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Original article

PECULIARITIES OF TROPHOLOGICAL STATUS IN VICTIMS OF EMERGENCIES WITH LONG CONSCIOUSNESS IMPAIRMENT DUE TO CRANIOCEREBRAL INJURY

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Abstract. *The aim of the study* was to investigate peculiarities of trophological status, to identify prevalence, severity and types of trophological insufficiency and to analyze the effect of infectious complications on the severity of protein-energy malnutrition in victims of emergency situations with long-term impairment of consciousness due to traumatic brain injury.
Materials and research methods. The study involved 126 victims of various age groups, who underwent primary screening using NRS-2002 scale, indicators of trophological status and the effect of infectious complications on the severity of protein-energy malnutrition were assessed.
Research results and their analysis. Screening showed a high risk of malnutrition in all patients. Indicators of trophological status were less than the reference values. In all age groups, both men and women, moderate protein-energy malnutrition prevailed (82.5%). For young patients, marasmus (64.6%) and marasmic kwashiorkor (34.3%) were most typical. The trophological status of the victims – regardless of the severity and in more than half of the cases – was represented by marasmus and, less often, by kwashiorkor. Patients with infectious complications had a high risk of moderate and severe protein-energy malnutrition development, p <0.001.

Key words: *emergency situations, long-term impairment of consciousness, nutritional support, PEM, protein-energy malnutrition, traumatic brain injury, trophological status*

Conflict of interest. The authors declare no conflict of interest

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Оригинальная статья

ОСОБЕННОСТИ ТРОФОЛОГИЧЕСКОГО СТАТУСА У ПОСТРАДАВШИХ В ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЯХ С ДЛИТЕЛЬНЫМИ НАРУШЕНИЯМИ СОЗНАНИЯ ВСЛЕДСТВИЕ ЧЕРЕПНО-МОЗГОВОЙ ТРАВМЫ

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Резюме. *Цель исследования* – изучить особенности трофологического статуса, выявить распространенность, выраженность, типы трофологической недостаточности и проанализировать влияние инфекционных осложнений на степень тяжести белково-энергетической недостаточности (БЭН) у пострадавших в чрезвычайных ситуациях (ЧС) с длительными нарушениями сознания вследствие черепно-мозговой травмы (ЧМТ).
Материалы и методы исследования. В исследовании участвовали 126 пострадавших различных возрастных групп. Проводился первичный скрининг с использованием шкалы NRS-2002, оценены показатели трофологического статуса и влияние инфекционных осложнений на степень тяжести БЭН.
Результаты исследования и их анализ. Проведенный скрининг показал высокий риск развития недостаточности питания у всех пациентов. Показатели трофологического статуса были меньше референсных значений. Во всех возрастных группах – как у мужчин, так и у женщин – преобладала (82,5%) БЭН средней степени тяжести. Для пациентов молодого возраста были наиболее характерны маразм (64,6%) и маразматический квашиоркор (34,3%). Трофологический статус у пострадавших – вне зависимости от степени тяжести и больше чем в половине случаев – был представлен маразмом и реже – квашиоркором. У пациентов с инфекционными осложнениями имелся высокий риск развития БЭН средней и тяжелой степени тяжести, p<0,001.

Ключевые слова: *белково-энергетическая недостаточность, длительное нарушение сознания, нутриционная поддержка, трофологический статус, черепно-мозговая травма, чрезвычайные ситуации*

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Introduction

Traumatic brain injury (TBI) is the most important medical and social problem due to its high prevalence, high mortality and disability rates, as well as to economic costs of treatment and rehabilitation of victims with TBI [1]. In recent years, the world sees an increase in number of natural disasters, man-made disasters, road traffic accidents, terrorism and military conflicts accompanied by traumatic injuries, especially those of the brain. The proportion of injuries to skull and brain is more than 1/3 in the total number of all injuries, and number of such injuries is growing by an average of 2% per year [2]. According to the World Health Organization (WHO), in the world every year 1.5 million people die from TBI and 2.4 million people become disabled.

The most severe neurological manifestations of TBI are bulbar and pseudobulbar syndromes, manifested by neurogenic dysphagia, in which the transport of food from oral cavity to esophagus suffers. This negatively affects the quality of life, increases risk of aspiration pneumonia, dehydration, energy metabolism disorders, leading to cachexia. In such cases, a mandatory component of modern approaches to treatment is nutritional support based on various mixtures for enteral nutrition.

