

## **Correlations between autonomic regulation and blood parameters in burn toxemia, depending on age**

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### **Abstract**

On the first day, the level of the mesor of the circadian rhythm OBT was increased in all burned children in the first age group by 45-88%, in the second - by 49-70%, in the third - by 34-90%. During the first 10 days of burn toxemia, autonomic nervous regulation was in a state of hyperfunction, exceeding the physiological level of activity by 45-55% in infancy, by 45-90% in the preschool and school age groups. Restoration of normal red blood counts is one of the stress-limiting methods for correcting disorders of homeostatic systems in burn toxemia. The tendency to a hypersympathotonic reaction in connection with leukocytosis was observed in 1 and 2 subgroups of preschool age and in 1 subgroup of senior school age. In group 4, a negative influence of the growth of leukocytes on the activity of sympathetic influences was found. Revealed a direct stimulating effect of the growth of the number of stab cells on OBT in 1 subgroup of 1 group of children. The tendency of a negative relationship between the number of stabs in 1,2 subgroups of group 3, 4,5 groups in the first 10 days of the toxemia period is due to sympatholytics with insufficient effectiveness of anti-inflammatory therapy. The tendency to a sympathotonic response with an increase in eosinophilia in infants of the 3rd subgroup, toddlers, reflects a tendency to sensitization with a systemic inflammatory response. Correction of hypoalbuminemia provided some decrease in the hypersympatotonic response in groups 4 and 6 of burned adult patients in the first 10 days of toxemia. The aggravating effect of functional and anatomical immaturity was revealed during the implementation of compensatory mechanisms of the hemocoagulation system in the first 10 days of burn toxemia in infants.

**Keywords: autonomic regulation, burn toxemia, age**

## **Relevance**

The complex of psychophysiological and autonomic changes accompanying burn disease is reduced to an increase in autonomic tone to hypersympathicotonia. Considering that in the course of treatment, patients undergo both surgical interventions and a significant number of dressings, changes in the psycho-vegetative sphere become significant. These changes persist for years. Those who have been burned with different values of the Frank index have similar psychophysiological and autonomic disorders. On the other hand, in a particular patient, the ratio of the above indicators may differ significantly from the average, which requires targeted correction of the identified violations [1-4]. With a large volume of research results for burn shock, toxemia, septicotoxemia of burn disease, there is not enough information in the literature on the dynamics of autonomic regulation, violation of the circadian rhythm of the indicator in severe burns depending on age, which was the reason for studying the results of monitoring the indicator of general autonomic tone (GAT) and laboratory data homeostasis during toxemia.

## **Purpose of the work**

To study and assess the correlations between autonomic regulation and blood parameters in burn toxemia, depending on age

## **Material and research methods**

The studies were carried out in the following age groups: group 1 - 6 months - 3 years, group 2 - 3.1-7 years old, group 3 - 7.1-18 years old, group 4 - 18.1-40 years old, group 5 - 41- 60 years old, group 6 - 61-85 years old. We studied the data of hourly GAT registration and daily monitoring of indicators of conventional blood test methods (erythrocyte count, hemoglobin, hematocrit, platelets, leukocyte formula, total protein, albumin, urea, plasma creatinine, electrolytes, prothrombin index (PI), thrombotest (TT), fibrinogen, diastase, alanine transferase (ALT), asparagine transferase (AST). The research data were processed by the method of variation statistics using the Excel program by calculating the arithmetic mean values (M) and mean errors (m). To assess the reliability of the differences between the two values, the parametric Student's test (t) The interrelation of the dynamics of the studied indicators was determined by the method of paired correlations, the critical level of significance being taken equal to 0.05.



