

Mild traumatic brain injury

Part 2: Concussion management

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Revisiting our case

An 18-year-old man was brought to the emergency department (ED) by ambulance on a Thursday evening. While playing hockey he was checked against the boards. He fell to the ice and did not get up on his own. Medical personnel rushed to his aid and found him breathing easily but completely unresponsive. His vital signs were normal. His cervical spine was immobilized and he was put on a backboard. En route to the hospital he began to regain consciousness.

On examination his airway and breathing were normal. Measurement of his vital signs revealed the following: heart rate of 90 beats/min, blood pressure of 120/80 mm Hg, oxygen saturation of 98% on room air, and a temperature of 36.8°C. On initial neurologic examination, the patient's Glasgow Coma Scale score was 13, because he was confused about the date and where he was, and he opened his eyes only on command. He was fully exposed but kept warm. A secondary physical survey revealed no injuries, including no obvious head injuries. An examination of his helmet revealed a crack in the back of it.

When the patient's parents arrived they immediately rushed to his side. His mother, a lawyer, urgently asked, "Doctor, aren't you going to scan him? He could have an intracranial bleed!"

His father, a hockey coach, interrupted, "Doctor, when can he get back on the ice? He's got a big game tomorrow!"

Since 2000, tremendous progress has been made in defining *mild traumatic brain injury* (MTBI) and determining which patients require brain imaging. Several rules are now available to guide us in this effort to not miss any important intracranial lesions while not wasting time and money, and avoiding patients' exposure to unnecessary radiation. These guidelines were addressed in part 1 of this article, published in the April 2010 issue of *Canadian Family Physician*.¹

But what of the father's question? When can his son return to hockey? This question introduces the topic of concussion. A *concussion* is defined as a head trauma resulting in short-lived impairment of neurologic function, that is, an MTBI.² Concussion might or might not involve a loss of consciousness (LOC), although usually

it does not.³ The only difference between the definitions of *concussion* and *MTBI* is that in the case of *concussion* no abnormality is seen with standard neuroimaging, whereas *MTBI* is defined only by clinical presentation and includes cases found to have intracranial lesions.⁴ Therefore, *concussion* and *MTBI* are indistinguishable on clinical presentation. *Concussion* is the term most commonly used when the injury is sports-related.

DeMatteo et al recently highlighted the importance of terminology. In a study of children with traumatic brain injury, it was demonstrated that labeling an injury a *concussion* strongly predicted earlier discharge from hospital and earlier return to school, independent of Glasgow Coma Scale and the presence of other associated injuries. The investigators concluded that clinicians treated *MTBI* and *concussion* as 2 separate diagnostic categories, when in fact they both reflect mild brain injury. The investigators further questioned whether the *concussion* label is potentially falsely reassuring to parents, who might understand it to mean lack of serious head or brain injury.⁵

In the recent past there have been many guidelines on concussion classification and management, including the Colorado Guidelines⁶ and those by Cantu,⁷ Roberts,⁸ and the American Academy of Neurology.⁹ These guidelines, which were based primarily on expert clinical opinion, classified *concussion* based on presence and duration of LOC and duration of symptoms. What the guidelines agreed upon was that repeated concussions, especially of greater severity, mandated longer absence from game play.

More recently, there have been 3 important international symposia on concussion in sport for diagnosis and management guidelines. The most recent symposium was held in Zurich in November 2008. The guidelines from this symposium were published in early 2009.¹⁰ While there is currently no agreed-upon classification system for *concussion* based on LOC and symptom duration (brief LOC is not predictive of *concussion* severity),^{11,12} the Zurich consensus statement provides definitions and management guidelines and is currently considered to be the standard of care in *concussion* management.

Concussion is extremely common. More than 350 000 athletes suffer *concussion* in North America yearly. Many athletes do not realize they have had one, and many deny their symptoms to avoid missing playing time.^{13,14} Sports most commonly implicated in *concussion* are hockey, football, soccer, and lacrosse.



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It has become more apparent over the years just how serious concussion can be. One concussion is a risk factor for another, and athletes show neurologic dysfunction after concussion.¹⁵ A very rare but deadly outcome of a repeat concussion when a patient has not recovered from the first one is the *second impact syndrome*, wherein loss of arteriolar autoregulation in the brain leads to edema. This condition is usually fatal.¹⁶

Management

After dealing with injuries that require acute management (the ABC's), the cornerstone of concussion management is rest. The Zurich guidelines recommend that a concussed player be removed from the contest and not return to play that same day* (**Box 1**).¹⁰

Box 1. Concussion management guidelines from the Third International Conference on Concussion in Sport, held in Zurich, November 2008

A concussed player should ...

- be removed from contest following any signs or symptoms of concussion
- not return to play in current game
- have a medical evaluation following injury ...
 - to rule out more serious intracranial pathology
 - that includes neuropsychological testing in postinjury assessment

Once the player resumes exercise, he or she should begin the following stepwise return to play:

- no activity; rest until asymptomatic
- light aerobic exercise
- sport-specific training
- non-contact drills
- full-contact drills
- game play

Data from McCrory et al.¹⁰

Rest after concussion means both physical and cognitive rest until all symptoms resolve. Players should not exert themselves until they have been asymptomatic for at least 24 to 48 hours. Some authors believe players should not exert themselves until they are asymptomatic for the same amount of time it took to become asymptomatic. Once players resume exercise, they should begin a stepwise return to play, with 24 hours between steps, from light aerobic exercise to sport-specific training to non-contact drills to full-contact drills to game play (**Box 1**).¹⁰ Any recurrence of concussive symptoms should lead to the athlete dropping back to the previous level.