Severe TBI refers to a group of pathological conditions occurring with pronounced symptoms of hypermetabolism – hypercatabolism syndrome. Metabolic stress and the subsequent cascade of catabolic events with the development of severe malnutrition have a significant impact both on survival of victims with severe TBI and on the level of neurological deficit in its outcome [3]. For example, in an acute period of severe TBI, the severity of metabolic disorders depends on the volume and nature of brain damage. Protein deficiency can reach 180-200 g / day, which corresponds to a loss of 750 g of muscle mass [4]. Untimely correction of emerging protein-energy malnutrition (PEM) in TBI patients leads to depletion of the body and to a decrease in adaptive reserves, to development of infectious complications and to multiple organ fail. This not only lengthens the period of hospital stay, but also increases mortality [5].

Infectious complications in patients, who are in prolonged unconsciousness, are primarily a consequence of the peculiarities of their immune status. The main mechanisms of the immunopathological process in them are: decrease in T-lymphocytes, IgG, phagocytic activity of leukocytes; violation of the relationship of immunoregulatory cells; autoneurosensitization and "autoaggressive" nature of immune responses [6]. Chronic infectious processes intensify the manifestations of trophological insufficiency.

Due to the fact that in patients with long-term impairment of consciousness after TBI, adequate correction of the trophological status is an obligatory component of rehabilitation process, an urgent task in managing such patients is the optimization of nutritional support.

The aim of the study was to explore the features of trophological status, to reveal the prevalence, severity, types of trophological insufficiency and to analyze the influence of infectious complications on the severity of PEM in victims of emergencies with long-term impairment of consciousness due to TBI.

Materials and research methods.

The study prospectively included 126 victims of emergencies (hereinafter referred to as patients) with long-term impairment of consciousness due to TBI, which took place in 2016–2020. They underwent a course of medical rehabilitation on the basis of the medical rehabilitation department of the All-Russian Center for Emergency and Radiation Medicine named after A.M. Nikiforov of EMERCOM of Russia. The age of the patients is 18–87 years old; the average age is (35.1 ± 1.28) years. In the total number of patients there were 102 men, aged 18–87, average age (36.3 ± 1.44) years; women — 24, aged 18–66, average age — (29.9 ± 2.57) years. In accordance with the WHO age classification, the group of young patients (18-44 years old) included 99 people; middle age (45–59 years old) — 20; elderly (60 — 74 years old) — 4; senile age (75–90 years old) — 3 people. Thus, young people predominated among the patients.

Inclusion criteria for the study: TBI duration - more than 1 month; level of consciousness - vegetative state or the state of minimal consciousness; signs of trophological insufficiency requiring correction at the time of admission; age — over 18 years old; duration of the inpatient medical rehabilitation course — 28 days. Patients excluded from the study: with a burdened history and concomitant urgent pathology, with unstable hemodynamics, with febrile syndrome, with systemic inflammatory reaction, with intestinal dysfunction (digestive disorder), with diseases of internal organs in the stage of decompensation.

Upon the initial examination anamnesis, clinical examination and determination of the level of consciousness were carried out. When examining and evaluating patients with chronic impairment of consciousness, a standardized integrated approach was applied using a protocol for managing patients in vegetative state and in a state of minimal consciousness of traumatic and nontraumatic genesis as well as a revised Coma Recovery Scale-Revised (CRS-R), and since 2018 year — Russified version of the revised scale of recovery after coma (Coma Recovery Scale-Revised - CRS-R) - [7, 8].

Chronic disturbances of consciousness were presented: in the form of a vegetative state — in 17 patients (men — 13, women — 4); in the form of a state of minimal consciousness — in 109 patients (men — 89, women — 20). Thus, among the surveyed, patients with a state of minimal consciousness prevailed (86.5%).

Clinical assessment of violations of trophological status requires an integrated approach for a correct interpretation of signs of trophological insufficiency. In accordance with the study design, after assessing the level of consciousness, all patients underwent step-by-step diagnostics in order to correctly and accurately identify impairment of their nutritional status. According to the recommendations of the European Society for Clinical Nutrition and Metabolism, screening was performed using the Nottingham Nutritional Risk Assessment Scale (NRS 2002) - [9]. The screening algorithm for early detection of malnutrition was simple and fast.