Table 1

Groups	men	women	age	total burn area,%	area of 3B degree,%	IF, units	days in hospital
1	15	7.0	18.1±7.5 months	33.6±10.1	9.0±6.5	42.1±16.6	22.2±9.6
2	11	9	4.8±1.0*years	50.8±14.9	25.8±11.6	88.7±36.8	46.3±18.4
3	14	4	12.1±3.0*years	50.7±12.7	11.7±6.5	76.3±19.1	34.3±18.2
4	13	2	27.1±4.8*years	58.2±14.1	20.2±12.0	112.3±35.6*	48.0±19.6
5	5	3	49.4±7.2*years	53.8±15.0	13.3±8.1	90.0±25.0*	26.5±13.4
6	5	3	70.1±6.4*years	35.7±10.6	20.5±7.8	77.3±30.2	41.6±19.3

\*-deviation is significant relative to the indicator in group 1

As shown in tab. 1, there were 63 male patients, 28 female patients. Age, anthropometric differences were significant in the absence of significant differences in age groups in the total area of the burn, deep damage of grade 3B and the duration of inpatient treatment. A significant predominance of the Frank index (IF) in groups 4 and 5 was found, due to the aggravation of the condition by concomitant factors, such as combined injury, carbon monoxide poisoning, concomitant ischemic heart disease, burns of the upper respiratory tract.

Intensive therapy from the moment of admission was aimed at removing burn shock, adequate anesthesia and intravenous administration of crystalloids, volemic solutions under the control of hemodynamics, volume of urine output, correction of deviations in homeostasis indicators.

## Results and discussion

Table 2

Dynamics of the GAT circadian rhythm mesor in childhood

Days	Group 1			Group 2			Group 3		
	6 months-3 years			3.1-7 years			7.1-18 years old		
	Subgroup 1	Subgroup 2	Subgroup 3	Subgroup 1	Subgroup 2	Subgroup 3	Subgroup 1	Subgroup 2	Subgroup 3
1	1.45±0.06	1.45±0.17	1.55±0.14	1.49±0.13	1.52±0.07	1.7±0.2	1.55±0.08	1.34±0.10	1.90±0.20*
2	1.36±0.05	1.37±0.09	1.53±0.10*	1.66±0.06	1.43±0.06	1.6±0.1	1.58±0.05	1.56±0.11	1.77±0.12*
3	1.36±0.04	1.43±0.11	1.30±0.09	1.52±0.05	1.53±0.05	1.8±0.1*	1.58±0.04	1.50±0.09	1.79±0.09*
4	1.39±0.05	1.43±0.11	1.49±0.20	1.53±0.05	1.45±0.09	1.7±0.1*	1.56±0.07	1.50±0.08	1.69±0.10
5	1.45±0.05	1.52±0.20	1.45±0.18	1.56±0.05	1.53±0.07	1.7±0.1*	1.58±0.06	1.64±0.06	1.79±0.10*
6	1.52±0.05	1.49±0.09	1.44±0.20	1.58±0.06	1.55±0.08	1.8±0.1*	1.61±0.05	1.69±0.16	1.83±0.08*
7	1.54±0.06	1.34±0.24	1.40±0.09	1.68±0.08	1.68±0.08	1.7±0.1	1.58±0.07	1.71±0.09	1.76±0.08*
8	1.55±0.05	1.38±0.11	1.43±0.10	1.75±0.10	1.60±0.05	1.8±0.1	1.84±0.13	1.65±0.12	1.80±0.11
9	1.69±0.13	1.38±0.04	1.53±0.30	1.62±0.08	1.57±0.06	1.9±0.1	2.15±0.25	1.79±0.15	1.69±0.07
10		1.45±0.14	1.45±0.22	1.67±0.22	1.62±0.09	1.9±0.1		1.81±0.16	1.84±0.07

\*-the difference is significant relative to the indicator in 1 subgroup

On the first day, the level of the circadian rhythm mesor GAT was increased in all burned children on average in the first age group by 45-88%, in the second - by 49-70%, in the third - by 34-90% (tab. 2). It draws attention to the fact that in the older school age, a significant difference in the degree of hypersympathotonic response was revealed in the 3rd subgroup relative to the first subgroup by 35% ( $p < 0.05$ ), the second subgroup by 56% ( $p < 0.05$ ).

