

Age features of correlations between oxygen saturation index and blood tests in burn toxemia

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Abstract

Oxygen therapy with almost continuous oxygen insufflation mainly through a nasal catheter during spontaneous breathing stabilized the oxygen saturation index at a level above 97% in all patients. Only in patients of subgroup 2, 7.1-18 years old, there was a direct dependence of oxygen saturation on the number of erythrocytes, hemoglobin level, hematocrit and platelets with a burn surface area of $55.1 \pm 14.4\%$, grade 3 B $4.8 \pm 3.5\%$, IF 86.3 ± 15.7 units. A high probability of a decrease in the oxygen saturation index (-0.76) was revealed with an increase in the concentration of glucose in the blood with the largest area of deep burn of 3B degree $9 \pm 2.8\%$ in infants. In the first 10 days of toxemia, the revealed inverse dependence of the oxygen saturation indicator on the increase in plasma osmolarity (the indicator of urea, creatinine, glucose) was due to the introduction of hypertonic glucose solutions as part of parenteral nutrition in conditions of pronounced hypermetabolism. A negative effect of an increase in

plasma fibrinogen on the oxygen saturation index was revealed in subgroup 2 of group 1 (up to 3 years), in 2 and 3 subgroups of group 2 (3.1-18 years) and a moderate trend in group 4 (19-40 years).

Keywords: oxygen saturation, burn toxemia, correlations.

Relevance

The acute period of burn disease (the first 8-9 days) accounts for 72% of the total mortality from burns, and this fact alone convincingly confirms the exceptional importance of understanding the complex chain of general and local changes in the body for the use of pathogenetically based treatment. During the period of acute burn toxemia and septicotoxemia, there is a decrease in the saturation of hemoglobin with oxygen, pO₂ in arterial blood, a decrease in hemoglobin and volumetric oxygen content in the blood. The shift of the oxyhemoglobin dissociation curve to the right is maintained. In these stages, metabolic alkalosis with hypokalemia is noted. In cases of complications of burn disease by exhaustion, dystrophy of internal organs, pneumonia, sepsis, arterial hypoxemia, metabolic alkalosis and hypokalemia are aggravated [1-4]. Due to the lack of information on a differentiated assessment of the features of the effect of burn toxemia on changes in the homeostasis system at different age periods, we considered it necessary to study the data of monitoring the oxygen saturation index, clinical and biochemical parameters of blood, to determine the relationship with the systemic inflammatory response in order to increase the effectiveness of treatment, to optimize the prognosis.

Purpose

To study and assess the correlations between the oxygen saturation index and blood tests in burn toxemia, depending on age.

Material and research methods

The results of monitoring the oxygen saturation index of patients admitted to the Department of Cambustiology of the Republican Scientific Center of Emergency Medicine due to severe burn 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 circadian rhythm of oxygen saturation were studied by hourly continuous recording of hemodynamic parameters 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, 3 group of 25 patients - 7.1-18 years old, 4 - 12 patients 19-40 years old, 5 - 7 patients 41-60 years old, group 6 - 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. Hemodynamic indices 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.

Table 1.

Patient characteristics

Subgroups	Groups	Age	Burn area of 2-3A degree in%	3 B degree	IF, units	Days in the ICU
1	2	19.3±6.2 months	32.7±9.8	0.1±0.03	33.4±10.1	6.8±1.8
		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	Group 2	4.7±0.8	37.3±14.7	3.1±4.4	42.5±15.7	8.1±1.3
		4.0±0.1	47.9±17.1	18.1±12.2	85.1±28.7	13.1±1.9
		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
		15±2	55.1±14.4	4.8±3.5	86.3±15.7	12.7±1.1
		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 tab. 1, the main factors influencing 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 3B degree, 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 $37.3 \pm 14.7\%$ in 1 subgroup, $47.9 \pm 17.1\%$ in 2, and 59.2 ± 12 in 3.2%. However, a statistically significant difference was found in the area of 3B degree burns in subgroups 1 and 3, which in the most severe group of children exceeded the 3B degree 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, and the area of 3B degree 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 the mean values were 27.3 ± 5.6 years in group 1, 50.7 ± 7.1 years in the second, and 71.3 ± 7 in the third. 0 years old. The total area and the area of deep burn damage to the skin did not differ significantly. The highest IF index was revealed in group 1, which determined the longest duration of intensive therapy in ICU conditions in group 4.

