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# THE FEATURES OF HEMODYNAMIC CHANGES IN PATIENTS WITH SEVERE TRAUMATIC BRAIN INJURY

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**Abstract.**

Based on an analysis of hemodynamic data from 76 patients with severe traumatic brain injury, this article demonstrates that progressive hypotension in fatal patients is accompanied by increasing tachycardia, deterioration of consciousness, and progression of neurological deficits. The observed tachycardia, which persisted throughout the study period, also reflected excessive stimulation of the sympathoadrenal system and a delay in the transition from the acute adaptation stage to the long-term adaptation stage.

**Key words**

traumatic brain injury, hemodynamics, autonomic nervous system

**Introduction.**

Traumatic brain injury (TBI) remains one of the most pressing healthcare issues today, not only in our country but also worldwide. [1, 2] Numerous publications highlight the main trends in diagnostic methods and intensive care aimed at reducing mortality in patients with severe TBI. [3, 4, 5] However, mortality and disability rates remain high [6, 7], necessitating the search for prognostic criteria for early risk identification. Hypoxia and hemodynamic instability [8, 9], leading to the development of secondary brain damage, are considered factors in adverse outcomes in severe TBI. [10]

Severe TBI triggers a number of specific and nonspecific compensatory and adaptive mechanisms aimed at maintaining homeostasis. Clinical and pathophysiological studies indicate that one of the most vulnerable areas of the brain in severe TBI is the diencephalic-hypothalamic region, which is the highest autonomic center. [11,12]

**Aim of study:** To assess systemic hemodynamics in patients with severe traumatic brain injury.

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**Study materials and methods.**

The study included 76 patients are treated in the surgical intensive care unit of the Tashkent State Medical University Clinic with a diagnosis of severe traumatic brain injury between 2022 and 2023. Of the 76 patients, 65 were men and 11 were women. The average age of the patients was 45 ± 2 years. The length of hospital stay ranged from 1 to 17 days (mean 11.3 ± 5.5 days). The level of consciousness on the Glasgow Coma Scale (GCS) upon admission was 7 ± 1 point.

Initial CT revealed compression of the brain cisterns in 3 patients, midline displacement of more than 5 mm in 20 patients, and intracerebral hematomas of 25-100 ml (evacuated surgically). Resection and decompression craniotomy was performed in all patients within the first 24 hours after admission.

Alcoholemia was present in 21% of cases, with blood ethanol levels ranging from 1.2 to 2.5%. Respiratory aspiration was observed in 44% of patients, and traumatic and hemorrhagic shock was observed in 34.3% of patients with severe traumatic brain injury.

All patients were intubated and maintained on mechanical ventilation (MV). MV was maintained for 5-15 days, with an average duration of 120±90 hours. Tracheostomy was performed in 23 patients as indicated.

Of the 76 injured patients, 15 died at various times after the injury. The mortality rate was 19.7%, and all deceased were men.

All patients were retrospectively divided into three groups based on the outcome of the disease: Group 1 - patients who died (n=15), Group 2 - patients with a favorable outcome without neurological recovery (n=24), and Group 3 - patients with a favorable outcome and complete neurological recovery (n=38).

The results obtained were processed by the method of variational statistics on a personal computer using Excel and by calculating arithmetic averages (m) and errors of averages (m). Reliable information about two different sources using the statistical Student's criterion (t) was needed. The critical significance level was assumed to be 0.05.

**Study results.**

For the purpose of our study the characteristics of systemic hemodynamics in the acute phase of severe traumatic brain injury, we examined the dynamics of systolic blood pressure (SBP), mean arterial pressure (MAP), heart rate (HR), and central venous pressure (CVP) in patients with varying disease outcomes. All patients received standard intensive care (IC) based on a clinical protocol. The study's control points were days 1, 3, 5, and 7 of hospitalization.

Analysis of the obtained data revealed that in the first three days of illness, systemic hemodynamic parameters were virtually identical in all study groups,

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indicating the body's protective and compensatory responses. Subsequent changes in systemic hemodynamic parameters varied between groups and depended on the severity of brain injury. The dynamics of the main study parameters in the study groups are presented in Table 1.