In the dynamics during the first ten days of the period of burn toxemia, there was no significant change in the sympathotonic response in children of all age groups and subgroups of pediatric patients. According to the severity of burn injury, a significant increase in sympathotonic response was revealed on day 2 in subgroup 3 of group 1, on days 3-6 in subgroup 3 relative to subgroup 1 in preschool age, on days 1-7 in children of subgroup 3 of school age ( $p < 0.05$ , respectively). That is, despite the intensive complex therapy, with timely surgical intervention (early, delayed necrectomy), the autonomic nervous regulation was in a state of hyperfunction, exceeding the physiological level of activity by 45-55% in infancy, by 45-90% in preschool and school age groups.

Table 3

Dynamics of the GAT circadian rhythm mesor in adults

Days	19-40 years	41-60 years	61-78 years
	Group 4	Group 5	Group 6
1	1.31±0.05	1.42±0.16	1.21±0.10
2	1.37±0.07	1.17±0.06*	1.27±0.08
3	1.36±0.06	1.16±0.05*	1.37±0.09
4	1.59±0.04	1.39±0.08*	1.33±0.07*
5	1.55±0.06	1.47±0.07	1.21±0.11*
6	1.60±0.07	1.49±0.11	1.28±0.07*
7	1.67±0.07	1.49±0.08	1.37±0.06*
8	1.71±0.08	1.37±0.07*	1.25±0.07*
9	1.64±0.08	1.42±0.05*	1.29±0.11*
10	1.65±0.06	1.18±0.05*	1.26±0.13*

\*-the difference is significant relative to the indicator in group 4

The hypersympathotonic response in adult patients (tab. 3) on the first day did not differ significantly from physiological values with a tendency to increase. Age differences were found, so in patients of group 5, GAT indices were found less than in 4 by 2.3.4 (by 15%,  $p < 0.05$ ), 8.9.10 (by 20%, 13%, 28%,  $p < 0.05$ , respectively) day of the period of burn toxemia. In the oldest age group, a relatively less pronounced stress sympathotonic reaction was found relative to group 5 of patients on days 4-10 (by 16 -23%,  $p < 0.05$ , respectively). This was due not only to the age-related functional adaptive capabilities of old age, but also to a significantly smaller total burn area by 22.5% and a significantly lower IF index by 35 units (the reliability was not revealed due to the large spread of indicators).