Results and its discussion

As can be seen from the data presented in Table 2, no significant deviations in the mesor of the circadian rhythm of the oxygen saturation indicator were found both on the first day and during the first 10 days of the toxemia period.

Table 2

Dynamics of the mesor of the circadian rhythm of the oxygen saturation indicator during the period of toxemia, depending on age

Days	Group 1 6 months-3 years			Group 2 from 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	Group 4	Group 5	Group 6
1	98.0±0.1	97.7±0.3	97.0±0.6	97.9±0.3	97.8±0.3	97.6±0.3	97.6±0.3	98.3±0.3	97.8±0.7	97.8±0.2	97.4±0.4	97.6±1.0
2	97.9±0.1	97.9±0.2	97.2±0.3	97.9±0.1	98.0±0.3	97.7±0.3	97.8±0.2	98.1±0.3	97.2±0.4	97.4±0.1	97.3±0.4	97.2±0.3
3	97.7±0.4	97.7±0.3	97.8±0.3	98.0±0.2	97.8±0.5	98.1±0.3	98.0±0.2	98.0±0.2	98.0±0.2	97.7±0.2	97.4±0.2	97.6±0.2
4	97.9±0.1	98.0±0.2	97.7±0.3	98.1±0.2	98.1±0.2	98.2±0.2	98.0±0.2	98.2±0.3	97.5±0.3	97.8±0.2	97.4±0.3	97.2±0.3
5	98.0±0.2	98.1±0.2	97.7±0.3	97.8±0.1	97.4±0.3	97.7±0.2	97.7±0.1	97.9±0.2	97.4±0.4	98.0±0.2	97.6±0.2	96.8±0.7
6	97.9±0.2	97.5±0.3	97.6±0.3	98.2±0.2	98.1±0.2	97.9±0.2	97.9±0.2	98.0±0.3	98.2±0.2	98.0±0.2	97.7±0.2	97.4±0.3
7	98.1±0.2	97.7±0.2	97.9±0.3	97.5±0.3	97.9±0.2	98.0±0.2	97.8±0.3	97.8±0.3	97.9±0.4	97.7±0.2	97.5±0.3	97.2±0.3
8	97.7±0.2	97.9±0.3	97.7±0.3	97.8±0.2	98.1±0.2	98.2±0.2	97.6±0.4	97.6±0.2	97.8±0.3	98.1±0.2	97.8±0.3	97.5±0.2
9	97.9±0.3	97.8±0.2	97.9±0.3	98.2±0.3	97.8±0.3	98.0±0.2	99.0±0.5	97.3±0.3	97.8±0.2	97.7±0.2	98.0±0.1	97.1±0.5
10	97.9±0.1	98.0±0.2	97.4±0.4		97.8±0.2	98.1±0.2		97.4±0.3	98.0±0.2	97.9±0.3	97.9±0.3	96.8±0.5

Oxygen therapy with almost continuous oxygen insufflation mainly through a nasal catheter during spontaneous breathing stabilized the oxygen saturation index at a level above 97% in all patients.

