# Dynamics of body temperature in the acute period of severe concomitant traumatic brain injury in children

Muhitdinova Hura Nuritdinovna

Doctor of Medical Sciences, Full Professor

*Center for the Development of Professional Qualifications of Medical Workers*

Abstract

The average daily body temperature can serve as an objective indicator of the severity of SCTBI in children over 7 years of age. Maintaining the index at the subfebrile level of 37 ± 0.1°C can be represented as a positive effect of complex multifactorial (anti-inflammatory, decongestant, anticonvulsant, membrane-protective, etc.) intensive therapy in the acute period of SCTBI in children over 7 years of age.

Keywords: temperature, severe concomitant traumatic brain injury, children

**Relevance.** The combination of TBI with damage to other organs and systems exacerbates the severity of brain damage. On the one hand, this is due to the inadequacy of systemic compensatory reactions in the shock period, and on the other hand, to direct or indirect damage to various organs or systems. An essential role is played by the progression of extracranial disorders, which coincides in time with the period of subcompensation of hemo- and liquorodynamic shifts. Intensive therapy aimed at compensating for multisystem disorders may conflict with the regularities of the course of sanogenic and reparative processes in the central nervous system. An increase in brain temperature or core body temperature is associated with a poor outcome in acute brain injury. While there is a simple mechanistic explanation that fever is harmful in itself, there is also the fact that patients with more poor outcomes have more episodes of fever. Therefore, control of the temperature of the damaged brain is aimed at preventing hyperthermia and maintaining controlled hypothermia. An increase in brain temperature leads to increased brain oxygen consumption and increased cerebral blood flow, which can worsen ischemia. According to many authors, normothermia should be maintained in patients with acute brain injury. The use of guided hypothermia for TBI is widely practiced but remains

controversial. A 2004 Cochrane review and four separate meta-analyzes did not confirm the effectiveness of the method [1,2].

Lack of information on the topic prompted us to study one of the priority tasks of intensive care (severe concomitant traumatic brain injury) SCTBI in the acute period.

**Purpose of work.** To study and assess the dynamics of body temperature in the acute period of severe concomitant traumatic brain injury in children

**Material and research methods.** The indicators of a comprehensive examination of 16 patients with severe concomitant craniocerebral trauma (SCTBI) who were admitted to the ICU of the RSCEMI neurosurgical department in the first hours after an accident - 14, catatrauma - 2 patients were studied. Continuous hourly monitoring of the temperature indicator, and taiga hemodynamic parameters were carried out for 30 days after SCTBI. According to the indications of the patients, on admission, invasive mechanical respiratory support (MRS) was started. Mechanical respiratory support began with continuous ventilation (CMV) followed by a switch to SIMV. The severity of the condition was assessed using scoring methods for assessing the severity of concomitant injuries - the PTS (Pediatric Trauma Score) scale (Tepas J.J. et al. 1985), the assessment of the severity of injuries on the ISS scale, the severity of acute cerebral failure according to the Glasgow coma scale. On admission, impaired consciousness in 14 injured patients was assessed on the Glasgow Coma Scale (GS) 8 points or less. Patients were considered in three age groups: group 1 - 11.5±3 years (4), 2 - 10.6±0.9 years (4), 3 - 12.7±2.8 years (8 patients). Complex intensive care consisted in identifying and timely correction of deviations: MRS, after removing from shock anesthetic, anti-inflammatory, hemostatic, antibacterial, infusion therapy, correction of protein, water-electrolyte balance disorders, surgical, as far as possible, early correction, stress-limiting, cytoprotective therapy. According to the PTS classification, the interpretation was: if the total score on a scale of 9-12 points is a minor injury, 6-8 points is a potential threat to life, 0-5 points is a life-threatening condition, o points is a fatal situation. The probability of death according to PTS is at <8, hospitalization from a specialized department is required, 4 points, the probability of death is 50%, at <1, the probability of death is> 98%.

The use of the scale for assessing the severity of injuries ISS allowed for a more differentiated assessment of the severity of injuries. ISS scale analysis: 1-9 points - mild injury; 10-15 points - moderate severity; 16-24 points - heavy; over 24 is extremely heavy. Mortality at 16-24 points - 5-7%; > 24 points - over 30%. Duration of the hospital period: 1-9 points - about 4 days; 10-15 points - 6-7 days; 16-24 points - 8-10 days; > 24 points - over 12 days. The introduction of the

scales made it possible to clearly delineate the severity of the shock and, depending on this, to determine the further tactics of action.

**Results and its discussion.** Admission in a serious condition was associated with SCTBI, severe cerebral contusion (SCC), severe closed brain injury (SCBI), open severe traumatic brain injury (OSTBI), subarachnoid hemorrhage (SAH), intraventricular hemorrhage (IVH), combined with severe injuries of other organs and fractures of the ribs, limbs, facial skeleton (tab. 2).

