Recommendations

Level I

There is insufficient data to support a Level I recommendation for this topic.

Level II

There is insufficient data to support a Level II recommendation for this topic.

Level III

The Glasgow Coma Scale (GCS) is the most frequently used scoring system for assessment and classification of traumatic brain injury.

2.1 Overview

Head injuries can be categorized in several ways: by mechanism of injury (closed or penetrating injury), morphology (fractures, focal intracranial injury, diffuse intracranial injury), or severity of injury (mild to severe).

Immediate triage and assessment of the severity and probable survival of the traumatized patient should be made whenever possible already at the scene of injury. Of useful help are the various trauma scores that have been developed to triage the patients for proper care and evaluate the severity of injury. The scores are based on physiological and/or anatomical features, as well as patient responses. Physiological scores are exemplified by Glasgow Coma scale (GCS) (Teasdale and Jennett 1974), the Revised Trauma Score (RTS) (Champion et al. 1989), and the Pediatric Trauma Score (PTS) (Tepas et al. 1987). The Injury Severity Score (ISS) is an anatomical score based on the Abbreviated Injury Scale (AIS) that provides an overall score of the patient (Baker et al. 1974).

The GCS has been the most valuable and frequently used scoring system for assessing the severity of a head trauma.

To estimate severity of brain injury after head trauma, various classification systems of head injury have been proposed and modified throughout the years. Most of them are based on the patients’ level of consciousness according to the GCS, as e.g. the Head Injury Severity Scale (HISS) (Stein and Spettell 1995). The Swedish Reaction Level Scale 85 (RLS) is a somewhat

Tips, Tricks, and Pitfalls

- Severe head injury is defined as a patient with conscious level of GCS 3–8 (RLS 4–8) after head injury.
simpler scale than the GCS, though less frequently used outside of Sweden (Starmark et al. 1988a).

### 2.2 Background

In the 1960s, there was a common belief amongst neurosurgeons that, aside from evacuating occasional hematomas or elevating depressed fractures, little could be done to influence outcome after head injury. However, with improvement of intensive care and resuscitation, the challenge for neurosurgeons was to assist in reducing mortality and morbidity for these severely head-injured patients. Pathological studies in Glasgow showed that by avoiding potentially preventable secondary brain damage, one could limit the degree of disabilities in survivors (Reilly et al. 1975).

Complications, such as the development of intracranial haematomas or increased intracranial pressure, were difficult to recognize; hence treatment was delayed. These concerns lead to the development of the Glasgow Coma Scale by Jennett and Teasdale in 1974 (Teasdale and Jennett 1974). The scale was initially designed as a research tool for assessment of the comatose patient, but is now one of the most frequently used scales in triage of head injuries and in daily assessment of severe head injury. The drawback of using the GCS is the confounding effect of alcohol or other drugs, especially during the first few hours after injury. Heavy alcohol intoxication has been associated with a reduction of 2–3 points in GCS in assaulted patients (Brickley and Shepherd 1995).

#### 2.2.1 Classification Systems

In 1981, Rimel and colleagues defined minor head injury as a head trauma with patient’s GCS score of 13–15 at admission, loss of consciousness (LOC) less than 20 min, and a duration of hospital admission less than 48 h (Rimel et al. 1981). About a decade later, Stein and Spettell introduced a modified classification system, the Head Injury Severity Scale (HISS), a five-interval severity scale (minimal through critical) based primarily on initial GCS score. The HISS scale also includes the aspects of retrograde amnesia, loss of consciousness, and focal neurological deficits for each severity interval (Stein and Spettell 1995).

In 2000, the Scandinavian Neurotrauma Committee (SNC) presented guidelines of management of adult head injury (Ingebrigtsen et al. 2000), using a modified version of the HISS classification, by classifying head injuries into minimal, mild, moderate, and severe (Table 2.1):

- **Minimal head injury** is presented by a patient with GCS 15 at admission and with no LOC or focal neurological deficits.
- **Mild head injury** is defined as initial GCS of 14–15, brief LOC (<5 min) and no focal neurological deficits.
- **Moderate head injury** defines a patient with initial GCS of 9–13 and/or focal neurological deficits or LOC ≥5 min after head trauma.
- **Severe head injury** includes all patients with an initial GCS score of 8 or below, hence, unconscious patients.

The definitions of mild and moderate head injury vary in the literature, especially with regard...
to the importance of a GCS score of 13 and the duration of loss of consciousness. Commotio cerebri is a clinical definition of an awake patient with posttraumatic amnesia possibly due to brief LOC after head trauma, but without any apparent brain injury. Amnesia is most often retrograde, but in some cases even antegrade amnesia is present, i.e. the inability to recall new memories after the head injury event.

