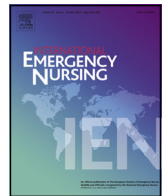




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## CASE STUDY

## Concussion management in the ED: Beyond GCS

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## 1. Introduction

Sports related concussions are a frequent presentation to the Emergency Department (ED) (Buchanan et al., 2011), and can be effectively managed by nurse practitioners (Jamault and Duff, 2013). Concussion and its sequelae are a significant cause of morbidity for patients, and may result in a premature end to sporting participation. The growing concern regarding concussion in sport has resulted in the publication of 5 major position and consensus statements from relevant groups since 2000 (Alla et al., 2011). Concussion, which is a subset of mild traumatic brain injury (mTBI) (McCroory et al., 2013), can be challenging to recognise, assess and manage in the ED setting.

While head injuries and concussion in field sports are generally associated with lower velocity than those in motor sports (Putukian and Madden, 2010), concussion has become an increasingly serious concern for all sporting activities worldwide (King et al., 2014). Among the many reasons for the increasing awareness and concern regarding concussion is the rapidly shifting evidence base, with research emerging suggesting a multifactorial neurometabolic cascade of physiologic changes (Giza and Hovda, 2001), which is challenging the purely "functional model" of concussion. Furthermore, there is evidence of an association between repetitive concussive/sub-concussive injury and lingering cognitive and behavioural dysfunction (Rossetti et al., 2015), as well as a possi-

ble link between concussion and neurodegenerative processes (Rowson et al., 2012). Although rare, the potentially catastrophic outcome from second impact syndrome has also heightened awareness of concussion in sports. In addition, several high profile legal cases have served to highlight the importance of appropriate recognition and management of concussion.

## 2. Initial case presentation

A 17 year old patient presented to the ED accompanied by his father. He reported that he had sustained an injury during a tackle playing rugby that afternoon, which he described as having his "bell rung." He denied any loss of consciousness (LOC) but admitted to being dizzy and nauseated after the injury, and had remained on the field of play for approximately 5–10 minutes following the event when he was removed by the referee due to his father's insistence. He reported that his symptoms of dizziness and nausea remained but had decreased in severity between the injury and presentation to the ED, and he had a residual headache. His father reported that his son had appeared unsteady on his feet following the injury, and "not quite with it" although the patient did not think that this was the case.

His previous medical history was limited to sports induced bronchospasm, for which he was prescribed salbutamol. He had no known previous head injury or concussion, was not taking any other regular medications and had no known drug allergies.

Systems review outruled neck, abdominal, spinal and other distracting injuries. His oxygen saturation was 98% on room air, heart rate was 70BPM and BP was 114/62 mmHg. The patient's Glasgow

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**Box 1.** ICS supplements to concussion definition.

1. Concussion can be caused by direct impacts to the head, face, neck, or elsewhere on the body with an impulsive force transmitted towards the head.
2. Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously.
3. Concussion may result in neuropathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury.
4. Concussion results in a graded set of clinical symptoms that may or may not involve loss of consciousness.
5. Concussion is typically associated with grossly normal structural neuroimaging studies.

Coma Scale (GCS) was 15/15 indicating that he was alert and orientated at the time of his initial presentation to the ED. He denied any retrograde or anterograde amnesia although questioning revealed that he had only a vague recollection of sustaining an injury.

### 3. Concussion definition

There is a lack of clarity and consistency regarding a definition of concussion (Rossetti et al., 2015). For the purposes of this paper, the definition offered by the International Symposia on Concussion in Sport (Zurich Conference 2013) shall be adopted. The Zurich group propose that *concussion is a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces*. Five common features were identified by the Zurich group to supplement the definition and these are outlined in Box 1.