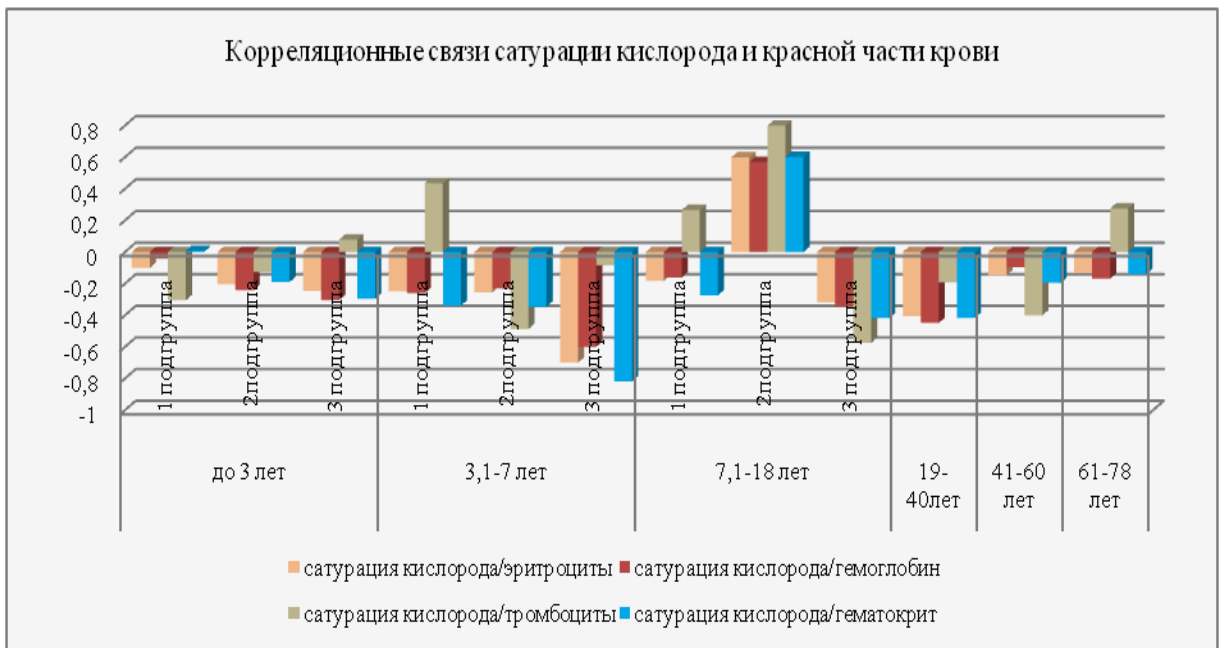


Fig.1

Direct correlation between the dynamics of the mesor of the circadian rhythm of the oxygen saturation indicator was revealed only in patients of the 2nd subgroup of the 3rd group, which amounted to 0.6 oxygen saturation with erythrocytes, hemoglobin, platelet count 0.9, hematocrit index 0.6, which indicates a direct dependence of the studied indicator on the number of erythrocytes, the level of hemoglobin, hematocrit and platelets with a burn surface area of $55.1 \pm 14.4\%$, 3B degree $4.8 \pm 3.5\%$, IF 86.3 ± 15.7 units. Moderate negative correlation with more severe burns with an area of $25.8 \pm 11.4\%$, with the depth of the surface lesion of 3B degree of $22.5 \pm 6.6\%$, IF 95.8 ± 19.1 units in subgroup 3 of group 3, suggests that that an increase in the area of deep 3B degree damage and an increase in IF are factors that violate the direct correlation dependence of oxygen saturation on the number of erythrocytes, platelets, hemoglobin and hematocrit. That is, blood transfusion in children of the 3rd subgroup of the 3rd group will not cause the desired increase in the oxygen saturation index and even there is a possibility of a tendency for a decrease in oxygen saturation with an increase in the number of erythrocytes, platelets, hemoglobin, and hematocrit in the blood. The same tendency of the negative effect of blood transfusion on the amount of oxyhemoglobin in the blood was revealed in the first 10 days of burn toxemia in children of the 3rd subgroup under the age of 3.1-7 years and less pronounced in adults.

