Correlation connections between respiration and blood parameters during burn toxemia

Muhitdinova Hura Nuritdinovna

Doctor of Medical Sciences, Full Professor

Center for the Development of Professional Qualifications of Medical Workers

Alauatdinova Gulhan Inyatdinovna

Assistant

Center for the Development of Professional Qualifications of Medical Workers

Salimov Davron Ubaidulaevich

Anesthesiologist-resuscitator

Republican Scientific Center for Emergency Medicine

Abstract

In the first 10 days of toxemia, the level of the mesor of the circadian rhythm of the respiratory rate (RR) remained at the level of the indicator on day 1, with a tendency to increased respiration relative to the age norm in all patients. The ongoing intensive therapy with timely correction of anemia revealed an insufficiency in replenishing the deficit of the studied blood parameters in school-age children. The direct influence of the number of metamyelocytes in infants on RR was revealed, when the inflammatory reaction was mainly expressed in an increase in the number of metamyelocytes. In school-age children, the number of monocytes in 1 and 2 subgroups of school and in subgroup 2 of preschool children turned out to be an indicator influencing the value of the mesor of the circadian rhythm RR. Perhaps the predominant role in the development of compensatory reactions of an increase in monocytes in the peripheral blood is an age-related feature of preschool and school children. A tendency to the stimulating effect of hypercoagulation in the 2nd phase of coagulation on RR was found in groups 4 and 5 of adult patients, while in children under 7 years of the first subgroup and people over 61 years of age, there was a tendency to increased respiration with a decrease in PI.

Keywords: correlations, respiration, blood, burn toxemia

Relevance. Being one of the reasons for the clinical features during the burn shock, toxemia subsequently, from the third day, comes to the fore, as it were, and becomes the leading factor in the course of the disease until the 8-9th day of the disease. It is characterized by pronounced clinical signs and distinct changes in metabolism. Clinical observations reveal anemia and increased hypoproteanemia. Diuresis in most seriously ill patients on the 3rd day reaches 4 - 6 liters. At the same time, in this regard, the amount of urea, residual nitrogen in the blood and electrolytes in plasma are normalized. The gradual return of incomplete protein breakdown products to the bloodstream mainly determines the clinical course and pathophysiological disorders in the body at the stage of burn toxemia. The beginning and end of the clinical course at this stage of the disease do not have clear outlines, and this, obviously, indicates the gradual development of its driving mechanisms. At the same time, there is penetration from the wound surface into the bloodstream of microbial bodies and their toxins, but it seems that in these first 8-9 days of the disease, they do not determine the course of the disease. The leading place in therapy for burn toxemia belongs to drugs that increase the reactivity of the body, reduce the toxic effect of protein breakdown products and regulate metabolic processes. Infusion therapy in this period of the disease gradually loses its purpose as a factor for improving hemodynamics. Sensitization reactions are often observed at this stage of the disease [1,2]. In the stage of toxemia, the highest mortality rate of patients is found. Toxemia dies, about 37% of all die from burns. Death usually occurs in individuals with the most common deep lesions. From burn shock, mainly elderly people and children die, sometimes even with relatively limited lesions, while in the stage of burn toxemia, young people, the healthiest, who can be removed from the shock state even with very extensive lesions [3, 4]. However, due to the lack of data on the assessment of age-related characteristics of compensatory changes in external respiration during burn toxemia, we set a goal to study the changes in the correlations of respiration and generally accepted laboratory blood parameters during the period of toxemia in severely burned patients.

Purpose. To study the correlations between the respiratory rate and laboratory parameters of the study during the period of burn toxemia.

Material and research methods. The results of hourly monitoring of the respiratory rate (RR) and data of laboratory and biochemical blood tests of patients admitted to the Department of Cambustiology of the Republican Scientific Center of Emergency Medicine due to burn injury in the first ten days after injury were studied. After recovery from shock, anti-inflammatory, antibacterial, infusion therapy, correction of protein and water-electrolyte balance disorders, early surgical, delayed necrectomy, additional parenteral nutrition, syndromic, symptomatic therapy were carried out. Changes in the RR circadian rhythm were studied by monitoring the