In patients with an unfavorable outcome, a 7% increase in SBP was recorded by day 3 compared to baseline, but compared to SBP in patients in groups 2 and 3, this value was lower by 7.7% and 8.2%, respectively. By day 5, this group showed a slight decrease in SBP compared to the previous stage. SBP in patients with a fatal outcome during this period was lower than in patients in groups 2 and 3 by 9.3% and 9.7%, respectively. By day 7, a persistent downward trend in SBP was recorded, by 7.1% compared to the previous stage.

These changes in SBP corresponded to negative dynamics in neurological status. The average level of consciousness according to the GCS was 11.5% lower than the baseline value. The heart rate in patients in Group 1 remained higher throughout the entire observation period than in surviving patients. On day 3, the heart rate was significantly higher by 9.5% compared to Group 2 and by 11.4% compared to Group 3. By day 5, it had increased by 15.2%, and by day 10, by 18.8%, compared to Group 3.

To identify the type of autonomic response in patients with severe traumatic brain injury, we used the Kerdo index (normally between +5 and +7 units). Positive index values indicated a predominance of sympathetic tone, while negative values indicated parasympathetic activity. The dynamics of changes in the autonomic nervous system and neurological status in the study groups are presented in Table 1.

Table 1.

**Autonomic nervous system, stress level, and neurological status indicators in patients with severe traumatic brain injury**

| *Indicator* | Group | Day 1 | Day 3 | Day 5 | Day 7 | Day 10 |
|---|---|---|---|---|---|---|
| *Kerdo index, units* | 1 | -8.5±1.5 | 7.3±1.1* | 7.4±1.3 | 16.8±4.5* | 17.5±5.1* |
| | 2 | -20.5±5.1 | -14.1±2.3* | -6.3±1.8* | -7.5±1.9 | 7.8±1.9* |
| | 3 | -18.3±3.7 | -17.5±3.1* | -14.1±3.8* | -10.9±3.3* | 1.5±0.2* |
| *GCS, points* | 1 | 7.5±1.5 | 7.0±0.5 | 6.7±1.4 | 5.8±0.7 | 5.5±0.5 |
| | 2 | 7.9±1.9 | 8.0±1.5 | 8.1±1.5 | 9.5±1.2 | 10.1±1.7 |
| | 3 | 8.0±1.8 | 9.1±1.5 | 10.5±0.5 | 13.7±1.9 | 14.9±0.1 |
| *Stress level* | 1 | 3.5±0.5 | 3.3±0.1 | 3.1±0.3 | 2.8±0.4* | 2.5±0.1* |
| | 2 | 3.3±0.1 | 2.9±0.1* | 3.3±0.2* | 3.2±0.2 | 3.8±0.3* |
| | 3 | 3.2±0.1 | 2.8±0.1* | 3.1±0.2* | 2.9±0.1* | 3.1±0.2* |

Note: * - reliable relative to baseline data; GCS – Glasgow Coma Scale.