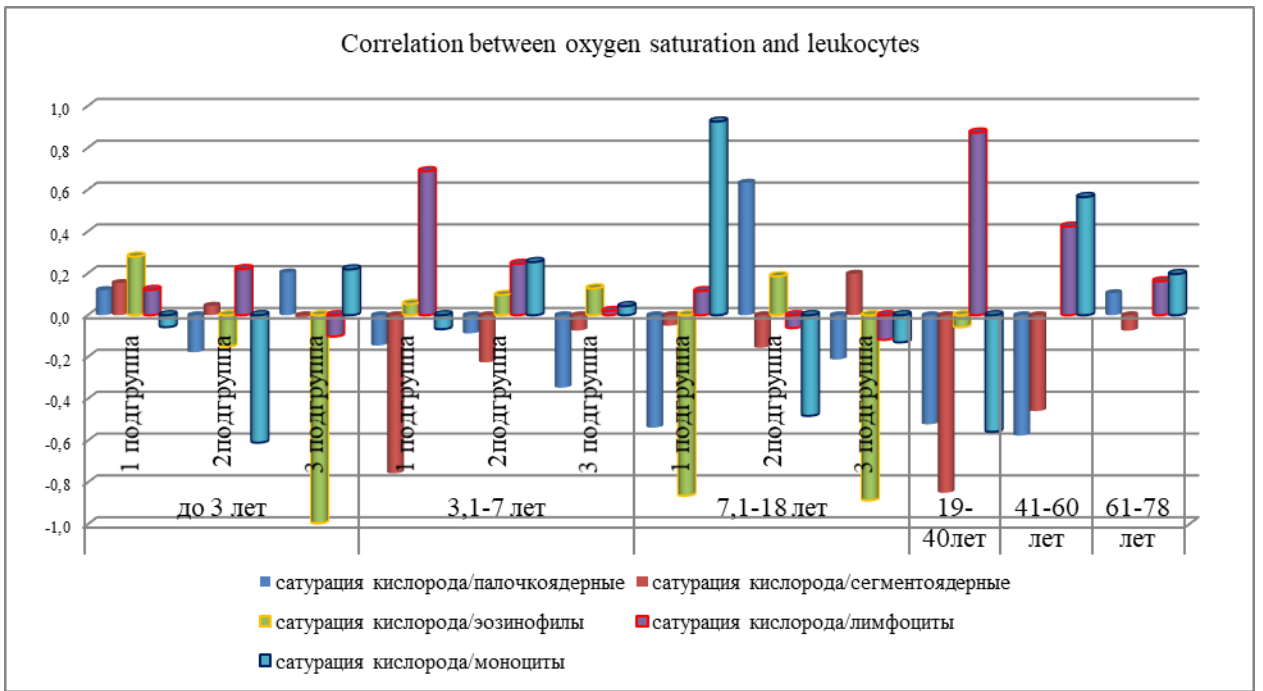


Fig.2

A strong direct correlation was found between the dynamics of monocytes and oxygen saturation in subgroup 1 of group 3, that is, with the area of the burned surface of the skin $37.3 \pm 14.7\%$, 3B degree $3.1 \pm 4.4\%$, IF 42.5 ± 15.7 units an increase in the number of monocytes with an increase in blood oxygenation can be interpreted as a feature of the inflammatory reaction of children of this age, when an increase in blood oxygenation increases the tendency to monocytosis with a relatively small area of 3B degree of skin lesion.