### 4. Concussion epidemiology

It is estimated that there are 1.6 to 3.0 million sports-related concussions among high school students annually in the U.S. (Centres for Disease Control and Prevention, 2006), while in South Africa, the seasonal concussion incidence ranges from 4% to 14% in school age rugby players (Shuttleworth-Edwards et al., 2008). A US study also found there has been a 60% increase in ED visits for sports and recreation related traumatic brain injuries by children and adolescents in the past decade (Gilchrist et al., 2011). It is generally accepted that many head injuries go undetected and are often underreported (Heegaard and Biros, 2013; Meehan et al., 2013). This underreporting may be due to injuries being viewed as part of the game, participants being concerned about being removed from play, athletes not recognising their symptoms as a significant injury (Karlin, 2011) and/or medical professionals not recognizing the symptoms of concussion (Lovell et al., 2004). A recent study of high-school American football players by McGuine et al. (2014) demonstrated that 9% of subjects sustained a sports related concussion, and 2.4% sustained two concussions within one season. The incidence of sports concussion in Ireland is unknown.

### 5. Mechanism of injury

In a 10 year prospective study by Delaney et al. (2014) the most common area to be struck resulting in concussion in athletes participating in college football, ice-hockey and soccer was the side/temporal area of the head. While the long-term effects of 'heading' the ball in soccer is yet to be elucidated, many concussions result from player to player contact when challenging for the ball with their heads (Maher et al., 2014). Elsewhere a 3-fold increase in concussion rates was observed in ice-hockey players playing in a league where body checking was allowed when compared with players playing in a league where body checking was not permitted (Emery et al., 2010).

The mechanism may be from either direct or indirect forces. The concussion may be caused by acceleration/deceleration forces

(e.g. a player falling and striking his head off the ground), rotational (e.g. may occur in body checking), or impact forces (e.g. player to player contact when 'heading a ball' in soccer).

### 6. Clinical assessment

The initial clinical assessment of a patient with a suspected concussion should involve a thorough history of the athlete's injury to include, but not limited to presenting chief complaint, events surrounding the present injury, specific mechanism of injury, past history including previous concussions/head injuries, family history, personal and social history and systems review (Bickley et al., 2012; Bradley 2014).

A detailed inspection and palpation of the face, head (including the neck, cervical vertebrae and musculature) and neurological screening are central to the assessment of patients presenting with concussion (France, 2011). Neurological screening involves sensory and motor testing of the cranial and peripheral nerves, brainstem reflexes and assessment of the patients pupils (Lacono and Lyons, 2005). The examiner should maintain a high index of suspicion for clinical signs of a basilar skull fracture (which, while not always related to severe brain injury, indicates that a significant impact force was sustained during head trauma) and signs of emergent intracranial bleed (Heegaard and Biros, 2013).

There is, however, an increasing recognition that standardised neurological assessment including postural testing is required in the ED in addition to the more traditional assessment of patients presenting with mTBI (Hartwell et al., 2015; Hunt and Asplund, 2010). Additionally, it has been stated that the GCS is not sensitive enough to be of prognostic usefulness in mTBI, and a score of 15/15 in the ED does not take into account the neurologic status immediately after trauma, or the presence or absence of focal neurologic injury (Heegaard and Biros, 2013). Standardised tools such as the Sports Concussion Assessment Tool, version 3 (SCAT3) (accessible at: <http://bjsm.bmj.com/content/47/5/259.full.pdf>) are in addition to the physical evaluation and provide a comprehensive test battery for individualised concussion assessment and assist in eliciting further information specific to concussion.

### 7. Back to the case: relevant clinical assessment findings

The systematic approach of look, feel, move and special tests was used to frame this patient's assessment (Purcell, 2010). The patient was assisted by his father while transitioning from the triage area to the ambulatory care area, but could walk with a normal gait unaided when prompted to do so. No wounds, bruising, erythema or areas of soft tissue swelling were noted. Observing his eyes out-ruled catastrophic globe injury, hyphema, or conjunctival injection. Pupils were equal and reactive to light and accommodation. No haemotympanum, post auricular bruising or otorrhoea were found while looking at this patient's ears. No septal deviation, septal haematoma, epistaxis or rhinorrhoea were observed while examining his nose.

During the feel (palpation) portion of the assessment, the patient was found to have mild tenderness over the right parietal area. He did not have tenderness elicited in his cervical spine, paraspinal musculature or facial bones. No defects were found when the cranial nerves were independently tested, and a swinging light test was used to out-rule a relative afferent pupillary defect. Sensory testing of the cranial and peripheral nerves was unremarkable.

