Mild Traumatic Brain Injury

John J. Bruns Jr, MD and Andy S. Jagoda, MD

Department of Emergency Medicine, Mount Sinai School of Medicine, New York, NY

ABSTRACT

Mild traumatic brain injury accounts for 1% to 2% of emergency department visits in the United States. Up to 15% of these patients will have an acute intracranial lesion identified on head computed tomography; less than 1% of mild traumatic brain injuries will require neurosurgical intervention. Clinical research over the past decade has focused on identifying the subgroup of patients with mild traumatic brain injury with acute traumatic lesions on computed tomography and specifically those at risk for harboring a potentially catastrophic lesion. This research has been used to generate evidence-based guidelines to assist in clinical decision making. There is no evidence to support the use of plain film radiographs in the evaluation of patients with mild traumatic brain injury. The utility of brain-specific biomarkers is rapidly evolving, and a growing body of evidence supports their potential role in determining the need for neuroimaging. Clinical predictors for identifying patients with abnormal computed tomography have been established and, if used, may have a significant positive impact on traumatic brain injury-related morbidity and healthcare utilization in the United States. Patients with negative computed tomography are at almost no risk of deteriorating; however, they should be counseled regarding postconcussive symptoms and should be given appropriate written instructions and referrals at discharge. Mt Sinai J Med 76:129–137, 2009. © 2009 Mount Sinai School of Medicine

Key Words: brain-specific biomarkers, computed tomography, mild brain injury, postconcussive symptoms, traumatic brain injury.

Address Correspondence to:

John J. Bruns Jr, MD
Department of Emergency Medicine
Mount Sinai School of Medicine
New York, NY
Email: john.bruns@mssm.edu

About 1.4 million incidents of traumatic brain injury (TBI) are reported in the United States each year,1 of which 75% are typically classified as mild.2 Most of these injuries result from falls and motor vehicle crashes. Falls are responsible for a significant proportion of mild traumatic brain injury (MTBI) at the extremes of age, and motor vehicle collisions are the predominant etiology in adolescent and young adult males.3,4 Up to 15% of patients with head trauma evaluated in the emergency department (ED) with a Glasgow Coma Scale (GCS) score of 15 will have acute traumatic pathology identified on head computed tomography (CT); however, less than 1% of these patients will require neurosurgical intervention.5–7 Depending on the criteria used to define disability, up to 15% of patients with MTBI will have compromised function 1 year after their injury.8,9 The primary objective in the initial evaluation of MTBI patients is to determine who has an acute traumatic intracranial injury and who can be safely discharged from the acute care setting.

DEFINITIONS

There is no consensus definition of MTBI. MTBI describes a state in which there is an alteration of minimal duration and severity or no change from the patient’s baseline neurological or mental status after an injury. MTBI may not be clinically evident during the initial medical and neurological evaluation because of symptom resolution or the employment of insensitive assessments. Although the term head injury is often used interchangeably with TBI, it is an antiquated and an inappropriate synonym for TBI. Head injury is defined as clinically evident trauma above the clavicles, such as lacerations, ecchymosis, and forehead abrasions. TBI refers to perturbations of the brain’s function itself and may occur in the absence of perceptible head injury: It is manifest as confusion, focal neurological deficits, an altered level of consciousness, and/or subtle abnormalities on neuropsychological examinations. Concussion is another term that is used interchangeably with MTBI,
Table 1. Concussion Grading Scales and Return-To-Activity Recommendations.

