

# Head Trauma

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Approximately one million cases of head injury are seen yearly in North American emergency departments.<sup>1</sup> Patients suffering head trauma are commonly seen by family physicians. The severity of head injury can vary greatly. Most cases can be considered minor and, although no obvious long-lasting sequelae may be apparent, more subtle neuropsychological problems are becoming increasingly recognized.<sup>2</sup> For the physician who first assesses a patient, the challenge is to recognize more serious head injuries that may be potentially life-threatening and require timely referral to a centre with neurosurgical expertise.

It is useful to distinguish between primary and secondary injuries in order to understand the pathophysiology of head injury. By definition, a primary central nervous system injury is untreatable and occurs at the time of impact. An example of primary injury is the mechanical disruption of axons resulting from acute deceleration of the brain at the time of injury.

Secondary injury is the result of physiological processes initiated at the time of the impact and is potentially preventable. Hypoxia and hypotension remain the most important treatable causes of secondary injury (Table 1). This concept of treatable secondary injury is particularly relevant to the management of patients with head injuries, where the goal is to facilitate recovery from the primary injury by preventing and treating secondary insults.



### Case 1

A 24-year-old male is checked into the boards while playing hockey. Witnesses say he lost consciousness for two minutes. Upon regaining consciousness, he complains of a headache and vomits once. He is taken to the emergency department. On examination, one hour after the injury, he is found to be fully awake and alert with a GCS of 15. The neurological examination is normal. There is no obvious scalp injury. There are no other injuries noted on detailed physical examination.

**Questions:**

*Should this patient have a CT scan of his head?*

*How should he be managed? Discussion on page 70.*

### Case 2

An 18-year-old female falls off of an all-terrain vehicle (ATV) travelling at high speed. She is not wearing a helmet. Her head strikes the ground and she loses consciousness for two minutes. Upon regaining consciousness, she complains of a headache and vomits once. She is taken to a hospital and arrives there one hour after the initial injury. This centre does not have neurosurgical services. While in the emergency department, the patient becomes progressively drowsy and vomits again. On examination, she is found to have adequate oxygen saturation, as well as stable blood pressure and heart rate. The two-minute neurological examination reveals that she utters incomprehensible sounds and does not open her eyes. She localizes a painful stimulus with her right arm only, whereas her left arm flexes abnormally in a decorticate posture. Her right pupil is dilated, as compared to the left. The right pupil does not react to light. Her left biceps and knee jerks are increased, as compared with the right, and she has a left up-going toe (positive Babinski's sign).

**Questions:**

*What is her GCS score?*

*How should this patient be managed? Discussion on page 70.*



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Table 1

## Secondary (Potentially Preventable) Injuries

- Hypoxia
- Hypotension
- Expanding intracranial hematoma
- Brain edema
- Increased intracranial pressure
- Electrolyte imbalance

Table 2

## ATLS Approach to Patient Evaluation Resuscitation

1. *Primary Survey and Resuscitation:*
  - A. Airway with cervical spine protection.
  - B. Breathing: Ventilation and oxygenation.
  - C. Circulation and control of external hemorrhage.
  - D. Disability: Brief neurologic evaluation.
  - E. Exposure/Environment: Undress patient but prevent hypothermia.
  - F. Consider Adjuncts to Primary Survey and Resuscitation (e.g., pulse oximetry, electrocardiograph, urinary/gastric catheters, X-rays of chest, pelvis, and cervical spine).
2. *Secondary Survey:* Total patient evaluation with history and complete physical examination.
3. *Definitive Care.*
4. *Transfer:* If patient's injuries exceed the institution's immediate treatment capabilities.

## Patient Assessment

Assessment of all trauma patients using an Advanced Trauma Life Support (ATLS) approach is the first order of importance (Table 2).<sup>3</sup> A rapid, streamlined neurological assessment performed as part of this approach can yield a wealth of helpful information. The initial neurological examination should focus, in particular, on determining the patient's mental status including the level of arousal and degree of orientation. A Glasgow Coma Scale (GCS) score should be assigned as part of the

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\* Based on a data analysis from 4 large 3-year osteoporosis treatment trials involving 2,725 patients (Relative Risk [RR] = 5.1, presence of 1 fracture,  $p < 0.001$ )

† Randomized, double-blind, placebo-controlled study of 2,458 postmenopausal women with at least one vertebral fracture. All patients received 1 g/d calcium and, if baseline levels were low, 500 IU/d vitamin D.

‡ Three-year clinical study (VERT-MN) in 1,226 postmenopausal women (18.1% vs 29%  $p < 0.001$ ). All patients received 1 g/d calcium and, if baseline levels were low, 500 IU/d vitamin D.