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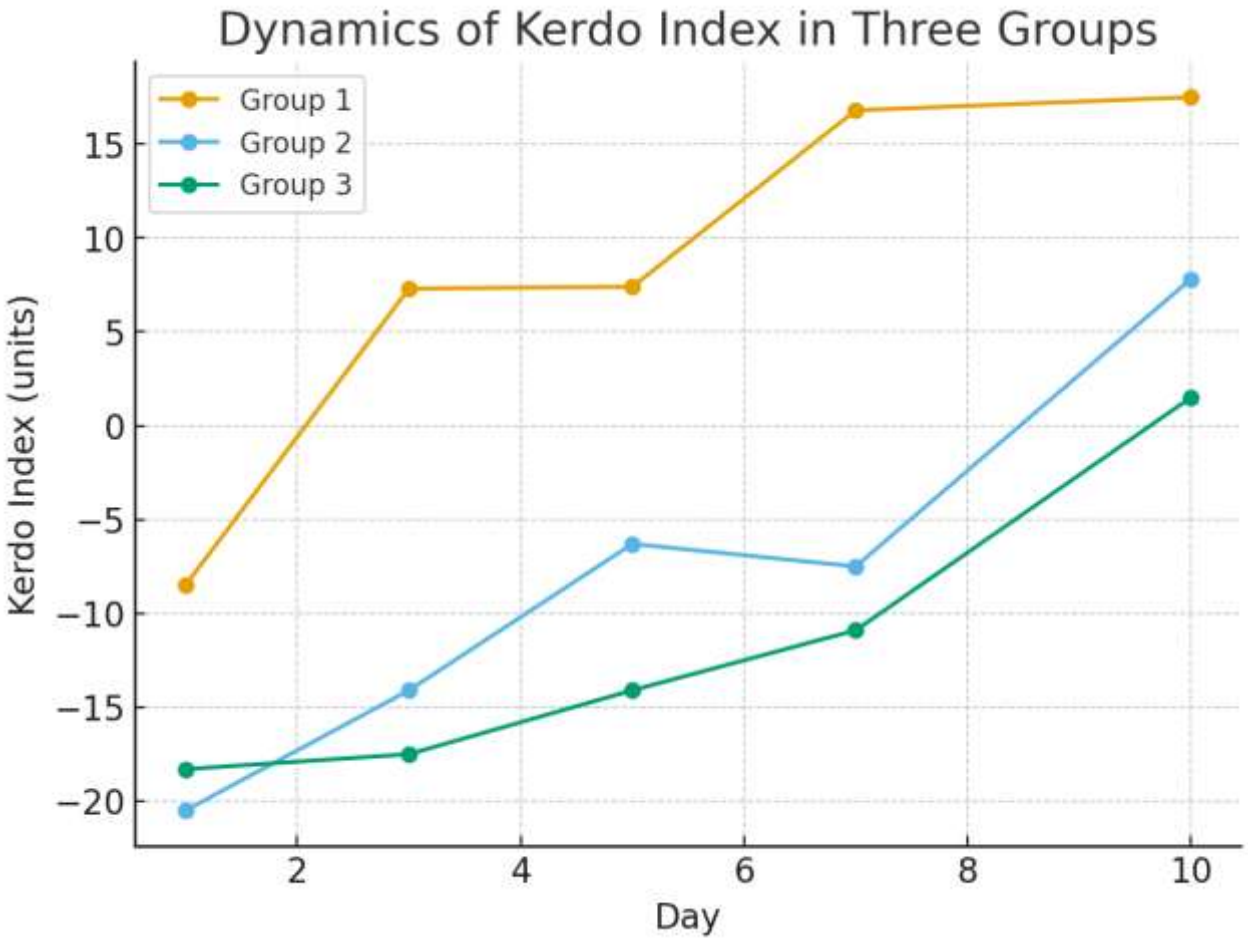


On the first day, patients who subsequently died showed a predominance of parasympathetic tone, confirmed by negative values of the Kerdo index. By the third day, they already showed a predominance of sympathetic tone, which persisted throughout all subsequent stages. These changes indicated a delay in the transition of acute adaptation mechanisms to long-term adaptation and the transformation of stress into distress.

The increased stress-adaptive responses and persistent activation of the sympathoadrenal system in deceased patients correlated with a decreased level of consciousness (a significant progressive decline in GCS values was noted by day 5) and worsening neurological deficits.

The clinical equivalent of increasing stress levels and persistent sympathicotonia was the development of multiple organ failure syndrome, further progression of coma, and irreversible impairment of vital functions, leading to death in the acute phase of severe traumatic brain injury.

We retrospectively studied the severity and direction of changes characterizing the reorganization of nonspecific defense factors and the degree of stress of adaptive mechanisms depending on the severity of brain injury and their prognostic significance.

On admission, all patients with severe traumatic brain injury differed in severity, level of consciousness, and severity of intracranial hypertension. However, already at this stage, everyone shows an increase in stress levels, with the norms being 1.5–2.0 conventional units.

