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## CHANGE OF THE HEMOGLOBIN LEVEL DURING THE RESUSCITATION PERIOD IN PATIENTS WITH TRAUMATIC BRAIN INJURY, ACCORDING TO THE CHARACTER OF THE TRAUMA

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The purpose of the study was to determine a possible relationship between the nature of the injury and hemoglobin levels in patients admitted to hospital with traumatic brain injury. The study included 299 trauma patients admitted to the Clinical Medical Center within 1–1.5 hours after trauma. In addition to dividing the patients by gender, they were divided into age ranges and the origin of the injury. The patients were analyzed in 4 groups depending on the isolation of the traumatic brain injury or its combination with other injuries. In each group, hemoglobin levels were determined in blood samples 4 times on the 1st, 2nd, 3rd, and 4th days. The average level of this parameter in individuals with traumatic brain injury was  $97.4 \pm 2.5$  g/L (50.0–157.0 g/L). In 32 patients who suffered a mixed form of injury, the average value was  $88.8 \pm 3.2$  g/L (50.0–142.0 g/L). The results show that there were no significant differences between the hemoglobin level in the blood and the nature of craniocerebral injuries. However, it is undoubtedly important to conduct a study of patients with craniocerebral injury in the acute period of pathology.

**Key words:** traumatic brain injury, combined injuries, immunity, hemoglobin.

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## ЗМІНА РІВНЯ ГЕМОГЛОБІНУ В РЕАНІМАЦІЙНОМУ ПЕРІОДІ У ХВОРИХ З ЧЕРЕПНО-МОЗКОВОЮ ТРАВМОЮ В ЗАЛЕЖНОСТІ ВІД ХАРАКТЕРУ ТРАВМИ

Метою дослідження було визначення можливого зв'язку між характером травми та показниками рівня гемоглобіну у пацієнтів, доставлених до стаціонару з черепно-мозковою травмою. До дослідження було включено 299 травматологічних хворих, доставлених до Клінічного медичного центру через 1–1,5 години після травми. Крім поділу пацієнтів за статтю, вони були поділені на вікові діапазони та походження травми. Пацієнти були проаналізовані за 4 групами залежно від ізолюваності черепно-мозкової травми або її поєднання з іншими травмами, у кожній групі показники гемоглобіну визначалися у зразках крові 4 рази на 1-й, 2-й, 3-й та 4-й день. Середній рівень зазначеного параметра в осіб із черепно-мозковою травмою становив  $97,4 \pm 2,5$  г/л (50,0–157,0 г/л). У 32 пацієнтів, які перенесли змішану форму травми, середній показник становить  $88,8 \pm 3,2$  г/л (50,0–142,0 г/л). Результати показують, що не спостерігалось значних відмінностей між рівнем гемоглобіну в крові та характером черепно-мозкових травм. Однак, безперечно, дослідження пацієнтів з черепно-мозковою травмою важливо проводити в гострому періоді патології.

**Ключові слова:** черепно-мозкова травма, поєднані травми, адаптивний імунітет, рівень гемоглобіну.

The development of industry, and the increase in construction works and vehicles have further increased the intensity of traumatic injuries, which has led to an increase in deaths and post-traumatic complications [5, 7]. Common traumas have a special place among traumatic injuries, as many serious extracranial complications occur during these types of traumas [12]. Hemodynamic disturbances, cases of aspiration, intubation of the trachea, etc., may cause complications in the broncho-pulmonary system in the

early period of a common head and brain injury [1, 8, 9]. Due to open fractures and loss of vascular integrity in persons with head trauma, serious changes in the health status of patients can be observed against the background of the development of extreme cases such as bleeding, suffocation, loss of consciousness in the form of coma. It should be noted that the percentage of death observed during inflammatory processes in the bronchus-pulmonary system during the acute period of independent and joint head injuries is higher in comparison with isolated chest injuries in joint injuries [2, 8].