<table>
<thead>
<tr>
<th>Concussion Severity</th>
<th>First Concussion</th>
<th>Second Concussion</th>
<th>Third Concussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1 (mild)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No LOC</td>
<td>May return to play if asymptomatic</td>
<td>May return in 2 weeks if asymptomatic at that time for 1 week</td>
<td>Should terminate season and may return next year if asymptomatic</td>
</tr>
<tr>
<td>PTA &lt; 30 minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 2 (moderate)</td>
<td>May return after being asymptomatic for 1 week</td>
<td>Should wait at least 1 month, may return then if asymptomatic for 1 week, and should consider terminating season</td>
<td>Should terminate season and may return next year if asymptomatic</td>
</tr>
<tr>
<td>LOC &lt; 5 minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTA &gt; 30 minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 3 (severe)</td>
<td>Should wait at least 1 month and may return then if asymptomatic for 1 week</td>
<td>Should terminate season and may return next year if asymptomatic</td>
<td></td>
</tr>
<tr>
<td>LOC &gt; 5 minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTA &gt; 24 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: LOC, loss of consciousness; PTA, posttraumatic amnesia.

often in the context of sports. Concussion is often classified into 3 arbitrary grades (see Table 1).10

Grade I concussion has no associated loss of consciousness or amnesia, grade II has amnesia but no loss of consciousness, and grade III is associated with loss of consciousness.10 The system most often used for grading the severity of brain injury is the GCS.11 An MTBI has historically been ascribed a score of 13 to 15. However, recent trends based on the higher association of positive CT, need for neurosurgical intervention, and long-term sequelae has resulted in an evolving consensus to exclude a GCS score of 13 from the mild category. The Centers for Disease Control and Prevention has developed a conceptual definition for MTBI,12 that is, the occurrence of injury to the head resulting from blunt trauma or acceleration or deceleration forces with 1 or more of the following conditions attributable to the head injury during the surveillance time period:

- Any period of observed or self-reported transient confusion, disorientation, or impaired consciousness.
- Any period of observed or self-reported dysfunction of memory (amnesia) around the time of injury.
- Observed signs of other neurological or neuropsychological dysfunction.
- Any period of observed or self-reported loss of consciousness lasting 30 minutes or less.

The primary challenge to the ED physician is to detect the well appearing, neurologically normal MTBI patient with a potentially significant intracranial injury. A secondary challenge is to identify those patients at risk for having prolonged postconcussive symptoms and those at risk for the postconcussive syndrome (PCS) in order to anticipate and provide proper discharge instructions and referrals. The management of minor closed head injury in children is presented in a clinical policy by the American Academy of Pediatrics and the American Academy of Family Physicians;13 this article specifically concerns the management of MTBI in patients without multisystem injury, 16 years old or older, with a GCS score of 14 or 15 presenting within 24 hours of injury.

METHODOLOGY

The framework for this document is derived from the evidentiary tables created by the Center for Disease Control (CDC) and the American College of Emergency Physicians (ACEP) MTBI practice guideline task force.14 The evidentiary table was created after a review and critical analysis of MEDLINE and the Cochrane Database, which was searched for articles from January 2000 through 2007. Search result articles and their bibliographies were screened by panel members for relevance. All selected articles that were used were graded on the basis of applicability to the clinical questions. Articles received a final grade of class I, II, or III on the basis of a predetermined formula taking into account the design and quality of the articles. The strength of the recommendations regarding patient management was then determined according to the following criteria:

- Level A: Generally accepted principles for patient management that reflect a high degree of clinical certainty.
- Level B: Recommendations for patient management that reflect moderate clinical certainty.
- Level C: Other patient management strategies based on preliminary or inconclusive data or, in the absence of any published literature, panel consensus.

DOI:10.1002/MSJ
SKULL RADIOGRAPHY IN MILD TRAUMATIC BRAIN INJURY

Even though they are readily available and relatively inexpensive, numerous studies have shown that skull radiographs are neither sensitive nor specific for the detection of intracranial injury after head trauma. A meta-analysis published in 2000 examined the association between skull fracture and brain injury.\textsuperscript{15} The authors reviewed 200 studies and identified 20 that fulfilled their inclusion criteria. They reported that the sensitivity of skull fracture in detecting patients with an intracranial lesion ranged from 0.13 to 0.75, and the specificity was 0.91 to 0.995. The authors’ findings suggested that the presence of a skull fracture increases the probability of an intracranial lesion 5-fold. The meta-analysis concluded that although a fracture demonstrated on plain film increased the likelihood of an intracranial lesion, its low sensitivity precluded its use in ruling out the diagnosis of an intracranial hemorrhage; it is thus of limited clinical value in risk stratification for brain injury. Consequently, current guidelines do not recommend plain film radiographs in the evaluation of patients with MTBI.\textsuperscript{16}