For a more detailed assessment of nutritional status, we used a set of somatometric and laboratory indicators, which can be used to determine the PEM degree [5]. Somatometric criteria (somatic protein pool) included body mass index (BMI), thickness of the skin-fat fold over the triceps, shoulder circumference, shoulder muscle circumference, percent deviation of actual body weight from the recommended one. Laboratory criteria (visceral protein pool) were represented by total serum protein, albumin and absolute lymphocyte count. To identify the type of malnutrition — marasmus, kwashiorkor, marasmic kwashiorkor — the recommended differential diagnostic criteria were applied [5].

All patients showed signs of neurogenic dysphagia. Therefore, a nutritional support was carried out using the method of tube feeding through a nasogastric tube (n = 56) and through a gastrostomy tube (n = 70). Thus, tube feeding was carried out through a gastrostomy tube by 11.2% more often than through a nasogastric tube. This was primarily due to the limitation period of TBI and to the international standards, according to which, if the need for tube feeding persists for more than 4 weeks, stoma is indicated [9, 10].

Statistical analysis methods. Statistical analysis was carried out using the StatTech v. 0 and Microsoft Excel spreadsheet resources. The probability of error (p) was considered statistically significant at p = 0.05.

Research results and their analysis.

Features of the trophological status of victims of emergencies with long-term impairment of consciousness due to TBI

During physical examination, patients showed characteristic early signs of a violation of the trophological status in the form of the hairline breach (sparse, thin hair, alopecia), skin (dryness, peeling, follicular lesions and decreased turgor), nails (fragility and stratification) and mucous membranes (stomatitis, cracks on the lips) impairment, edema of lower extremities, decrease in subcutaneous fat and muscle mass (muscle wasting, protruding bones of the skeleton, sunken abdomen, cachexia).

Further, when screening using the NRS-2002 scale, in all patients, due to the initial presence of TBI, a high risk of malnutrition was diagnosed, which required further assessment of their trophological status and an active correction of nutrition. BMI indicators - 13.1-23.1 kg / m2, average - (18.2 ± 0.17) - testified to low nutrition and malnutrition. The deviation of factual body mass from recommended body mass was in the range of 52.9–96.9%, the average was (74.4 ± 0.71), which confirmed a significant progressive loss of body weight since the onset of the disease. Determination of shoulder circumference, thickness of the skin-fat fold over the triceps and shoulder muscles circumference made it possible to assess the state of the somatic protein pool: shoulder circumference — 18-29.5 cm, average — (21.8 ± 0.15); thickness of the skin-fat fold over the triceps —2–12 mm, average — (5.41 ± 0.22); shoulder muscle circumference — 17.1–26.4 cm, average — (20.1 ± 0.12). The listed indicators confirmed a decrease in both the fat depot and the muscle mass as well as a violation of the trophological status.

Laboratory results made it possible to assess the state of the visceral pool of protein and immunity. The obtained indicators of the level of total blood serum protein — 47-83 g / l, average — (64.9 ± 0.59) and albumin — 17.1-45.6 g / l, average — (32.8 ± 0.43) — showed a decrease in the visceral protein pool. Along with this, the absolute number of lymphocytes — 0.6-4.8 thousand, average — (2.04 ± 0.07) indirectly indicated the severity of suppression of the immune system.

When analyzing the indicators of trophological status depending on gender, it was not possible to establish statistically significant differences. When comparing BMI, deviation of factual body mass from recommended body mass, depending on the level of consciousness, statistically significant differences were found, p <0.05. For patients in the vegetative state the most characteristic features were a decrease in BMI and a deviation of factual body weight from recommended body weight. The analysis of the visceral protein pool, depending on the level of consciousness, did not show statistically significant differences.

Thus, in the study group of patients, the trophological status indicators were less than the reference values, which indicated the presence of signs of PEM of varying severity in victims of emergencies with long-term impairment of consciousness due to TBI.

Prevalence, severity and types of trophological insufficiency in victims of emergencies with long-term impairment of consciousness due to TBI

The study of the obtained data on the nutritional status of victims of emergencies with long-term impairment of consciousness due to TBI made it possible to conduct a clinical and epidemiological analysis of trophological insufficiency in patients of this group. Among victims in emergencies with long-term impairment of consciousness due to TBI, the severity of trophological insufficiency was presented as mild (n = 12), moderate (n = 104) and severe (n = 10). Thus, in the study group (82.5%) PEM of moderate severity prevailed.

