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## **Characteristics of diagnostic defects in traumatic brain injury (forensic medical approach)**

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### **Abstract**

Diagnostic defects in the evaluation of TBI, such as the violation of protocols, neglect of neurological symptoms, and incorrect description of head injuries, can significantly impact the diagnosis and forensic assessment of TBI. The study of defects in the provision of medical care in traumatic brain injury (TBI) was conducted based on the data from forensic medical examinations of Kharkiv Regional Bureau of Forensic Medical Examination (KhRBFME) (307) and SI "Main Bureau of Forensic Medical Examination of the Ministry of Health of Ukraine" (SI MBFME) (226). The largest number of undiagnosed diagnostic and treatment measures related to clinically mild forms of TBI due to incomplete description of the neurological status, failure to consider the complete neurological symptomatology specific to a particular form of TBI, diagnosis based solely on subjective complaints of the patient and historical data (head injury, according to the patient's words), lack of patient examination by

related specialists, and absence of additional investigations. Significant defects influencing the forensic medical assessment of TBI in the affected individuals included: incomplete description of neurological symptomatology ( $91\pm2.4\%$ ), absence of trauma history ( $23.5\pm1.8\%$ ), defects in describing external head injuries ( $67.9\pm2.0\%$ ), simulation, and aggravation.

**Key words: forensic medical examination; traumatic brain injury; diagnostic defect.**

## **Introduction**

Traumatic brain injury (TBI) is a significant public health concern, often leading to long-term disability and mortality. Accurate and timely diagnosis of TBI is crucial for appropriate management and prognosis. However, diagnostic defects in the evaluation of TBI, such as the violation of protocols, neglect of neurological symptoms, and incorrect description of head injuries, can significantly impact the diagnosis and forensic assessment of TBI [1-7].

Diagnostic errors, including the violation of protocols, contribute to the misdiagnosis or delayed diagnosis of TBI. Aaronson et al. [1] emphasize the importance of trigger tools in detecting diagnostic errors, particularly within 72 hours of patient admission. Failure to adhere to established protocols, such as those outlined in the Guidelines for the Management of Traumatic Brain Injury [5], can result in suboptimal evaluation and management of TBI. Chesnut et al. [2] propose a consensus-based management protocol (CREVICE protocol) to guide treatment decisions in severe TBI cases when intracranial pressure monitoring is not employed. Deviation from such evidence-based protocols may lead to inappropriate care and adverse outcomes.

Neglect of neurological symptoms in the diagnostic process is another significant defect that affects the identification and management of TBI. Gleason et al. [3] highlight the feasibility of patient-reported diagnostic errors following emergency department discharge. Patients may experience unaddressed neurological symptoms, which can result in delayed treatment or undetected complications. Failure to recognize the potential severity of these symptoms may hinder accurate diagnosis and appropriate referral for specialized care.

Furthermore, incorrect description of head injuries poses a challenge in diagnosing TBI accurately. Hautz et al. [4] demonstrate that diagnostic errors in emergency departments increase mortality rates and hospital stays. The improper documentation or incomplete description of head injuries during initial evaluation may lead to misinterpretation of the severity of TBI and subsequently inadequate management. Zorilă et al. [6] emphasize the

importance of accurate epidemiological data to inform healthcare policies and resource allocation, highlighting the need for precise reporting and documentation of head injuries in the context of TBI.

These diagnostic defects have significant implications for both the diagnosis and forensic assessment of TBI. Delayed or missed diagnoses can result in delayed treatment initiation and suboptimal patient outcomes. Moreover, accurate diagnosis and documentation are essential for medico-legal purposes, including insurance claims, forensic investigations, and determination of legal responsibility. The impact of diagnostic defects on the forensic assessment of TBI necessitates improvements in diagnostic processes to ensure accurate and comprehensive documentation.