hourly continuous recording of respiratory rate indicators in 107 patients with severe thermal burns in six age groups - group 1, 31 patients aged 6 months - 3 years, group 2 - 25 patients aged 3.1-7 years, Group 3 25 patients - 7.1-18 years old, 4 - 12 patients 19-40 years old, 5-7 patients 41-60 years old, 6 group - 7 patients 61-78 years old. The division into groups was dictated by the well-known features inherent in each age group, described in detail in the literature. The indicators in each pediatric group were differentiatedly studied in three subgroups, depending on the severity of the burn injury according to the duration of intensive care in the ICU. Children were in the ICU from 4 to 10 days - 1 subgroup, 2 subgroup from 11 to 20 days, 3 subgroup from 21 to 50 days. After recovery from shock, anti-inflammatory, antibacterial, infusion therapy, correction of protein and water-electrolyte balance disorders, early surgical, delayed necrectomy, additional parenteral nutrition, syndromic, symptomatic therapy were carried out. In groups - 1 group 12 patients aged 20-40 years, 2 group - 7 patients aged 41-60 years, group 3, 6 patients - 61-78 years old. The division into groups was dictated by the well-known features inherent in each age group, described in detail in the literature.

Table 1.

Characteristics of patients admitted with thermal burns

Subgroups	Groups	Age	Area of 2-3A degree burn in%	3 B degree	IF, units	In ICU, days
1		19.3±6.2 months	32.7±9.8	0.1±0.03	33.4±10.1	6.8±1.8
2		14.2±4.6 months.	24.8±7.4	9±2.8	48.4±11.28	12.8±1.3
3	Group 1	10.1±2.1 months.	26.7±2.2	6±2.7	71.3±8.4	26.3±2.4
1		4.7±0.8	37.3±14.7	3.1±4.4	42.5±15.7	8.1±1.3
2		4.0±0.1	47.9±17.1	18.1±12.2	85.1±28.7	13.1±1.9
3	Group 2	4.4±0.6	59.2±12.2	36.7±13.3	127.5±33.3	27.3±3.2
1	Group 3	11.4±3.2	41±11	6.6±6	57±11	7.3±1.1
2		15±2	55.1±14.4	4.8±3.5	86.3±15.7	12.7±1.1
3		9.7±1.5	25.8±11.4	22.5±6.6	95.8±19.1	28.8±4.8
	Group 4	27.3±5.6	59.4±13.5	21.3±13.3	119.4±38.4	22.4±14.6
	Group 5	50.7±7.1	54.3±16.5	11.9±8.9	92.5±20.8	13.3±2.4
	Group 6	71.3±7.0	40.8±5.8	21.7±6.7	86.7±12.8	18.8±9.5

As shown in Table 1, the main factors affecting the severity of the condition of children with thermal burns of infancy were age (the younger the child, the more severe the condition), the area of damage to the skin surface of grade 3B, and the IF index.

The average age of children with severe burns in the age group from 3.1 to 7 years (group 2) ranged from 3.9 to 5 years (tab. 1). There were no significant differences between the groups and in the index of the area of the 2-3A burn, and amounted to 37.3 ± 14.7% in 1 subgroup, 47.9 ± 17.1% in 2, and 59.2 ± 12.2% in 3. However, a statistically significant difference was found in

the area of grade 3B burns in subgroups 1 and 3, which in the most severe group of children exceeded the grade 3B burn in group 1 by 11 times (p <0.05) and was 6 times greater than in subgroup 2. In accordance with the severity of the condition, the duration of intensive therapy in ICU conditions in subgroup 2 was more than in the first by 62% (p <0.05), in subgroup 3 more than three times longer (p <0.05) than in the first. The determining the duration of treatment in the hospital in groups 1, 2 and 3 were such indicators as the size of the burn area of the 3B degree, the Frank index, the duration of intensive care in the ICU. Thus, age, IF index, area of grade 3B thermal damage served as objective indicators of the severity of thermal burns and made it possible to predict the duration of intensive care in the ICU and inpatient treatment of pediatric patients.

As can be seen from Table 1, the age groups of adult patients were significantly different and averaged 27.3 ± 5.6 years in group 1, 50.7 ± 7.1 years in the second, and 71.3 ± 7. 0 years in the third. The total area and the area of deep burn damage to the skin did not differ significantly. The highest index of IF was revealed in group 1, which determined the longest duration of intensive therapy in ICU conditions in the youngest group 1.

Discussion of research results.

Table 2.

