

Assessment and immediate management of traumatic brain injury

Valoración y manejo inmediato del traumatismo craneoencefálico

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Introduction

With a significant morbimortality rate in people under 45 years of age, in Europe it is estimated that traumatic brain injuries (TBIs) have an incidence of 235 cases per 100,000 inhabitants/year and an approximate mortality rate of 11%¹. TBI is the cause of neurodegenerative sequelae such as Alzheimer's, Parkinson's and chronic traumatic encephalopathy (CTE), the latter being particularly relevant in athletes who repeatedly sustain mild TBIs².

That is why the initial assessment of all TBIs in athletes, the measures taken and the decision to return to competition are decisive for their health.

Initial assessment of traumatic brain injury

The severity of a TBI is defined by two concepts: the primary injury, caused by the traumatic agent which directly affects the brain, and the secondary injury, which causes ischaemia and hypoxia, produces an inflammatory response with the release of neurotransmitters and metabolic deregulation, and leads to raised intracranial pressure (ICP), all of which mark the outcome and prognosis of the injured person³.

After assessing and stabilising the airway and respiratory and cardiovascular functions, and correctly managing the cervical spine manually or with a spinal motion restriction (SMR) device, attention must be paid to the central nervous system (CNS).

The data from the initial examination must be recorded in writing so that any deterioration in the clinical evolution of the patient can be detected. The neurological examination should be as complete as possible.

If the injury is isolated or located on the skull or face, examination and assessment focussing on detecting signs which may alert us to an alteration in neurological function should be carried out in order to establish its severity and start to take appropriate therapeutic measures.

The neurological assessment should be as thorough as possible and begin with anamnesis.

Anamnesis

The usual medical details with history, allergies and treatments must be taken, together with a detailed medical record of the cause and mechanisms of the trauma, and the characteristics of where the head was struck.

Information should be collected from the patient if he/she can collaborate or from witnesses about:

- Initial loss of consciousness, its duration or presence of seizure.
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- Signs of temporo-spatial disorientation or amnesia
- Signs of problems paying attention or with language.
- Assessment of deep tendon, plantar and pupillary reflexes.
- Changes in strength, sensitivity, coordination and/or gait.
- Other signs to watch out for are dizziness, sustained or progressive headache, and vomiting.

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Initial clinical examination

The skull and face are inspected for wounds, contusions, scalp laceration, depression as a sign of skull fracture, or signs of skull base fracture such as otorrhagia, epistaxis, panda/raccoon eyes (peri-orbital ecchymosis) or the appearance of Battle's sign, characterised by ecchymosis over the mastoid process.

The deep tendon, plantar and pupillary reflexes are assessed, as is any change in strength, sensitivity, coordination and gait.

The Glasgow Scale is a good assessment and prognosis evaluation tool which varies depending on whether the patient is able to collaborate or not. Its main limitation is in the assessment of children, facial trauma, people with language disorders and those who do not know the language.

Pupillary assessment

The pupillary examination (Table 1) can provide relevant information because it tests the functioning of the third cranial nerve. The size, shape, symmetry and light response of the pupils should be assessed. One dilated pupil, anisocoria, with poor responsiveness usually indicates uncal herniation. Two small or medium-sized but responsive pupils indicate metabolic encephalopathy or diencephalic transtentorial haemorrhaging. Unresponsive miotic pupils indicate pons damage or opioid use. Hippus (rhythmic dilation and contraction of the pupil) has no meaning.

The absence of pupillary light reflex and anisocoria suggest a structural injury⁴.

Level of consciousness

The Glasgow Coma Scale (GCS) assesses the level of consciousness according to three types of response which have a direct relationship with the neurological function: eye response, verbal response and motor response.

It is currently the starting point for TBI assessment.

This type of assessment designed for adults needs to be adapted for children who are unable to communicate orally due to their age.

