $p<0.001$). GT content in the children of the main group was by 1.8 times lower that in children of the experimental group ($p<0.01$). After the treatment the tendency to its increase was observed in the children of the main group (from 5.20 ± 0.84 to 9.57 ± 2.31 versus 18.65 ± 1.61 u/l, ($p<0.001$). A significant increase and normalization of GT level was noticed in the experimental group, namely from 9.22 ± 0.93 to 16.10 ± 2.2 versus 18.65 ± 1.61 u/l, ($p>0.1$).

Analysis of GGTP content as a marker of oxidative stress indicated the increase of its indices in all studied groups of children. Thus, GGTP level in children of the main group exceeded its content in healthy children constituting 34.05 ± 1.24 versus 18.90 ± 0.77 nM/l, ($p<0.001$) and in the children of the experimental group comprising 25.75 ± 0.88 versus 18.90 ± 0.77 nM/l, ($p<0.001$). GGTP content in children of the main group was higher by 1.4 times than in the experimental group ($p<0.001$). Despite the significant decrease in GGTP level, the treatment did not promote its normalization in children of the main group (from 34.05 ± 1.24 to 27.61 ± 0.38 versus 18.90 ± 0.77 nM/l, ($p>0.01$)). However, its indices normalized in the experimental group (from 25.75 ± 0.88 to 20.40 ± 0.40 versus 18.90 ± 0.77 nM/l, ($p>0.1$).

Conclusions

Glutathione redox system dysfunction was observed children with pneumonia. It was more severe in patients who suffered from ARD. Normalization of glutathione system was noticed after protocol therapy for pneumonia treatment in children who occasionally suffered from ARD. Functional activity of glutathione system enzymes did not restore in children who often suffered from the disease indicating the depletion of the system reserves.

Prospects for further research involve the search for the ways to improve pathogenetic treatment of such children in order to restore functional activity of the glutathione system enzymes.

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