These problems lead to an increase in cases of frequent and complete loss of working capacity and even disability, the prevalence of which will have poor dynamics in the future due to the continuing increase in the number of traumatic brain injuries (TBI) [5, 9, 13]. Such negative dynamics can be corrected by conducting comprehensive studies to reduce the incidence of serious complications and secondary brain damage, as well as by searching for and implementing accessible and at the same time optimal methods of diagnosis and management of people with traumatic brain injuries [12, 15]. Determination of the severity of brain damage in traumatic brain injury and its impact on the body's condition allows, along with the implementation of radiation diagnostics, the study of quantitative indicators of some diagnostically and prognostically significant biochemical markers, since after serious and deep traumatic injuries, there may be pronounced stress in the immune system, which contributes to the development of immune imbalances against the background of suppression of the reserve capabilities of immune homeostasis [3, 6, 14, 15]. The state of compensatory immune reactions, the study of the role of these factors in the formation of clinical manifestations of TBI, during the post-traumatic period, the development of complications in victims currently remain poorly studied issues, although early detection and determination of optimal diagnostic criteria will allow predicting the nature of the course of the pathological condition of traumatic genesis and the development of serious post-traumatic complications [6, 10, 11].

**The purpose** of the study was to determine the possible relationship between the nature of the trauma and hemoglobin level indices in patients brought to the hospital with a head injury.

**Materials and methods.** In order to determine the possible relationships between the nature of the trauma in patients brought to the hospital with head trauma, the occurrence of complications and death in the respiratory system, and the relationship between a number of blood parameters (hemoglobin and hematocrit) from the trauma on 299 traumatological patients who were brought to the Clinical Medical Center after 1–1.5 hours were included in the study, and the study consisted of several stages. In addition to dividing patients by gender, they were divided into age ranges of <20, 20–29, 30–39, 40–49, 50–59, 60–69 and  $\geq 70$ , and according to origin of the trauma: “unknown”, falls from height, traffic, industrial and household. Separation was also made according to the presence or absence of previous lung and heart diseases in the patients.

Whether or not the patients received first aid, whether or not intubation was done, whether it was done within 1 hour or longer, according to the conditions of the brought patients, which are normal, moderate, severe, very severe and preagonal, whether the consciousness is clear or unclear. conditionally separated according to the presence or absence of sedation or the presence of degrees I, II and III. After separating the patients into head trauma only, head trauma+peripheral trauma, head trauma+chest trauma, head trauma+abdominal trauma, and head trauma+mixed trauma of other areas, each trauma group Hemoglobin (HGB) indicators were determined in blood samples brought to the hospital 4 times on the first, second, third and finally the fourth day.

At the next stage of the research, the analysis of patients with similar blood parameters, complications in the respiratory system, and complications that occurred in the cases of death were performed on groups that had complications that were also noted in the research facilities. Patients were conditionally separated due to the application of additional examination methods such as primary X-ray, ultrasound, computed tomography, detection of subdural hematomas, development of arterial hypotonia and complications to the bronchus-pulmonary system, and finally death. The criteria for inclusion in the study were the following – victims with a verified diagnosis of TBI; age older than 18 years; patients without concomitant somatic pathology; Patients with laboratory and instrumental parameters without pronounced deviations and reflecting the general state of the body are normal. The inclusion criteria for the study were as follows: victims with a verified diagnosis of TBI; age over 18 years; patients without concomitant somatic pathology; patients with laboratory and instrumental parameters without significant deviations and reflecting the general condition of the body within the norm.

The exclusion criteria were victims with severe somatic pathology, in particular, with liver, kidney and severe cardiovascular failure; age under 18 years. All patients without exception, in addition to the clinical, laboratory and instrumental studies, were examined by doctors of other specialties, including a therapist, psychiatrist, ophthalmologist, otolaryngologist, and, in the presence of combined traumatic injuries, a urologist, pulmonologist, etc.

The obtained numerical data were processed using statistical methods that took modern requirements into account. The mean values (M), their standard error (m), the minimum (min) and maximum (max) values of the series, as well as the frequency of occurrence of the quality indicators in the groups, and the lower and upper limits of the 95 % confidence interval were determined for the group indicators. For this purpose, the Statistica 7.0 application computer program was used, the obtained results were reflected in a table and a diagram.

