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Were you knocked out? a team physician's approach to initial concussion management

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Abstract

To present an evidence-based approach reviewing the acute management of concussive brain injury in sport. All published articles on the acute management of sport-related brain injury were extracted using searches of computerised databases (Medline, Embase, Sport Discus) as well as detailed literature reviews based upon the published bibliographies in this area. The review details the aspects where prospective scientific data is available upon which to base clinical management strategies. The first few minutes after an athlete receives a concussive injury provides a window of opportunity during which time the initial medical management forms a crucial and potentially lifesaving treatment. All clinicians involved in care of the concussed athlete need to have an understanding of the early management of the concussed athlete and a strategy by which they may manage such problems. An efficient and appropriate response to the immediate concussion management will help minimise the potential sequelae which may impact upon the athletes ability to return to sport.

In sport, clinicians recognize and manage a spectrum of brain injury ranging from mild concussion through fatal penetrating brain trauma. Sports medicine physicians, trainers, and others involved in athletic care need to have a thorough understanding of the early management of the

concussed athlete and the potential sequelae of such injuries that may impact on the athlete's ability to return to sports.

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DEFINITION OF CONCUSSION

The primary difficulty that limits research and clarification of this area is the lack of universal agreement on a standard definition of concussion. The definition of concussion proposed by the Committee on Head Injury Nomenclature of the Congress of Neurological Surgeons in 1966 has gained a measure of acceptance among researchers in this field since that time and will be utilized in this paper (9).

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INJURY SEVERITY

The classification of severity of concussive injury remains another contentious area. At the present time, there are at least 16 different published injury-grading systems. Most of these are impractical for clinical use. All of the classification systems, with the exception of the Glasgow Coma Scale (GCS), are based on anecdotal experience and have not been prospectively validated in sports-related head injuries(5,6,11,17-19,21,29,33-36,40,45,49,50,53).

Despite this concern, considerable experience has been gained in using the Cantu classification system. The majority of sports medicine clinicians are familiar with this scale (5,41). This simple and easy-to-use grading scale utilizes the duration of loss of consciousness (LOC) and posttraumatic amnesia (PTA) to differentiate mild, moderate, and severe concussive injury. The other scale in common use are the Colorado guidelines(49) (Table 1).

Apart from the lack of scientific validation, there are a number of practical difficulties with both of these scales. Loss of consciousness may be difficult to detect if it is momentary. By the time a trainer or physician reaches a

concussed player on the field he may be only dazed, and it may be impossible to be certain if LOC has occurred. Does this matter? From an athlete's and coach's standpoint, it may result in being included in a more severe category, which may in turn have implications regarding return to play. An example of the inconsistencies among scales is that a momentary LOC, with an asymptomatic recovery, would be considered a Cantu grade 2 (moderate) injury and the athlete would miss 1 wk of play, whereas under the Colorado guidelines, this same injury would be seen as a grade 3 (severe) injury and the player concerned would miss 1 month. Clinical experience of team physicians worldwide demonstrates that this latter advice is overly conservative and is unlikely to be followed (41). Physicians, coaches, and athletes can easily "shop around" for an injury scale and return-to-play advice that suits their sporting needs but which may not be the best medical management for their injury problem.

There is also considerable neuropsychological evidence that the cognitive impairment is the same in a concussive injury regardless of whether the individual has lost consciousness or not (23,44). The strategy of basing return to play decisions on the presence of LOC is therefore not scientifically sound. Furthermore, posttraumatic amnesia, although a relatively simple concept, can only be precisely determined in retrospect and thus is of limited practical use in the on-field situation. The limited data in this area demonstrate that while PTA is an important prognostic measure in *severe* brain injury, this has not been demonstrated for mild brain injury(14,24,42,43).

One of the difficulties of virtually every grading scale is the problem of trying to be "all-inclusive." Whereas the practical need in the majority of concussions is for a scale which is biased toward distinguishing the marginal injury from the mild to moderate injury, most of the scales are biased toward the higher severity injuries which in some cases include coma and death (35,36,50). No perfect scale exists which satisfies the needs of the clinician to be simple, valid, and practical. What all of these scales should emphasize is that their real value lies in the serial measurement of clinical symptoms. A change in conscious state or neurological function is a far more important sign than the presence or absence of an individual symptom in the development of cerebral pathology. The model of the GCS

for the assessment of severe brain injury demonstrates this concept brilliantly (18). Unfortunately the current sport-based scales do not emphasize this approach.