Table 1.

Characteristics of patients with concomitant severe traumatic brain injury over 7 years old

| Groups | 1 | 2 | 3 |
|---|---|---|---|
| Numb. of pat. | 4 | 5 | 7 |
| Days at the ICU | 7.7±1.7 | 14.8±2.2 | 34.6±14.1 |
| Age, years | 11.5±3 | 10.6±0.9 | 12.7±2.8 |
| GS, points | 10±0.4 | 8.2±0.9 | 7.8±0.7 |
| ALV, days | 2±0.9 | 10.7±2.6 | 22.2±4.5 |
| PTS, points | 4±0.2 | 1±0.3 | 1±0.25 |
| ISS, points | 52±8 | 60±13 | 47.8±8.5 |

Table 2.

Types of traumatic injuries

| Damage types | Group 1 (4) | Group 2 (4) | Group 3 (8) |
|---|---|---|---|
| SCBI | 50% (2) | - | 75% (6) |
| SCC | 75% (3) | 75% (3) | 62% (5) |
| Light CC | 25% (1) | - | 25% (2) |
| SOTBI | 50% (2) | 100% (4) | 25% (2) |
| SAH | 50% (2) | 75% (3) | 62% (5) |
| Imbibed by the brain blood | 50% (2) | 25% (1) | 37% (3) |
| Intracerebral hematoma | 50% (2) | 25% (1) | 37% (3) |
| Subdural hematoma | 25% (1) | - | 25% (2) |
| IVH | 25% (1) | - | 25% (2) |
| Dislocation syndrome | 25% (1) | - | 37% (3) |
| Facial bone fracture | 50% (2) | 75% (3) | 25% (2) |
| Fracture of the pelvic bones | - | 25% (1) | 25% (2) |
| Fracture of the humerus, femur, | - | 75% (3) | 37% (3) |

| | | | |
|---|---|---|---|
| shin bones | | | |
| Lung contusion | 50% (2) | 50% (2) | - |
| Pneumothorax | 25% (1) | 25% (1) | - |
| Crushing injury of the liver | 25% (1) | - | - |
| Ruptured kidney | 25% (1) | - | - |
| Hemoperitoneum | 25% (1) | - | - |
| Retroperitoneal hematoma | 25% (1) | - | 12% (1) |
| Laceration of the thigh | 25% (1) | 25% (1) | 12.5% (1) |

The severity of the patients' condition was mainly determined by the severity of the brain damage (tab. 1). With a comparatively less pronounced traumatic effect on the brain, timely etiopathogenetically determined measures were able to bring patients out of the state of severe traumatic shock in a fairly short time, timely surgical correction of bone fractures, effective intensive therapy of bruises of parenchymal organs, and compensation of blood loss.

The efficacy of treatment for severe cerebral contusion (CC) was more favorable with open TBI, as evidenced by the shorter recovery time in group 1 7.7±1.7 days, in group 2 14.8±2.2 days, ALV duration in 1 group 2±0.9, in group 2 10.7±2.6 days than with SCTBI (tab1). While the duration of intensive therapy in group 3 patients was significantly longer and amounted to 34.6±14.1 days ($p < 0.05$), ALV 22.2±4.5 days ($p < 0.05$) (tab. 1).

It is known that the initial severity of the condition is in direct proportion to the volume of traumatic injuries that cause more severe stress mobilization of defense systems. One of them is the systemic inflammatory response of the body, the objective indicator of the severity of which is thermoregulation. In this regard, an attempt was made to study and assess the dynamics of the temperature reaction depending on the severity of the condition of injured children over 7 years old.

As shown in Table 3, on the first day in group 1, the average daily body temperature was within the normal range, however, in groups 2 and 3, a tendency towards a hyperthermic reaction was revealed (the lack of reliability is associated with a large scatter of the indicator). In dynamics in the acute period of SCTBI in group 1 on the 3.4.5th day there was an increase in body temperature by 0.5°C ($p < 0.05$). A decrease to normal values was detected on the 8th day. In group 2 of traumatized children during the entire observation period in the ICU, no significant deviations from the indicator on day 1 were found. In children of group 3, on day 3, the average daily temperature increased by another 0.4°C, remaining at a subfebrile level for up to 30 days. In a comparative analysis, attention is drawn to the fact that in group 2 the temperature did not

differ from that in the first in the first 9 days. However, in group 3, significantly higher rates were observed by 3,6,7,8 days by 0.4°C ($p < 0.05$). And also in patients of group 3, the average daily temperature reaction was more pronounced than in group 2 on days 10-15 by 0.4-0.6°C ($p < 0.05$, respectively).

