

## TRAUMATIC BRAIN INJURY

### **Introduction:**

Traumatic Brain Injury (TBI) is defined as a traumatically induced structural injury and/or physiologic disruption of brain functions as a result of an external force. The force may be caused by a bump, blow, or jolt to the head, or a penetrating head injury that disrupts normal functions of the brain.

### **Classifications:**

TBI can be classified as mild, moderate or severe. The degree of impairment has diagnostic and therapeutic implications. The majority of patients with mild TBI will improve significantly within 90 days, while patients with moderate or severe TBI may develop chronic and/or permanent handicap or disability.

1. Mild Traumatic Brain Injury: A traumatically induced physiological disruption of brain function manifested by at least one of the following:

Any alteration of mental status at the time of the injury, e.g. disorientation or confusion

Any loss of consciousness < 30 minutes

A history of retrograde or anterograde amnesia

A Glasgow Coma Scale (GCS) score of 13-15

Some patients with mild TBI may be described as having a concussion, i.e. an alteration of mental status at the time of injury resulting in disorientation or confusion. A post-concussion syndrome may include headache, photophobia, dizziness, decreased concentration, short-term memory dysfunction, word finding difficulty, irritability, mood swings, and/or changes in normal activities of daily living. 80-90% of individuals with mild TBI will recover fully in < 90 days. However, some symptoms may persist for up to 1 year post-injury.

2. Moderate TBI: A traumatically induced physiological disruption of brain function manifested by at least one of the following:

Memory loss of 24 hours to 7 days

Any loss of consciousness > 30 minutes and up to 24 hours

A Glasgow Coma Scale (GCS) score < 9-12

3. Severe TBI: A traumatically induced physiological disruption of brain function manifested by at least one of the following:

Memory loss lasting more than 7 days

Any loss of consciousness > 24 hours

A Glasgow Coma Scale (GCS) score of 8 or less

Persons with a moderate to severe TBI frequently require significant medical and surgical interventions and will often require inpatient care on a long-term or chronic basis. The types of medications and physical interventions used in the acute phase, and the long-term rehabilitation needs such as splinting, nerve block procedures, etc., are beyond the scope of this protocol.

### **Diagnostic Evaluation:**

1. Imaging Studies:

a. X-rays. X-rays have generally been replaced by CT scanning, which has a higher accuracy and sensitivity for detecting fractures. X-rays may be helpful if the CT scan is unavailable and if a fracture is possible but very unlikely.

b. CT scan is the imaging study of choice in the acute period. CT scanning is sensitive to the detection of blood, fractures, and structural abnormalities.

c. MRI scanning. Usually not performed in the acute setting since CT scanning is preferable for the detection of acute intracranial bleeding. MRI scans are very sensitive and are more commonly used in the subacute or chronic phase.

d. Vascular imaging. Vascular studies are performed in the acute setting when venous or arterial abnormalities are expected from the patient's history, symptoms, and clinical examination. CT angiography (CTA) may be used when abnormalities of the carotid or vertebral system are suspected. MRA and carotid ultrasound are not generally indicated in the acute setting.

Advanced imaging studies are most likely to be indicated in the following cases:

- initial GCS score of 13 or less, and/or < 15 by 4 hours post-injury
- age > 55 years
- exam is unreliable due to intoxication or drugs
- retrograde amnesia of > 30 minutes
- witnessed loss of consciousness > 15 minutes
- repeated vomiting
- evidence of basilar skull fracture

2. Lumbar Puncture. A lumbar puncture may be used to examine the cerebrospinal fluid in neurological disease and/or injury. When indicated, a qualified and trained physician may perform a lumbar puncture under sterile conditions. Contraindications to a lumbar puncture may include acute trauma to the spinal column, infection, increased intracranial pressure and/or coagulation disorders.

3. Laboratory testing. Laboratory tests may be necessary to evaluate a patient with mild TBI when there is a suspicion of systemic illness, electrolyte disorder, drug use, alcohol intoxication or an underlying medical disease. Hypopituitarism occurs in up to 17% of patients with a mild traumatic brain injury and laboratory testing for this disorder may be indicated. Patients who require medication for treatment of their mild traumatic brain injury may require periodic laboratory testing to measure drug levels and/or assess drug effects on organ function.

4. Neurophysiology Studies. Electroencephalography (EEG) measures brainwave function and may be performed in the subacute or chronic phase of the illness, or in the acute phase, when seizure activity is suspected. A normal EEG does not rule out a seizure disorder. Techniques such as sleep deprivation and photic stimulation may enhance accuracy. Brain Stem Auditory Evoked Responses (BAER) are helpful in assessing mid brain and brainstem abnormalities. Somatosensory Evoked Potentials (SEPs) are not usually indicated in mild traumatic brain injury. Visual Evoked Potentials (VEPs) can be used to assess abnormalities from the anterior to posterior visual pathways, i.e., from the retina to the occipital cortex.