In conclusion, diagnostic defects in the evaluation of TBI, including the violation of protocols, neglect of neurological symptoms, and incorrect description of head injuries, have substantial consequences on the diagnosis and forensic assessment of TBI. Addressing these defects through the implementation of evidence-based protocols, improved recognition of neurological symptoms, and accurate documentation of head injuries is vital for optimizing patient care and facilitating medico-legal processes associated with TBI. Future research and initiatives should focus on developing standardized approaches to enhance the accuracy and efficiency of TBI diagnosis and forensic assessment.

**The aim of the study** is the identification of defects in the diagnosis of traumatic brain injuries, including fatal ones, committed by healthcare professionals at various stages of providing medical care based on the results of forensic medical examinations of victims and deceased individuals.

**Materials and methods.** The study of defects in the provision of medical care by doctors in cases of traumatic brain injury (TBI) was conducted based on the data from forensic medical examinations of victims carried out by the Kharkiv Regional Bureau of Forensic Medical Examination (KhRBFME) (307 cases from their own practice) for the years 2008-2012, and the commission forensic medical examinations of TBI cases conducted on victims by the SI "Main Bureau of Forensic Medical Examination of the Ministry of Health of Ukraine" (SI MBFME) for the years 2020-2021 (226 cases), in order to investigate the main clinical defects that affect the subsequent assessment of TBI by forensic medical experts. It was determined which clinical forms of TBI pose the greatest difficulties for healthcare professionals in terms of diagnosis, and which specific defects contribute to these challenges, including the quality of description of neurological symptoms and soft tissue head injuries in cases of TBI.

When characterizing qualitative indicators, the share of variants possessing the studied features ( $n$ ) was expressed as a percentage ( $P$ ) of their total number and the error of representativeness ( $m_p$ ). The confidence interval (CI) was 95%.

To test the hypothesis about the equality of the general means of two independent (unconnected) samples distributed according to the normal law, the two-sample Student's test ( $t$ ) was used. The significance level was  $p < 0.05$ .

### **Results and discussion**

During the statistical analysis of examinations it was found that the majority of diagnoses of concussion ( $81.4 \pm 2.2\%$  according to KhRBFME and  $83.6 \pm 2.5\%$  according to the Main Bureau of Forensic Medical Examination) and mild traumatic brain injury ( $14 \pm 2.0\%$  according to KhRBFME and  $12.4 \pm 2.2\%$  according to SI MBFME) were unfounded. This particularly applies to cases of clinically mild forms of traumatic brain injury, including concussion.

It was also revealed that patient examinations were not always conducted comprehensively, which complicated the forensic medical assessment. Neurologists diagnosed "concussion" based solely on subjective complaints from the patient and historical data, without examination by neurosurgeons, otolaryngologists, and ophthalmologists, which are necessary in cases of traumatic brain injury. In some cases, the diagnosis of "concussion" was made by doctors who were not specialists in the field.

The research showed that the percentage of unfounded diagnoses of intracranial hematomas was  $1.5 \pm 0.5\%$  (all of them were subarachnoid), as they were not confirmed by CT or MRI of the brain, and no blood samples or lumbar punctures were performed.

In the analysis of forensic medical examinations in cases of traumatic brain injury, fractures of the base and vault of the skull were detected in  $4.1 \pm 0.9\%$  of the total number of TBI examinations. In  $36.4 \pm 10.3\%$  of cases, the diagnosed fractures were not confirmed radiographically. It was also found that in 22 cases, skull fractures were mistakenly classified as fresh because doctors did not take into account information from medical documentation regarding previous fractures. Proper examination of medical records in these cases could have revealed that the skull fractures occurred long before the events, as documented in the medical charts.

During the analysis of the medical documentation of the victims, the completeness of diagnostic procedures was examined. The number of cases with incomplete description of neurological symptoms amounted to 485 cases ( $91 \pm 2.4\%$ ). The absence of description of neurological symptoms that are most commonly encountered in cases of traumatic brain

injury (TBI) is presented in Figure 1.