EMERGENCY DEPARTMENT EVALUATION OF MILD TRAUMATIC BRAIN INJURY

Noncontrast Head Computed Tomography

Although up to 15\% of ED-attended MTBI patients with a GCS score of 15 will have head CT acute intracranial pathology identified, less than 1\% of these patients will require neurosurgical intervention.\textsuperscript{5–7} Early studies using trauma registries established that up to 15\% of MTBI patients with a GCS of 14 or 15 will show an acute intracranial traumatic injury on noncontrast head CT; 1\% of these will require neurosurgical intervention. The existing literature does not identify which MTBI patients with intracranial lesions clinically deteriorate, nor does it define the relationship between acute traumatic intracranial lesions and the development of postconcussive symptoms. Most studies on patients with MTBI have focused on identifying patients with acute intracranial lesions on CT; ascertaining clinical criteria for the development of postconcussive symptoms has thus far been elusive.

Several clinical decision rules have been developed in an attempt to determine clinical criteria for CT scanning. Two of these rules, the New Orleans Criteria (NOC)\textsuperscript{5} and the Canadian CT Head Rule (CCHR),\textsuperscript{17} have been validated prospectively (see Table 25).

In the CCHR study,\textsuperscript{17} 3121 patients were prospectively evaluated for having a neurosurgical lesion. Acute intracranial traumatic lesions deemed unimportant were defined by consensus and included smear subdurs and small traumatic subarachnoid hemmorhages. The authors concluded that head CT in MTBI is indicated only in those patients with 1 of 5 high-risk factors: failure to reach a GCS score of 15 within 2 hours of injury, suspected open skull fracture, sign of basal skull fracture, vomiting more than once, or age greater than 64 years.

In deriving the NOC, Haydel et al.\textsuperscript{5} prospectively assessed 1429 patients with a GCS score of 15 in the ED and a history of loss of consciousness or amnesia of the traumatic event. A derivation phase in which patients with intracranial injury predictors (n = 520) were identified was followed by a validation phase (n = 909). The authors reported that 6.5\% of patients

<table>
<thead>
<tr>
<th>New Orleans Criteria: MTBI with a GCS Score of 15</th>
<th>Canadian CT Head Rule: MTBI with a GCS Score of 13 to 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>High risk (for neurosurgical intervention)</td>
</tr>
<tr>
<td>Vomiting</td>
<td>GCS score less than 15 at 2 hours after injury</td>
</tr>
<tr>
<td>Age greater than 60 years</td>
<td>Suspected open or depressed skull fracture</td>
</tr>
<tr>
<td>Drug or alcohol intoxication</td>
<td>Any sign of basal skull fracture</td>
</tr>
<tr>
<td>Persistent anterograde amnesia (deficits in short-term memory)</td>
<td>More than 1 episode of vomiting</td>
</tr>
<tr>
<td>Visible trauma above the clavicle</td>
<td>Age greater than 64 years</td>
</tr>
<tr>
<td>Seizure</td>
<td>Medium risk (for brain injury on CT)</td>
</tr>
<tr>
<td></td>
<td>Amnesia before impact greater than 30 minutes</td>
</tr>
<tr>
<td></td>
<td>Dangerous mechanism (eg, pedestrian struck by motor vehicle, occupant ejected from motor vehicle, or fall from a height greater than 3 feet or 5 stairs)</td>
</tr>
</tbody>
</table>

NOTE: CT is needed if the patient meets 1 or more of the listed criteria.

Abbreviations: CT, computed tomography; GCS, Glasgow Coma Scale; MTBI, mild traumatic brain injury.

DOI:10.1002/MSJ
Table 3. Predictor Variables for Intracranial Lesions.