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Initial Injury Recognition and Management

The practical management of concussion can be divided into three broad areas where the issues and treatment priorities differ considerably. These areas are immediate, early, and late management.

Immediate management. This occurs when the clinician is in attendance at a sporting event and is called on to manage the acute brain injury. The major priorities at this early stage are the basic principles of first aid. The simple mnemonic DR ABC may be a useful memory aid(Fig. 1).

Once these basic aspects of care have been achieved and the patient stabilized, then consideration of removal of the patient from the field to an appropriate facility is necessary. At this time, careful assessment for the presence of a cervical spine or other injury is necessary. If an alert patient complains of neck pain, has evidence of neck tenderness or deformity, or has neurological signs suggestive of a spinal injury, then neck bracing and transport on a suitable spinal frame are required. If the patient is unconscious, then a cervical injury should be assumed until proven otherwise. Airway protection takes precedence over any potential spinal injury. In this situation, the removal of helmets or other head protectors should only be performed by individuals trained in this aspect of trauma management(37).

The clinical management may involve the treatment of a disorientated, confused, unconscious, uncooperative, or convulsing patient. The immediate treatment priorities remain the basic first-aid principles of"ABC-airway, breathing, and circulation." Once this has been established and the patient stabilized, a full medical and neurological assessment examination should follow. On-site physicians are in an ideal position to initiate the

critical early steps in an athlete's care to ensure optimal recovery from a head injury.

Early management. This takes place when an athlete has been brought to the medical room for assessment or alternatively to an emergency department or medical facility post-injury. Assessment of injury severity is best performed in a quiet medical room rather than in the middle of a football field in front of 100,000 screaming fans. Figure 2

When assessing the acutely concussed player, various aspects of the history and examination are important. The common symptoms of concussion have been examined in prospective studies and include headache, dizziness, blurred vision, and nausea (2,28). It is worth noting that the presence of headache is not confined to concussion with up to 20% of sporting athletes reporting exercise-related headache(30). Given that much emphasis has been placed on headache as an important symptom of concussion, medical assessment needs to be accurate in ascertaining the nature and cause of the player's symptoms.

When examining a concussed athlete, a full neurological examination is important. Because the major management priorities at this stage are to establish an accurate diagnosis and exclude a catastrophic intracranial injury, this part of the examination should be particularly thorough.

In recent times the application of simple neuropsychological tests have created considerable interest as a means to objectively assess concussed athletes. The standard approach of asking the orientation items (e.g., day, date, year, time, date of birth, etc.) has been shown to be unreliable following concussive injury. This aspect of memory remains relatively intact in the face of concussive injury and should not be used(28). More useful, as demonstrated in prospective studies, are questions of recent memory. These have been shown to be more sensitive in discriminating between concussed and nonconcussed individuals(28,54,55). A typical question battery is presented in Figure 3.

Some clinicians utilize other tests of new learning or immediate and recent memory function, such as three-item recall or digit span, in order to determine whether PTA has resolved (47).

Having determined the presence of a concussive injury, the patient needs to be serially monitored until full recovery ensues. Assessment of return to play and the role of neuropsychological testing will be considered in the next section. If the concussed player is discharged home after recovery, then he should be in the care of a responsible adult. It is the author's policy to give the patient and his attendant a head injury advice card upon discharge.

The use of computerized tomography or magnetic resonance scanning to ascertain the presence or absence of cerebral pathology is necessary in certain situations. The availability of the various imaging techniques may influence imaging strategies. It is the author's practice not to routinely scan patients with uncomplicated mild (Cantu grade 1 or Colorado grades 1 and 2) concussion.

The treating clinician must also face the decision of who should be referred on to a hospital emergency facility or neurosurgical center. There are a number of urgent indications which are listed in Table 2 below. Apart from these "cookbook" type approaches, referral to such a center depends on the experience, ability, and competency of the physician at hand. If the team physician happens to be a neurologist, neurosurgeon, or team physician experienced in concussion management, then the clinical referral pathways will be different than those of an orthopedic surgeon called to assist at a football match after an injury has occurred. The overall approach should be "when in doubt, refer."