*Same-day return to play is rarely permissible and only occurs in cases involving adult athletes who have access to experienced team physicians and neurocognitive assessment.

Evidence supports neuropsychological testing as a tool for assessing the severity of concussion.¹⁷ Several standardized neuropsychological tests exist to assess the concussion victim at baseline and later to assess recovery. One of the most commonly used tests is the updated Sport Concussion Assessment Tool 2 (see "Further resources" box).

Previous guidelines recommended that the length of time an athlete should stay away from sport depended on grade of concussion and number of previous concussions. Those guidelines agreed that when athletes experienced symptoms of concussion that lasted longer than 15 minutes or sustained concussions associated with posttraumatic amnesia, athletes should not return to play until asymptomatic for at least 1 week.⁶⁻⁹

There is currently no agreed-upon guideline for the management of second, third, or additional concussions in the same athlete. The Zurich guidelines address this issue by stating that medical officers must consider in each case modifiers such as symptoms, signs, sequelae, frequency, timing, recency, age, comorbidities, medications, play style, and type of sport to further define the appropriate management for the athlete (**Table 1**).¹⁰

It is important for these athletes to have appropriate follow-up to determine when they are ready to begin exercise and to help guide them on a progressive return to activity. Another reason to provide education to and follow-up of concussed patients is for the prevention and treatment of postconcussion syndrome. Postconcussion syndrome is a group of signs and symptoms that a person might experience for a substantial duration after concussion. Postconcussion syndrome might involve psychological, behavioural, physical, and higher-mental-function symptoms and signs. It can be serious and even debilitating, and it affects a substantial number of victims of concussion and MTBI (up to 80% of mild head injuries).¹⁸ Review studies have shown that providing educational information about postconcussive symptoms reduces long-term complaints,¹⁹ and that psychological treatment reduces long-term problems.²⁰

In the case of our athlete, given the apparent severity of the injury, he should certainly have no exertion until completely asymptomatic and then a slow graded return. Most authorities would likely recommend at least a week of rest after an event like this. And if he has experienced other concussions this season, the time away from the sport should be even longer. Hence he would have to miss the game the following day.

Awareness

Given the prevalence and substantial morbidity of head injury, prevention must be emphasized. There are several non-profit organizations dedicated to the prevention of brain and spinal cord injuries. In Canada, ThinkFirst has been heightening public awareness of concussion since 1992. In the United States, the

Table 1. Modifying factors in concussion management from the Third International Conference on Concussion in Sport, held in Zurich, November 2008


FACTORS	MODIFIERS
Symptoms	Number Duration (> 10 d) Severity
Signs	Prolonged LOC (> 1 min)
Sequelae	Postconcussive convulsions
Temporal	Frequency (ie, repeated concussions over time) Timing (ie, injuries close together in time) Recency (ie, recent concussion or traumatic brain injury)
Threshold	Repeated concussions occurring with progressively less impact force or slower recovery after each successive concussion
Age	Child and adolescent (< 18 y)
Comorbidities and premorbidities	Migraine Depression or other mental health disorders ADHD Learning disabilities Sleep disorders
Medication	Psychoactive drugs Anticoagulants
Behaviour	Dangerous style of play
Sport	High-risk activity Contact-and-collision sport High sporting level

ADHD—attention deficit hyperactivity disorder, LOC—loss of consciousness.

Adapted from McCrory et al.¹⁰

Centres for Disease Control and Prevention developed the Heads Up initiative to educate the public about the prevention, recognition, and response to concussion in young athletes.

Conclusion

Since 2000, more and more evidence has indicated how serious concussive injuries can be. The guidelines from the Third International Conference on Concussion in Sport, held in Zurich in 2008, provide us with a useful tool for defining how to manage concussed athletes. Key points from these guidelines include removal of a concussed athlete for the duration of the game, complete rest until the athlete is entirely asymptomatic, and a stepwise return to play. An individualized approach with consideration of important modifiers is recommended. Education is key to preventing concussion and limiting its long-term effects. Ensuring follow-up of concussed athletes optimizes outcomes. 

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BOTTOM LINE

- Concussion is a common and underreported mild traumatic brain injury, which can lead to serious long-term neuropsychological sequelae.
- The cornerstone of management is rest until patients are completely asymptomatic, taking into account individual modifying factors, followed by stepwise return to play.
- Neuropsychological testing is useful in assessing severity and recovery.
- Prevention begins with education, and appropriate follow-up optimizes outcomes.

POINTS SAILLANTS

- La commotion est une lésion cérébrale légère fréquente, mais peu souvent déclarée, d'origine traumatique, qui peut entraîner des séquelles neuropsychologiques graves à long terme.
- La pierre angulaire de la prise en charge est le repos jusqu'à ce que le patient soit complètement asymptomatique, en tenant compte des facteurs modificateurs individuels, suivi par un retour au jeu progressif.
- Les tests neuropsychologiques sont utiles pour évaluer la gravité et le rétablissement.
- La prévention commence par l'éducation, et un suivi approprié optimise les résultats.

Competing interests

None declared

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Further resources

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