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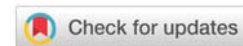
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**Keywords:** Traumatic Brain Injury (TBI); Industrial injuries; Members of vessel's crew; Northern water basin

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## Research Article

# Disabled industrial traumatic brain injury of members of vessel's crew in water transport of the Northern Water's Basin

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## Annotation

**Introduction:** Epidemiological study of Traumatic Brain Injury (TBI) and the improvement of the organizational capabilities of medical care at all stages of its provision plays an important role in forecasting and social and labor rehabilitation of the sailing crew. Planning the development of the neurosurgical service of port hospitals is impossible without knowing the structure of TBI, both in severity and sectoral, occupational and territorial prevalence.

**Materials and methods:** The analysis of the treatment of 92 patients from members of the vessel's crew who received industrial TBI with a disability while performing voyage tasks in the northern water basin was carried out.

When working on the material, analytical and statistical methods were used. The significance of differences was calculated using a t-test for independent samples.

**Results:** In the general structure of traumatism of the studied contingent of the members of the vessel's crew, TBI accounted for 4.1% of cases, while in the territorial population, they reach 30.0% - 40.0%. Most of the victims worked in the transport fleet of the northern water basin - 68.7% (9.4), while in the fishing fleet - 17.2% (3.3) and the river fleet - 14.1% (4.6). Command staff: navigators (10.5), captains (10.1), chiefs of radio stations (7.4), skippers (6.8), as well as boatswains (27.8), who are responsible for organizing and conducting deck operations, receive TBI 4.0 - 2.5 times more often than rank-and-file personnel. This distribution becomes easy to understand if we take into account that 43.4% of the damage was sustained during the performance of ship operations related to movement on ladders and decks, in the engine room, and their hasty execution by the supervisors in the absence of safety precautions leads to severe TBI. The members of the vessel's crew receive them several times less often when performing loading and unloading operations (0.9), closing holds (0.4), mooring, and servicing deck mechanisms (0.2 each). The probability of getting TBI is especially high during the first three years of work in the specialty (34.8% of all injuries). With an increase in work experience, injuries decrease by more than 1.4 times among workers with 15 years of work experience. Every third TBI (36.5%) on ships is associated with a fall of the victim from a height, that is, it is a catatrama. All injuries arise from collisions with blunt objects.

**Discussion:** Every twenty-fifth work-related injury with loss of ability to work, sustained by the members of the vessel's crew of the northern water basin, while performing ship operations, is a TBI. The minimum knowledge required for shipboard crew members, and ship managers to suspect this life-threatening condition, is given during an injury first aid session that is required by the ship's medical officer.

**Conclusion:** 1. In the general structure of industrial injuries of the studied contingent of the members of the vessel's crew, TBI accounted for 4.1% of cases, while in the territorial population, they reach 30.0% - 40.0%. The incidence of TBI in men from among the members of vessel's crew is only 1.5 times higher than in women and is the highest in people under 20 years of age (4.8%; 11.0).

2. Most of the victims worked in the transport fleet of the northern water basin - 68.7% (9.4), while in the fishing fleet - 17.2% (3.3) and river - 14.1% (4.6). The members of the vessel's crew receive them several times less often when performing loading and unloading operations (0.9), closing holds (0.4), mooring, and servicing deck mechanisms (0.2 each). Every third TBI (36.5%) on ships is associated with a fall of the victim from a height, that is, it is a catatrama.

3. TBI, accompanied by a concussion, in the northern basin accounts for up to two-thirds of all head injuries, of which 69.5% fall on the most able-bodied and productive age of workers (20-39 years). Concussions occur 4 times more often in the transport fleet than in the fishing and river fleet. Sailors and minders make up 44.3% of the victims. Falls from a height onto decks, mooring lines, into the hold, or overboard were the cause of 78.5% of concussions.

4. Mild brain contusions are a rarer pathology and occur mainly in transport and fishing fleets with rank-and-file personnel during falls from a height.

5. Brain contusions of moderate and severe degrees occur only in the transport fleet in the youngest men: in every second case, the patients were 20-29 years old. Every third victim is a sailor, every sixth is a minder. A severe degree of brain injury was more often observed in persons who received TBI while servicing deck mechanisms, moving along ladders, and mooring operations. More than half of them are associated with falls from a height.