<table>
<thead>
<tr>
<th>Class of evidence</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GCS score of 14</td>
<td>2 (1–3)</td>
<td>7 (4–14)</td>
</tr>
<tr>
<td>Neurological deficit</td>
<td>2 (1–3)</td>
<td>7 (2–25)</td>
</tr>
<tr>
<td>Signs of basilar skull fracture</td>
<td>25 (13–47)</td>
<td>11 (6–23)</td>
</tr>
<tr>
<td>LOC</td>
<td>2 (1–3)</td>
<td>7 (4–11)</td>
</tr>
<tr>
<td>Posttraumatic amnesia</td>
<td>1.5 (1–2)</td>
<td>3 (2–5)</td>
</tr>
<tr>
<td>Headache, mild to moderate</td>
<td>1 (0.8–2)</td>
<td>1 (0.8–2)</td>
</tr>
<tr>
<td>Headache, severe</td>
<td>–</td>
<td>3 (2–6)</td>
</tr>
<tr>
<td>Vomiting</td>
<td>3 (2–4)</td>
<td>4 (2–7)</td>
</tr>
<tr>
<td>Posttraumatic seizure</td>
<td>3 (0.8–10)</td>
<td>2 (0.25–17)</td>
</tr>
<tr>
<td>Alcohol or drug intoxication</td>
<td>1 (0.6–2)</td>
<td>1 (0.3–3)</td>
</tr>
<tr>
<td>Anticoagulation</td>
<td>2 (1–5)</td>
<td>4 (3–7)</td>
</tr>
<tr>
<td>Age ≥ 65 years</td>
<td>–</td>
<td>2 (1–5)</td>
</tr>
<tr>
<td>Dangerous mechanism</td>
<td>2 (1–4)</td>
<td>–</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; GCS, Glasgow Coma Scale; LOC, loss of consciousness; OR, odds ratio.

Table 4. Postconcussive Symptoms.

<table>
<thead>
<tr>
<th>Somatic</th>
<th>Cognitive</th>
<th>Affective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
<td>Impaired attention</td>
<td>Anxiety</td>
</tr>
<tr>
<td>Sleep disturbances</td>
<td>Difficulty concentrating</td>
<td>Depression</td>
</tr>
<tr>
<td>Dizziness/vertigo</td>
<td>Memory problems</td>
<td>Emotional lability</td>
</tr>
<tr>
<td>Nausea</td>
<td>Fatigue</td>
<td>Photophobia/phonophobia</td>
</tr>
</tbody>
</table>

exhibited intracranial injury on CT, and 0.4% of these patients needed neurosurgical intervention. The NOC consists of 7 identified predictors of an abnormal CT scan, including headache (any head pain), vomiting, age greater than 60 years, intoxication, deficit in short-term memory (persistent anterograde amnesia), physical evidence of trauma above the clavicle, and seizure. A negative predictive value of 100% (95% confidence interval: 99%-100%) accompanies a clinical absence of all 7 criteria.

The presence of any of the clinical elements in the NOC and the CCHR criteria essentially identified all patients requiring emergent neurosurgical intervention. However, both rules have low specificity; if applied appropriately, use of the Canadian rule would result in a 37% reduction in head CT scans, whereas the New Orleans Rule would reduce CT scans by only 3% to 20%. The specificity difference is attributable to the CCHR’s primary outcome measure being a lesion requiring neurosurgical intervention, whereas the NOC’s primary outcome measure is any identified acute traumatic intracranial lesion.

Studies that provided external validation of the NOC and CCHR have identified several limitations of these rules. However, both decision rules use loss of consciousness or amnesia as entry criteria, and neither applies to patients on anticoagulants. Thus, neither rule can be reliably applied to all patients with head trauma. In addition, if the primary outcome measure of acute traumatic lesion is used (without subcategorization into significant and nonsignificant lesions as stratified in the CCHR), it becomes clear that specificity is sacrificed for sensitivity.

After the NOC and CCHR studies, several database analyses from other countries were published (see Table 3 and references therein). These databases highlighted that neither loss of consciousness nor posttraumatic amnesia were sufficient discriminators for determining who needs neuroimaging. Although identified in the NOC, neither seizure nor mild or moderate headache was found to be a significant univariate predictor of intracranial injury. Alcohol was also not found to be a univariate predictor of intracranial injury in 2 of the studies. However, a dangerous mechanism of injury does emerge as an important factor in deciding who requires neuroimaging.