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## Head Injury

neurological assessment (Table 3).<sup>4</sup> The GCS score is useful because it can be reproduced easily and is well understood by other health-care professionals. It is also helpful in classifying the severity of the head injury and, therefore, assists the physicians in making management decisions. Beyond the GCS, lateralizing signs should be sought out by noting the following:

- Pupil size;
- Symmetry and reaction to light;
- Movement in all four limbs;
- Deep tendon reflexes; and
- Plantar responses.

We feel that this initial, streamlined neurological assessment can be performed in two minutes (Table 4). This initial neurological assessment may prompt immediate discussion with a referring trauma centre with neurosurgical capability. A more thorough neurological examination can be completed at a later time. A careful examination of the head also can be performed at this time to check for scalp lacerations, palpable deformity of the skull, hemotympanum and cerebrospinal fluid (CSF), rhinorrhea or otorrhea.

## Head Injury Classification

Most neurosurgical references classify the severity of head injury as mild, moderate or severe.<sup>5</sup> This classification scheme is useful in predicting prognosis, but is less helpful for the primary-care physician who first assesses a patient with head trauma. A more practical approach is to broadly divide head injuries into minor or major categories based on the patient's GCS score (Table 5).

Table 3

### Glasgow Coma Scale (GCS)

Score = E+M+V. Best possible score = 15; Worst score = 3.

Variable	Score	Description
<i>Eye</i> <i>Opening</i> <i>(E)</i>	4	Spontaneous
	3	To speech
	2	To pain
	1	None
<i>Verbal</i> <i>Response</i> <i>(V)</i>	5	Oriented
	4	Confused
	3	Inappropriate words
	2	Incomprehensible sounds
	1	None
	<i>Best</i> <i>Motor</i> <i>Response</i> <i>(M)</i>	6
5	Localizes painful stimulus	
4	Withdraws from painful stimulus	
3	Abnormal flexion (decorticate)	
2	Abnormal extension (decerebrate)	
1	None	

Table 4

### The Initial Two-Minute Neurological Assessment

- GCS.
- Pupil size, symmetry and reactivity to light.
- Equal movement in all four limbs?
- Biceps and knee jerk reflexes.
- Plantar responses.

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**Major head injury (GCS score of three to 12).** Most patients with a major head injury should be promptly referred to a trauma centre where a neurosurgical consultation is available. Patients with a GCS score of eight or less and patients with a declining GCS score should undergo endotracheal intubation as part of their resuscitation. Concern regarding possible co-existing cervical spine injury mandates that the neck be maintained in a neutral position with a rigid collar. Radiological investigations of the spine and head may be necessary, but this is best determined using neurosurgical referral practices. In many jurisdictions, these imaging studies may be most efficiently obtained once the patient is admitted to the neurosurgical centre. Patient transfer to a centre with neurosurgical expertise should not be delayed in order to obtain imaging studies.

**Minor head injury.** Patients with a closed-head injury and a presenting GCS score of 13 to 15 can be considered as having a minor head injury. This group of patients is, by far, more common and must be carefully scrutinized in order to identify the important few that harbour a significant mass lesion requiring urgent neurosurgical care. These patients also should be assessed using an ATLS approach, focusing first on resuscitation. A detailed neurological exam-

Table 5

## Head Injury Classification

### Severity GCS

- Minor 13 to 15
- Major 3 to 12

Table 6

## Canadian CT Head Rule for GCS 13-15

CT of the head is only required for patients with a history of mild head injury within the previous 24 hours and any one of the following high-risk factors for neurological intervention:

- GCS < 15 at two hours after injury.
- Suspected open or depressed skull fracture.
- Any sign of basal skull fracture (hemotympanum, "raccoon" eyes, cerebrospinal fluid otorrhea/rhinorrhea, Battle's sign).
- Vomiting > 2 episodes.
- Age > 65.

Adapted from: Stiell IG, Wells GA, Vandemheen K, et al: The Canadian CT Head Rule for patients with minor head injury. Lancet 2001; 357:1391-6.

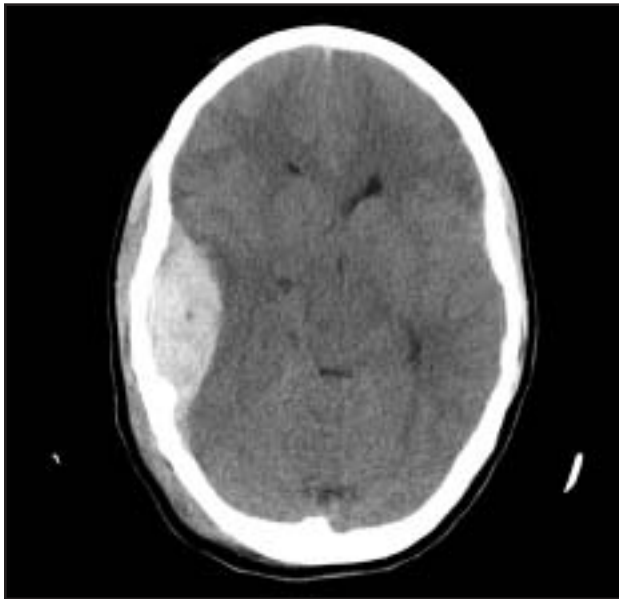


Figure 1. CT scan of head demonstrating a left temporal epidural hematoma.