## Introduction

Traumatic Brain Injury (TBI) is a multidisciplinary problem at the intersection of a number of clinical and biomedical disciplines, including public health, healthcare organizations, and social hygiene. Epidemiological study of TBI and improving the organizational capabilities of medical care at all stages of its provision play an important role in predicting and social and labor rehabilitation of the members of the vessel's crew. Planning the development of the neurosurgical service of port hospitals is impossible without knowing the structure of TBI, both in severity and sectoral, occupational, and territorial prevalence. The volume and nature of organizational and diagnostic and treatment measures carried out on ships by medical workers with TBI have a number of peculiarities in comparison with territorial medical institutions [1-4]. No other independent targeted studies of industrial head injury of a floating composition of water transport have been found in the available literature.

## Materials and methods

The analysis of the treatment of 92 patients from the number of the members of the vessel's crew, who received industrial TBI with a disability while performing voyage tasks in the northern water basin was carried out.

When working on the material, methodological approaches were used: systemic, complex, integration, functional, dynamic, process, normative, quantitative, administrative, and situational. Analysis methods included: an analytical and comparison. Techniques were used: grouping, absolute and relative values, average values, detailing, and generalization. The results were processed statistically. As the main characteristics of descriptive statistics, the arithmetic mean and standard deviation were used for the normal distribution of variables. Qualitative characteristics were presented in the form of relative frequencies with the definition of a confidence interval. The significance of differences in quantitative characteristics between groups with a normal distribution of quantitative variables was calculated using t-tests for independent samples. The threshold value of the probability of error for statistically significant differences was set at a level of 0.05.

## Results

In the general structure of traumatism of the studied contingent of the members of the vessel's crew, TBI accounted for 4.1% of cases, while in the territorial population, they reach 30.0% - 40.0%. The frequency factor is 6.4. Among the victims, there were 92.7% of men (6.6) and 6.3% of women (4.4). Thus, the incidence of TBI in men from among the swimming team is only 1.5 times higher than in women and is the highest in people under 20 years of age (4.8%; 11.0). It remains high in subsequent older age groups, reaching the lowest rates among workers over 50 (7.4%; 6.1) while decreasing by 1.8 times. The proportion of patients 20-29 years old and 30-39 years old among all victims was 70.6% of patients [5-7].

Most of the victims worked in the transport fleet of the northern water basin - 68.7% (9.4), while in the fishing fleet

- 17.2% (3.3) and the river fleet - 14.1% (4.6). Command staff: navigators (10.5), captains (10.1), chiefs of radio stations (7.4), skippers (6.8), as well as boatswains (27.8), who are responsible for organizing and conducting deck operations, receive TBI 4.0 - 2.5 times more often than rank-and-file personnel. This distribution becomes easy to understand if we take into account that 43.4% of the damage was sustained during the performance of ship operations related to movement on ladders and decks, in the engine room, and their hasty execution by the supervisors in the absence of safety precautions leads to severe TBI. The members of the vessel's crew receive them several times less often when performing loading and unloading operations (0.9), closing holds (0.4), mooring, and servicing deck mechanisms (0.2 each) [8-10]. The probability of getting TBI is especially high during the first three years of work in the specialty (34.8% of all injuries). With an increase in work experience, injuries decrease by more than 1.4 times among workers with 15 years of work experience. Every third TBI (36.5%) on ships is associated with a fall of the victim from a height, that is, it is a catatrauma [11,12]. All injuries arise from collisions with blunt objects.

The members of the vessel's crew do not have a reliable dependence on TBI with the time of year or certain days of the week ( $p > 0.05$ ). Of the voyages, 39.5% of them occurred, while the majority (60.5%) - was when carrying out ship operations while staying in ports. Swimming in the Arctic zone, especially in the autumn-winter period, increases injuries by 1.6 times compared to temperate latitudes. In the structure of TBI, the proportion of polytraumas was 46.4%, among which the overwhelming majority were of a combined nature. Most often they are accompanied by injuries of the chest with fractures of 2 - 3 ribs complicated by hemothorax, fractures of the clavicle, ruptures of the acromioclavicular joints, wounds of the hands and forearms, bruises of the spinal column and knee joints. Despite the remoteness of the ships from the coastline, 63.5% of the victims were evacuated to territorial medical institutions in the first 6 hours and another 16.8% - 12 hours after the injury. The rest of the patients were admitted to onshore hospitals at a later date. As a rule, these are victims with mild forms of TBI [13,14]. Their structure in the floating composition of the northern basin is presented in Table 1.

