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# THE CONTRIBUTION OF EXTRACRANIAL COMPLICATIONS TO THE OUTCOME OF INTENSIVE CARE IN PATIENTS WITH SEVERE TRAUMATIC BRAIN INJURY

Krasnenkova M. B.
Tashkent Medical Academy, Tashkent, Uzbekistan

## ABSTRACT

Not only the damage to the brain matter itself as a result of injury, but also secondary damaging factors affect the outcome of TBI.

**The purpose of this study** is to analyze the structure of extracranial complications occurring in patients with severe TBI and to assess the impact of these complications on mortality.

**Materials and methods**. An observational retrospective cohort study included 110 adult patients with severe isolated TBI (baseline level of consciousness on the Glasgow Coma scale (SHG) <9 points). The average age was 34±7 years, 76 of them were men. The average length of stay in the intensive care unit (ICU) was 15± 6 days.

**The results.** In the present study, it was found that extracranial complications were frequent during ICU stay in a cohort of patients with severe TBI. Hypoxia and hypotension were most often observed when patients with PMT were admitted. Thus, hypoxia at admission was found in 67 patients, and arterial hypotension at admission to the ICU was found in 39 patients. We found that hypotension, pneumonia, infectious complications and coagulation dysfunction were associated with unfavorable results, along with indicators of TBI severity (low initial GSC score, worse data on initial CTG and intracranial hypertension) independently contributed to an increase in hospital mortality ($p < 0.05$).

**Conclusions**. Extracranial complications increase both the length of stay and morbidity in the ICU, as well as mortality in patients with severe traumatic brain injury. Severe respiratory insufficiency and low GSC values on the background of hypotension are independently associated with mortality in the ICU.

## INTRODUCTION

Given the widespread incidence of traumatic brain injury (TBI) and high mortality, predicting outcomes for these patients and their families is of great importance. The ability to predict the outcome of TBI is necessary for several reasons. The ability to anticipate the development of an unfavorable outcome, adjust therapy in advance, determine the volume and degree of intensive care activity – all these are potential points of application of forecasting [2].

Not only the damage to the brain matter itself as a result of injury, but also secondary damaging factors affect the outcome of TBI. Thus, hypoxia, hypotension, intracranial hypertension, hyperglycemia and other pathological conditions play an important role in the degree of brain damage [1,3]. Extracranial complications contribute to the development of secondary brain damage and the rate of its recovery. The mechanisms of development of such complications are ambiguous, and the frequency of development, despite prevention, remains high [4,5].

Complications may occur as a result of direct exposure to trauma or as a result of side effects of intensive care [6,7]. Neurogenic causes associated with brain damage may also contribute to systemic complications [8-10]. In addition, intensive treatment of patients with TBI is mainly aimed at neurological problems and may contribute to the development of extracerebral complications [7].

**The purpose of this study** is to analyze the structure of extracranial complications occurring in patients with severe TBI and to assess the impact of these complications on mortality.

## MATERIALS AND METHODS

An observational retrospective cohort study included 110 adult patients with severe isolated TBI (baseline level of consciousness on the Glasgow Coma scale (GCS) <9 points). The average age was 34±7 years, 76 of them were men. The average length of stay in the intensive care unit (ICU) was 15± 6 days. The management of patients in the ICU corresponded to international recommendations in order to maintain cerebral perfusion pressure (CPP) from 60 to 70 mmHg and intracranial pressure (ICP) <20 mmHg. The patients were divided into 2 groups: the deceased (35 people (31.5%) and the survivors - 75 (68.5%) patients.

The following extracerebral complications have been reported: Cardiovascular system: arterial hypotension (systolic blood pressure (SAD) < 90 mmHg), arterial hypertension (SAD > 160 mmHg), arrhythmias (bradycardia < 60 beats per minute or tachycardia > 120 beats per minute) and the need for vasoactive drugs (dopamine infusions or norepinephrine). Respiratory: respiratory infectious complications (aspiration, tracheobronchitis or pneumonia, acute respiratory distress syndrome (ARDS), and severe acute respiratory failure (ARF). Septic: severe sepsis and septic shock. Renal: acute kidney injury (AKI) (serum creatinine > 150 mmol/l). Abdominal/gastrointestinal complications: gastrointestinal ulcers, ileus, bilirubin levels> 18 mmol/L and aspartate aminotransferase (AST)> 1 mccat/l. Endocrine and metabolic: hyponatremia <130 mmol/l, hyponatremia > 150 mmol/L, syndrome of insufficient secretion of antidiuretic hormone (SIADH) (Na<130 mmol/L, urine density, predominant sublimation density), high salt intake (extreme level with sodium levels below 20 mmol/l) and diabetes insipidus (consumption > 200 ml/hour for 24 hours), which responds to population restriction or desmopressin treatment.

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.