Dynamics of the mesor of the circadian rhythm of respiration in burn toxemia depending on age (RR per minute)

Days	Age group 1 (6 months-3 years)			Group 2 (3.1-7 years)			Group 3 (7.1-18 years)			Group 4 (19-40 years)	Group 5 (41-60 years)	Group 6 (61-78 years)
	Subgroup 1	Subgroup 2	Subgroup 3	Subgroup 1	Subgroup 2	Subgroup 3	Subgroup 1	Subgroup 2	Subgroup 3			
1	35.0±2.1	31.9±0.7	36.5±0.8	28.1±1.4*	27.3±0.6*	28.7±1.1*	21.3±0.8″	20.7±0.6″	25.0±3.8	20.5±0.6	19.6±0.3	21.4±0.4
2	30.2±0.2	29.1±1.0	32.6±0.8	27.8±0.4*	25.5±0.7*	28.1±0.3*	21.2±0.3″	21.3±0.4″	22.4±0.4″	20.4±0.2	19.4±0.2	20.2±0.4
3	30.2±0.4	31.1±0.8	31.9±1.1	26.2±0.5*	25.1±0.5*	27.9±0.5*	21.1±0.2″	20.7±0.3″	22.8±0.3″	20.6±0.2	19.4±0.2	20.3±0.4
4	29.7±0.3	30.6±0.3	35.6±0.4	26.2±0.4*	28.2±0.5*	27.7±0.4*	22.1±0.4″	20.8±0.3″	23.3±0.4″	20.5±0.6	19.7±0.2	20.2±0.3
5	29.9±0.4	31.2±0.5	34.2±0.7	25.0±0.3*	26.9±0.5*	27.3±0.4*	22.3±0.3″	21.1±0.4″	23.2±0.4″	20.3±0.2	19.5±0.3	20.3±0.3
6	30.2±0.5	31.6±0.6	33.8±0.4	26.6±0.4*	26.3±1.0*	28.2±0.6*	22.3±0.2″	21.1±0.5″	23.0±0.3″	20.5±0.2	20.1±0.3	19.9±0.4
7	30.5±0.4	31.8±0.5	33.1±0.4	24.9±0.5*	27.1±0.5*	27.8±0.8*	23.0±0.7	21.0±0.4″	23.6±0.3″	20.9±0.3	20.1±0.3	19.5±0.3
8	29.4±0.5	30.6±0.5	33.9±0.5	26.5±0.4*	26.2±0.4*	27.6±0.3*	22.1±0.9″	21.3±0.6″	23.9±0.4″	20.7±0.2	20.3±0.3	20.3±0.5
9	29.5±0.6	30.0±0.3	33.2±0.7	25.6±0.7*	27.7±1.1*	27.3±0.5*	23.8±0.7″	22.4±0.5″	23.0±0.5″	20.4±0.2	20.0±0.4	21.1±0.6
10		30.1±0.5	32.5±0.6		27.9±0.5*	27.3±0.5*		21.8±0.5″	23.2±0.3″	21.1±0.3	19.5±0.5	21.4±0.5

*-reliable relative to the subgroup of the same name of group 1

″-reliable relative to the indicator of the same name subgroup of group 2

As can be seen from the data presented in Table 2, on the first day, the RR indicator of the mesor of the circadian rhythm indicated a tendency towards increased respiration relative to the age norm in all patients. During the first 10 days of toxemia, no significant dynamics of the mesor of the RR circadian rhythm was revealed. That is, in children of group 2, RR was 20% less in day 1 than in group 1, and in group 3 it was 25% less. In the 4,5,6 groups of adults, the indicators of the mesor of the circadian rhythm RR did not differ significantly from the indicator in school-age children. Thus, during the period of toxemia, the age-related difference in the RR indicator in 1,