Neurological assessment scales

The neurological assessment of TBIs is carried out using assessment scales. The most widely used is the Glasgow scale.

Glasgow Scale

The Glasgow Scale (Figure 1) was created by Graham Teasdale and Bryan Jennett, members of the Institute of Neurological Sciences at the University of Glasgow, in 1974. Their goal was to provide a simple and reliable method of recording and monitoring the level of consciousness of patients with traumatic brain injury.

The Glasgow Coma Scale (GCS) (Table 2) assesses eye, verbal and motor responses by scoring each separately and adding them up to arrive at a score that quantifies the neurological situation of the patient and their prognosis.

It should be performed in all cases of TBI as soon as possible and periodic assessments should be carried out to detect improvement or worsening of the clinical picture.

Eye-opening assessment

If after a TBI, the patient keeps their eyes open spontaneously, a score of 4 is given.

If they keep them closed and have to be asked to open them, a score of 3 is given.

If only a painful stimulus (pressure on a finger lasting 10") makes them open their eyes, 2 points are given.

Finally, if no stimulus is able to make them open their eyes, a score of 1 is given.

This assessment is difficult in situations such as facial trauma with orbital hematomas or eyelid oedema.

Assessment of the verbal response

If after a TBI, the patient is able to maintain a guided conversation and answer the simple questions: What's your name? Where are you? What day of the week is it?, a score of 5 is obtained.

If they are confused or disoriented by the same simple questions, they score 4.

If their conversation is incoherent or meaningless, they are given a score of 3.

If the patient only emits incomprehensible sounds or babbles, they score 2.

If no verbal response is noted, 1 point.

Assessment of motor response

The assessment of the movement of a patient who has suffered a TBI is carried out by ordering them to do simple actions such as lifting their

Table 1. Pupillary examination.

Size	Symmetry	Responsiveness
Miotic: < 2mm diameter Mydriatic: > 5mm diameter Normal: 2-5 mm diameter	Isocoria: equal Anisocoria: unequal Dyscoria: irregular	Responsive: contract with light Unresponsive: do not contract with light

Figure 1. Updated Glasgow Coma Scale (GSC).

GLASGOW COMA SCALE : Do it this way

EYES
 VERBAL
 MOTOR

Institute of Neurological Sciences NHS Greater Glasgow and Clyde

CHECK

For factors Interfering with communication, ability to respond and other injuries

OBSERVE

Eye opening , content of speech and movements of right and left sides

STIMULATE

Sound: spoken or shouted request
Physical: Pressure on finger tip, trapezius or supraorbital notch

RATE

Assign according to highest response observed

Eye opening

Criterion	Observed	Rating	Score
Open before stimulus	✓	Spontaneous	4
After spoken or shouted request	✓	To sound	3
After finger tip stimulus	✓	To pressure	2
No opening at any time, no interfering factor	✓	None	1
Closed by local factor	✓	Non testable	NT

Verbal response

Criterion	Observed	Rating	Score
Correctly gives name, place and date	✓	Orientated	5
Not orientated but communication coherently	✓	Confused	4
Intelligible single words	✓	Words	3
Only moans / groans	✓	Sounds	2
No audible response, no interfering factor	✓	None	1
Factor interfering with communication	✓	Non testable	NT

Best motor response

Criterion	Observed	Rating	Score
Obey 2-part request	✓	Obeys commands	6
Brings hand above clavicle to stimulus on head neck	✓	Localising	5
Bends arm at elbow rapidly but features not predominantly abnormal	✓	Normal flexion	4
Bends arm at elbow, features clearly predominantly abnormal	✓	Abnormal flexion	3
Extends arm at elbow	✓	Extension	2
No movement in arms / legs, no interfering factor	✓	None	1
Paralysed or other limiting factor	✓	Non testable	NT

Sites For Physical Stimulation

Finger tip pressure

Trapezius Pinch

Supraorbital notch

Features of Flexion Responses

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Ned Tijdschr Geneesk

Abnormal Flexion

Slow Stereotyped
Arm across chest
Forearm rotates
Thumb clenched
Leg extends

Normal flexion

Rapid
Variable
Arm away from body

For further information and video demonstration visit www.glasgowcomascale.org

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Table 2. FOUR (Full Outline of UnResponsiveness) scale.