As evident from the figure, the majority of records did not include assessments based on the Glasgow Coma Scale in 448 cases ( $84.1 \pm 1.6\%$ ), descriptions of the Marinescu-Radovici symptom in 438 cases ( $82.2 \pm 1.7\%$ ), and the Gurevich-Man symptom in 402 cases ( $75.4 \pm 1.9\%$ ), which are crucial for establishing a diagnosis of TBI, assessing the severity, and determining further management.

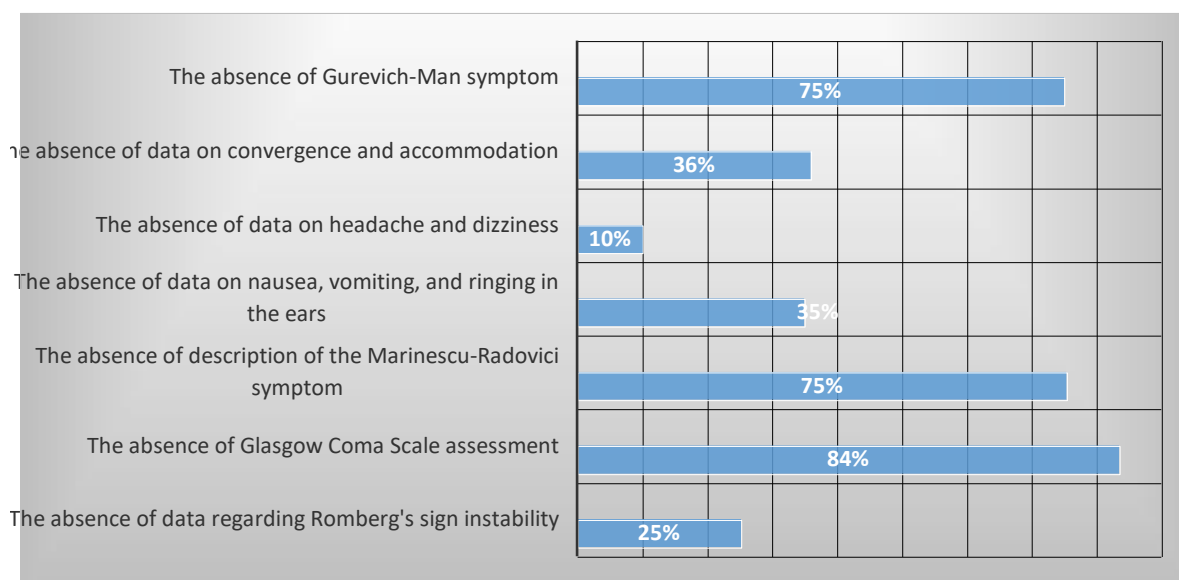


Figure 1. Percentage distribution of the number of diagnostic defects in TBI.

Therefore, during the analysis of the medical documentation of patients with traumatic brain injury (TBI), a lack of important data for forensic medical assessment of the nature, timing, mechanism of injury, and other factors was identified. Among such data, the following were observed.

#### **History of trauma:**

The absence of a trauma history was observed in  $23.5 \pm 1.8\%$  of cases, where the medical records lacked information regarding the time and circumstances of the injury (e.g., falls from height, blunt or sharp object injuries, motor vehicle accidents, etc.). Additionally, the circumstances described in the medical documentation sometimes did not match those stated in the decision to conduct a forensic medical examination and the materials of the criminal proceedings. There were cases where a significant amount of time elapsed between the injury and the arrival at the healthcare facility, and information regarding where the patient received treatment, where they sought medical attention, or if they engaged in self-treatment was absent from the medical records. Furthermore, instances of subsequent injuries to the victim between the initial trauma and their presentation at the healthcare facility were

identified, which became known only after investigative actions with the victim (such cases amounted to 7.45%).