On the basis of the best available current evidence, the 2008 CDC/ACEP joint practice guideline...
Table 5. Discharge Instruction Recommendations for Patients with Mild Traumatic Brain Injury.

Instructions should be written at approximately a sixth- to seventh-grade level.

Instructions should be given to the patient and immediate caregiver in both print and verbal form. The layout and type fonts should be appropriate for low-literacy materials.

Patients who develop the following symptoms should be instructed to return to the emergency department for re-evaluation:
- Repeated vomiting
- Worsening headache
- Problems remembering
- Confusion
- Focal neurological deficit
- Abnormal behavior
- Increased sleepiness or passing out
- Seizures

A list of postconcussive symptoms should be provided to the patient in written and verbal form and be used as a prompt for the patient to seek specialist referral (for a list of postconcussive symptoms, see Table 4). Specialist referral in traumatic brain injury should be provided at discharge to patients who have suffered a head injury.

on MTBI\textsuperscript{6} makes 2 recommendations regarding neuroimaging in the ED:

- Level A. Noncontrast head CT is indicated in head trauma patients with loss of consciousness or posttraumatic amnesia only if 1 or more of the following is present: headache, vomiting, age greater than 60 years, drug or alcohol intoxication, deficits in short-term memory, physical evidence of trauma above the clavicle, posttraumatic seizure, a GCS score less than 15, focal neurological deficit, and coagulopathy.
- Level B. Noncontrast head CT should be considered in head trauma patients with no loss of consciousness or posttraumatic amnesia if there is a focal neurological deficit, vomiting, severe headache, age greater than or equal to 65 years, physical signs of a basilar skull fracture, a GCS score less than 15, coagulopathy, or a dangerous mechanism of injury, which includes ejection from a motor vehicle, a pedestrian struck, and a fall from a height of more than 3 feet or 5 stairs.

**Magnetic Resonance Imaging**

There are currently no published studies that evaluate magnetic resonance imaging (MRI) within 24 hours of injury in MTBI patients. Therefore, at this time, no evidence-based recommendations can be made regarding the utilization of MRI in the acute evaluation of MTBI patients, particularly in comparison with the current neuroimaging standard, noncontrast head CT.

Most studies comparing CT to MRI in patients with TBI do not distinguish or stratify MTBI and more severe TBI in their results. MRI has been shown to be more sensitive than CT for exhibiting small subdural hematomas and cortical contusions in patients with MTBI undergoing MRI within 24 hours of ED discharge.\textsuperscript{20} However, no significant symptom difference has been established between patients with abnormal and normal MRI scans, nor has any impact of these findings on outcomes been established. Several other studies have demonstrated MRI abnormalities that could be attributed to TBI, including contusions, diffuse axonal lesions, and epidural hematomas.\textsuperscript{21,22} However, the clinical relevance of abnormal MRI scans has not been demonstrated in patients with MTBI, and these studies were not temporally proximate to the time of injury; this limits their relevance to the acute management and disposition time frame.

Recent improvements in MRI technology, including decreased scan times and specialized pulse sequences, have improved the detection of structural and functional abnormalities associated with MTBI.\textsuperscript{23} One recent study using diffusion tensor imaging in 10 patients with normal CT presenting with a GCS score of 15 established an association between the severity of postconcussion symptoms and diffusion tensor imaging abnormalities.\textsuperscript{24} Technological refinements, further investigation, enhanced access, and overcoming logistical challenges will determine the future utility of MRI in the MTBI patient’s acute evaluation.