**Results of the study and their discussion.** In the first stage of the study, a total of 299 were conducted in order to determine the possible relationships between the nature of the trauma, the occurrence of complications and death in the respiratory system, and a number of blood parameters (hemoglobin) in patients brought to the hospital with head trauma. In 90 traumatological patients, head trauma only occurred, of which 80 had hemoglobin levels determined on the first day of hospitalization. At this time, the average level of the mentioned parameter in persons with head trauma was found to be  $97.4 \pm 2.5$  g/L, where the minimum value was 50.0 g/L, and the maximum value was 157.0 g/L. has been done. The lower limit of the 95 confidence interval was 92.4 g/L and the upper limit was 102.4 g/L when we determined the mean level of the patients who had only head trauma and had hemoglobin analysis performed on the first day of hospitalization.

In the period of the study covering the second day of the patients' hospitalization, only 48 of the patients with head trauma (n=90) had blood hemoglobin levels determined. The average level of hemoglobin in the examined patients (n=48) during this period was  $82.2 \pm 2.1$  g/L, while the minimum hemoglobin level among patients was 50.0 g/L, and the maximum level was 110.0 g/L. received. The lower and upper limits of the confidence interval of 95 g/L were 77.9 g/L and 86.5 g/L, respectively, in the patients in whom we determined the hemoglobin level only from the patients who received a head injury during the corresponding period. Hemoglobin levels were determined in 19 patients (n=90) with only head trauma on the 3rd day of the patients' hospitalization, at which time the minimum value was 50.0 g/L, and the maximum value was 110.0 g/L, with an average of  $86.7 \pm 3.5$  g/L was calculated.

Based on these indicators, the lower indicator of the 95 g/L confidence interval is 79.3 g/L and the upper indicator is 94.1 g/L. On the last day of the study or on the 4th day of the patients' hospitalization, only 11 of the patients with head trauma (n=90) had repeated hemoglobin levels in the blood, and the mean level was calculated to be  $82.5 \pm 5.0$  g/L. the minimum value was 44.0 g/L and the maximum value was 108.0 g/L. The lower and upper limits of the 95 g/L confidence interval for hemoglobin level indicators in the relevant period were 71.5 g/L and 93.6 g/L, respectively (Table 1).

Table 1

**Hemoglobin levels in blood samples by days of hospitalization**

Parameter	The nature of trauma	N	Mean HGB	Low HGB	High HGB	95 % confidence interval (g/L)		
						Lower bound	Upper bound	
Hospitalization, Days	1st day	TBI	80	$97.4 \pm 2.5$	50.0	157.0	92.4	102.4
		TBI + extremity	84	$101.8 \pm 2.3$	50.0	150.0	97.3	106.3
		TBI + chest	50	$92.8 \pm 3.1$	50.0	136.0	86.6	99.0
		TBI + abdominal	21	$97.2 \pm 4.7$	60.0	146.0	87.5	107.0
		TBI + concomitant	32	$88.8 \pm 3.2$	50.0	142.0	82.2	95.3
		Total	267	$96.9 \pm 1.3$	50.0	157.0	94.3	99.5
	2nd day	TBI	48	$82.2 \pm 2.1$	50.0	110.0	77.9	86.5
		TBI + extremity	46	$85.3 \pm 2.7$	44.0	140.0	79.9	90.8
		TBI + chest	26	$84.6 \pm 3.1$	44.0	124.0	78.2	91.0
		TBI + abdominal	16	$86.6 \pm 3.1$	68.0	110.0	80.0	93.3
		TBI + concomitant	21	$81.1 \pm 3.8$	60.0	140.0	73.3	89.0
		Total	157	$83.8 \pm 1.3$	44.0	140.0	81.3	86.4
	3rd day	TBI	19	$86.7 \pm 3.5$	50.0	110.0	79.3	94.1
		TBI + extremity	17	$82.8 \pm 3.1$	55.0	106.0	76.1	89.4
		TBI + chest	16	$81.5 \pm 2.4$	62.0	98.0	76.5	86.5
		TBI + abdominal	8	$84.8 \pm 7.1$	50.0	110.0	67.9	101.6
		TBI + concomitant	6	$86.3 \pm 1.3$	82.0	92.0	83.0	89.7
		Total	66	$84.2 \pm 1.6$	50.0	110.0	80.9	87.4
	4th day	TBI	11	$82.5 \pm 5.0$	44.0	108.0	71.5	93.6
		TBI + extremity	20	$87.3 \pm 1.7$	68.0	100.0	83.7	90.9
		TBI + chest	12	$88.2 \pm 2.0$	78.0	100.0	83.7	92.6
		TBI + abdominal	8	$82.5 \pm 6.4$	44.0	108.0	67.4	97.6
		TBI + concomitant	3	$89.3 \pm 4.1$	82.0	96.0	71.9	106.8
		Total	54	$85.9 \pm 1.6$	44.0	108.0	82.8	89.1