<p>Eye Response</p> <p>E4: Eyes tracking horizontally or vertically, or blinks twice to command</p> <p>E3: Eyelids open but not tracking</p> <p>E2: Eyelids open to loud or painful stimuli</p> <p>E1: Eyelids open to pain</p> <p>E0: Eyelids remain closed with pain</p> <p>Motor Response</p> <p>M4: Gives thumbs-up, clenches fist or makes peace sign to command</p> <p>M3: Localises pain (applying a supraorbital or temporomandibular stimulus)</p> <p>M2: Flexion response to pain (includes decorticate posturing and withdrawal responses) in upper extremities</p> <p>M1: Extensive response to pain</p> <p>M0: No response to pain or generalised myoclonus status</p> <p>Brain stem reflexes</p> <p>B4: Pupil and corneal reflexes present</p> <p>B3: Pupil reflex absent on one side</p> <p>B2: Pupil or corneal reflexes absent</p> <p>B1: Pupil and corneal reflexes absent</p> <p>B0: Absent pupil, corneal and cough reflexes</p> <p>Respiration</p> <p>R4: Not intubated, regular breathing pattern</p> <p>R3: Not intubated, Cheyne-Stokes breathing pattern</p> <p>R2: Not intubated, irregular breathing</p> <p>R1: Intubated, breathes above ventilator rate</p> <p>R0: Intubated, breathes at ventilator rate or apnoea</p>

arms or legs and moving their fingers, or with more elaborate actions such as touching the tip of their nose with their right index finger ⁵.

If they obey the order given, they get a score of 6.

If they do not obey, a painful stimulus is applied (pressure to the trapezius or supraorbital notch for 10"). If they try to alleviate the pain by locating the point that hurts, they are given 5 points.

If the pain causes them to move and try to withdraw from the stimulus, they score 4.

If the pain causes an abnormal flexion of the arms, the score is 3. This may indicate decorticate posturing, which can manifest itself as stiffness with bent arms.

If the pain causes them to stretch out their arms and hands, it is indicative of decerebrate posturing and the score given is 2.

If the painful stimulus does not cause any movement: 1 point.

The sum of each of these points gives a score between a maximum of 15 points and a minimum of 3 points. The following classification is made according to this scale:

- Mild TBI. GCS score of 15-13 points.
- Moderate TBI. GCS score of 12-9 points.
- Severe TBI. GCS score of < 9 points.

It is important to carry out this assessment before sedating or paralysing the patient^{6,7}.

Interpretation of the Glasgow Coma Scale

According to the score obtained with the Glasgow Coma Scale, three levels of TBI severity are established: mild, moderate and severe.

Mild head trauma: Score of 13-15. The patient has experienced an alteration in their level of consciousness or unconsciousness lasting less than 30 minutes. The symptoms or signs they show are headache, confusion and amnesia. There is complete neurological recovery even though some of these patients have transient concentration or memory difficulties.

Moderate head trauma: Score of 9-12. The patient is clinically lethargic or stuporous. Patients with moderate TBI require hospitalisation and can develop post-concussion syndrome, manifesting a state of neurological instability after a mild or moderate TBI. The symptoms may include dizziness, headache, fatigue and difficulty concentrating.

Severe brain trauma: Score of 3-8. The patient is in a comatose state, is unable to open their eyes or follow orders and is suffering from significant neurological injuries. Structural injuries such as skull fracture or intracranial haemorrhage are usually seen in computed tomography (CT) scans. These patients require admission to the Intensive Care Unit (ICU) or neurosurgical treatment. Recovery is lengthy and usually incomplete. A significant percentage of patients with severe TBI do not survive more than one year.