Table 3

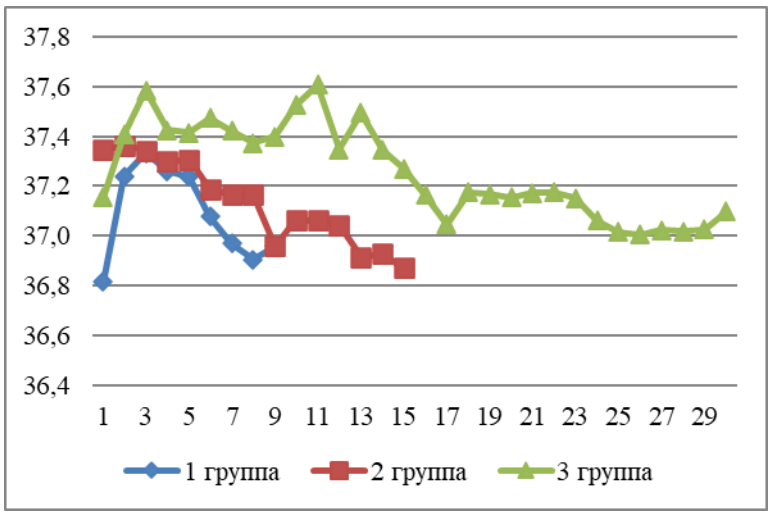
Dynamics of thermoregulation in the acute period of severe concomitant traumatic brain injury in children

| Days | Group 1 | Group 2 | Group 3 |
|---|---|---|---|
| 1 | 36.8±0.2 | 37.3±0.5 | 37.2±0.2 |
| 2 | 37.2±0.2 | 37.4±0.2 | 37.4±0.1 |
| 3 | 37.3±0.1* | 37.3±0.1 | 37.6±0.1*‴ |
| 4 | 37.3±0.1* | 37.3±0.2 | 37.4±0.2 |
| 5 | 37.2±0.1* | 37.3±0.1 | 37.4±0.2 |
| 6 | 37.1±0.1 | 37.2±0.1 | 37.5±0.2 |
| 7 | 37.0±0.1 | 37.2±0.1 | 37.4±0.1‴ |
| 8 | 36.9±0.1 | 37.2±0.1 | 37.4±0.1‴ |
| 9 | 37.0±0.1 | 37.0±0.1 | 37.4±0.2‴ |
| 10 | | 37.1±0.1 | 37.5±0.1⁰ |
| 11 | | 37.1±0.1 | 37.6±0.2⁰ |
| 12 | | 37.0±0.1 | 37.3±0.1⁰ |
| 13 | | 36.9±0.1 | 37.5±0.1⁰ |
| 14 | | 36.9±0.1 | 37.3±0.1⁰ |
| 15 | | 36.9±0.1 | 37.3±0.1⁰ |
| 16 | | | 37.2±0.1 |
| 17 | | | 37.0±0.1 |
| 18 | | | 37.2±0.1 |
| 19 | | | 37.2±0.1 |
| 20 | | | 37.2±0.1 |
| 21 | | | 37.2±0.1 |
| 22 | | | 37.2±0.1 |
| 23 | | | 37.2±0.1 |
| 24 | | | 37.1±0.1 |
| 25 | | | 37.0±0.1 |
| 26 | | | 37.0±0.02 |
| 27 | | | 37.0±0.1 |
| 28 | | | 37.0±0.1 |
| 29 | | | 37.0±0.1 |
| 30 | | | 37.1±0.1 |

*- reliably relative to the indicator in 1 day

‴ - reliably relative to the indicator in group 1

$^0$ - reliably relative to the indicator in group 2




Dynamics of body temperature depending on the severity of the SCTBI. Fig. 1

Confirmation of the effect on temperature regulation of the severity of SCTBI is confirmed in fig. 1, where, throughout the entire observation, the average daily body temperature in children of group 3 was higher than in children of groups 2 and 1.

Thus, the average daily body temperature can serve as an objective indicator of the severity of SCTBI in children over 7 years of age. Maintaining the index at the subfebrile level of 37±0.1°C can be represented as a positive effect of complex multifactorial (anti-inflammatory, decongestant, anticonvulsant, membrane-protective, etc.) intensive therapy in the acute period of SCTBI in children over 7 years of age.

**Conclusion.** The average daily body temperature can serve as an objective indicator of the severity of SCTBI in children over 7 years of age. Maintaining the index at the subfebrile level of 37±0.1°C can be represented as a positive effect of complex multifactorial (anti-inflammatory, decongestant, anticonvulsant, membrane-protective, etc.) intensive therapy in the acute period of SCTBI in children over 7 years of age.

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