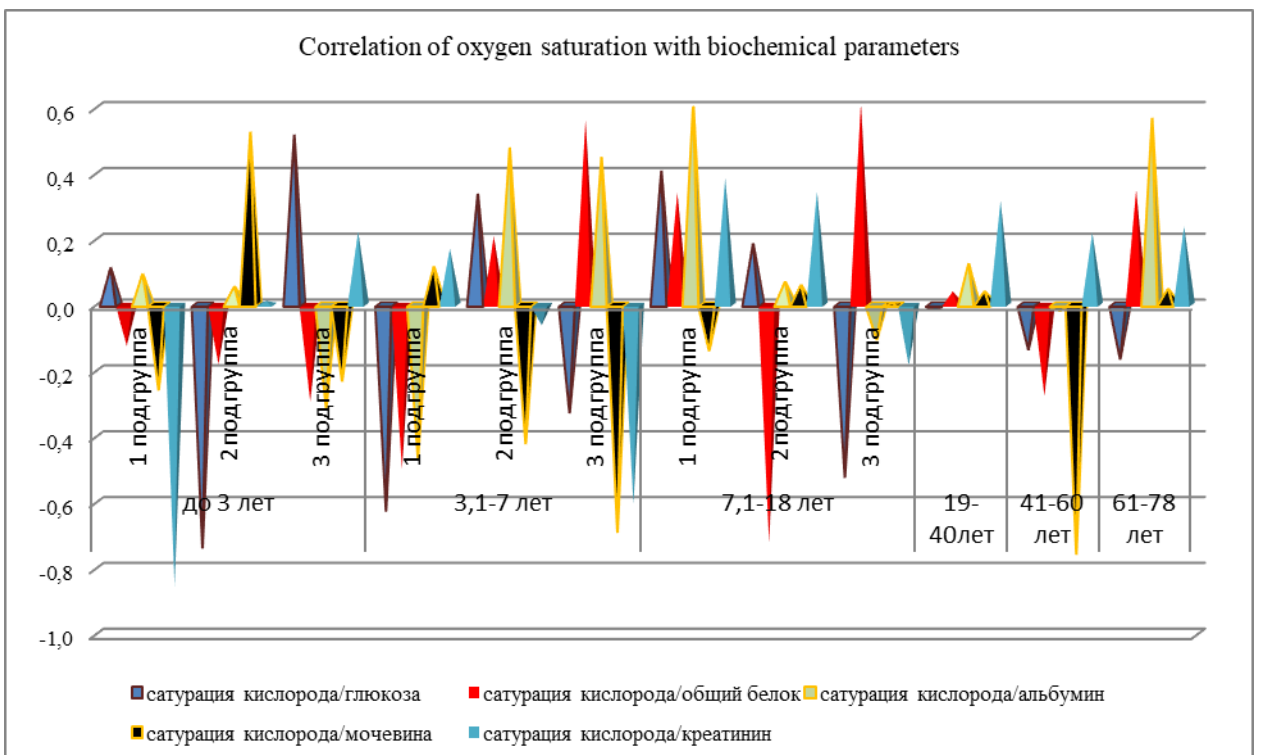


Fig.3

The feedback of oxygen saturation and glucose concentration in the blood (fig. 3) was revealed in subgroup 2 of group 1, which characterized a high probability of a decrease in the oxygen saturation index (-0.76) with an increase in blood glucose concentration with the largest area of deep burn 3B degree $9 \pm 2.8\%$ in infants. In order to correct the energy deficit state, all burned patients received parenteral nutrition in addition to the enteral administration of amino acids + reimbursement of the calorie requirement in the first days of toxemia with concentrated glucose solutions and later with fat emulsions. Probably in conditions of severe intoxication due to deeper destruction of the skin surface, high-osmolar solutions contributed to the difficulty of oxygen diffusion, which was manifested by the inverse relationship of the oxygen saturation index on the increase in plasma osmolarity by the introduction of hypertonic glucose solutions. The same tendency was revealed in patients of the 1st and 3rd subgroups of the second group, in the 3rd subgroup of the 3rd group. Confirmation of the effect of changes in the physical properties of plasma (increased oncotic pressure) on oxygen saturation is the inverse correlation between the protein concentration in the blood and the oxygen saturation index in the 2nd subgroup of children of the 3rd group in the burn area $55.1 \pm 14.4\%$, 3B degree $4.8 \pm 3.5\%$, IF 86.3 ± 15.7 units (fig. 3) Negative correlation between oxygen saturation and concentration in subgroup 1 of group 1, as well as a significant trend in the feedback of indicators in subgroup 3 of group 2, can also be explained by negative the influence on oxygenation at the level of the alveoli of changes in the concentration of creatinine in subgroup 1 of group 1 (-0.83), in subgroup 3 of group 2 (-0.61). The same direction of the influence of an increase in plasma osmolarity on blood oxygenation (-0.7) was found in children of the 3rd subgroup of the 2nd group with the most severe burns in this age group with an area of $59.2 \pm 12.2\%$, 3B degree $36.7 \pm 13.3\%$, IF 127.5 ± 33.3 units That is, excessive catabolism with more extensive and deep burns, causing an increase in metabolic products (urea and creatinine), significantly inhibited the process of hemoglobin oxygenation at the level of the pulmonary parenchyma.