5. Cognitive/neuropsychology testing. Neuropsychological testing is helpful in defining the extent of cognitive and behavioral deficits, severity, and determining the relationship of these abnormalities to the patient's vocational responsibilities and/or activities of daily living. Neuropsychological testing may help establish rehabilitative strategies and realistic outcomes. These studies provide a baseline to assess improvement - or lack thereof - over time. The efficacy of rehabilitative interventions can be assessed and either modified or terminated as indicated. The assessment may be important in determining MMI and degree of impairment. Initial referral for neuropsychological testing at 30 days after injury is reasonable if the patient does not show significant improvement in the first month. Other factors that determine the time of testing and may compel earlier testing include stressful and demanding occupations, age, or pre-existing factors that may influence outcome. Periodic neuropsychological testing may be necessary depending upon the patient's progress.

6. Vestibular testing. Vestibular dysfunction, including hearing loss, vertigo, and balance problems, may occur. In the majority of patients these symptoms are self-limited and resolve within 3 months. If the patient shows no improvement at 4 weeks or if the initial symptoms are severe, impairing activities of daily living such as driving a car, referral for neuro-otology evaluation is indicated. The most common type of vertigo following MTBI is benign positional vertigo which does not usually require additional extensive testing since it is diagnosed with clinical maneuvers and treated with a variety of canalith-repositioning maneuvers, e.g. Epley Maneuvers. If the diagnosis of vertigo is unclear or concomitant vestibular abnormalities are suspected, further evaluation should be pursued. Frequently utilized and generally accepted testing includes tympanometry, vestibular function studies such as electro- or video-nystagmography (ENG/VNG), and Rotary Chair Testing.

**Treatment:**

a. Cognitive rehabilitation refers to therapy programs that aid in the management of specific problems such as perception, memory, thinking, and problem solving. Skills are practiced and strategies are taught to help improve function and compensate for remaining deficits. Cognitive rehabilitation is indicated in individuals who have experienced mild TBI resulting in cognitive symptoms that impair activities of daily living or vocational function. Rehabilitation must be prescribed by the attending physician and carried out by a qualified individual such as a psychologist, speech

therapist, or occupational therapist. Individuals who receive cognitive rehabilitation are expected to show measurable functional improvement within a pre-determined timeframe from the side of cognitive rehabilitation therapy. Goals and expected timeframes should be assessed prior to therapy and updated every 3-4 weeks. Objective changes should be documented, and the patient should demonstrate measurable improvement. Lack of objective improvement questions the efficacy, and therefore the need, for further therapy.

b. Post-traumatic headaches (PTH) have an incidence of > 50% in cases of mild TBI, are usually self-limited and resolve spontaneously in 80-90% of patients within 3 months. The treatment and prognosis of PTH may be diagnosis-dependent and can occur as a result of injury due to extracranial structures such as cervico-occipito-cranial muscles, temporomandibular joint, or sinuses. Pre-existing migraine headache may be exacerbated by a mild TBI. Treatment of PTH should be matched with the underlying or causative etiology.

c. Vestibular Rehabilitation: This form of rehabilitation is performed by qualified clinicians including audiologists, nurses, and physical therapists. Vestibular rehabilitation is indicated for abnormalities such as balance disorders, postural control, and vertigo.

d. Post-traumatic Psychiatric Disorders are common following mild TBI, are usually mild and self-limited with resolution within 90 days. Mood swings, irritability, anxiety, and depression are most common. Interpersonal relationships often suffer. Mild problems can be treated with reassurance or counseling. Anti-depressants and anti-anxiety medications are often helpful. In more severe cases where there is significant impairment of activities of daily living or issues affecting return back to work, psychiatric referral is indicated.

e. Sleep Disorders: Insomnia is common, is usually self-limited and will spontaneously resolve within a period of weeks. Environmental and behavioral modifications are frequently helpful. Short-term medication usage can be used. If sleeplessness causes significant impairment in activities of daily living or interferes with return to work, sleep lab evaluation may be helpful.

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**Table 1.** The Glasgow Coma Scale  
And The Glasgow Outcome Scale.

**Glasgow Coma Scale**

**Eye opening**

Spontaneous	4
To speech	3
To pain	2
No response	1

**Verbal response**

Alert and oriented	5
Disoriented	4
Speaking but nonsensical	3
Moans	2
No response	1

**Motor response**

Follows commands	6
Localizes pain	5
Withdraws to pain	4
Decorticate flexion	3
Decerebrate extension	2
No response	1

**Grading of TBI:\***

Mild†	13-15
Moderate	9-12
Severe	3-8

\* A single GCS score is neither diagnostic of TBI nor predictive of outcome.

† Because of the 10% or greater incidence of craniotomy in these patients, many authorities now consider a GCS of 13 to represent moderate brain injury.

**Glasgow Outcome Score**

D	=	Dead
PVS	=	Persistent vegetative state
SD	=	Severe disability
MD	=	Moderate disability
GR	=	Good recovery

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**TRAUMATIC BRAIN INJURY**

**PROTOCOL HISTORY:**

Passed: 9/1/1992 (as Post-Concussion Syndrome)

Amended: 11/19/2002

Amended: 5/5/2009 (as Post-Traumatic Headache)

Amended: 10/25/2016 (as Traumatic Brain Injury)