Other neurological assessment scales

The Brussels Coma Score, Grady Coma Scale and Innsbruck Coma Scale are not widely used because they do not have good inter-observer reliability and have lower predictive capacity than the Glasgow Coma Scale.

One scale to consider, as an alternative in intubated patients, is the FOUR scale (Full Outline of UnResponsiveness) developed by Wijdicks *et al*⁸, which could prove very useful in coma assessment because it covers other brain stem functions. This scale evaluates four aspects: eye opening, motor response, pupillary and corneal reflexes and respiratory pattern (Table 2).

There is another simpler assessment scale which is in disuse as far as health professionals are concerned but which could be of interest to those who are not (athletes, coaches, physical trainers, etc.) thanks to its simplicity: the AVPU scale.

An estimation of a patient's level of consciousness is arrived at by observing their behavioural response to different stimuli.

- A: Alert.
- V: Responds to verbal stimulus.
- P: Responds to painful stimulus.
- U: Unresponsive to stimuli.
- The assessment procedure is simple after a TBI:
- If the patient is awake and talking to the assessor, they are categorised as A (alert), even if they are disoriented.

- If the patient is not fully awake, it is necessary to see if they respond to the assessor's voice. For example, by opening their eyes, talking or moving. If they do, they are V (responding to verbal stimuli).
- If the patient does not respond to the voice, apply a painful stimulus, such as pressing or pinching the trapezius and checking for a response (opening of eyes, moaning or movement). If there is a response, the patient is classified as P (responsive to pain).
- Those who do not respond are U (unresponsive).

- Progressive decline in or loss of consciousness, modification of GCS score.
 - Alteration in behaviour.
 - Focal neurological deficit.
 - Constant amnesia over time.
 - Presence of seizure.
- Complications should also be suspected when associated with:
- High-energy accidents.
 - Persons over 65 or under 2 years of age.
 - Alterations in coagulation.
 - Consumption of alcohol or narcotics.

Therapeutic strategy for different situations

At the scene

The initial management of a TBI seeks to identify patients at vital risk and provide adequate assessment and diagnosis in order to avoid the development of possible complications⁹.

TBI is often part of the context of a polytrauma patient, and any patient who has sustained a TBI should be evaluated for trauma with indication of surgical intervention. The ITLS (*International Trauma Life Support*) assessment in the extra-hospital environment and the ATLS (*Advanced Trauma Life Support*) assessment at hospital level set the standard for action in the event of polytrauma.

This procedure includes the stabilisation and control of the cervical spine as soon as possible either manually or with a cervical collar.

Once the possible injuries which could put the life of the injured person at risk are under control, the neurological assessment should include the patient's level of consciousness based on the Glasgow Coma Scale (GCS) and the presence of anterograde or retrograde amnesia. Any signs of focal neurological deficit should also be detected, including: pupillary size and responsiveness, limb paresis and cranial nerve deficit.

It is also important to perform a detailed inspection of the skull and face, looking for contusions, wounds, embedded objects and deformities which may suggest fractures or cranial collapse.

Otorrhagia, orbital haematomas, mastoid ecchymosis (Battle's sign) and cerebrospinal fluid otorrhea and rhinorrhoea are indicative of skull base fracture.

It is also very useful to know, if possible, the injury mechanism involved because it can provide information on the energy generated in the trauma and the damage we should expect, which may not be evident at the time.

Finally, it is advisable to know some aspects of the patient's previous medical history, such as allergies, current treatments (anticoagulants, etc.) and toxic habits.

We know that the symptoms which may arise as a result of a TBI are varied, but it is important to be aware of the signs which should make us suspect intracranial structural injury, whether they manifest themselves from the start or later on.