To assess the prevalence of trophological insufficiency, we analyzed the severity of PEM depending on demographic parameters. In the study group, both men (n = 85 - 83.3%) and women (n = 19 - 79.2%) in all age groups most often suffered from trophological insufficiency of moderate severity. Among young patients, there were different degrees of severity of PEM, while for old age only moderate severity was characteristic — n = 3 — 100%. In elderly patients, in one case (25%) it was mild, in 3 cases (75%) it was moderate. Severe PEM was found only in young (n = 8 - 8.1%) and middle-aged (n = 2 - 10%) patients. Thus, when comparing the severity of PEM depending on gender and age, we were unable to establish statistically significant differences — p = 0.386 and p = 0.566, respectively.

All patients with long-term impairment of consciousness had signs of oropharyngeal dysphagia, and therefore, nutrition was carried out using a gastrostomy tube and a nasogastric tube. An assessment was made of the influence of nutritional delivery methods on the severity of trophological insufficiency from the moment of TBI till the moment of inclusion in the study (Table 1)

Table 1 shows that when assessing the influence of the feeding method on the severity of PEM, statistically significant differences were found, p <0.05. Mild PEM was more common with nasogastric tube feeding, while moderate PEM was common with both tube feeding methods. Trophological status was presented by severe PEM only in the case of gastrostomy.

In the study group, trophological insufficiency was also assessed on the basis of objective data and diagnostic criteria — body weight, fat storage, somatic and visceral protein pool. Analysis of the data obtained made it possible to identify the main types of PEM in victims of emergencies with long-term impairment of consciousness due to TBI. Most often, were registered: PEM of marasmus type (55.6%) and of mixed type — marasmic kwashiorkor (41.3%), less often — kwashiorkor (3.2%). In men, marasmus (n = 53 - 52%) and marasmus kwashiorkor (n = 46 - 45.1%) occurrence were almost equal, while marasmus was more common in women

Таблица 1/Table No 1

Распределение пациентов по степени тяжести белково-энергетической недостаточности (БЭН) в зависимости от метода введения питания, чел./%

Distribution of patients in accordance with severity of protein-energy malnutrition (PEM) depending on feeding method, per./ %

Метод введения питания Feed introduction method	Степень тяжести БЭН Severity of protein-energy malnutrition			P
	легкая light	средняя medium	тяжелая severe	
Гастростома Gastrostomy	4/5,71	57/81,43	9/12,86	0, 024*
Назогастральный зонд Nasogastric tube	8/14,29	47/83,93	1/1,79	

* Здесь и в табл. 2–4 – различия показателей статистически значимы, p <0,05
* Here and in Tables No. 2-4 – differences in indicators are statistically significant, p <0,05

(n = 17 - 70.8%). Kwashiorkor-type malnutrition was less common in patients of both sexes. For young patients, marasmus (n = 64 - 64.6%) and marasmus kwashiorkor (n = 34 - 34.3%) were most typical — the latter was more often observed in middle-aged (n = 15 - 75%) and in elderly (n = 2 - 66.7%) (Table 2).

When comparing the distribution of patients by PEM type depending on age, statistically significant differences were found, p <0.001. When comparing the distribution of patients by PEM type depending on gender, no significant differences were found, p = 0.124.

To identify the prevalence of trophological deficiency, the nutritional status was analyzed depending on the level of consciousness of the patients. For patients who were in a state of minimal consciousness and in a vegetative state, the most characteristic was an average degree of malnutrition — (n = 90 - 82.6%) and (n = 14 - 82.4%), respectively. In patients in both groups, marasmus was more common - (n = 61 - 56%) and (n = 19 - 52.9%), respectively, and marasmic kwashiorkor — (n = 46 - 42.2%) and (n = 16 - 35, 3%), respectively. When analyzing the influence of the level of consciousness on the severity and type of PEM, no statistically significant differences were found — p = 0.117 and p = 0.13, respectively.

To obtain a general idea of trophological insufficiency in patients with long-term impairment of consciousness due to TBI got in emergency, the type of protein-energy deficiency was analyzed depending on the severity of PEM (Table 3).

According to Table 3, when comparing the type of PEM depending on the severity of PEM, significant differences were found, p <0.05.

In patients of the study group, regardless of the severity of PEM, in more than half of the cases, the type of PEM was represented by marasmus and, less often, by kwashiorkor, which is characteristic primarily of severe PEM.