ination usually can be conducted following an initial two-minute neurological assessment to identify patients requiring urgent computed tomography (CT) scanning. Many of these patients have no long-lasting sequelae other than amnesia concerning the events that occurred at the time of the injury. Others, however, can suffer difficulties over a prolonged period. “Post-concussion syndrome” consists of a constellation of lingering symptoms, which may last for weeks to months following a head injury. These symptoms can include headache, dizziness, nausea, poor concentration, fatigue, irritability, phonophobia and sleep disturbances.

It can be challenging to decide which patients with minor head injuries should undergo a CT scan investigation. Physicians assessing these patients must identify significant lesions while at the same time avoiding unnecessary investigation. This problem was the subject of a recent study by Stiell *et al.*<sup>6</sup> These authors identified specific risks for significant intracranial injury

### Practice Pointers

- Most patients with a major head injury should be promptly referred to a trauma centre where a neurosurgical consultation is available.
- A detailed neurological examination usually can be conducted following an initial two-minute neurological assessment to identify patients requiring urgent CT scanning.

requiring neurological intervention in patients who had a minor head injury and developed the “Canadian CT Head Rule.” This rule dictates that a CT scan of the head in patients with a GCS of 13 to 15 is only indicated when one or more of the specific risk factors is present (Table 6).

## Discussion of Case 1

To determine whether this patient requires a CT scan of the head, please refer to Table 6. This patient has suffered a minor head injury. His GCS score is 15 one hour after the injury. There is nothing on physical examination to suggest a skull fracture. He vomited only once, and is under 65 years of age. He is, therefore, at very low risk of having any traumatic brain lesion and does not require a CT scan. He can be observed in the emergency room until he is well (*i.e.*, headache resolving and no further vomiting) and discharged. He should not return to hockey until he has had at least two weeks without symptoms.<sup>7</sup> Follow-up with his family doctor should be arranged for re-examination and to identify any neuropsychological sequelae.

## Discussion of Case 2

The patient’s GCS score would total eight points. She receives one point for the absence of eye opening, five points for localization of a painful

stimulus with her left arm (GCS score is based on the best response) and two points for uttering incomprehensible sounds.

This patient's airway and breathing appear adequate and her blood pressure and heart rate are stable. Her current GCS score is eight and her overall neurological status has declined since arriving to the emergency department. Although her airway and breathing appear adequate, endotracheal intubation should be carried out in order to protect her from aspiration and prevent hypoventilation. Her neck should be kept in a neutral position in a rigid collar. She clearly has suffered a major head injury and requires urgent transfer to a trauma centre with neurosurgical services. A CT scan is indicated. Where this scan is done depends upon local referring patterns, but will likely be most expeditiously carried out on her arrival at the trauma centre where definitive management is available. The decision to administer mannitol can be made after consulting with the trauma centre.

This patient was transferred to a trauma centre, where a CT of the head revealed an acute epidural hematoma (Figure 1). She was taken immediately to the operating room for evacuation of the hematoma. Following a period of rehabilitation, she returned to independent living. CME

#### References

1. McCaig LF: National hospital ambulatory medical care survey: 1992 Emergency department summary. *Adv Data* 1994; 245:1-12.
2. Leininger BE, Gramling SE, Farrell AD, et al: Neuropsychological deficits in symptomatic minor head injury patients after concussion and mild concussion. *J Neurol Neurosurg Psychiatry* 1990; 53:293-6.
3. *Advanced Trauma Life Support for Doctors. Student Course Manual*. American College of Surgeons, Chicago, 1997, p. 444.
4. Teasdale G, Jennett B: Assessment of coma and impaired consciousness. A practical scale. *Lancet* 1974; 2:81-4.
5. Vollmer DG, Dacey RG Jr.: The management of mild and moderate head injuries. *Neurosurg Clin N Am* 1991; 2:437-55.
6. Stiell IG, Wells GA, Vandemheen K, et al: The Canadian CT Head Rule for patients with minor head injury. *Lancet* 2001; 357:1391-6.
7. Quality Standards Subcommittee: Practice parameter: The management of concussion in sports (summary statement). *Neurology* 1997; 48:581-5.

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