**BRAIN-SPECIFIC SERUM BIOMARKERS**

Serum biomarkers have the potential to eliminate head CT scan requirements in MTBI patients. The proteins and molecules released after a brain injury diffuse into the cerebrospinal fluid, cross the blood-brain barrier, and can be measured with serum assays. Although several brain-specific neuronal and astrocyte proteins and acute phase reactants have been studied, to date S-100B holds the most promise. Serum concentrations of S-100B rise and fall within hours after MTBI, and this makes early measurement critical.\textsuperscript{25} At a cutoff of 0.10 µg/L, the sensitivity approaches 100%. One class I study and 7 class II studies have reported sensitivities of 90% to 100% but low specificities of 4% to 65% in predicting acute traumatic lesions on head CT.\textsuperscript{26–33} Because

DOI:10.1002/MSJ
S-100B is also present in adipose, skin, and cartilage, its use is valid only in the absence of extracranial injury. The exact role that biomarkers will take in the future evaluation of MTBI is yet to be determined, but they could conceivably play a significant role in resource utilization and in prehospital transport decision algorithms. On the basis of the best available evidence, the 2008 CDC/ACEP joint practice guideline on MTBI recommends the following:

- Level C: In MTBI patients without significant extracranial injuries and a serum S-100B level less than 0.1 µg/L measured within 4 hours of injury, consideration can be given to not performing a CT. (This test has not yet received Food and Drug Administration approval for clinical use in the United States.)

### ISSUES IN EMERGENCY DEPARTMENT DISCHARGE PLANNING FOR PATIENTS WITH MILD TRAUMATIC BRAIN INJURY

Several class II and III studies have supported the discharge of MTBI patients after negative head CT. af Geijerstam and Britton conducted a systematic review of the MTBI literature on head CT and collated the outcomes of more than 62,000 MTBI patients with a GCS score of 15. Eleven cases of deterioration after negative CT were identified, but only 3 of the cases were considered definitive. The authors concluded that patients with MTBI who have negative CT can be safely discharged without concern of neurological deterioration.

In a class I multicenter Swedish study involving 39 hospitals, 1292 patients with MTBI were prospectively evaluated for delayed complications post-discharge. Although more than 6% of the patients had a positive intracranial finding, of those with a negative interpretation (and who were discharged from the ED unless other factors required admission), none had developed a complication requiring hospital admission or surgical intervention at the 3-month follow-up.

Thus far, no study has had sufficient power to identify specific potentially higher risk MTBI patients requiring prolonged hospital observation, such as patients with intrinsic or pharmacological bleeding disorders, patients with previous neurosurgical procedures (such as a ventriculoperitoneal shunt), and those with preexisting neurological disorders or signs. On the basis of the best available evidence, the 2008 CDC/ACEP joint practice guideline on MTBI makes the following recommendation.

**Table 6. Key Points in Dealing with Mild Head Trauma.**

1. Obtain a careful history focusing on loss of consciousness, amnesia, the use of warfarin, a history of hemophilia, and the anatomic location of the injury.
2. Perform a careful physical and neurological examination, looking for signs of a basilar skull fracture (eg, external canal laceration or hemotympanum) and for cranial nerve deficits, specifically in cranial nerves IV and VI.
3. Consider obtaining a noncontrast head computed tomography scan for all patients with a history of loss of consciousness or posttraumatic amnesia. Although the incidence of finding a neurosurgically correctable lesion in patients with a Glasgow Coma Scale score of 15 is less than 1%, the incidence of finding evidence of brain injury approaches 5% to 10% and may have a significant impact in predicting sequelae.
4. Consider imaging infants less than 12 months old with any history or physical findings of head trauma because historical and clinical findings are unreliable.
5. Consider arranging or referring for postdischarge consultation and magnetic resonance imaging in patients with minor head trauma who present with symptoms consistent with postconcussive syndrome.
6. Provide appropriate guidance to athletes regarding sports activities after a concussion, ensuring that they understand the potential consequences related to second impact syndrome.
7. Advise all mild traumatic brain injury patients of the postconcussive syndrome, its time course, and its overall positive prognosis.
8. Preventive strategies are the cornerstone for reducing the morbidity and mortality associated with traumatic brain injury.

- Level B: Patients with an isolated MTBI who have a negative head CT scan result are at minimal risk for developing an intracranial lesion and therefore may be safely discharged from the ED. (There are inadequate data to include patients with a bleeding disorder, patients who are receiving anticoagulation therapy or antiplatelet therapy, or patients who have had a previous neurosurgical procedure in this population.)