2 and 3 age groups remained. There were no significant differences depending on the severity of burn injury in subgroups 1,2,3.
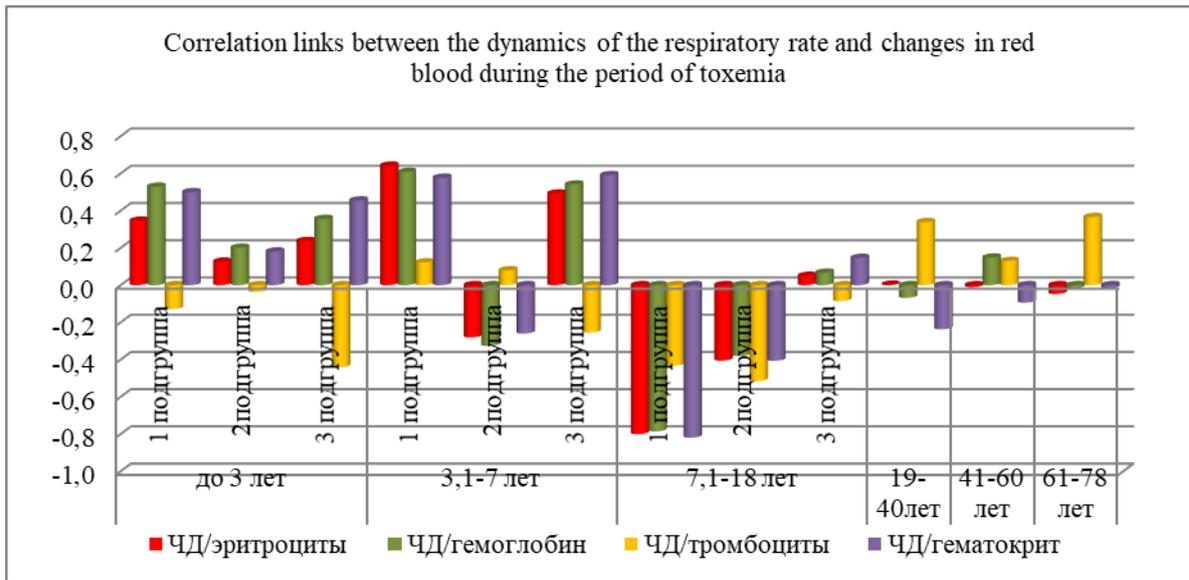
Fig.1

The deficit in the number of erythrocytes led to the emergence of a reliable inverse correlation of the indicator with RR, that is, in subgroup 1 and to a lesser extent in subgroup 2 of children of group 3, a further decrease in the number of erythrocytes, hemoglobin, hematocrit would cause an even greater compensatory increase in respiration due to an increase in hemic hypoxia (fig.1). Thus, the ongoing intensive therapy with timely correction of anemia, according to the views of the attending physicians, revealed an insufficiency in replenishing the deficit of the studied blood parameters in school-age children.
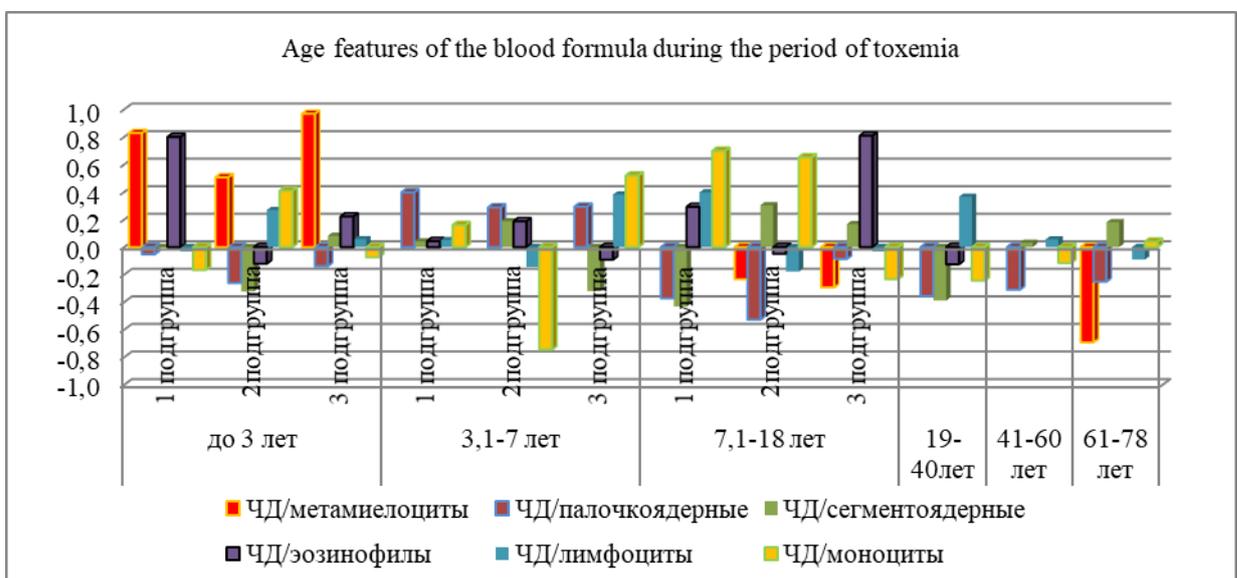
Fig.2