### **Description of skin injuries on the head**

During the analysis of 533 expert forensic examinations conducted at SI MBFME, it was found that in cases where visible bodily injuries were present, 470 cases had medical documentation when the victims sought medical attention. In 362 cases ( $67.9 \pm 2.0\%$  of the total), deficiencies were observed in describing visible bodily injuries. This complicated the determination of the timing of these injuries by the expert commission. The majority of such cases involved the description of visible bodily injuries in medical documentation by clinician physicians (335 cases, accounting for  $62.9 \pm 2.1\%$ ). In medical records of inpatient or outpatient individuals, as well as in medical certificates, there were generally no descriptions of any morphological features of the injuries provided by physicians. It should be noted separately that in almost one-third of TBI cases with available medical documentation (172 cases, accounting for  $32.3 \pm 2.0\%$ ), a diagnosis of "Soft Tissue Contusion of the Head" (STC) was established for the victims in medical institutions without any descriptions of visible bodily injuries, which are not subject to forensic medical assessment according to section 4.6 of "Rules for Forensic Medical Determination of the Severity of Bodily Injuries" of the Order No. 6 dated January 17, 1995, of the Ministry of Health of Ukraine. Therefore, among the deficiencies in describing visible bodily injuries on the head (out of 470 examinations with accompanying medical documentation), the following were noted by physicians: the color of the injury was not described, the edges or ends of the wounds were not described, the characteristics of the scab were not described, the condition of the surrounding tissues around the injury was not described, and STC was diagnosed without describing the injuries (see Figure 2).

In the context of a comprehensive assessment of head injuries (when there are more profound and significant injuries such as fractures, brain membrane injuries, brain substance injuries, etc., in the same location as the bodily covering injuries), typically, even in the absence of a sufficient description of the morphological characteristics of the injuries, their timing can be determined. However, in cases where only skin injuries are present, determining their timing of formation without an appropriate description is entirely impossible.

The inadequate or missing description of the morphological characteristics of head injuries (hematoma color, abrasion characteristics, nature of wound edges and ends, sedimentation, etc.) significantly affected the forensic medical assessment of TBI.

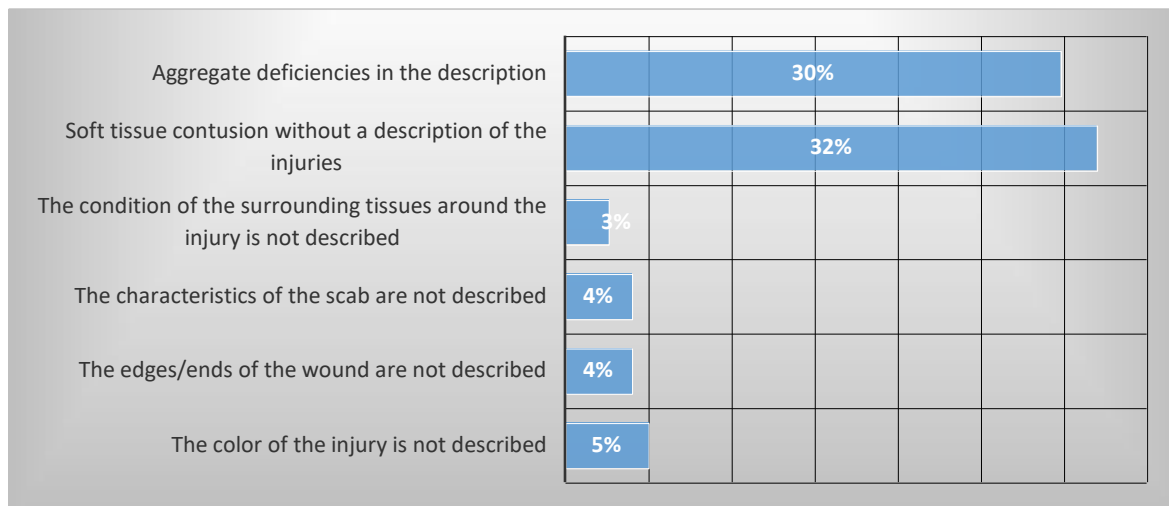


Figure 2. Quantitative characteristics of defects in the description of visible physical injuries in medical documentation in cases of TBI.