Late management. This occurs when a player has sustained a concussive injury previously and is now presenting for advice or clearance prior to resuming sport. The main management priorities at this stage are the assessment of recovery and the application of the appropriate return-to-sport guidelines.

Criteria for return to sport following a concussion remain the most contentious area of debate (6,7,40,41). Although the traditional approach is to advocate a mandatory arbitrary exclusion period from sport, the use of neuropsychological testing in conjunction with clinical assessment opens the door to the possibility of objective and scientifically valid testing of patient recovery.

The concept of a mandatory exclusion policy following concussion is not based on sporting injuries, but on data derived from motor vehicle accident studies (12,14,15). The few prospective sport-related studies suggest that recovery occurs within hours to days rather than the 2 seconds to 3-wk period after motor vehicle-related brain injury(1,2,25,27). The recent development of return-to-play strategies based on severity scales is entirely arbitrary and should be taken as loose guidelines rather than scientific fact(5,19).

There are a number of inherent dangers in a universal mandatory exclusion approach. This idea may tempt players, trainers, and coaches to believe that medical assessment is not required after a head injury and may lead to the assumption that a concussed player is medically safe to return to play as soon as an arbitrary time period has passed. A conservative approach in management should be emphasized ensuring that all cases of head injury are examined by a medical practitioner prior to consideration of resumption of a sport.

The guiding policy should be that until *completely* symptom-free, concussed athletes should not resume any training or competition. All athletes sustaining a concussion require a medical clearance, which may include neuropsychological testing, before resumption of their sport. Once the acute concussive symptoms resolve, a graduated plan of return to low level aerobic training, followed by noncontact drills and finally contact play, will allow close monitoring of the development of any adverse symptoms. Persisting or newly developing symptoms necessitate further follow-up and detailed medical evaluation.

There is published evidence that the postconcussion recovery rates vary between individuals. Some patients may take days, whereas others may take weeks to recover fully from a concussive injury(2,16,25). The demands and inherent risks of a given sport, as well as differences in individual recovery rates, must be taken into account when the medical decision of returning to play is determined.

Recent prospective Australian studies in sport-related concussion have led to the development of simple valid neuropsychological (NP) tests to determine whether a player has returned to a baseline level of cognitive

function after a concussive injury. Based on a study of many different NP tests, a standard test battery was developed which includes the digit symbol substitution task from the WAIS-R (52), Paced Auditory Serial Addition Task(13), Trail Making Task B (39), and measurement of reaction times (51) and provides a balance between ease of use and discriminant ability. The total administration time is approximately 7 min (25-28). These postinjury tests were compared to the individual's preseason baseline test results in order to ascertain cognitive recovery. With experience a large normative database has been developed, specific to Australian football, which enables postinjury testing in the absence of baseline information.

The most important conceptual point is the understanding that these tests are not designed to be used as a diagnostic test for concussion in the acute situation. In practice, the test battery is performed once all postconcussive symptoms have resolved, as a means of objectively measuring return to baseline level of function. These tests have been routinely used to monitor recovery in elite Australian football since 1985, and to date there have been no adverse outcomes following this clinical paradigm. Although these are not yet in widespread use, they may provide a simple aid for medical practitioners to objectively measure recovery from concussion.

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Specific Postconcussion Risks

Second impact syndrome. Diffuse cerebral swelling (DCS) is a rare but well-recognized complication of mild traumatic brain injury in sports that occurs predominantly in children and teenagers(3,4,38). It has been postulated that a form of diffuse swelling may be the consequence of a repeated minor head injury. Specifically, the so-called “second impact syndrome” (SIS) has been defined as occurring when “an athlete who has sustained an initial head injury, most often a concussion, sustains a second head injury before symptoms associated with the first have fully cleared”(7). This second impact, however trivial, sets in train the rapid development of cerebral swelling which usually results in brainstem herniation and death (7,8). Its cause is unknown but is thought to involve disordered cerebral vascular autoregulation(3,20,48).