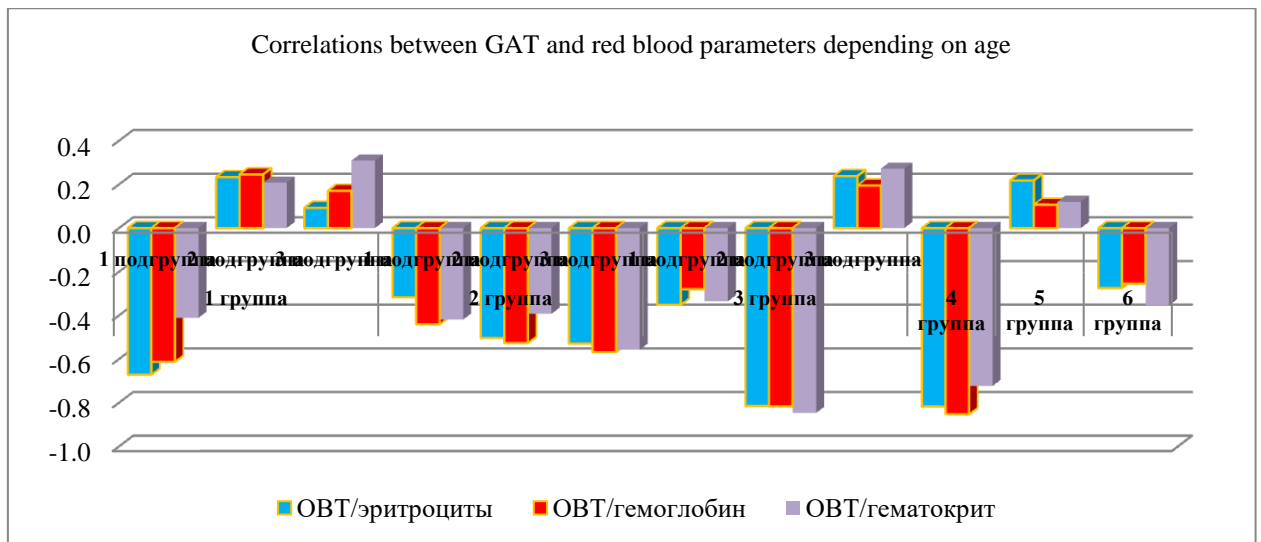


Fig.1

The predominance of negative correlations between the state of autonomic tone and the number of erythrocytes (fig. 1), the level of hemoglobin and hematocrit indicates that one of the factors contributing to the development of a hypersympathotonic reaction is a deficiency of blood parameters, that is, anemia in children of subgroup 1 of group 1, in all burned children of preschool age, 1,2 subgroups of senior school age, patients in 4 and, to a lesser extent, 6 groups. Thus, the restoration of normal red blood counts can be attributed to one of the stress-limiting methods for correcting disorders of homeostasis systems in burn toxemia.

The sympathotonic effect of the systemic inflammatory response is known under stressful influences on the body, including severe burn injury. Differentiated assessment of GAT correlations with leukocyte count parameters revealed some features depending on the age and severity of burn injury in childhood. Thus, a tendency to a hypersympatotonic reaction in connection with leukocytosis was observed in subgroups 1 and 2 of preschool age and in subgroup 1 of senior school age. In group 4, a negative influence of the growth of leukocytes on the activity of sympathetic influences was found.