Motor testing revealed no deficits in strength or function in any of the cranial or peripheral nerves. Once the examiner out-ruled 'red-flags' indicative of suspected intracranial bleed, the SCAT3 was used as an adjunctive screening tool in this patient's clinical evaluation. The standardised proforma was used, and the patient was found to have 7 out of a possible 22 symptoms and scored a total of 14 out of a possible maximum of 132 for total severity of symptoms. Full normal pain-free range of cervical movement was preserved. He demonstrated a number of incorrect responses with his immediate and delayed memory recall and had a number of errors with balance testing. It was noted that his balance was found to be affected, even though the patient did not rate balance problems in his self-rated symptom evaluation. His upper limb co-ordination test was unremarkable.

## 8. Imaging

Both the NICE criteria (NICE 2014) and the Canadian CT Rule (Stiell et al., 2001) were applied during the assessment, and this patient did not reach the threshold for CT brain. Diagnostic imaging is generally of limited utility in concussion assessment not only as it rarely affects clinical management and exposes the patient to ionizing radiation (Armstrong et al., 2012), but also due to the functional rather than the structural nature of the diagnosis. Newer neuroimaging techniques however such as diffusion tensor imaging are showing promise in predicting outcome in concussion (Yuh et al., 2014); however, these advanced techniques are more likely to be only readily available in research settings rather than in clinical practice.

## 9. Discharge and follow-up

The patient was discharged from the ED following assessment by the registered advanced nurse practitioner (RANP). He went home accompanied by his father. Both were provided with detailed verbal and written guidance with a plan for cognitive and physical rest over the following week. They were provided with a list of red-flag symptoms, which would require him to return to the ED. Cognitive rest includes limiting screen time (e.g. television, computer screens and games), and also not attending school or completing homework. Additionally they were informed regarding possible emotional and physical responses such as low mood, headache and tiredness which may result following concussive events (Aquino, 2015).

As there is currently a paucity of specialised concussion clinics in Ireland to which patients can be referred to, the patient was reviewed at the consultant led review clinic the morning subsequent to the initial presentation. The review clinic is a multi-disciplinary group providing senior clinician review for patients whom the emergency medicine doctors and RANPs feel require such follow up but who do not meet the requirement for referral to a tertiary clinic (e.g. fracture clinic). In the patient's subjective opinion, most of his symptoms had settled. His SCAT3 was repeated (without Maddocks questions which are not used in serial testing), and his scores had improved from his initial presentation (see Table 1 labelled SCAT3 scores). A letter was sent to his General Practitioner (GP) following this appointment outlining the patient's presentation and progress.

At review on day seven, the patient was again reviewed at the consultant led review clinic collaboratively by the RANP and consultant in emergency medicine. He reported that his symptoms had

**Table 1**  
Scoring summary SCAT3.

Scoring summary:			
Test domain	Score		
	Date: May 03rd	Date: May 04th	Date: May 10th
Number of symptoms of 22	6	4	0
Symptom severity score of 132	12	7	0
Orientation of 5	5	5	5
Immediate memory of 15	13	14	14
Concentration of 5	4	5	5
Delayed recall of 5	2	3	4
SAC Total	24	27	28
BESS (total errors)	4	4	1
Tandem Gait (seconds)	19	14	12
Co-ordination of 1	1	1	1

completely resolved. He had completed a full day of school at his normal academic level without a return of symptoms. A repeat full neurological exam was normal, and his SCAT3 scores were again improved.

## 10. Return to play

Most athletes ask about return to play (RTP) following injury. Patients must be advised that cognitive rest is one of the pillars of concussion management (McCrorey et al., 2013) and that the cognitive stress associated with sports participation must be recognized in RTP decisions (Shrier, 2015). Modifying factors such as previous concussion, level of risk in the individual sport, age of the athlete and medications will also influence return to play. The 'school first' strategy, where children/adolescents return to normal academic levels without symptoms before returning to sports participation is a worthwhile strategy (Sady et al., 2011).