Note: \* – these indices include the moment when the patients were admitted to the hospital; in the study, the scores obtained for the first day increased after they were given first aid.

In the first, second, third, and fourth days after hospitalization, 84 of the patients (n=95) with head trauma and limb trauma were recorded during the general blood analysis of blood samples taken on the first day of hospitalization. At this time, the minimum and maximum level indicators were recorded as 50.0 g/L and 150 g/L, respectively, and the mean level index was calculated as  $101.8 \pm 2.3$  g/L. During this period, the lower and upper limits of the confidence interval of 95 g/L for the obtained hemoglobin level in patients with traumatic brain injury (TBI)+peripheral trauma were determined as 97.3 g/L and 106.3 g/L, respectively. Hemoglobin levels were determined in 46 of them (n=95) on the 2nd day after hospitalization with TBI+peripheral trauma, and the minimum, maximum, and average level indicators were  $85.3 \pm 2.7$  g/L, 44.0 g/L and 140.0 g/L, respectively.

Hemoglobin levels were determined in 17 patients (n=95) with appropriate co-trauma on the next day of hospitalization of patients with TBI+peripheral trauma, i.e. on the 3rd day, at which the minimum, maximum and average hemoglobin values were 55.0g/ L, 106.0 g/L and  $82.8 \pm 3.1$  g/L were recorded. The lower limit of the 95 g/L confidence interval was determined at 76.1 g/L and the upper limit at 89.4 g/L according to the hemoglobin level indicators conducted in the corresponding period. On the last day of the study or on the 4th day of the patients' hospitalization, hemoglobin levels were studied in 20 patients (n=95) who had TBI+peripheral trauma, and as a result, its minimum, maximum and average levels in the research objects were 68.0 g/L, 100.0 g/L and  $87.3 \pm 1.7$  g/L were determined. During this period of the study, according to the hemoglobin level indicators obtained in patients with TBI+peripheral trauma, the lower and upper limits of the 95 g/L confidence interval were 83.75 and 90.9 g/L, respectively.

The next stage of the research was the analysis of the hemoglobin levels of the patients who had head trauma and chest trauma on the first, second, third and fourth days of the patients' hospitalization. At this time, on the first day of being brought to the hospital, as a result of the blood analysis conducted in 50 of the 53 TBI+chest trauma patients, the minimum, maximum, and mean level indices of hemoglobin in the research facilities were 50.0 g/L, 136.0 g/L, respectively. and  $92.8 \pm 3.1$  g/L was recorded. In this period, the minimum limit of the confidence interval of 95 g/L was defined as 86.6 g/L, and the maximum limit was determined as 99.0 g/L. On the next day of hospitalization of the respective patients, the level of hemoglobin in the blood was carried out in 26 research facilities, in which the minimum level index was 44.0 g/L, the maximum level index was 124 g/L and the mean level index was  $84.6 \pm 3.1$  g/L it was calculated that the minimum and maximum limits of the confidence interval of 95 g/L according to the indices were 78.2 g/L and 91.0 g/L, respectively. On the 3rd day of bringing the patients to the hospital, 16 of the patients (n=53) who had TBI+chest trauma had hemoglobin indices in their blood again, as a result, the minimum, maximum and mean level indices of the mentioned blood parameter in the corresponding patients were 62.0 g/L was calculated as 98.0 g/L and  $81.5 \pm 2.4$  g/L, while the lower and upper limits of the 95% confidence interval were 76.5 g/L and 86.5 g/L, respectively.