Warning signs:

Referral and transfer

Most head injuries do not present any neurological symptoms. In these cases and after a thorough study and assessment, GCS 15, it is not necessary to refer them to a health centre, although supervision is recommended for 24/48 hours in case warning signs appear.

Regardless of their GCS, patients with TBI should be transferred to a hospital which has permanent comprehensive care with 24-hour Computed Tomography (CT) scanner, ICU and 24-hour neurosurgical service (level 3 hospital) if the following circumstances arise:

- Presence of neurological focality.
- Presence or suspicion of cranial fracture-collapse.
- Non-immediate post-traumatic seizure.
- TBI as a result of high-energy accidents.
- Cranial CT scan identifying the appearance of a recent traumatic injury.
- Whenever there is any doubt regarding the diagnosis or it is thought that evaluation, monitoring or neurosurgical treatment may be required.
- Over-65s.
- Anticoagulant treatment or coagulation disorders.
- In paediatric ages which present altered behaviour or irritability.

All TBIs with a GCS under 13 should be transferred by Advanced Life Support (ALS) ambulance with specific monitoring and treatment capacity, as should all patients presenting:

- Warning signs.
- Cranial wound with embedded object, cranial collapse.
- Suspected skull base fracture.
- Polytrauma.
- High-energy accident.

TBIs with GCS over 13 can be transferred in a Basic Life Support (BLS) Ambulance.

Hospital level

In the hospital emergency department, the care provided previously should be continued and the diagnostic and therapeutic measures unavailable in a non-hospital environment should be taken.

Computed tomography (CT) scanning is the test of choice for the

diagnosis of acute intracranial injury and is sometimes complemented with cervical spine radiology, especially when there are signs of suspected cervical spine involvement. Indications of when CT scans should be performed are described in Table 3.

The relevant therapeutic measures should be taken according to the level of consciousness indicated by GCS, which will again be reassessed at this stage.

Table 3. Computed tomography (CT) indication assessment.

Category	Characteristics	CT (yes/no)
Mild		
1	GCS: 15	NO
2	GCS: 15 + warning signs	YES
3	GCS: 13-14 with/without warning signs	YES
Moderate	GCS: 9-12	YES
Severe	GCS: ≤ 8	YES

Mild TBI with GCS of 15

The patient should be kept under observation for 4 hours and can be discharged for 24 hours if no neurological deterioration is appreciated. If any warning sign appears or the patient’s level of consciousness declines during that time, a CT scan should be performed with evaluation by neurologists.