A direct effect of the number of metamyelocytes in infants on RR was revealed (fig. 2), when the inflammatory reaction was expressed in an increase in the number of metamyelocytes. In school-age children, the indicator influencing RR was the number of monocytes in subgroups 1 and 2 and in subgroup 2 of preschool children. Perhaps the predominant role in the development of compensatory reactions of an increase in monocytes in the peripheral blood is an age-related feature of preschool and school children.
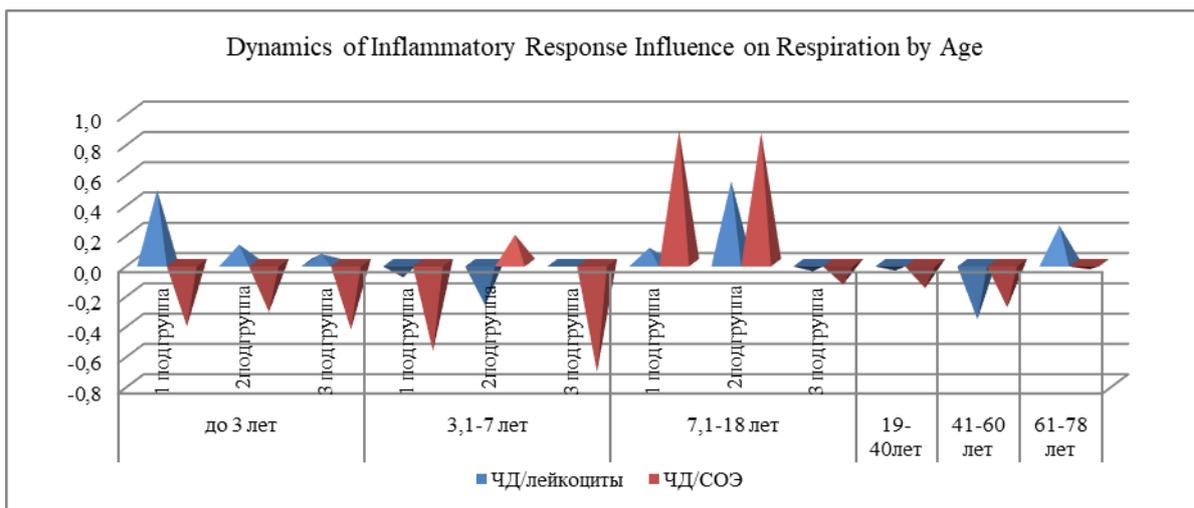

Fig.3

A significant inverse was found in subgroup 3 of preschool children and a direct correlation between changes in ESR and RR in subgroups 1 and 2 of school age children. That is, the direct compensatory value of the activity of the respiratory system during the systemic inflammatory response of the body was revealed in children of group 3, which was apparently due to the insufficient effectiveness of anti-inflammatory, stress-limiting therapy (fig. 3).
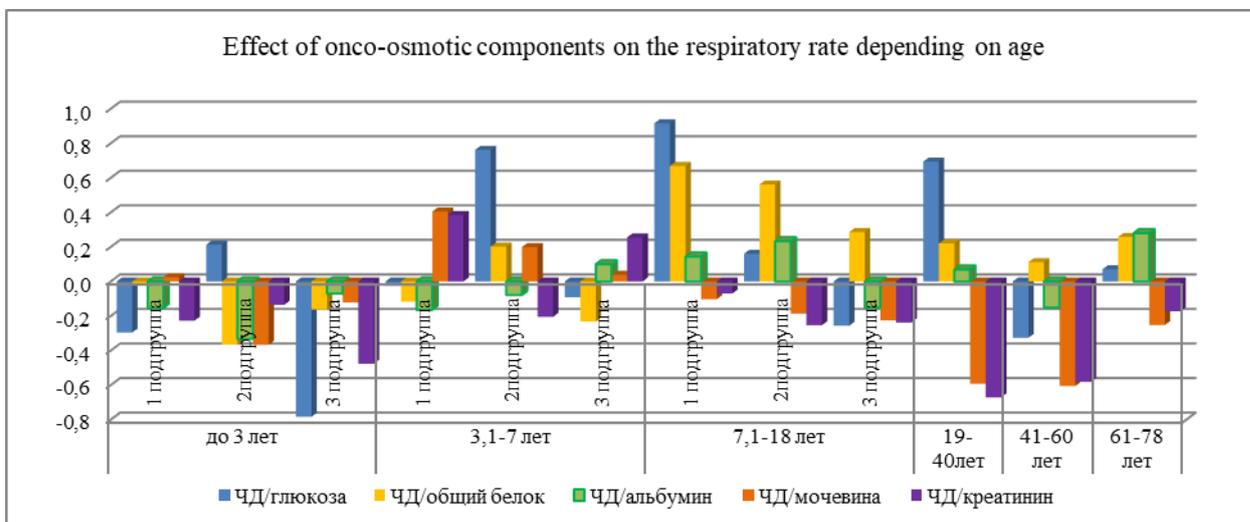