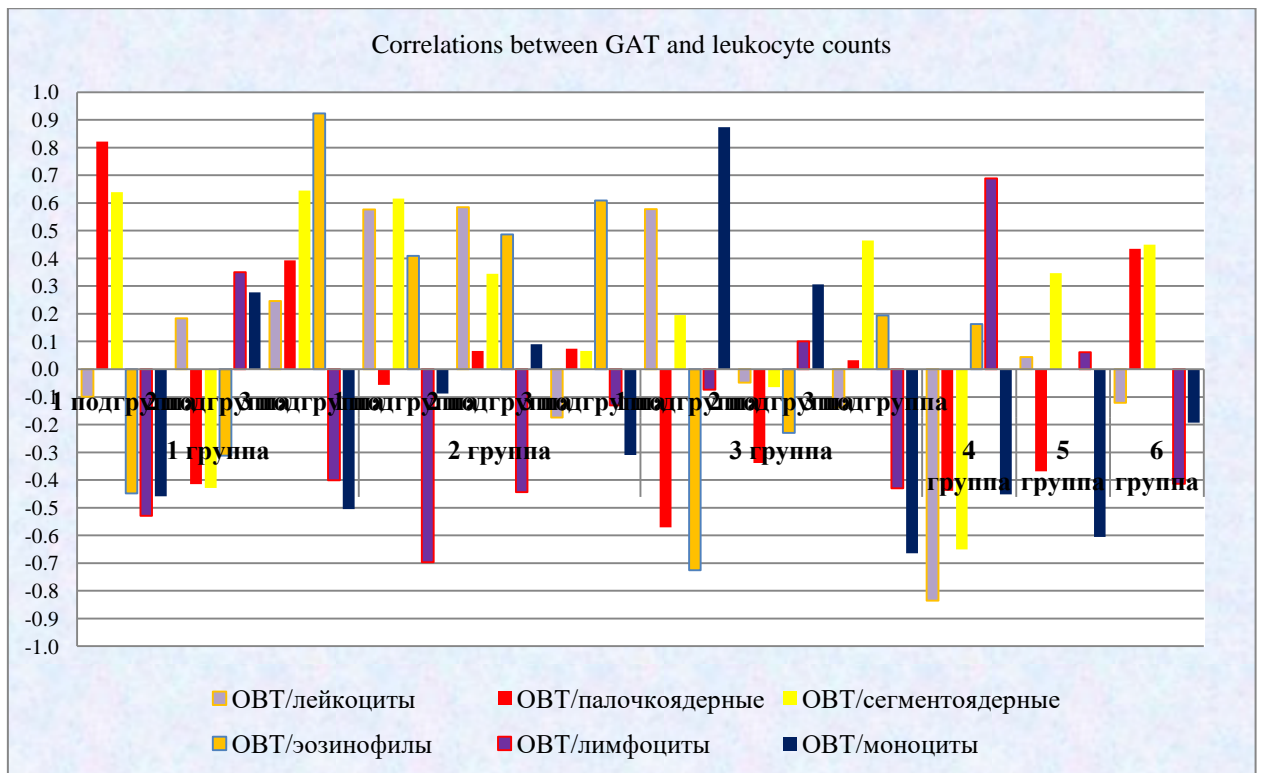


Fig. 2

A direct stimulating effect of an increase in the number of stab cells on GAT was revealed in subgroup 1 of group 1 of children, less pronounced in group 6 of patients. An interesting trend is the negative relationship between the number of stabs in 1,2 subgroups of group 3, in 4,5 groups in the first 10 days of the toxemia period, which is probably associated with the use of sympatholytic drugs with insufficient effectiveness of anti-inflammatory therapy (fig. 2). Confirmation of this assumption is the inverse correlation between GAT and segmented in group 4, moderate negative correlation between GAT and monocytes in 1 and 3 subgroups of infants, in subgroup 3 of senior school age, 4,5,6 groups of adult patients. A direct strong correlation between GAT and the number of monocytes in subgroup 1 of group 3 indicates a physiological hypersympathotonic response to the systemic inflammatory response of the body in the first 10 days of burn toxemia in schoolchildren, characterizing the insufficient effectiveness of anti-inflammatory therapy. The tendency to a sympathotonic response with an increase in eosinophilia is probably a feature of the physiological response of the autonomic nervous system to the systemic inflammatory response in infants of the 3rd subgroup, toddlers, reflecting the propensity to sensitization with a systemic inflammatory response in children of this age group (fig. 2).