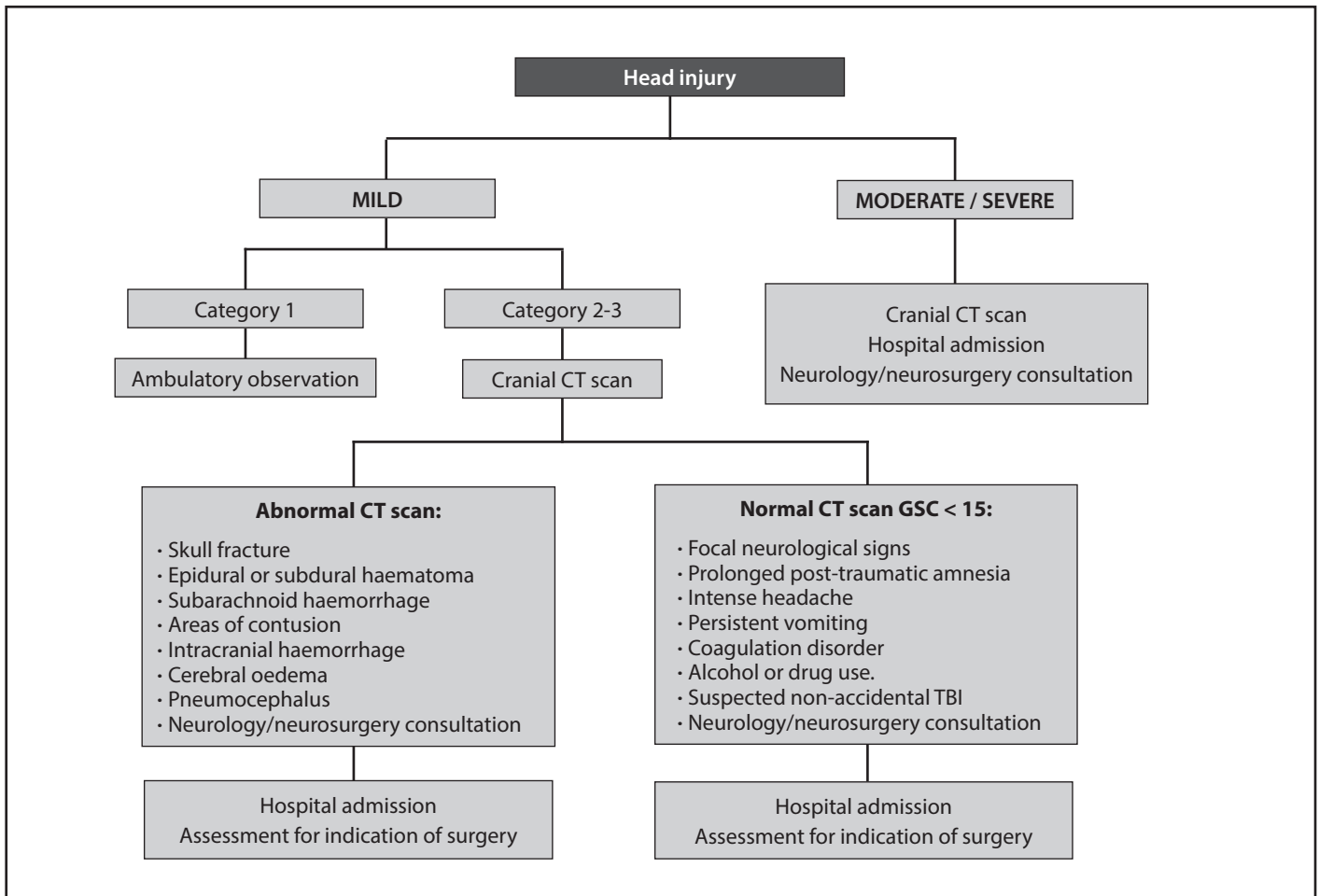
Mild TBI with GCS of 15 presenting a warning sign over time

A CT scan should be performed, the neurology service should be consulted and the patient should be kept under observation for 24 hours, monitoring vital signs and periodically re-evaluating level of consciousness (GCS) or the appearance of neurological focality.

Some type of antiseizure treatment may also be given and a neurosurgical evaluation should be carried out.

If the warning signs appear in patients over 65 years of age, there is neck pain or pain on examination, the patient has suffered a high-energy accident or fall from height, a three-projection radiological study of the cervical spine should also be requested.

Figure 2. Strategy of action when faced with a traumatic brain injury (TBI).



Mild TBI with GCS of 13-14

A cranial CT scan and evaluation by the neurology service is always required.

In these cases, the presence in the CT scans of signs of structural involvement such as cranial fracture, epidural or subdural haematoma, subarachnoid haemorrhage, intraparenchymal haemorrhage with signs of contusive foci or pneumocephalus requires an urgent neurosurgical evaluation in order to establish the therapeutic measures to deal with the injuries.

In the case of a normal CT scan in which warning signs persist, an examination by the neurology service will also be necessary in order to determine the action to be taken, including hospital admission.

In the presence of moderate or severe TBI, coordination of the emergency, radiodiagnosis, neurology, neurosurgery and intensive care departments is required to provide the best therapeutic response and ensure the best possible neurological outcome.

Figure 2 describes the algorithm of action for a traumatic brain injury (TBI)^{9,10}.

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