Fig.4

The stimulating effect of blood glucose concentration on RR was observed only in subgroup 1 of patients in group 3 (fig. 4). In children of the 3rd subgroup of the 1st group, a negative correlation was found between the blood glucose level and RR, possibly due to a tendency to hypoglycemia, which caused a compensatory rapid breathing to correct the energy deficit state due to insufficient carbohydrate load in the parenteral nutrition. To correct the latter, it is necessary to increase the introduction of carbohydrates, taking into account the highest level of hypermetabolism in burns $26.7 \pm 2.2\%$, grade 3B $6 \pm 2.7\%$, IF 71.3 ± 8.4 units under the age of 3 years.
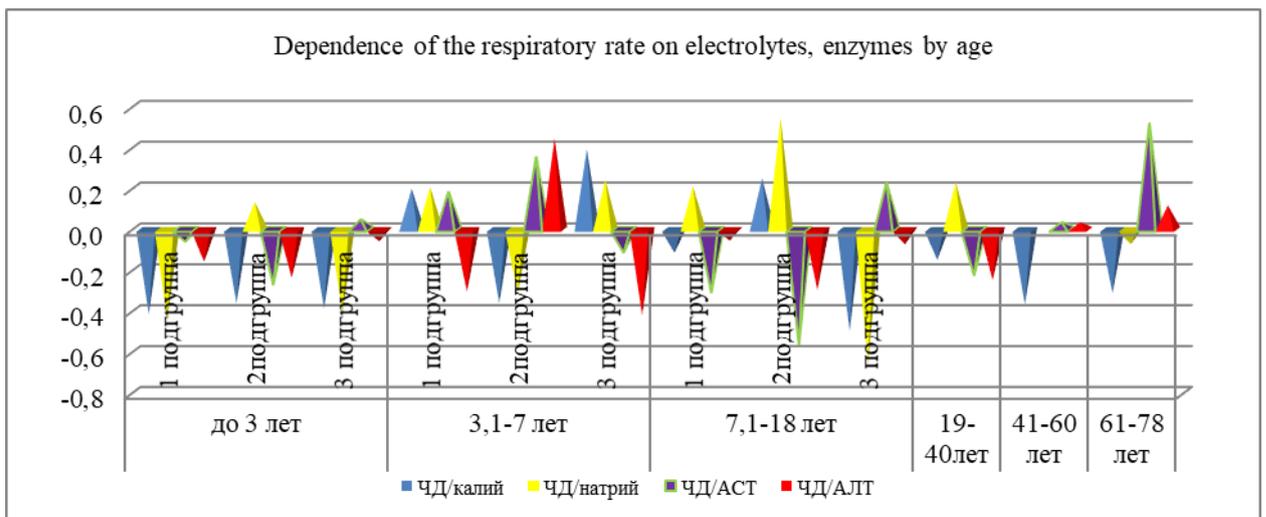