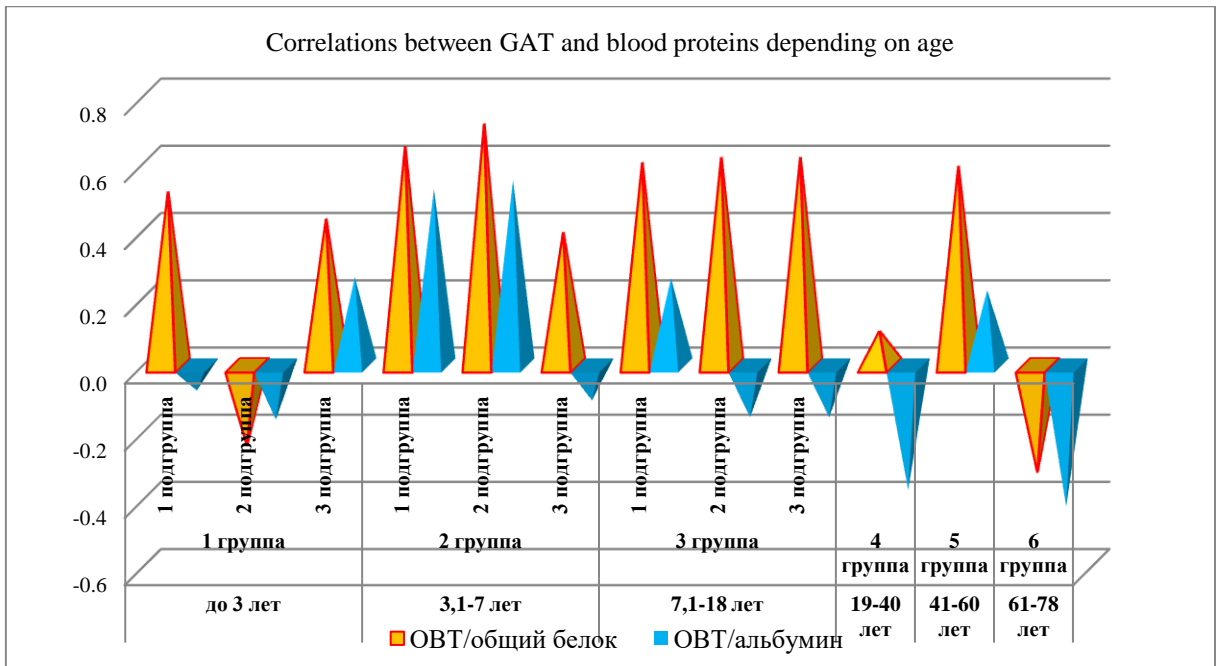


Fig.3

A positive effect on autonomic regulation of hypoproteinemia correction and restoration of plasma albumin concentration was revealed in patients in subgroups 1 and 3 of group 1, all children of preschool and school age, patients in groups 4 and 5 (fig. 3). Correction of hypoalbuminemia had a slight decrease in hypersympathotonic response in 4 and 6 groups of burned adult patients during the period of toxemia.

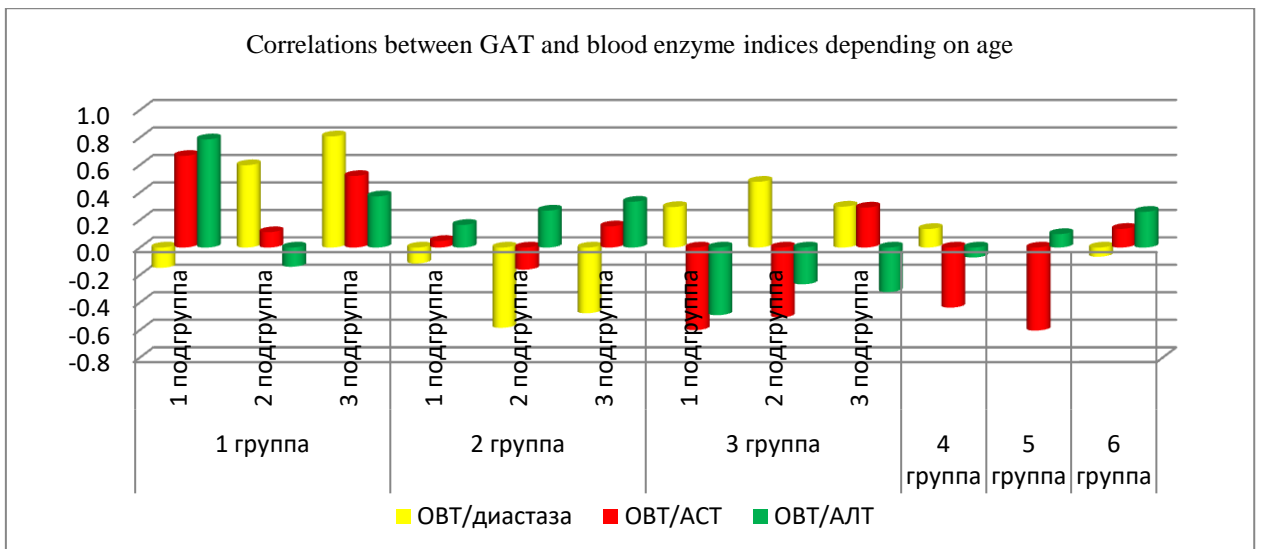


Fig. 4

As shown in fig. 4, the tendency of the hypersympathotonic response to an increase in plasma diastase was revealed in 2.3 subgroups of infants, in children of senior school age. In preschool



age, insignificant stimulation of GAT was noted with a decrease in blood diastza. A significant direct correlation between GAT and ALT was found only in children of the 1st subgroup of infancy.