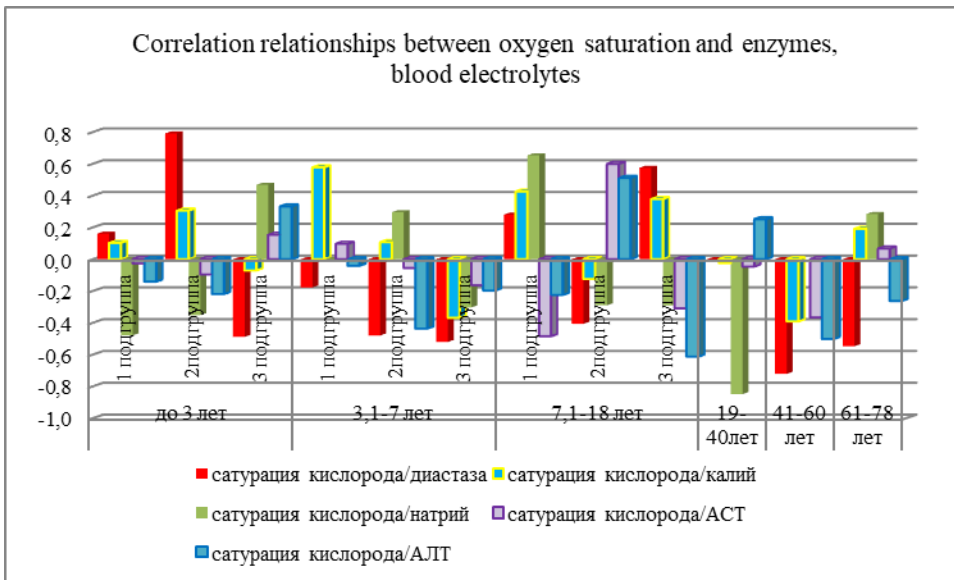


Fig.4

The greatest effect of diastase on oxygen saturation (Fig. 4) was observed in children of subgroup 2 of group 1 (0.78). The negative effect of an increase in the concentration of sodium in the blood on the oxygen saturation index was revealed in patients of group 4 (19-40 years old).

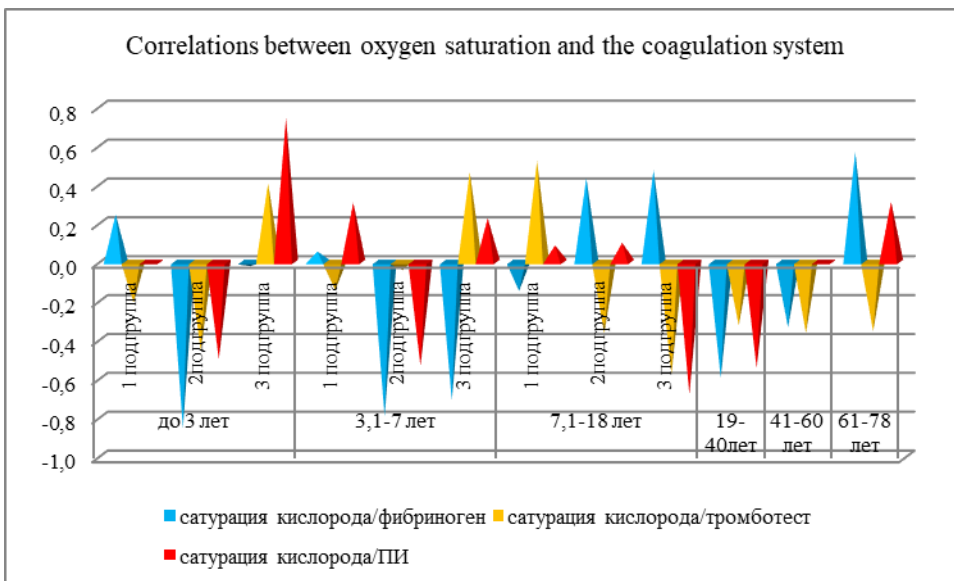


Fig.5

A negative effect of an increase in plasma fibrinogen (hypercoagulation in phase 3) on the oxygen saturation index in subgroup 2 of group 1, in 2 and 3 subgroups of group 2 and a moderate trend in group 4 was revealed, which characterized the negative effect of hypercoagulation in 3 phase on the process of blood oxygenation (fig. 5). The increase in the direct correlation between PI (coagulation in phase 2 of coagulation) and oxygen saturation

(0.69) in subgroup 3 of group 1 was due to the negative effect of liver dysfunction in toxic hepatitis on the process of blood oxygenation in the most severely burned infants.