### POSTCONCUSSIVE SYMPTOMS

Symptoms such as headache, dizziness, anxiety, and impaired cognition and memory may persist after MTBI (see Table 4). The proportion of MTBI cases with postconcussive symptoms (< 3 months in duration) and PCS (> 3 months in duration) varies widely in studies and is found to usually diminish over time. It affects more than of 58% of patients 1 month after the injury and 15% at 1 year.
Identification of the subgroup of patients with a Glasgow Coma Scale score of 15 who do not need computed tomography and who can be safely discharged home.

Uniform diagnostic criteria for mild traumatic brain injury, including the role of neuroimaging in distinguishing mild traumatic brain injury from moderate traumatic brain injury.

The role of computed tomography in differentiating mild traumatic brain injury from moderate traumatic brain injury.

The role of cognitive testing in the diagnosis of mild traumatic brain injury.

Patients at risk for second impact syndrome and prevention recommendations.

The role of magnetic resonance imaging and other imaging studies in the diagnostic management of traumatic brain injury patients in the emergency department.

This information, however, is often omitted from most MTBI discharge instruction sheets. A systematic review concluded that providing educational information on postconcussive symptoms may reduce long-term complaints, but other studies have failed to confirm this conclusion.46,47 The presence of headache, nausea, and dizziness during the acute head injury evaluation can be prognostic of PCS: the presence of all 3 symptoms is associated with a 50% likelihood of having PCS at 6 months, whereas an absence of all 3 purports a 28% possibility.48

In addition to being challenging to the patient and his family, PCS is a substantial financial and societal burden. As a result of PCS symptoms, patients miss an average of 4.7 work days, and approximately 20% of patients are unemployed at 1 year.49 Whether the basis of these problems is structural or functional remains unclear. Regardless of the cause, the patient’s complaints should be recognized as a clinical entity for which treatment options exist and follow-up resources should be ideally provided. On the basis of the best available evidence, the 2008 CDC/ACEP joint practice guideline on MTBI makes the following recommendation.6

- Level C: MTBI patients discharged from the ED should be informed about postconcussive symptoms.

DISCHARGE INSTRUCTIONS

MTBI patients discharged from the ED should be provided instructions and ideally go home with a responsible adult. One study of discharged MTBI patients reported that 9% were not given any follow-up recommendations, and 28% were only told “return to the ED as needed.” No study has validated criteria for patients to use to return to the ED, although it is generally accepted that changes in mental status, progressive headache, vomiting, new neurological deficit, and seizure are noteworthy signs of which patients should be cognizant. One prospective study46 found that MTBI patients rarely remember their discharge instructions, and this implies that it is best to provide post-MTBI discharge instructions in a written form. Table 5 provides the building blocks for discharge instructions recommended in the 2008 CDC/ACEP MTBI guidelines.

CONCLUSION

The lack of uniformity in the definition of MTBI and the absence of large, well-designed trials make the interpretation of much of the MTBI literature difficult at best. The dilemma that the acute care provider faces on a regular basis is which neurologically intact patients with MTBI require CT, who can be safely sent home, and when they can be sent home. Large databases have validated the NOC, which apply to TBI patients with a GCS of 15 who have experienced trauma-related loss of consciousness or posttraumatic amnesia. Large databases have also revealed that neither loss of consciousness nor posttraumatic amnesia is discriminatory for identifying MTBI patients at risk for harboring a neurosurgical lesion, and this makes clinical decision making challenging. No set of clinical criteria has been established that identifies all patients with a neurosurgically significant lesion. There is a growing body of literature supporting the use of brain-specific biomarkers, and these markers may play an important role in the future in identifying patients requiring neuroimaging. All head-injured patients deserve proper counseling regarding postconcussive symptoms with proper follow-up arranged.

DISCLOSURES

Potential conflict of interest: Nothing to report.

REFERENCES


DOI: 10.1002/MSJ