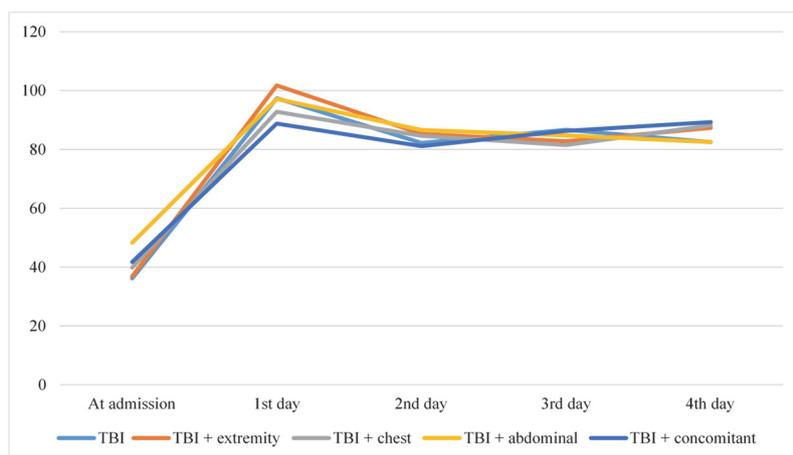


Fig. 1. The dynamics of hemoglobin levels detected in blood samples by days of hospitalization.

On the 4th day of hospitalization, blood hemoglobin levels were determined again in 12 of the patients (n=53) who received TBI+chest trauma, and at this time, the minimum level of hemoglobin we recorded in the research facilities was 78.0 g/L, the maximum level was 100.0 g/L and the mean level index was  $88.2 \pm 2.0$  g/L. Based on the indices obtained at this time, the minimum and maximum limits of the 95 g/L confidence interval were 83.7 g/L and 92.6 g/L, respectively (Fig. 1).

The next stages of the research were determined the hemoglobin levels of 21 research subjects on the first day of hospitalization in a subgroup consisting of patients with head trauma and abdominal trauma (n=24), and as a result, the minimum level index of the mentioned parameter was 60.0 g/L, the maximum index was 146.0 g/L and the mean level index was  $97.2 \pm 4.7$  g/L, while the lower and upper limits of the confidence interval of 95 g/L for the corresponding indices were 87.5 g/L and 107.0 g/L, respectively. On the next day of hospitalization, i.e., on the second day, 16 of the patients (n=24) who had TBI+abdominal trauma had repeated hemoglobin level indices, at which time the minimum hemoglobin level index was

68.0 g/L, and the maximum analogous index was 110.0 g/L. It was recorded and the mean analogue index was determined by calculations to be  $86.6 \pm 3.1$  g/L. According to the relevant indices, the lower and upper limits of the 95 g/L interval were calculated as 80.0 g/L and 93.3 g/L.

On the 3rd day of the study and the patients' hospitalization, hemoglobin levels were again determined from 8 patients ( $n=24$ ) who had joint trauma in the form of TBI+abdominal trauma. As a result of the study, it was determined by calculations that the mean level of hemoglobin in the blood samples of the relevant patients was  $84.8 \pm 7.1$  g/L. Among the subjects, the minimum hemoglobin level was 50.0 g/L and the maximum analog level index was 110.0 g/L, the limits of the 95 g/L confidence interval were 67.9 g/L and 101.6 g/L, respectively. On the 4th day of hospitalization of the study subjects, hemoglobin levels were repeatedly determined in 8 patients ( $n=24$ ) who received TBI+abdominal trauma, and the minimum and maximum hemoglobin levels detected in their blood materials were 44.0 g/L and 108.0 g/L, respectively. The mean analogue level index was calculated as  $82.5 \pm 6.4$  g/L. According to the relevant indices, the minimum and maximum limits of the 95 g/L confidence interval were 67.4 g/L and 97.6 g/L, respectively.