Concussion among the members of the vessel's crew train was accompanied by symptoms of diffuse brain tissue damage in combination with stem symptoms. It is especially important for a ship doctor to establish the duration of the loss of consciousness of the victim and assess its severity as the main prognostic sign that will determine tactical, medical, and evacuation measures both from the scene of the accident to the ship's medical center and to the coastal medical institutions. The identification of symptoms of traumatic brain tissue damage in severe brain contusions after resuscitation at the site of injury is an indication for changing the course of the vessel and emergency evacuation of the patient due to the impossibility of providing adequate therapeutic measures. Among members of the vessel's crew linear fractures of the bones of the cranial vault in every third case are of an open nature (37.6%). And in the structure of skull base fractures, the

**Table 1:** The structure of traumatic brain injury injuries of members of the vessel's crew of the northern basin (in%), average bed-day, and duration of incapacity for work (in days).

The clinical form of traumatic brain injury	Northern Water's Basin	Transport fleet	Fishing fleet	River fleet	Average bed-day	Not working property
Concussion	62,0 ± 3,2	60,8 ± 3,8	55,5 ± 8,9	83,2 ± 7,6	17,3	31,3
Mild brain contusions	17,3 ± 2,5	9,9 ± 2,3	44,5 ± 8,3	16,8 ± 7,6	41,4	94,3
Middle brain contusions degree	13,7 ± 2,2	19,4 ± 3,1	--	--	18,7	85,4
Severe brain contusions degree	7,0 ± 1,7	9,9 ± 2,3	--	--	33,5	81,6
Total	100,0	100,0	100,0	100,0	16,6	36,0

proportion of open injuries is the highest and reaches 74.8%. This, in turn, determines the need for early primary surgical treatment during the first day. As a rule, due to insufficient neurotraumatological training of ship doctors, they do not undertake any manipulations on the skull and brain and are limited to toilet wounds with antiseptic solutions, hemostasis, and the imposition of an aseptic dressing, administration of tetanus toxoid, and antibiotic therapy. In the course of treatment, purulent complications occur in 16.1% of patients (0.9).

After the end of TBI treatment, 87.4% of patients returned to the vessel's crew, group II of disability II was established in 2.6% of patients, and death occurred in 10.0% of patients. The duration of disability averaged 36.0 working days, of which 16.6 more were spent in a hospital bed.

## Discussion

Every twenty-fifth industrial facility with a loss of ability to work, received by the members of the vessel's crew of the Northern Water's Basin, during the performance of ship works is a TBI.

What is the minimum knowledge required for shipboard crew members, and ship supervisors, to suspect this life-threatening condition?

TBI is a mechanical injury to the skull, brain, and membranes. The main causes of traumatic brain injury are 1) Road traffic accidents (RTA); 2) Industrial, sports, street, and domestic injuries; 3) Fights, and attacks; 4) Gunshot wounds.

Depending on the damage to the skin of the head, the following types of TBI are distinguished: 1) Closed TBIs arise as a result of injuries inflicted through the soft tissues and bones of the skull, in which the integrity of the skin of the head is not disturbed. There are no conditions for infection of the brain and its membranes; 2) Open is characterized by damage to the skin of the head and bones of the skull. They are 1) Non-penetrating. The integrity of the dura mater is preserved; 2) Penetrating. The dura mater is damaged. Conditions arise for primary or secondary infection of brain tissue.

By the nature and severity of damage to the substance of the brain, the following types of TBI are distinguished: 1) Concussion. It develops more often with a closed TBI. It is characterized by functional disorders without morphological changes: loss of consciousness, nausea or vomiting, headache, and retrograde amnesia. These disorders are temporary and reversible; 2) Brain contusion. This type of injury is a serious injury. It is characterized by focal disorders associated with damage to brain tissue and can be not only at the site of

application of the traumatic force but also on the opposite side. As a result, severe circulatory disorders are possible, accompanied by cerebral edema and increased spinal pressure; 3) Compression of the brain. It is a serious complication of skull damage. It occurs with intracranial hematoma (bleeding from intracranial vessels), cerebral edema, trauma by bone fragments of the cranial vault and a foreign body, pneumocephalus (accumulation of air in the cranial cavity); 4) Diffuse axonal brain damage. It is characterized by a prolonged (up to 2–3 weeks) coma and pronounced stem symptoms. There are disturbances in the frequency and rhythm of breathing. Autonomic disorders are expressed.

According to the severity, TBI is distinguished: 1) Mild: characterized by a concussion and mild brain contusion; 2) Moderate: characterized by moderate brain contusion; in this case, the following are possible: fracture of the vault and base of the skull, traumatic subarachnoid hemorrhage, epileptic seizures; 3) Severe: characterized by severe contusion of the brain, compression of the brain, severe axonal damage to the brain; possible fracture of the vault and base of the skull, epileptic seizures, pronounced brainstem, and diencephalic disorders.