Influence of infectious complications on the severity of PEM in victims of emergencies with long-term impairment of consciousness due to TBI

Concomitant infectious complications of various localization were detected in 109 patients (86.5%). In 17 patients (13.5%) there were no complications. The most typical localizations: bronchopulmonary infections — 82% of cases; urinary tract infections — 61%; infected bedsores — 27% of cases. Considering the high prevalence of infectious complications among patients, we analyzed their effect on the degree of trophological insufficiency (Table 4).

From the data of Table 4, analyzing the severity of PEM, depending on the presence or absence of infectious complications, we revealed statistically significant differences, p <0.001. The incidence of moderate and severe trophological insufficiency was higher in the presence of infectious complications — 9.2 and 88.1%, respectively.

Conclusion

1. In victims of emergencies with long-term impairment of consciousness due to TBI, during the initial screening, high risks of developing a rapidly progressing malnutrition are determined. The trophological status is manifested by deficiency of the somatic (decrease in fat depot, muscle mass) and visceral (violation of the protein-synthetic function of the liver, state of hematopoietic organs and of immune system) protein pools.

2. The trophological status of victims of emergencies with long-term impairment of consciousness due to TBI — regardless of the severity of PEM — in more than half of the cases was represented by marasmus and, less often, by kwashiorkor. In all age groups, PEM of moderate severity prevailed in both men and women, while a severe degree was found only in middle-aged and young patients. Marasmus and senile kwashiorkor as types of PEM were more common than kwashiorkor. At the same time, marasmus and marasmus kwashiorkor were almost equally met in men, while in women PEM predominated in the form of marasmus. For a young age, the most characteristic PEM type was marasmus, for the elderly it was kwashiorkor.

3. Patients with infectious complications have a high risk of developing moderate and severe PEM, which requires additional screening and timely sanitation of foci of chronic infection.

4. The identified features require further study and assessment of the impact of timely and adequate nutritional support on the trophological status in these patients.

Таблица 2/Table No 2

Распределение пациентов по типам БЭН в зависимости от их пола и возраста, чел./%

Distribution of patients by protein-energy malnutrition type depending on their gender and age, per. %

Группировка пациентов по полу и возрасту Patients groups by gender and age	Тип БЭН /Protein-energy malnutrition type			P
	маразм marasmus	квашиоркор kwashiorkor	маразматический квашиоркор marasmic kwashiorkor	
Женщины Women	17/70,83	1/4,17	6/25,0	0,124
Мужчины Man	53/51,96	3/2,94	46/45,1	
Молодой возраст Young age	64/64,65	1/1,01	34/34,34	< 0,001* $P_{Молодой\ возраст - Средний\ возраст}$ = 0,004* $P_{Young\ age - Average\ age}$ = 0,004* $P_{Молодой\ возраст - Пожилой\ возраст}$ = 0,012* $P_{Young\ age - Elderly\ age}$ = 0,012* $P_{Молодой\ возраст - Старческий\ возраст}$ <0,001* $P_{Young\ age - Old\ age}$ <0,001*
Средний возраст Average age	4/20,0	1/5,0	15/75,0	
Пожилой возраст Elderly age	2/50,0	1/25,0	1/25,0	
Старческий возраст Old age	–	1/33,33	2/66,67	

Таблица 3/Table No 3

Распределение пациентов по типам белково-энергетической недостаточности в зависимости от степени её тяжести, чел./%

Distribution of patients by protein-energy malnutrition type depending on the severity of protein-energy malnutrition, per./%

Степень тяжести БЭН Severity of protein-energy malnutrition	Тип БЭН /Protein-energy malnutrition type			P
	маразм marasmus	квашиоркор kwashiorkor	маразматический квашиоркор marasmic kwashiorkor	
Легкая Light	11/91,67	–	1/8,33	0, 046*
Средняя Medium	55/52,88	3/2,88	46/44,23	
Тяжелая Severe	4/40,0	1/10,0	5/50,0	

Таблица 4/Table No 4

Распределение пациентов по степени тяжести БЭН в зависимости от отсутствия или наличия инфекционных осложнений, чел./%

Distribution of patients by severity of protein-energy malnutrition depending on the presence or absence of infectious complications, per./%

Инфекционные осложнения Infectious complications	Степень тяжести БЭН Severity of protein-energy malnutrition			P
	легкая light	средняя medium	тяжелая severe	
Отсутствие Absence	9/52,94	8/47,06	–	0, 001*
Наличие Presence	3/2,75	96/88,07	10/9,17	

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