The concept of SIS rests on the interpretation of anecdotal reports. No case-control studies have been done to identify risk factors for either SIS or sport-related DCS. In those cases with a history of prior head injury, the evidence that SIS is a risk factor for this pathophysiological entity is not compelling mainly due to the paucity of medical details presented.

Many of the published case reports (32,46) and most notably the guidelines of the Colorado Medical Society(19,49) suggest that prevention of this syndrome should be based upon a policy of not allowing individuals to return to a sport until postconcussive symptoms have resolved. The reason for these practices relates to the belief that "individuals who are symptomatic from a concussion, even without LOC, are at risk for developing diffuse brain swelling after a second impact to the head" and that the risk of complications such as SIS or DCS is lessened with time(19,49).

Would this practice reduce the risk of SIS or DCS? The risk factors for this condition are not understood at present, and the rationale for such an approach remains unproven.

Concussive or impact convulsions. Concussive convulsions in collision sports are an uncommon but dramatic symptom associated with minor head injury. A recent study has delineated the phenomenology and nature of these convulsions (31). These concussive convulsions occur within 2 seconds of impact and are not associated with structural brain injury.

It is speculated that the concussive impact itself creates a transient functional decerebration akin to the corticomedullary dissociation seen in convulsive syncope (10,22). In the players suffering concussive convulsions, the universally good outcome and absence of structural injury or long-term neuropsychological damage reflect the benign nature of these episodes. From a clinical standpoint, late seizures do not occur, antiepileptic therapy is not indicated, and prohibition from participation in collision sports is unwarranted. The treating clinician can reassure the patient that concussive convulsions are be-nign, and overall management should center on the appropriate treatment of the concussive injury itself.

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CONCLUSION

The area of concussion management is surrounded by myth and uncertainty. Recent developments in the adoption of certain concussion management guidelines (most notably the Colorado guidelines) by key medical and sporting bodies is premature based on the available scientific data. The need for case-controlled studies is paramount at the present time as the issue of improving standards of athletic care are questioned. The specter of medical litigation raised by this development may stop quality scientific research into concussion management from being conducted in the United States, a situation which few team physicians should accept.

Grade	Cantu Guidelines	Colorado Guidelines
Grade 1 (mild)	No LOC PTA <30 min	Confusion without amnesia No LOC
Grade 2 (moderate)	LOC <5 min PTA >30 min	Confusion with amnesia No LOC
Grade 3 (severe)	LOC >5 min PTA >24 h	LOC

Adapted from Cantu, R. C. Guidelines for return to contact sports after cerebral concussion. *Phys. Sportsmed.* 14:75–83, 1986; Colorado Medical Society. *Report of the Sports Medicine Committee: Guidelines for the Management of Concussions in Sport* (revised). Denver: Colorado Medical Society, 1991.

D	Danger	Ensuring that there are no immediate environmental dangers which may potentially injure the patient or treatment team. This may involve stopping play in a football match or marshalling cars on a motor racetrack.
R	Response	Is the patient conscious? Can he/she talk?
A	Airway	Ensuring a clear and unobstructed airway. Removing any mouthguard or dental device which may be present.
B	Breathing	Ensure the patient is breathing adequately
C	Circulation	Ensure an adequate circulation

History: Time and place of injury

Mechanism of injury (eyewitness or video)

Presence or duration of LOC

Post injury behaviour

Presence of convulsions post-injury

Past medical history

Medication use

Which ground are we at?

Which team are we playing today?

Who is your opponent at present?

Which quarter is it?

How far into the quarter is it?

Which side scored the last goal?

Which team did we play last week?

Did we win last week?

Clin. J. Sports Med. 5:32-35, 1995.

Any player who has or develops the following:
Fractured skull
Penetrating skull trauma
Deterioration in conscious state following injury
Focal neurological signs
Confusion or impairment of consciousness >30 min
Loss of consciousness >5 min
Persistent vomiting or increasing headache postinjury
Any convulsive movements
More than one episode of concussive injury in a match or training session
Any assessment difficulty (e.g., an intoxicated patient)
Head injuries in children
High-risk condition (e.g., hemophilia, anticoagulant use)
Inadequate postinjury supervision
Injury that results from high-risk mechanism (e.g., high-velocity impact, missile injury)

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