## The results and their discussion

In the present study, it was found that extracranial complications were frequent during ICU stay in a cohort of patients with severe TBI. Hypoxia and hypotension were most often observed when patients with ICU were admitted. Thus, hypoxia at admission was found in 67 patients, and arterial hypotension at admission to the ICU was found in 39 patients. The average stay in the ICU was 15± 6 days.

The following structural divisions were noted during the entire time of selection in the ICU: sepsis - in 75% of respondents, respiratory infectious complications - in 68%, hypotension - in 44%, severe respiratory insufficiency ($PaO_2/FiO_2$<200) in 41% and ACI 8% of cases. Vasoactive drugs were used in 96% of patients with hypotension. We found that hypotension, pneumonia, infectious complications and coagulation dysfunction were associated with unfavorable results, along with indicators of TBI severity (low initial GSC score, worse data on initial CTG and intracranial hypertension) independently contributed to an increase in hospital mortality ($p < 0.05$).

Hypotension, both at admission and during ICU stay, was associated with a poor prognosis. The duration of hypotension is also considered one of the worst prognostic factors in these patients. In our study, hypotension was a frequent occurrence (44%) and increased mortality in patients with a low initial GSC score ($p < 0.05$).

The cause of respiratory failure in TBI is multifactorial and likely reflects a combination of disease-specific pathophysiology and iatrogenic causes [1]. Respiratory complications are very common in severe TBI and are associated with worse outcomes [7]. In our study the most common pathology (42%) was pneumonia, but it was not significantly associated with an increase in mortality. In most cases, pneumonia was observed in patients with aspiration syndrome (70% of all reported cases). Ventilator–associated pneumonia has also been reported in patients with severe TBI. Pneumonia prolonged the duration of artificial lung ventilation (12 vs 7 days), $p < 0.01$, the duration of stay in intensive care units (19 vs 15 days), $p < 0.01$, increased the need for tracheostomy. Severe ARF was observed in 41% of patients.

Hypothalamic-pituitary-adrenal dysfunction can occur at any time during TBI and is more common in severe injuries. Cerebral salt wasting (CSW) is another common disorder of sodium homeostasis in TBI, and in contrast to SIADH presents with hypovolaemic hyponatraemia. [9,10]. We have founded electrolytic dysbalanses in 11 (31,9%) murder and in 25 (32,5%) survived patients ($p<0,1$).

Table 1. The number of systemic complications in the groups of patients with TBI

| **Types of complications** | **Non survivors 35 (31,5%) n (%)** | **Survivors 75 (68,5%) n (%)** | ***P*** |
|---|---|---|---|
| Respiratory infections | 19 (55,1) | 54 (70,2) | < 0,1 |
| Atelectasis | 3 (8,7) | 6 (7,8) | < 0,1 |
| ARDS | 18 (52,2) | 2 (2,6) | < 0,01 |
| $PaO_2/FiO_2 < 200$ | 15 (43,5) | 29 (37,7) | < 0,05 |
| Hypotension | 20 (58) | 11 (14,3) | < 0,05 |
| Hypertension | 4 (11,6) | 11 (14,3) | <0,1 |
| Arrhythmias | 4 (11,6) | 11 (14,3) | < 0,1 |
| The need for vasopressors | 28 (81,2) | 45 (58,5) | < 0,05 |
| Sepsis | 21 (60,9) | 52 (67,6) | < 0,1 |
| Septic shock | 11 (31,9) | 4 (5,2) | < 0,05 |
| AKI | 8 (23,2) | 4 (5,2) | < 0,05 |
| Abdominal | 12 (34,8) | 26 (33,8) | < 0,1 |
| Electrolytic dysbalanses | 11 (31,9) | 25 (32,5) | <0,1 |
| Bleedings | 5 (14,5) | 7 (9,3) | < 0,05 |

Notes: ACI - acute kidney injury, ARDS - acute respiratory distress syndrome $PaO_2/FiO_2 < 200$ - severe acute respiratory failure (ARF).

In addition, patients with TBI and an initial low level of consciousness (GCS <8 points) had a higher incidence of sepsis, ARF and the need for vasopressor therapy than patients with GCS > 8 points ($p < 0.01$).

When analyzing the number of complications in the groups of surviving and deceased patients, a greater number of life-threatening complications were found among deceased patients (Table 1). Cases of septic shock (11 vs. 4), ARDS (18 vs. 2), $p < 0.01$ were more common in the group of non-survives. In our study, mortality depended mainly on the initial severity of TBI (low GG 3-5). As in other studies, cardiovascular, respiratory, and infectious problems were the most common extracranial complications among this category of patients.

Even in the absence of direct extracranial organ injury, 86% of patients with severe TBI can exhibit significant organ dysfunction, which is independently associated with worse outcomes. This dysfunction and failure can affect a multitude of systems and can occur in the acute setting all the way through to rehabilitation.

## CONCLUSIONS

Extracranial complications increase both the length of stay and morbidity in the ICU, as well as mortality in patients with severe traumatic brain injury. Severe respiratory insufficiency and low GSC values on the background of hypotension are independently associated with mortality in the ICU.

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