During TBI, periods are distinguished: 1) Acute; 2) Intermediate; 3) Remote.

TBI is manifested by: 1) Loss of consciousness; 2) Dizziness; 3) Severe headache; 4) Ringing in the ears; 5) Increasing general weakness, drowsiness, and lethargy; 6) Retrograde amnesia; 7) Nausea and vomiting; 8) leakage from the nose of cerebrospinal fluid or cerebrospinal fluid [3,15].

The ship's medical officer should provide this minimum information to members of the ship's crews during routine technical training so that they can suspect TBI in injured seafarers and provide first aid before the ship's doctor arrives at the scene of the accident.

It can be stated that, in general, the tactics and practical actions of the person responsible for providing first aid on board the ship (as a rule, the chief mate) in the absence of a medical worker correspond to the medical doctrine for TBI and do not lead to additional injury and deterioration of the patient's condition. Experience shows that a telephone consultation and (or) a video consultation of a surgeon or neurosurgeon is an invaluable additional help in the structure of emergency actions in the provision of severe traumatic brain injuries.

Analysis of TBI made it possible to identify a number of epidemiological features of its individual clinical forms. Concussions in the Northern Water Basin account for up to two-thirds of all head injuries, of which 69.5% occur in the

most able-bodied and productive age of workers (20–39 years). Concussions occur 4 times more often in the transport fleet than in the fishing and river fleet. Sailors and minders make up 44.3% of the victims. Falls from a height onto decks, mooring lines, into the hold, or overboard were the cause of 78.5% of concussions. More than half of them occur during intensive loading and unloading operations by the crew. Every second accident leads to polytrauma, of which 31.2% were multiple, and 68.8% were combined.

Mild brain injuries are a rare pathology and occur mainly in transport and fishing fleets with rank-and-file personnel (90.1%) when crossing ladders and decks, as well as loading and unloading operations. Most of the patients with this clinical form of TBI (75.2%) were injured when falling from a height. After providing them with resuscitation measures, removing them from traumatic shock, and stabilizing vital indicators, it was possible to evacuate 71.6% of patients from the ship's medical center to coastal hospitals within the first six hours after the injury.

Moderate and severe brain injuries occur only in the transport fleet in the youngest men: in every second case, the patients were 20–29 years old. Every third victim is a sailor, every sixth is a minder. A severe degree of brain injury was more often observed in persons who received TBI while servicing deck mechanisms, moving along ladders, and mooring operations. More than half of them are associated with falls from a height. According to the primary documentation of the ship's outpatient clinics, the members of the vessel's crew of the Northern Water's Basin were not diagnosed with compression of the brain against the background of its contusion and compression of the brain without concomitant contusion.

## Conclusion

1. In the general structure of industrial injuries of the studied contingent of members of the vessel's crew of the Northern Water's Basin, TBI accounted for 4.1% of cases, while in the territorial population, they reach 30.0% – 40.0%. The incidence of TBI in men from among the members of the vessel's crew is only 1.5 times higher than in women and is the highest in people under 20 years of age (4.8%; 11.0).

2. Most of the victims worked in the transport fleet – 68.7% (9.4), while in the fishing fleet – 17.2% (3.3) and river – 14.1% (4.6). The members of the vessel's crew receive them several times less often when performing loading and unloading operations (0.9), closing holds (0.4), mooring, and servicing deck mechanisms (0.2 each). Every third TBI (36.5%) on ships is associated with a fall of the victim from a height, that is, it is a catatrauma.

3. TBI, accompanied by a concussion, in the Northern Water's Basin account for up to two-thirds of all head injuries, of which 69.5% fall on the most able-bodied and productive age of workers (20–39 years). Concussions occur 4 times more often in the transport fleet than in the fishing and river fleet. Sailors and minders make up 44.3% of the victims. Falls from

a height onto decks, mooring lines, into the hold, or overboard were the cause of 78.5% of concussions.

4. Mild brain contusions are a rarer pathology and occur mainly in transport and fishing fleets with rank-and-file personnel during falls from a height.

5. Brain contusions of moderate and severe degree occur only in the transport fleet in the youngest men: in every second case, the patients were 20–29 years old. Every third victim is a sailor, every sixth is a minder. A severe degree of brain injury was more often observed in persons who received TBI while servicing deck mechanisms, moving along ladders, and mooring operations. More than half of them are associated with falls from a height.

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