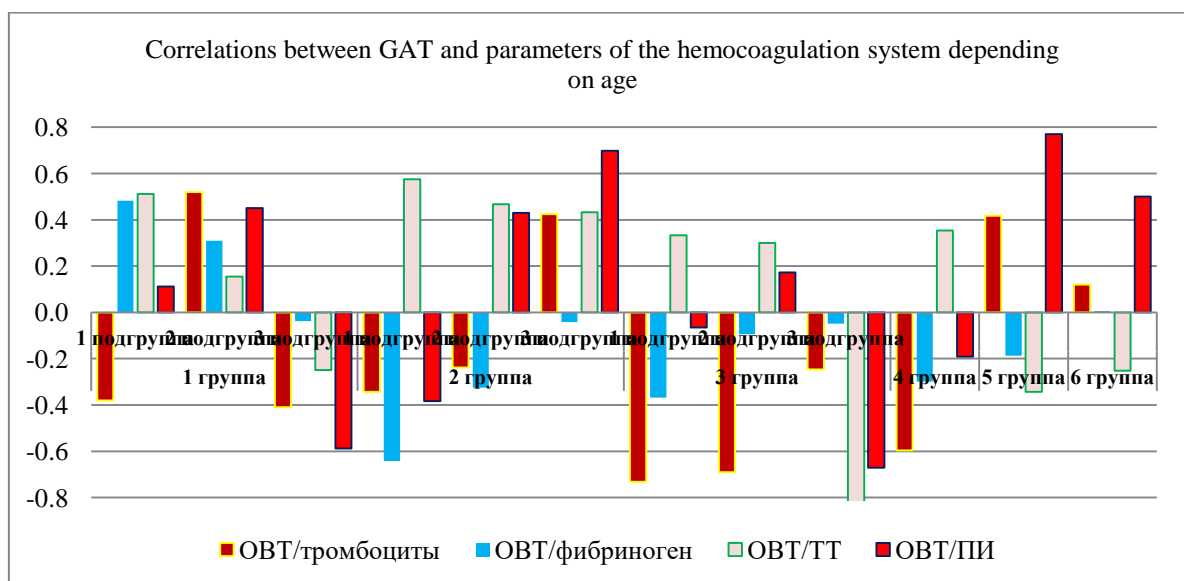


Fig. 5

Of particular interest is the correlation between the activity of autonomic regulation and the parameters of the hemocoagulation system under conditions of heparin administration with a complex of intensive therapy during the period of toxemia of burn disease, depending on the age and severity of the lesion in childhood (Fig. 5). Thus, a significant inverse relationship between GAT and the number of platelets in the first 10 days of toxemia in 1 subgroup of school-age children was found, as the injury worsened, this relationship weakened. That is, an increase in the number of platelets corresponded to an increase in sympathetic influences with a total burn area of  $41 \pm 11\%$ , grade 3B of  $6.6 \pm 6\%$  and an IF index of  $57 \pm 11$  units ( $-0.73$ ). While in subgroup 3 of group 3, the degree of correlation significantly decreased with an increase in the severity of burn injury, an increase in the area of a deep burn 3B by 3 times to  $22.5 \pm 6.6\%$ , IF to  $95.8 \pm 19.1$  units, despite almost half the total area of the burn, which was  $25.8 \pm 11.4\%$  in subgroup 3 of group 3. Thus, on the basis of the obtained result, it can be concluded that the change in the number of platelets in peripheral blood during the period of toxemia is mainly influenced not so much by the total surface damage, but the depth of the skin lesion, causing a violation of the compensatory mobilization of sympathetic influences with deeper damage to the skin surface. A reliably significant direct correlation between GAT and PI level was found in subgroup 3 of toddlers and in group 5 (aged 41-60 years), which corresponded to the concept of physiological hypercoagulation of phase 2 of coagulation in response to increased sympathetic activity during the period of burn toxemia. An unexpressed negative correlation between GAT and PI in

subgroups 3 and groups 1 and 3 corresponded to the presentation of a breakdown of compensatory hypercoagulation to a sympathotonic response under conditions of a burn of 3B degree  $6 \pm 2.74\%$ , IF  $71.3 \pm 8.4$  units in infants and 3B degree  $22.5 \pm 6.6\%$ , IF  $95.8 \pm 19.1$  units in school-age children. It should be noted the aggravating effect of functional and anatomical immaturity of both the autonomic nervous system and the liver in the process of implementing the compensatory mechanisms of the hemocoagulation system in the first 10 days of burn toxemia in infants.

