


## Neurosurgery: study guide

**КУПИТИ**

## Про книгу

The study guide is compiled in accordance with the curriculum in neurosurgery. The basics of diagnosis and treatment of patients with the most common neurological diseases of the brain and spinal cord, spine and its structures, peripheral nerves are highlighted. The publication uses modern European and American protocols for the management of such patients. Each section contains a list of recommended reading.  For students of higher medical education establishment, interns.



# NEUROSURGERY

STUDY GUIDE

Edited by Professor **V.O. PIATYKOP**

APPROVED

by the Academic Council of Kharkiv National  
Medical University as a study guide for students  
of higher medical education establishment

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## Contents

<i>Topic 1. Traumatic Brain Injury</i> .....	4
<i>Topic 2. Spinal Cord Injuries</i> .....	23
<i>Topic 3. Cerebrovascular Diseases</i> .....	41
<i>Topic 4. Tumors of the Brain, Spinal Cord.</i> Pathology of Intervertebral Discs.....	55
<i>Topic 5. Hydrocephalus</i> .....	94
<i>Topic 6. Functional and Stereotactic Neurosurgery</i> .....	100
List of Recommended Literature .....	111

## Topic 1

# TRAUMATIC BRAIN INJURY

Traumatic brain injury is the most common and severe type of trauma that is the main cause of death for victims aged 20—40. Skull and brain injuries constitute over one-third of injuries and rank the top among the reasons of lethality and disability of the victims. The number of disabled people due to brain damage in the late twentieth century reached around 150 million people worldwide. Every year, 1.5 million people die from traumatic brain injury, and 2.4 million become disabled. The incidence of traumatic brain injury is on average 3—4 cases per 1000 population (E.G. Pedachenko et al., 2007; B.V. Zadorozhnaya, 2012; V.V. Kosharnyi et al., 2014; M.E. Polishchuk et al., 2015).

One of the main causes of high morbidity and mortality from a severe traumatic brain injury is irreversible changes in brain structures, particularly in the brainstem, resulting in their displacement and compression with subsequent development of acute stroke, edema, swelling and dislocation of the brainstem.

In Ukraine, patients with traumatic injuries of the nervous system account for more than 70 % of the total number of patients admitted to the neurosurgical departments. Severe forms occur in over 30 % of patients with traumatic brain injury. 30 to 50 % of patients with severe traumatic brain injury die; complete survival of the central nervous system is relatively rare among survivors. In the unfavorable course, the mortality rate may reach more than 80 % (N.E. Polishchuk et al., 2000; V.M. Shevag et al., 2009; N.N. Zavadenko et al., 2010; V.G. Poltoratsky, 2013; M.H. Morgalla et al., 2014).

Organizations such as the NICE (National Institute for Clinical Excellence) and BTF (Brain trauma foundation) regularly issue protocols and guidelines for patients with severe brain injury. These protocols are based on multi-center, prospective, randomized trials and are consistent with the principles of evidence-based medicine.

### **Classification of traumatic brain injury**

For the first time, the classification of traumatic brain injury was proposed by J.L. Petty in 1774. He described three major clinical forms of brain damage:

- 1) brain concussion (*commotio cerebri*);
- 2) brain contusion (*contusio cerebri*);
- 3) brain compression (*compressio cerebri*).

This classification was used for over three centuries and became the basis for many other classifications of traumatic brain injuries.

Modern clinical classification of acute traumatic brain injury includes seven main clinical forms (A.N. Konovalov, 2001):

- 1) concussion;
- 2) contusion of a mild degree;
- 3) middle-level contusion;
- 4) severe contusion;
- 5) diffuse axonal brain damage;
- 6) brain compression;
- 7) head compression.

Considering infection of the brain injury is divided into closed (70—75 %) — not initially infected, and open — initially infected with the presence of open paths for penetration of infection into the cranial cavity.

Closed brain injury — there is no violation of the integrity of the soft tissues of the head or there are such disorders, but there is no violation of the integrity of the aponeurosis or no damage to the bones.

Open brain injury — is a trauma characterized by 1) damage to all layers of soft tissues of the head and underlying bone (fractures linear, fragmentary, punctured); 2) fracture of the skull bones in the area of the air-bearing sinuses or fracture of the base of the skull; 3) wounds of the soft tissues of the head with damage to the aponeurosis.

Open traumatic brain injuries are penetrating (damaged dura mater accompanied by liquorrhea) and nonpenetrating (without damaging the dura mater).

An important diagnostic and prognostic criterion is the level of consciousness.