**Conclusion**

Thus, progressive hypotension in fatal patients was accompanied by increasing tachycardia, deterioration of consciousness, and worsening neurological deficits. The observed tachycardia, which persisted throughout the study period, also reflected excessive stimulation of the sympathoadrenal system and a delay in the transition from the acute adaptation stage to the long-term adaptation stage.

The increased stress-adaptive responses and persistent activation of the sympathoadrenal system in deceased patients correlated with a decrease in consciousness and worsening neurological deficits. The clinical manifestations of increasing stress and persistent sympathicotonia included the development of multiple organ failure, further progression to coma, and irreversible impairment of vital functions, leading to death.

## REFERENCES:

1. Tobi K.U., Azeez A.L., Agbedia S.O. Outcome of traumatic brain injury in the intensive care unit: a five-year review. Southern African Journal of Anaesthesia and Analgesia 2016; 22(5):135–139

2. Sheriff FG, Hinson HE. Pathophysiology and clinical management of moderate and severe traumatic brain injury in the ICU. Semin Neurol. 2015 Feb;35(1):42-9. doi: 10.1055/s-0035-1544238. Epub 2015 Feb 25.

3. Epidemiology of severe traumatic brain injury. Iaccarino C, Carretta A, Nicolosi F, Morselli C. J Neurosurg Sci. 2018 Oct;62(5):535-541.

4. Chirkin Yu. N., Bukina V. M., Simonov S. N. Otse The contribution of traumatic brain injury mortality to the loss of vital potential in the population // Bulletin of Russian Universities. Mathematics. 2015. No. 2.

5. Rubiano AM, Carney N, Chesnut R, Puyana JC. Global neurotrauma research challenges and opportunities. Nature. 2015 Nov 19;527(7578):S193-7. doi: 10.1038/nature16035. PMID: 26580327.

6. Ortiz-Prado E, Mascialino G, Paz C, Rodriguez-Lorenzana A, Gómez-Barreno L, Simbaña-Rivera K, Diaz AM, Coral-Almeida M, Espinosa PS. A Nationwide Study of Incidence and Mortality Due to Traumatic Brain Injury in Ecuador (2004-2016). Neuroepidemiology. 2020;54(1):33-44.

7. Majdan M, Plancikova D, Brazinova A, Rusnak M, Nieboer D, Feigin V, Maas A. Epidemiology of traumatic brain injuries in Europe: a cross-sectional analysis. Lancet Public Health. 2016 Dec;1(2):e76-e83.

8. Sabirov, D. M., et al. "Analysis of Lethality Causes in Patients With Severe Craniocerebral Injuries." The Bulletin of Emergency Medicine 4 (2011): 5-9.

9. Ley EJ, Berry C, Mirocha J, Salim A. Mortality is reduced for heart rate 80 to 89 after traumatic brain injury. J Surg Res 2010;163:142–5.

10. Кирячков Ю. Ю., Гречко А. В., Колесов Д. Л., Логинов А. А., Петрова М. В., Пряников И. В., Щелкунова И. Г., Прадхан П. Функциональная активность автономной нервной системы при различных уровнях сознания у пациентов с повреждением головного мозга // Общая реаниматология. 2018. №2. URL: https://cyberleninka.ru/article/n/funktsionalnaya-aktivnost-avtonomnoy-nervnoy-sistemy-pri-razlichnyh-urovnyah-soznaniya-u-patsientov-s-povrezhdeniem-golovnogo-mozga.

11. Sykora M, Czosnyka M, Liu X, Donnelly J, Nasr N, Diedler J, Okoroafor F, Hutchinson P, Menon D, Smielewski P. Autonomic impairment in severe traumatic brain injury: a multimodal neuromonitoring study. Crit Care Med. 2016;44(6):1173–81

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12. Sabirov, D.; Krasnenkova, M.. The role of monitoring autonomic nervous system in prognosis of brain trauma: 7AP4-2. European Journal of Anaesthesiology 29():p 111, June 2012.