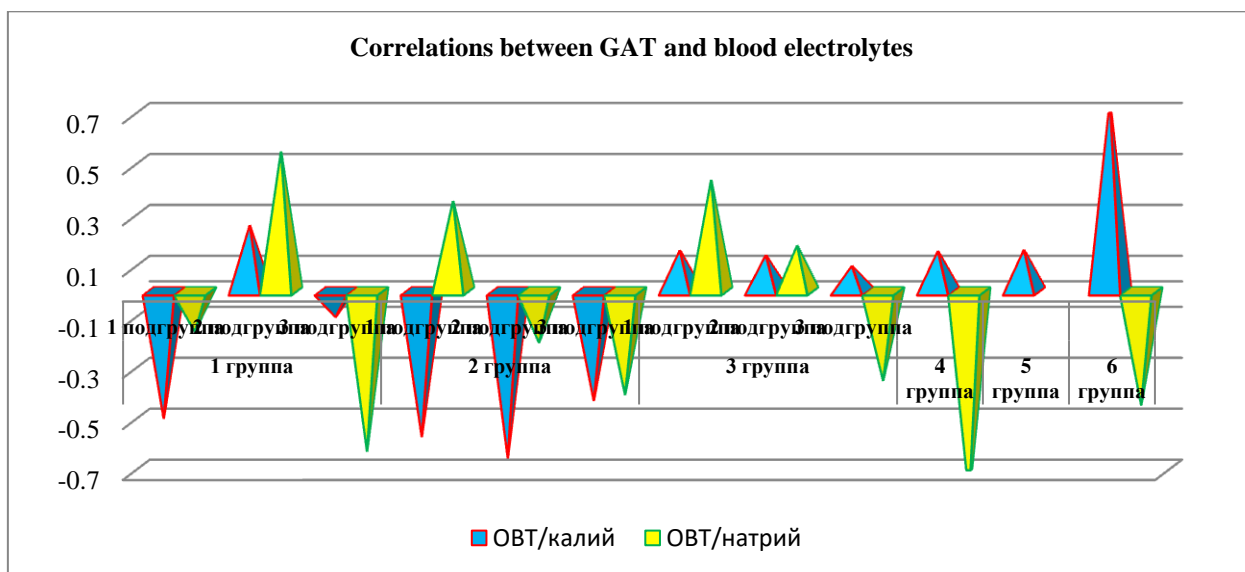


Fig. 6

Timely correction made it possible to prevent significant deviations in the electrolyte balance, which manifested itself in the formation of insignificant compensatory GAT responses, although the prevalence of negative correlations in early childhood draws attention. Thus, there was a tendency towards an increase in sympathetic influences in hypokalemia in subgroup 1 of group 1, in all children of group 2. A direct correlation was found between the concentration of potassium in plasma and GAT, which is more typical for functional abnormalities of the urinary system in group 6.

**Conclusions.** On the first day, the level of the mesor of the circadian rhythm GAT was increased in all burned children in the first age group by 45-88%, in the second - by 49-70%, in the third - by 34-90%. During the first 10 days of burn toxemia, autonomic nervous regulation was in a state of hyperfunction, exceeding the physiological level of activity by 45-55% in infancy, by 45-90% in the preschool and school age groups. Restoration of normal red blood counts is one of the stress-limiting methods for correcting disorders of homeostatic systems in burn toxemia. The

tendency to a hypersympathotonic reaction in connection with leukocytosis was observed in 1 and 2 subgroups of preschool age and in 1 subgroup of senior school age. In group 4, a negative influence of the growth of leukocytes on the activity of sympathetic influences was found. A direct stimulating effect of an increase in the number of stab cells on GAT was revealed in subgroup 1 of group 1 of children. The tendency of a negative relationship between the number of stabs in 1,2 subgroups of group 3, 4,5 groups in the first 10 days of the toxemia period is due to sympatholytics with insufficient effectiveness of anti-inflammatory therapy. The tendency to a sympathotonic response with an increase in eosinophilia in infants of the 3rd subgroup, toddlers, reflects a tendency to sensitization with a systemic inflammatory response. Correction of hypoalbuminemia provided a slight decrease in the hypersympathotonic response in groups 4 and 6 of burned adult patients during the period of toxemia. The aggravating effect of functional and anatomical immaturity was revealed during the implementation of compensatory mechanisms of the hemocoagulation system in the first 10 days of burn toxemia in infants.

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