### 2.2.2 Primary and Secondary Brain Injury

Primary brain injury refers to the immediate brain damage caused upon impact. This includes cerebral contusions, shearing lesions (diffuse axonal injuries – DAI), lacerations from a foreign body, and acute subdural or epidural hematomas. Secondary brain injury refers to progressive cerebral oedema, which is more commonly seen in children, ischemia, and the expansion of cerebral contusions and the surrounding focal oedema, which causes an increase in intracranial pressure (ICP) within the confined skull and can eventually lead to cerebral herniation and death.

### 2.2.3 Assessment Scales

The GCS has been the most valuable and frequently used scoring system for assessing severity of neurologic injury after head trauma. The scale is divided in three parts: eye response, verbal response, and motor response, adding to a total score of 3–15 points. The GCS scale has, however, been considered difficult to apply on especially preverbal children (Yager et al. 1990) since their ability to express themselves verbally or nonverbally in a consistent manner is limited. The response from an infant is also clearly different from an adult. Reilly et al. were the first to design the paediatric version of the GCS, where verbal responses were reported as appropriate words, social smiles, cries, irritability, and agitation (Reilly et al. 1988; Simpson and Reilly 1982). Some modifications of the scale have later also been made to suite even the youngest children and infants (Table 2.2). The paediatric GCS scale has proved to be accurate in evaluating preverbal children with head trauma with regard to the need for acute intervention (Holmes et al. 2005).

In Sweden, the most practiced scale for assessment of the level of consciousness is the Swedish Reaction Level Scale 85 (RLS) (Johnstone et al. 1993; Starmark et al. 1988a, b). This scale evaluates the consciousness in an inverted manner to the GCS, with a scoring range from 1 (best) to 8 (worst), and without specific focus on the verbal response (Table 2.3). This has made the score more practical to use, particularly on neurologically traumatized patients (who also may suffer from aphasia) and children, as well as more easily remembered in acute situations.

The Revised Trauma Score (RTS) is a numeric grading system for estimating the severity of injury. It is composed of the GCS, systolic blood pressure, and respiratory rate, each giving rise to a score between 0 and 4. The severity of injury is estimated by the total sum of the three parameters, where the highest score is 12, hence, the least severe injury (Table 2.4).

The Injury Severity Score (ISS) is an anatomical score that provides an overall score of the patient with multiple injuries after severe trauma (Table 2.5). It is based on the AIS score, which

### Table 2.1 Classification of head injuries according to SNC in 2000 (Ingebrigtsen et al. 2000)

<table>
<thead>
<tr>
<th>HISS category</th>
<th>Clinical characteristics</th>
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<tbody>
<tr>
<td>Minimal</td>
<td>GCS = 15, no loss of consciousness</td>
</tr>
<tr>
<td>Mild</td>
<td>GCS = 14 or 15, brief (&lt;5 min) loss of consciousness or amnesia, or impaired alertness or memory</td>
</tr>
<tr>
<td>Moderate</td>
<td>GCS = 9–13, or loss of consciousness ≥5 min, or focal neurologic deficit</td>
</tr>
<tr>
<td>Severe</td>
<td>GCS = 3–8</td>
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The head injury classification systems mainly apply to adults, although in clinical practice the SNC classification is also used on children and adolescents. This is mainly due to the lack of specific head injury classification systems for children. In some hospitals, the level of consciousness is more properly evaluated with use of the paediatric GCS score (Reilly et al. 1988). The Pediatric Trauma Score (PTS) has been developed as an assessment score for trauma severity in children (Table 2.6), but its use in Scandinavia has so far been limited.

2.3 Specific Paediatric Concerns

The head injury classification systems mainly apply to adults, although in clinical practice the SNC classification is also used on children and adolescents. This is mainly due to the lack of specific head injury classification systems for children. In some hospitals, the level of consciousness is more properly evaluated with use of the paediatric GCS score (Reilly et al. 1988). The Pediatric Trauma Score (PTS) has been developed as an assessment score for trauma severity in children (Table 2.6), but its use in Scandinavia has so far been limited.

Definitions of mild to moderate head injury in children vary even more extensively in the literature than for adults, especially with regards to the duration of LOC (AAP 1999; Schutzman et al. 2001). Other clinical factors, such as scalp haematoma, low age (<2 years), history of excessive vomiting, and suspected skull fracture and post-traumatic seizures, have in former studies and proposed guidelines been considered as risk factors for developing an intracranial complication (Dunning et al. 2006; Holmes et al. 2004;
The definition of severe head injury in children still include all with GCS 3–8 (Adelson et al. 2003). The Revised Trauma Score Scale (RTS) is calculated using the GCS, systolic blood pressure (SBP), and respiratory rate (RR) as:

$$\text{RTS} = \text{GCS} + \text{SBP} + \text{RR}$$

where GCS is the Glasgow Coma Scale score, SBP is the systolic blood pressure (mmHg), and RR is the respiratory rate (breaths/min) ranging from 0 to 4.

**References**


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