Fig.5

As can be seen from the data presented in fig. 5, only in the third subgroup of school-age patients, a decrease in the concentration of sodium in the plasma would cause an increase in respiration, indicating an imbalance in the electrolyte composition of the plasma.
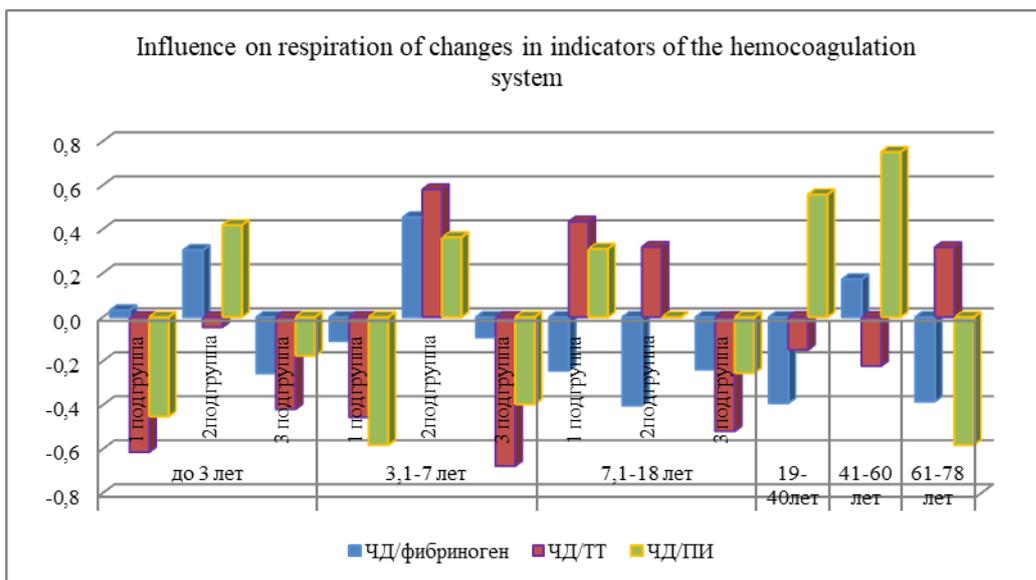

Fig.6

A tendency to the stimulating effect of PI growth (hypercoagulation in phase 2 of coagulation) on RR was found in groups 4 and 5 of adult patients, while in children under 7 years of the first subgroup and people over 61 years of age, there was a tendency for increased respiration with a decrease in PI (fig. 6). A decrease in the level of TT also caused a tendency to increase respiration in 1.3 subgroups of infants, in subgroups 1 and 3 of preschool age, and in subgroup 3 of school age. The change in the level of fibrinogen had a slightly smaller effect on respiration. Thus, in general, the compensatory value of an increase in the activity of the respiratory system was revealed with a tendency to hypocoagulation in the 2nd and 3rd phases of blood coagulation. This can be understood as an adequate syndromic correction by the volume of anticoagulant, infusion therapy, correction of rheological disorders of the blood in the first 10 days of burn toxemia.

Conclusions. In the first 10 days of toxemia, the level of the mesor of the circadian rhythm RR remained at the level of the indicator on day 1 with a tendency to increased respiration relative to the age norm in all patients. The ongoing intensive therapy with timely correction of anemia revealed an insufficiency in replenishing the deficit of the studied blood parameters in school-age children. The direct influence of the number of metamyelocytes in infants on RR was revealed, when the inflammatory reaction was mainly expressed in an increase in the number of metamyelocytes. In school-age children, the number of monocytes in 1 and 2 subgroups of school and in subgroup 2 of preschool children turned out to be an indicator influencing the value of the mesor of the circadian rhythm RR. Perhaps the predominant role in the development of compensatory reactions of an increase in monocytes in the peripheral blood is an age-related feature of preschool and school children. A tendency to the stimulating effect of hypercoagulation in the 2nd phase of coagulation on RR was found in groups 4 and 5 of adult patients, while in children under 7 years of the first subgroup and people over 61 years of age, there was a tendency to increased respiration with a decrease in PI.

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Фамилия, имя, отчество автора (на английском языке)	Alauatdinova Gulhan Inyatdinovna
Название статьи (на русском языке) *(!!!)	Корреляционные связи дыхания и показателей крови в период ожоговой токсемии
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Фамилия, имя, отчество автора (на английском языке)	Salimov Davron Ubaidulaevich

Название статьи (на русском языке) *(!!!)	Корреляционные связи дыхания и показателей крови в период ожоговой токсемии
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