In the next part of the study, the analysis of the blood hemoglobin levels of the patients ( $n=37$ ) who had a mixed trauma of several other areas and the skull brain trauma on the first, second, third and fourth day of hospitalization was carried out according to the mentioned parameter. As a result of determination of hemoglobin levels in 32 patients who were exposed to a common form of trauma, the minimum level index was 50.0 g/L, the maximum level index was 142.0 g/L, and the mean for the group was calculated as  $88.8 \pm 3.2$  g/L.

Based on the results, the lower and upper limits of the 95 g/L confidence interval were 82.2 g/L and 95.3 g/L, respectively. On the next day of hospitalization, 21 of the patients ( $n=37$ ) who had TBI+combined trauma had hemoglobin indices recorded again. As a result, the minimum and maximum hemoglobin levels found in the patients' blood samples were 60.0 g/L, and the mean hemoglobin level was  $81.1 \pm 3.8$  g/L. At this time, according to the indices, the lower limit of the confidence interval of 95 g/L was determined at 73.3 g/L and the upper limit at 89.0 g/L. On the 3rd day of the patients' hospitalization, blood hemoglobin levels were recorded in 6 of the patients ( $n=37$ ) who had a head trauma and a mixed trauma of other areas. the mean index was calculated to be  $86.3 \pm 1.3$  g/L with the level indices corresponding to 82.0 g/L and 92.0 g/L. The minimum and maximum limits of the confidence interval of 95 g/L were determined as 83.0 g/L and 89.7 g/L, respectively. On the 4th day after the hospitalization of the patients, the indices of the amount of hemoglobin in the blood were studied repeatedly in 3 traumatized patients ( $n=37$ ) who received TBI+mixed combination.

At that time, the minimum hemoglobin level index was 82.0 g/L, and the maximum analogous index was 96.0 g/L. During the calculations, it was revealed that the mean hemoglobin level index in the blood materials of the research subjects was  $89.3 \pm 4.1$  g/L. The lower and upper limits of the 95 g/L confidence interval were calculated as 71.9 g/L and 106.8 g/L, respectively.

Thus, during the examination of the patients included in the study, TBI was found most often of moderate and severe degree. At the same time, there is a fact of a pronounced predominance of persons of the male gender. All patients underwent a thorough comprehensive examination, during which special attention was paid to the study of clinical symptoms associated or accompanying trauma, in particular, such as the presence of complaints of decreased memory, concentration, disorientation, as well as the development of somatic and mental pathologies in patients, neurological broken.

Patients, with their written consent, were tested for the concentration of hemoglobin in the blood to confirm the role of some biomarkers in the early diagnosis of TBI and its complications. With the subsequent statistical analysis, a data base was formed, establishing laboratory symptoms of low, medium and high hemoglobin content, as an important diagnostic criterion in our case for early disorders of carbohydrate metabolism. The obtained results were compared in the group of patients with isolated TBI and clinically significant brain damage and in persons burdened by combined traumatization of the head area and various organs. This data are similar with other sources [3, 14].

Some studies, devoted the analyzing of causes and age of patients with TBI depending on the frequency, showed that the increase in the incidence of severe TBI was associated with TBI related to falls. The authors noted the importance of preventing TBI by reducing falls, especially in the elderly [4, 13].

In the other works it was emphasized that the high level of traumatic brain injuries presents among people of the most working age. Such possible dynamics can be excluded by conducting in-depth comprehensive studies to further study the characteristics of the occurrence and development of traumatic brain injuries and their complications [5, 11].

## Conclusions

1. The mean level of this parameter in individuals with traumatic brain injury was  $97.4 \pm 2.5$  g/L (50.0–157.0 g/L).

2. In 32 patients who suffered a mixed form of injury, the mean value was  $88.8 \pm 3.2$  g/L (50.0–142.0 g/L). The results show that there were no significant differences between the hemoglobin level in the blood and the nature of craniocerebral injuries.

Clinical, instrumental and laboratory methods of research of patients with brain trauma should be carried out, first of all, in the very initial period, that is, in the acute period of pathology. The results obtained during the study show that no significant differences were observed between the correction and management of blood hemoglobin levels when head injuries occurred independently or jointly, when they were brought to the hospital and later operative interventions were performed, and the management of hemoglobin levels in the blood was not observed with the specified forms of trauma. dependence was not registered with significant statistical indices.

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