### **Simulation and aggravation of traumatic brain injury (TBI)**

These are cases where medical documentation contains records of a nonexistent diagnosis with corresponding examination data or exaggeration of symptoms and severity of the existing TBI. In forensic medical examinations conducted in such cases, the diagnosis was not confirmed.

For example, a victim presented for a forensic medical examination with medical documentation indicating the presence of post-traumatic arachnoiditis with corresponding clinical and diagnostic data. Based on the circumstances of the case and the victim's statements, it was known that the injury occurred a year ago when the TBI was diagnosed as a concussion (which was not confirmed by any clinical or diagnostic criteria, including the absence of external head injuries). The forensic medical examination revealed that neither the concussion nor the post-traumatic arachnoiditis were confirmed.

The above-mentioned data indicate that clinicians do not adhere to the standards prescribed in the Clinical Protocols for providing medical care to patients with TBI when diagnosing "TBI." It is precisely due to these reasons that forensic medical experts face difficulties in conducting forensic medical assessments, as properly documented medical records and justified performance of a series of clinical and diagnostic measures play a leading role in forensic medical assessment, especially in cases where a significant amount of time has passed since the victim's injury, and the manifestations of a specific form of TBI may disappear. In such cases, defects in TBI diagnosis can be identified.

The aforementioned deficiencies in patient examination can be assessed as improper

provision of medical care and pose a potential danger in terms of the occurrence of severe complications, particularly considering the possibility of a "lucid interval" in the course of post-traumatic subdural hematomas.

### **Conclusions and prospects for further research**

1. The medical documentation provided for forensic medical examination contains unjustified TBI diagnoses in many cases. This may indicate a low level of qualification among the doctors making these diagnoses or insufficient attention to detail when filling out the medical documentation.

2. The diagnosis of concussion is often unjustified. This may be due to the fact that the symptoms of a concussion can be relatively mild, leading doctors to misinterpret them or not thoroughly investigate the patient.

3. Mild traumatic brain injury (MTBI), such as a mild brain contusion, is also frequently diagnosed without justification. This may be because this form of TBI can be easily tolerated and may not require significant medical attention, but doctors may believe that any head injury can result in this type of trauma.

4. Overall, the identification of unjustified TBI diagnoses in medical documentation indicates the need for improvement in the quality of medical practice and a more attentive approach to patients.

5. The majority of patients diagnosed with a concussion did not receive a comprehensive neurological assessment, which complicates forensic medical evaluations. In some cases, the diagnosis of "concussion" was made by non-specialist doctors. The defects identified in the medical documentation in forensic medical examinations of severe TBI (e.g., brain contusion) resembled those observed in concussions. Additionally, cases were found where there was a complete absence of clinical symptoms in patients with brain contusions. In 15.4% of cases, patients did not undergo a CT scan or MRI of the brain.

6. Analysis of the medical documentation of patients with TBI indicates that the absence of important data regarding the time, mechanism of injury, and circumstances of trauma can complicate the forensic medical assessment of the nature of the injury. Furthermore, defects in the description of visible physical injuries can also affect the accuracy of injury diagnosis.

7. Cases of TBI simulation are mentioned, which can also complicate diagnosis and forensic medical assessment. Such cases may be caused by the exaggeration of symptoms and severity of an existing injury.

Therefore, it is important to ensure the accuracy and completeness of documenting

medical information regarding injuries in medical documentation to avoid complications in subsequent forensic medical evaluations. It is also crucial to exercise caution in diagnosing TBI, especially in cases where there is suspicion of simulation.

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