In our country there are seven gradations of the state of consciousness:

- 1) clear consciousness;
- 2) stunning moderate;
- 3) stunning deep;
- 4) sopor;
- 5) moderate coma;
- 6) deep coma;
- 7) terminal coma.

However, in most countries around the world, the Glasgow coma scale is more widely used to quantify consciousness disorders. On this scale, the degree of impaired consciousness is assessed by three parameters: 1) eye response; 2) motor response; 3) verbal response.

### **Eye response (E)**

Four grades are starting with the most severe:

Eyes opening spontaneously — 4 points.

Eye-opening to speech. — 3 points. (Not to be confused with the awakening of a sleeping person; such people receive a score of 4, not 3.)

Eye-opening in response to pain stimulus — 2 points (a peripheral pain stimulus, such as squeezing the lunula area of the person's fingernail is more effective than a central stimulus such as a trapezius squeeze, due to a grimacing effect).

No opening of the eye — 1 point.

### **Verbal response (V)**

Five grades are starting with the most severe:

Oriented — 5 points. (Person responds coherently and appropriately to questions such as the person's name and age, where they are and why, the year, month, etc.)

Confused — 4 points. (The person responds to questions coherently but there are some disorientation and confusion.)

Inappropriate words — 3 points. (Random or exclamatory articulated speech, but no conversational exchange. Pronounces words without sentences.)

Incomprehensible sounds — 2 points. (Moaning but no words.)

No verbal response — 1 point.



### **Motor response (M)**

There are six grades:

Obeys commands — 6 points (the person does simple things as asked).

Localizes to pain — 5 points (purposeful movements towards painful stimuli; e.g., brings a hand up beyond chin when supraorbital pressure applied).

Withdrawal from pain — 4 points (absence of abnormal posturing; unable to lift hand past chin with supraorbital pain but does pull away when nailbed is pinched).

Decorticate posturing accentuated by pain — 3 points (flexor response: internal rotation of the shoulder, flexion of forearm and wrist with a clenched fist, leg extension, plantarflexion of foot).

Decerebrate posturing accentuated by pain — 2 points (extensor response: adduction of the arm, internal rotation of the shoulder, pronation of forearm and extension at the elbow, flexion of wrist and fingers, leg extension, plantarflexion of foot).

No motor response — 1 point.

According to the Brain Trauma Foundation (BTF) protocols <https://www.braintrauma.org/> (2016), the management of patients with severe brain injury is conducted in three categories: procedures, monitoring, and indicators.

#### ***Procedures***

1. Decompressive craniectomy.
2. Prophylactic hypothermia.
3. Hyperosmolar therapy.
4. Cranial-brain drainage of fluid.
5. Ventilation therapy.
6. Anesthetics, analgesics, and sedatives.
7. Steroids.
8. Nutrition.
9. Prevention of infection.
10. Prevention of deep vein thrombosis.
11. Rash prevention.

#### ***Monitoring***

12. Intracranial pressure.
13. Excessive brain perfusion.
14. Advanced brain monitoring.

#### ***Indicators***

15. Blood pressure.

16. Intracranial pressure.

17. Brain perfusion.

The Glasgow outcome scale (B. Jennet, M. Bond) is used to evaluate the results of treatment after a traumatic brain injury.

1. Death	Severe injury or death without recovery of consciousness
2. Persistent vegetative state	Severe damage with a prolonged state of unresponsiveness and a lack of higher mental functions
3. Severe disability	Severe injury with the permanent need for help with daily living
4. Moderate disability	No need for assistance in everyday life, employment is possible but may require special equipment
5. Low disability	Light damage with minor neurological and psychological deficits

### Basic clinical forms and their characteristics

**Brain concussion** (*commotio cerebri*) is a mild form of closed traumatic brain injury, characterized by a prevalence of reversible functional changes in the brain. It is believed that there are no macroscopic pathomorphological changes in the case of concussion. Electron microscopic studies have made it possible to find damage to neurons in the form of destruction of their cell membranes, mitochondria, and other changes.

Brain concussion occurs in 70—80 % of the affected and is accompanied by loss of consciousness after trauma of 1—2 to 10—20 min. There is a presence of characteristic cerebral symptoms such as headache, dizziness, general weakness, poor sleep, increased sensitivity to bright light, noise. Also note the presence of autonomic disorders — blood flow to the face, redness of the face, asthenia. In neurological status — divergent strabismus, oscillating pendulum-like nystagmus, moderately manifested Kernig's symptom. These symptoms disappear within 5—7 days after the injury.

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