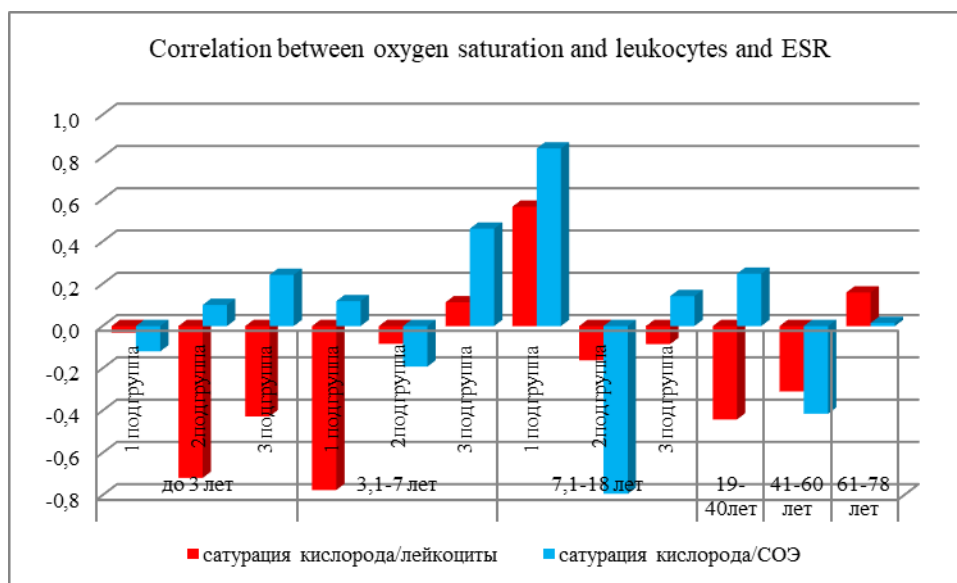


Fig.6

In the first decade of burn toxemia, a decrease in leukocytosis increased the oxygen saturation index of AO 2 in subgroup 1 of group 2 (-0.72), in subgroup 1 of group 2 (-0.76) (Fig. 6). In the 1st subgroup of children of the 3rd group, the revealed direct correlation (ESR) of the erythrocyte sedimentation rate, apparently with the participation of additional compensatory mechanisms, increases oxygen saturation (0.8), and in the 2nd subgroup of the 3rd group, a decrease in ESR (-0.78).

Conclusions. Oxygen therapy with oxygen insufflation through a nasal catheter during spontaneous breathing stably maintained oxygen saturation at a level above 97% in all patients. Only in patients of subgroup 2 of group 3 was there a direct dependence of oxygen saturation on the number of erythrocytes, hemoglobin level, hematocrit and platelets with a burn surface area of $55.1 \pm 14.4\%$, grade 3 B $4.8 \pm 3.5\%$, IF $86, 3 \pm 15.7$ units. A high probability of a decrease in the oxygen saturation index (-0.76) was revealed with an increase in the concentration of glucose in the blood with the largest area of deep burn 3B degree $9 \pm 2.8\%$ in infants. In conditions of severe intoxication due to deeper destruction of the skin surface, an increase in osmolarity and oncotic pressure of plasma contributed to the difficulty of oxygen diffusion in the alveolocapillary membrane, which was manifested by an inverse relationship between the oxygen saturation index and plasma osmolarity when hypertonic glucose solutions were administered. A negative effect of an increase in plasma fibrinogen on the oxygen saturation index was revealed in subgroup 2 of group 1, in 2 and 3 subgroups of group 2 and a moderate trend in group 4.

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