The RTP ideally should be a stepwise process which transitions the patient from a period of no activity to a period of limited activity with supervision and ultimately a full return to activity as the patient progresses through each stage asymptotically. If there is symptom exacerbation at any stage, the patient must return to the previous step. Ideally, this process should be managed by a health care professional with expertise in concussion evaluation and management.

The patient was discharged from the ED following review on day seven, with advice to complete the return to play protocol with his GP. A discharge summary to his GP included the Irish Rugby Football Union (Irish Rugby 2015) guidance that 16-19 year olds do not return to play until at least day 23 post-concussion.

## 11. Learning points

- Concussive events may result in functional deficits, but generally do not involve structural injury to the brain.
- Loss of consciousness is not a prerequisite to diagnose concussion
- While imaging may be warranted to exclude a structural brain injury there are currently no positive imaging findings suggestive of a diagnosis of concussion.
- The clinical nature of the diagnosis and the inability for imaging to assist in the diagnosis results in the need for adjunct measures of assessment to evaluate for the aforementioned deficits in cognition and balance.
- Concussion assessment tools (such as SCAT3) are adjunctive to clinical assessment and judgment and do not replace it. Versions of the tool are available for children from 5 to 12 years (<http://bjsm.bmj.com/content/47/5/263.full.pdf>) and also a pocket concussion recognition tool™ (<http://bjsm.bmj.com/content/47/5/>)

**Box 2.** Website resources for concussion management and prevention.

- UK Sport and Recreation Alliance: Guidelines on Concussion Management <http://www.sportandrecreation.org.uk/concussion-guidelines>
- United States Centre for Disease Control and Prevention (“Heads-up” Concussion Awareness/ Prevention Programme) <http://www.cdc.gov/headsup>
- The American Academy of Neurology <http://www.aan.com/concussion>
- Sports Concussion South Africa <http://www.sportsconcussion.co.za>
- Sports Medicine Australia <http://www.sma.org.au/resources-advice/concussion>
- Concussion in Sport Project (Australia) [http://www.concussioninsportproject.com.au/concussioninsportproject.com.au/The\\_Project.html](http://www.concussioninsportproject.com.au/concussioninsportproject.com.au/The_Project.html)
- KingDevick test for Concussion <http://kingdevicktest.com/for-concussions/>
- Parachute Canada (provides a range of concussion awareness and prevention resources) <http://www.parachutecanada.org/injury-topics/C9>
- Scottish Sports Association/Scottish Government Concussion guidance for grassroots sport across all codes: <http://www.sportscotland.org.uk/resources/resources/scottish-sports-concussion-guidance/>

267.full.pdf) which is designed to help parents and coaches identify concussion in sports participants.

- Optimal management of the concussed athlete back to full sports participation requires a multi-disciplinary approach, with effective communication across the secondary–primary care interface. Guidelines and recommendations regarding return to play vary across sporting organisations and level of participation. Clinicians should only offer advice where they are satisfied they are current with the position stand of the particular sporting code, and refer the patient for specific guidance where appropriate.
- A number of website resources which may be helpful to emergency nurses are outlined in Box 2.

## 12. Conclusion

Although it must be recognised that every impact in contact sports does not result in a concussion or head injury, these remain significant and important injuries for the RANP to evaluate and manage. Challenges in concussion diagnosis and management include variable symptoms, the absence of a singular diagnostic test and the evolving nature of the condition. The landscape has been made somewhat clearer by the Concussion in Sport Group and the development of the SCAT tools. The challenges in the diagnosis and management in this case were also somewhat mitigated by the collaborative approach employed between the RANP and EM consultant. Collaboration is recognised as a cornerstone of effective teamwork, and has been recognised as being essential to the delivery of high-quality patient care (D'Amour et al., 2005). It would have benefited this case had the patient had a baseline SCAT3 prior to injury, as this would have been useful in objectively assessing the patient's full recovery. While the SCAT3 is only one part of a complete neurological examination which includes cranial nerve testing, motor and sensory function and assessment of the patient's pupils, it is nonetheless a valuable addition to the RANP's armamentarium in the assessment and management of concussion.

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